SOUTHWEST FISHERIES CENTER

NATIONAL MARINE FISHERIES SERVICE
SOUTHWEST FISHERIES CENTER
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MAY 1983

DIRECTOR'S REPORT
To The
THIRTY-FOURTH TUNA CONFERENCE
On
TUNA AND TUNA-RELATED ACTIVITIES
At The
SOUTHWEST FISHERIES CENTER
LA JOLLA, CALIFORNIA

For The Period
MAY 1, 1982 TO APRIL 30, 1983

ADMINISTRATIVE REPORT LJ-83-06

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INTRODUCTION

Tuna research in the National Marine Fisheries Service (NMFS) is conducted at the NMFS Southwest Fisheries Center's two laboratories in Honolulu, Hawaii, and La Jolla, California, with one exception. Studies on Atlantic billfishes and bluefin tuna are carried out at the NMFS Southeast Fisheries Center in Miami, Florida.

Under the leadership of Richard Shomura, tuna research at the Honolulu Laboratory includes studies on the behavior, energetics, physiology and sensory biology of tropical tunas, South Pacific albacore and other tuna populations of the central and western Pacific, and recreational fisheries research, principally, the sportfishery for billfishes. Research results are important in the development of management plans by the Western Pacific Regional Fishery Management Council, the development of international policy on tuna and billfish management by the U.S. Department of State and Department of Commerce, and for the evaluation of fishing potentials and exploitation strategies by the U.S. tuna industry.

At the La Jolla Laboratory, the staff of the Oceanic Fisheries Resources Division under the leadership of Dr. Gary Sakagawa provides basic fishery analysis and management advice on tunas and billfishes to U.S. Commissioners serving on international fisheries bodies, and conducts studies on the status of dolphin involved in the tuna purse seine fishery of the eastern tropical Pacific. The staff of the Coastal Fisheries Resources Division, led by Dr. Reuben Lasker, also conducts studies on the distribution, availability and migration patterns of North Pacific albacore and associated environmental influences in the eastern North Pacific. Results of these studies are a key source of information and advice for U.S. representatives to international tuna management organizations, the International Commission for the Conservation of Atlantic Tunas, fisheries scientists, and administrators, and the U.S. tuna industry.

Significant advances in tuna research were made at the Southwest Fisheries Center during the past year incorporating high technology and new methodologies with classical fishery research methods. For example, satellite imagery is being used in research dealing with relationships between albacore tuna and the environment, interactive computer systems are being used to develop simulation models, acoustic and radio telemetry are being used to track the movements of tuna and marine mammals and mitochondrial DNA biochemical methods are being used to study tuna and mammal stock structure.

The report which follows is not intended as a comprehensive presentation of the Southwest Fisheries Center's research on tuna and tuna-related activities but rather as an informal account of major on-going activities,

accomplishments, and advances we have made during this reporting period toward our primary goal: To deliver scientific information and advice to the National Marine Fisheries Service, the U.S. Department of State, U.S. Commissioners to international commissions, and U.S. delegates and negotiators participating in bilateral or international negotiations.

The information was compiled by technical writer Martha Brown from material supplied by our scientific staff at the Honolulu and La Jolla Laboratories.

Izadore Barrett, Director
NMFS Southwest Fisheries Center

May, 1983

IN SUPPORT OF EXISTING INTERNATIONAL AGREEMENTS

RESEARCH ON ATLANTIC TROPICAL TUNAS AT THE SOUTHWEST FISHERIES CENTER

Research on Atlantic albacore and tropical tunas in support of the United States' commitment to the International Commission for the Conservation of Atlantic Tunas (ICCAT) is conducted at the La Jolla Laboratory of the Southwest Fisheries Center. The Center also administers a tuna port sampling program in Puerto Rico, maintains a comprehensive Atlantic tunas data base, facilitates the exchange of data between U.S. and foreign researchers and coordinates general scientific matters involving ICCAT-related research being done by U.S. scientists.

During 1981-1982 research continued on stock assessments and fishery evaluations of Atlantic tropical and albacore tunas. U.S. fisheries were monitored and biological and fishery data collected in cooperation with the U.S. tuna industry and government officials. Atlantic tuna imports were sampled for biological information in Puerto Rico. Data collected through these activities were compiled and submitted to ICCAT, as required of ICCAT members.

A document describing 1981 Puerto Rican import sampling activities has been prepared for the 1982 SCRS meeting. Results indicate that 79% by number of the yellowfin tuna imports sampled were less than 55.0 cm fork length, and 83% of the bigeye tuna imports sampled were less than 55 cm fork length in 1981. Sampling for species composition in Puerto Rico during 1981 indicated that approximately 8% by weight of the mixed yellowfin/bigeye tuna import tonnage sampled consisted of bigeye tuna.

A production model analysis of the Atlantic yellowfin tuna fishery was conducted that employs a different approach toward calculating vectors of catch-per-unit-effort, and considers the appropriateness of the different production curves on the basis of current population theory. Results indicate that maximum sustainable yield (MSAY) is between 110,000 mt and 150,000 mt for the eastern Atlantic, and that the present fishery is operating near this level with the optimal amount of effort.

A review of Atlantic tropical tuna fisheries between 1975 and 1980, which focuses attention on the expansion of the surface fishery, was conducted. This expansion consisted mainly of an increase in the number of large purse seiners participating in the fishery and an offshore extension of the fishery in the eastern tropical Atlantic during this period.

An analysis of single set data from the U.S. tropical tuna fleet covering the period 1968-1981 was conducted. Changes in fishing patterns and operations were examined with respect to changes in fishing success.

The condition of the south Atlantic albacore tuna stock was evaluated through production model analysis and Monte Carlo Simulation using updated data. The sensitivity of the results to data accuracy was investigated. The

production model analysis suggests that the south Atlantic albacore tuna stock is being exploited beyond MSAY under the current pattern of fishing.

Fishery Statistics

During 1981 most of the tropical tuna fishing occurred in the eastern Atlantic. Led by the FISM (French, Ivory Coast, Senegalese and Moroccan) and Spanish fleets the eastern fishery contributed an estimated 116,000 mt of yellowfin tuna, or 83%, and 110,000 mt of skipjack tuna, or 85% of the total Atlantic catches of these species. The remainder of the 1981 yellowfin tuna catch, 23,000 mt, was taken by longliners (78%) that fished in the eastern and western Atlantic, and baitboats and purse seiners (22%) that fished in the western Atlantic. The remainder of the estimated skipjack tuna catch for 1981, 19,000 mt, was taken by baitboats and purse seiners, off Brazil and in the Caribbean Sea.

Longliners dominated the estimated 1981 Atlantic bigeye tuna catch (48,000 mt): 77% overall; 67% and 87% respectively of the north (23,000 mt) and south (25,000 mt) catches.

During 1981 eight U.S. vessels, all class-6 purse seiners, fished in the Atlantic, primarily for tropical tunas. Four of the eight U.S. vessels fished approximately 565 days in the eastern Atlantic and caught 1,472 mt of yelowfin tuna, 2,800 mt of skipjack tuna and 128 mt of bigeye tuna. Catch rates in the eastern Atlantic for these U.S. vessels were 2.6 mt of yellowfin tuna and 5.0 mt of skipjack tuna per day's fishing. These rates are higher by 18% and 28% respectively when compared to those for 1980.

Five of the eight U.S. vessels fished approximately 395 days in the western tropical Atlantic during 1981 and caught 285 mt of yellowfin tuna and 448 mt of skipjack tuna. Western Atlantic catch rates were 0.7 mt of yellowfin tuna and 1.1 m of skipjack tuna per day's fishing.

Five U.S. purse seiners, fishing primarily for bluefin tuna, caught approximately 2,100 mt of skipjack tuna off the U.S. east coast during 1981.

In 1981, the number of undersized (less than 3.2 kg) Atlantic yellowfin tuna in the landings of the U.S. fleet was approximately 58% of the total number landed. This is a 28% reduction from 1980. The number of Atlantic bigeye tuna below 3.2 kg in the U.S. fleets' landings was approximately 3% of the total; a 40% reduction from 1980.

Thus far in 1982 two U.S. class-6 purse seiners have participated in the Atlantic tropical tuna fishery. Together they have spent approximately 150 days in the Atlantic and have caught an estimated 1,000 mt of yellowfin tuna and 500 mt of skipjack tuna. Preliminary information indicates that skipjack tuna catches off the U.S. east coast during 1982 are far below those experienced in 1981.

INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS

Status of Atlantic Tuna and Billfish Resources Assessed by ICCAT

Southwest Fisheries Center Director Izadore Barrett, together with Oceanic Division Chief Gary Sakagawa, and fishery biologists Norm Bartoo and David Au, attended the 1982 meeting of the International Commission for the Conservation of Atlantic Tunas (ICCAT) Standing Committee for Research and Statistics (SCRS), November 3-9, 1982, in Funchal, Madeira, Portugal.

Several working papers were prepared by the Southwest Fisheries Center Tuna/Billfish Resources Staff and presented at the meeting of the Standing Committee of Research and Statistics (SCRS). Authors and titles of the working papers are:

Au, D. Production model analysis of the Atlantic yellowfin tuna (Thunnus albacares) fishery.

Bartoo, N.W., and A.L. Coan. Production model analysis of the south Atlantic albacore stock and effect of data accuracy.

Coan, A.L., and G.T. Sakagawa. U.S. tropical tuna purse seine single set analysis, 1967-1980.

Foster, T.C. Size and species compositions of Atlantic tunas from imports landed in Puerto Rico during 1981.

Herrick, S. A review of the tropical tuna fishery of the Atlantic Ocean, 1975-1980.

The SCRS scientists prepared status of stocks reports on Atlantic tuna and billfish stocks to assist the Commission in identifying needed conservation measures.

The SCRS appraisal of yellowfin tuna stocks in the Atlantic Ocean found that on an Atlantic-wide basis yellowfin tuna catches are currently near estimated maximum sustainable yield (MSY) (123,000 MT) and that the fishery might be operating beyond the optimal level of effort (i.e., the effort level corresponding to the estimated MSY). Considered separately, yellowfin tuna in the eastern Atlantic are currently being fished above the lower end of the range of point estimates for MSY (110,000-120,000 MT) with the corresponding effort level possibly in excess of that which is considered optimal. It was not possible to draw any conclusions concerning the status of yellowfin tuna in the western Atlantic due to lack of information from the fisheries operating in this area.

The Committee's opinion was that Atlantic skipkjack tuna catches are still below potential levels. However, the relation of recent catches to MSY is still unknown pending completion of analyses which recently have begun using data collected during ICCAT's International Skipjack Year Program.

The SCRS assessment of Atlantic bigeye tuna found that on an Atlantic-wide basis the stock is currently being exploited close to the lowest point estimate of MSY (52,900 MT). For a separate northern Atlantic bigeye tuna stock, current catches and corresponding effort levels have been below those associated with MSY (33,000-71,000 MT). For a separate south Atlantic stock, current catches and corresponding effort levels have been above those associated with MSY (21,000-49,000 MT). Only in the case of a separate northern stock would an increase in effort likely result in an increase in sustainable yield.

The Committee's appraisal of Atlantic albacore tuna stocks indicated that the northern stock is currently subject to moderate exploitation, while the southern stock appears to be over-exploited, given results of production model analyses presented at this year's meeting.

The SCRS was unable to make a conclusive statement concerning the status of bluefin tuna in the western Atlantic due to the uncertainty surrounding results of analyses presented at their 1982 meeting. However, the principal analyses did agree that, for the west, there has been some decline in abundance, that recruitment may have decreased in recent years, and that there is little relation between recruitment and spawning potential with data so far used. For the eastern Atlantic as well as the total Atlantic, uncertainty related to analytical results and significant changes in the historical catch statistics was too great to allow conclusions as to the status of the stocks.

As in 1981, the Committee expressed concern over the decline in catches and apparent abundance of Atlantic billfish (blue marlin, white marlin, sailfish and swordfish) resources. However, there is still insufficient information to make firm evaluations on the condition of these resources at this time.

Reports were also prepared on the multi-species aspects of fisheries for both temperate and tropical tuna and tuna-like species. The SCRS recognized that multi-species interaction considerations fall into two broad categories. One involves the biological requirements of coexisting or competing species in the same habitat. The second has to do with fisheries that exploit this co-occurrence of species with various fishing gears and fishing procedures.

The SCRS did not recommend any new management measures for the conservation of Atlantic tuna and billfish at its 1982 meeting.

Foreign-caught Atlantic tuna transshipped to Puerto Rico are sampled routinely for biological information by biological technician Eugene Holzapfel. Data on fork length, weight and species composition of catches are collected. Results of Holzapfel's sampling during the period January 1, 1982 to December 1, 1982, are as follows:

Species and gear	# of samples	# of fish sampled	Tonnage sampled (MT)
Yellowfin			
Baitboat	10	893	123.70
Purse seine	26	2015	1806.13
Longline	1	89	246.59
Unknown	10	775	67.00
Skipjack			
Baitboat	15	659	1472.88
Purse seine	12	602	3665.95
Unknown	4	203	940.22
Bigeye			
Baitboat	2	61	1.24
Purse seine	19	706	675.40
Unknown	4	107	155.13
Albacore			
Longline	1	50	372.10
Blackfin			
Baitboat	1	50	6.12

In addition, the staff of the Tuna/Billfish Resources Program has received biological samples from the western Atlantic throughout 1982. Holzapfel and biological aid Raul Rivera have collected and sent to the Southwest Fisheries Center 635 skipjack tuna gonads and 211 skipjack tuna stomachs. The Tuna/Billfish Resources Program also received 905 skipjack tuna gonads and 9110 skipjack tuna stomachs from the Brazilian Fisheries Agency S.U.D.E.P.E.

INTERNATIONAL SKIPJACK YEAR PROGRAM (ISYP)

The Tuna/Billfish Program at the La Jolla Laboratory has been actively involved in the International Skipjack Year Program (ISYP) of the International Commission for the Conservation of Atlantic Tunas (ICCAT). The ISYP was carried out from 1979 through 1982, and relied on the participation of 19 ICCAT member countries to provide the resources for research designed to increase the information base on Atlantic skipjack tuna. The purpose of ISYP is to develop a rational expansion of the fishery to full utilization of the resource.

In 1982, Southwest Fisheries Center (SWFC) scientists conducted studies in support of the ISYP in three broad areas: port sampling, dart tagging and exploratory fishing, and biology. The major effort consisted of sampling the catch of the U.S. purse seiners fishing in the Atlantic Ocean and landing at Mayaguez and Ponce in Puerto Rico. In general, these large purse seine vessels fish the Atlantic after the close of the IATTC Commission Yellowfin Regulatory Area (CYRA) in the eastern tropical Pacific. Usually closure occurs sometime in the early summer (depending upon the catch), but may occur as early as April or as late as September. Some of the vessels then move to the Atlantic and fish until December. Samples were also collected from the catch of foreign-flag vessels which transship Atlantic tunas at Ponce and Mayaguez, Puerto Rico.

In addition, U.S. scientists undertook a number of analytical studies including research on feeding habits, maturity and fecundity, stock identification and relation of environmental variables to fish distribution.

Current efforts underway at La Jolla include analyses of data collected for the ISYP, in preparation for a June 1983 ISYP scientific conference where the program results will be reviewed.

New Study on Genetic Variability in Tuna Stocks Initiated

In 1982, researchers in the Tuna and Billfishes Resources Program at the Southwest Fisheries Center initiated a study to apply a new technique for measuring genetic variability to the old problem of defining the "unit stock" for population analyses and management needs. Traditionally, unit stocks have been identified by particular morphological, ecological, or more recently, electrophoretic characters. However, because not all populations of exploited species differ enough from each other to be characterized by the above means, a new technique involving analysis of genetic material is now being used. With the technique, researchers compare fragments of mitochondrial DNA (mtDNA) between individuals in order to calculate the frequency of base pair substitution between individuals. The greater the frequency of base pair substitutions, the more distant the relation.

mtDNA analysis was recently applied to skipjack tuna from the Atlantic and Pacific Oceans, and indicated a surprisingly high degree of genetic similarity between tuna from the two oceans. These results suggest continued genetic contact between the two populations since the uplift of the Panama land bridge 1.3 million years ago. The new technique also has application to stock analysis of various other tunas and different species of dolphins.

Study of Fecundity of Atlantic Skipjack Tunas Completed

Dr. David Au, Operation Research Analyst, reports that a histological examination of female skipjack tuna gonads from tuna collected in the western Atlantic Ocean was completed by Dr. Steven Goldberg from Whittier College, California. A total of 951 female gonads was examined, 916 from Brazil and 35

from the Caribbean, to assess reproductive condition. A portion of the Brazilian sample (from 25°S to 45°W) was in spawning condition in November; the condition continued through March. The Brazilian fish are batch spawners and spawn more than once. Minimum length of sexually mature females was 510 mm with minimum gonad indices of 30. For skipjack tuna measuring 510-720 mm fork length (2600-9650 g), the average number of eggs was 385,936.

Food Habits of Bait Caught Tuna Examined

Stomachs from 1041 adult skipjack tuna caught off southern Brazil were analyzed for the occurrence of juvenile skipjack tuna as well as other forage items. Changes in diet were examined by season and by size of the predator.

No juvenile skipjack tuna were found in any of the stomach contents. While Auxis thazard and Scomber japonicus represented the major scombrid prey items, Euphausia similas and Maurolicus muelleri provided the bulk of the diet items throughout the entire season and size range of the sample.

OVERVIEW OF ECONOMICS OF U.S. TUNA FISHERIES

A Review of 1982 U.S. Tuna Harvesting and Processing Activity

During 1982 there was a substantial decline in domestically-caught U.S. tuna receipts, raw tuna imports and domestic production activity. Preliminary information indicates that total U.S. cannery receipts (domestic catches plus imports) of albacore and tropical tunas (skipjack, yellowfin, bluefin and bigeye tuna) were down 16% from 1981 and 17% below the 1977-81 average volume of annual receipts.

Popular accounts attribute the 1982 U.S. tuna industry downturn to a number of factors, foremost of which was an apparent excess of canned inventories. Large inventories led to shutdowns and slowdowns in the canning operations of the three major U.S. tuna processors: Bumble Bee Seafoods, a division of Castle and Cooke, closed its San Diego plant in June of 1982, idling 900 workers; the leading producer, Starkist, Heinz Foods, imposed a three-week work stoppage at its plants located in San Pedro, California, Puerto Rico and American Samoa; and Van Camp Seafoods, Ralston Purina, reduced operations at its San Diego cannery. All processors imposed 40-60 day tie-up periods for those tuna seiners in which they held a major interest.

Total domestically-caught receipts, 227,784 st, were down approximately 5% in 1982, with albacore and yellowfin tuna (including bluefin, bigeye and blackfin tuna) off 56% and 6% respectively while domestically-caught receipts of skipjack tuna increased approximately 5%. Yellowfin tuna comprised over 52% of the total domestically-caught, U.S. cannery receipts of major market species in 1982, with albacore and skipjack tuna contributing approximately 3% and 45% each of the total.

The average ex-vessel prices paid by U.S. processors since August 1982 ranged from $795.00 st for skipjack tuna to $1036.00 st for yellowfin and bigeye tuna decreases of approximately 24% and 14% respectively from 1981. The top ex-vessel price for albacore tuna (accounting for size differentials) fell approximately 25% during 1982, from $1800.00 st at the close of 1981 to $1350.00 st at the close of 1982.

In 1982 receipts of U.S. caught albacore and tropical tunas generated approximately 237 million dollars in ex-vessel revenues, down 16% from 1981. Domestically-caught, U.S. albacore tuna receipts produced ex-vessel revenues of approximately 9 million dollars, 67% below 1981, which divided by total volume results in a weighted ex-vessel price of $1,382 per short ton, down 25% from 1981. Domestically-caught, U.S. receipts of skipjack tuna generated approximately 98 million dollars in ex-vessel revenues, 8% below 1981, at an average weighted price of $957 per short ton, down 7% from 1981. Receipts of U.S. caught yelowfin tuna produced approximately 130 million dollars in ex-vessel revenues, 8% below 1981, at an average weighted price of $1,117 per short ton, which is 6% below the 1981 average weighted price per ton.

U.S. imports of raw tuna during 1982 are estimated to be 272,345 short tons, a decrease of 24% from 1981. Imports of albacore tuna totaled 94,599 st in 1982, 8% above 1981, while imports of skipjack tuna (127,106 st) and yellowfin tuna (50,781 st) were both down from 1981, 32% and 39% respectively.

Based on the weighted average ex-vessel prices for albacore, skipjack and yellowfin tuna calculated for domestically-caught U.S. landings in 1982, the value of imports in 1982 approached 310 million dollars, 31% below the corresponding value of 1981. Albacore, skipjack and yellowfin tuna generated 131 million, 122 million and 57 million dollars each, down 18% , 35% and 42% respectively from 1981.

In terms of the total supply (domestically-caught receipts plus imports) the U.S. is mainly dependent on tuna resources in the Pacific Ocean, which in 1982 accounted for approximately 72% of all U.S. tuna receipts; the Atlantic and Indian Oceans provided approximately 24% and 4% of the 1982 total U.S. tuna receipts, virtually all imports. These proportions were not greatly different from 1981. However, there were some significant shifts between 1981 and 1982 with respect to sub-oceanic area of origin and domestic or foreign source of supply. Of particular interest in this regard was the large increase in domestically-caught receipts relative to the decline in imports from the western Pacific Ocean, as well as the increase in imports from the western Atlantic and Indian Oceans.

U.S. canned tuna production during 1982 is estimated at 27,233 thousand standard cases (based on 19.5 pounds to the standard case), off approximately 14% from 1981. The pack of light meat tuna (tropical species) is estimated at 21,221 thousand standard cases for 1982, down 18% from 1981; white meat (albacore tuna) production during 1982 is estimated at 6,012 standard cases, up 3% from 1981. Compared to the 1977-81 annual average, the 1982 total pack was down 12%, reflecting a 15% decrease in the light meat pack and no change in the white meat pack.

The average wholesale list price of advertised light meat tuna fell from $50.44 per standard case in 1981 to $47.61 in 1982, a 6% decrease. On the other hand, the average wholesale list price of advertised white meat tuna rose from $61.55 per standard case in 1981 to $63.92 in 1982, an increase of almost 4%.

Imports of canned tuna in 1982 totaled approximately 4,496 thousand standard cases, an increase of 23% from 1981. Imports of canned white tuna meat amounted to 572 thousand standard cases, a 12% decrease from 1981, while approximately 3,192 standard cases of light meat tuna were imported in 1982, up 32% from 1981.

U.S. production of canned tuna in 1982 generated approximately 885 million dollars in wholesale revenues, down nearly 25% from 1981. Based upon total light and white meat volume this results in a weighted average standard case price of $32.49 for 1982 compared to $37.17 for 1981, a 13% decrease. The value of imported canned tuna was approximately 113 million dollars in 1982, a 2% increase from 1981, this despite a 19% decrease in the weighted average price of imported canned tuna (white and light combined) from $30.87 to $25.13 per standard case.

The Effect of the 1982 U.S. Tuna Year on the California Economy

King and Shellhammer (1982) derived California economic impact multipliers for tuna purse seiners (which accounted for almost all of the U.S. tropical tuna landings in 1982), salmon/albacore vessels and tuna processors based in California. Their findings indicate that every $1,000 of California tropical tuna landings by California-based purse seiners generates approximately $3,633 in California production activity, $1,042 in household income and 0.028 full-time jobs. For each additional $1,000 of California albacore landings by California-based salmon/albacore vessels, California production activity increases by $3,554, household income increases $890 and approximately 0.098 full-time jobs are created.

Based on the decline in continental tropical tuna landings by the California-based purse seine fleet between 1981 and 1982 and corresponding price conditions, ex-vessel sales revenue is estimated to have decreased by an estimated 34 million dollars. The decrease in albacore tuna landings by California-based vessels at continental sites during 1982 resulted in ex-vessel albacore tuna revenues falling an estimated 20 million dollars. The combined decline in albacore and tropical tuna landings between 1981 and 1982 translates into an overall harvesting related production decline of approximately 196 million dollars, a decrease in household income of about 53 million dollars and a predicted loss of more than 2,900 full-time jobs for California.

The King and Shellhammer (1982) study also derived economic impact multipliers for the processing sector of the California based segment of the U.S. tuna industry. These multipliers, as in the case for landings, can be used to assess the impact of reduced processing at continental canneries on

the California economy. The decrease in total continental tropical tuna receipts (domestic catches and imports) for 1982 could have reduced canned light meat tuna production by as much as 1.91 million standard cases. At an average U.S. list price of $47.61 per standard advertised case this amounts to approximately 90 million dollars in reduced light meat tuna revenues at the wholesale level. White meat tuna production could have fallen by as much as 617,000 standard cases, which at an average list price of $63.92 per standard advertised case results in lost wholesale revenues of approximately 43 million dollars.

The combined decrease in wholesale revenues from reduced white and light meat production at continental sites during 1982 is approximately 133 million dollars. The predicted impact of this decline on the California economy is a decrease of approximately 489 million dollars in processing related economic production, a reduction of about 109 million dollars in household income and a loss of approximately 4,800 full-time jobs.

The multiplier analysis suggests a substantial impact on the California economy due to reduced activity in the California based segment of the U.S. tuna industry. When the predicted impacts of reduced domestically-caught U.S. tuna receipts, imports and associated canned production are combined, there is an overall decrease of 684 million dollars in California production activity, a decrease of 162 million dollars in household income and a loss of approximately 7,700 full-time jobs.

Tuna Consumption

Canned tuna is the leading fishery product consumed in the United States. In 1981, U.S. per capita consumption of canned tuna was 3.1 pounds out of a total of 13.0 pounds of all fishery products.

Growth of tuna consumption over the long term has been substantial, but it has not been a smooth, continuous process (Figure 1). Significant short-term setbacks have occurred, notably in 1975-76 and again in 1979-82. Studies have suggested that tuna consumption rises or falls with changes in consumer income. The noticeable drop in consumption during recession periods appears to bear this out. Price competition from substitute products--ground beef and chicken, for example--are other factors that likely have an impact on tuna consumption. Tuna prices have increased much faster than chicken prices since 1975 (Figure 2). Over the long term, however, retail prices of canned light meat tuna compare reasonably well with beef.

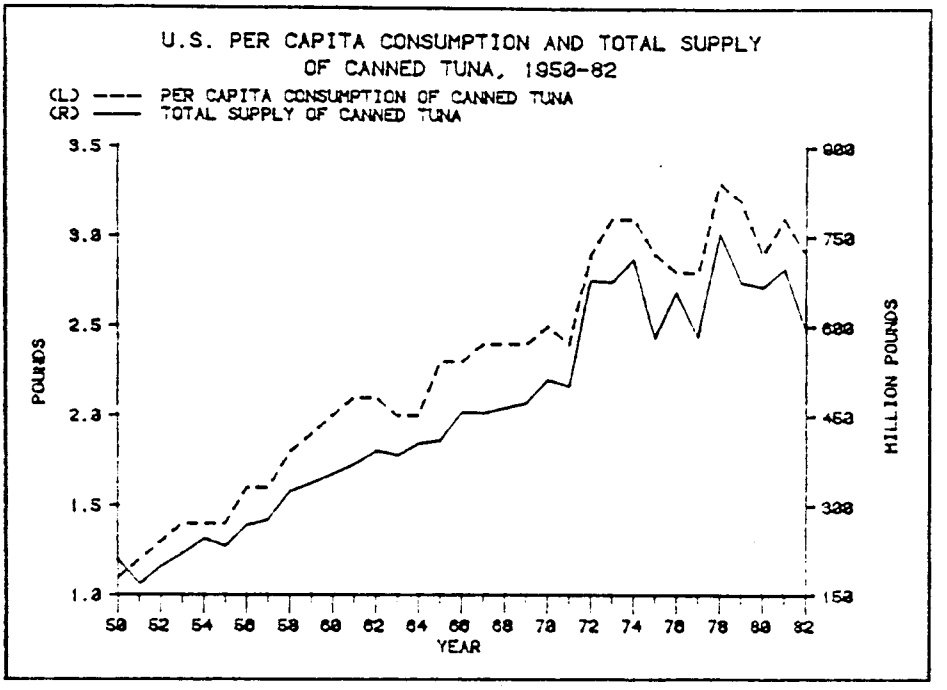

Figure 1

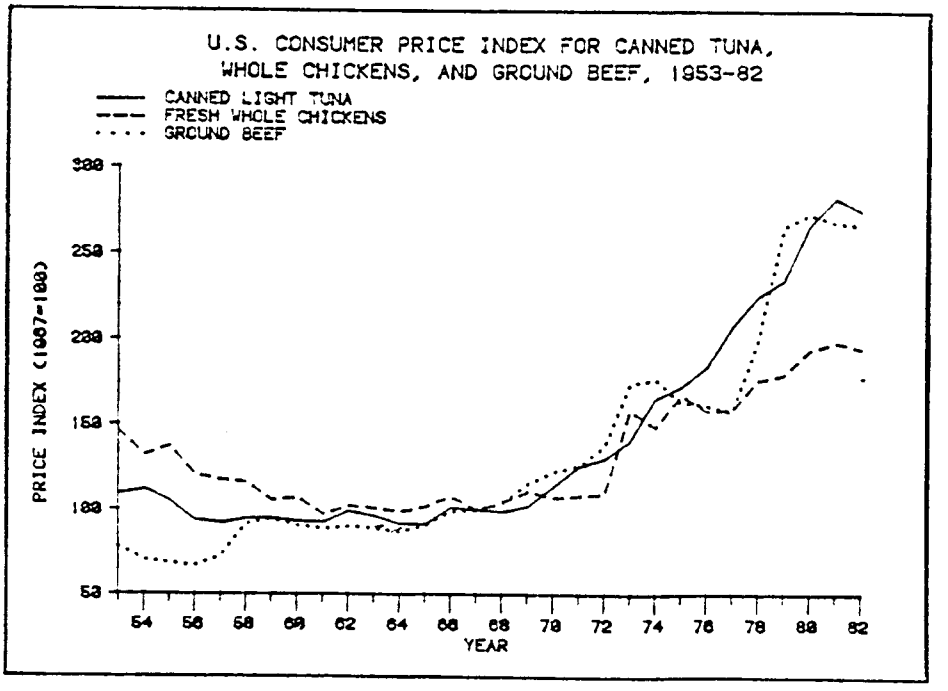

Figure 2

SOUTH PACIFIC COMMISSION

Tagging Mortality Studied

Dr. Robert E. Kearney, South Pacific Commission (SPC), in cooperation with fishery biologist Dr. Jerry Wetherall and several members of the Experimental Ecology of Tunas Program, conducted an experiment to measure the mortality caused by tagging skipjack tuna at the Kewalo Research Facility. This project was designed specifically to complement the SPC skipjack tuna tagging project in the South Pacific. Results so far show that tagging induces no increase in mortality.

These results are of importance in the analysis of data in the SPC tuna tagging program. About 153,000 skipjack tuna were tagged during the 3-year field program.

South Pacific Commission Meeting Held in New Caledonia

Fishery biologist Dr. Robert A. Skillman attended the 14th Regional Technical Meeting on Fisheries held in Noumea, New Caledonia from August 2 to 6, 1982. The substantive agenda items included discussions on coastal fisheries, artisanal fisheries development, workshops on deep-bottom fisheries resources, fish aggregating devices, oceanic fisheries, workshops on foreign vessel observer programs, and mariculture.

Dr. Robert Kearney reviewed the results of the SPC's Skipjack and Assessment Programme. The revised estimate of the standing stock of skipjack tuna in the SPC area was upped from 3.1 to 3.4 million metric tons. Dr. Kearney also reviewed progress on the new Tuna and Billfish Assessment Programme. So far the program has concentrated on the establishment of a regional data base for fishery statistics. Computer programs for data entry, verification, and summarization have been developed. Reporting forms for purse seine and pole-and-line vessels have been approved and data are being entered into the data management system. Dr. Kearney noted that fishing activities of the Japanese and the United States purse seine fleets in waters outside the SPC member countries' 200-mile zone were not being monitored and that this was causing difficulties in analyzing the recapture data of the Skipjack Survey Assessment Programme.

IN SUPPORT OF POSSIBLE FUTURE INTERNATIONAL AGREEMENTS

NORTH PACIFIC ALBACORE

Seventh North Pacific Albacore Workshop

The North Pacific Albacore Workshop series originated in 1974 with an informal agreement on a joint exchange of research results from North Pacific albacore resources. The original agreement, between the Southwest Fisheries Center (SWFC, United States) and Far Seas Fisheries Research Laboratory (FSRFL, Japan) was extended in 1982 to include the Pacific Biological Station (PBS, Canada).

The Seventh North Pacific Albacore Workshop was held in La Jolla at the Southwest Fisheries Center, May 20-25, 1982. Scientists from Japan, Canada, Korea, and the United States participated. High utilization of the albacore resource and development of new fisheries combined with expansion of existing fisheries underscore the need to better understand the biology and dynamics of the North Pacific albacore resource.

The following research results were presented:

1. Tagging

In 1981, a few hundred tagged fish were released in eastern Pacific waters through a continuing arrangement with the American Fishermen's Research Foundation (AFRF) and the SWFC. Tagging is currently in progress (summer of 1982) by jig boats operating in the mid-Pacific (from the date-line eastward), with an objective of 1800 releases of fish in the 6-8 kg class during 1982. In addition, it is expected that 300-400 fish will be tagged in waters close to the North American coast.

Attempts by the Fisheries Agency of Japan to tag albacore in 1981 were hampered because of the unavailability of fish. Prefectural agencies were asked to tag incidentally caught albacore during the same year but the number tagged is not known at this time. The Fisheries Agency itself plans no tagging in 1982 but has asked for assistance from prefectural agencies.

2. Ageing

During a 2-year period (1977-78) a total of 2544 albacore were injected with oxytetracycline, tagged and released from fishing boats chartered by AFRF (NPALB/82/2). Of 178 recaptures, 116 were accompanied by information requisite for determining the relationship between otolith ring increments and time at liberty. The relationship is nearly 1:1, thus indicating that increments are laid down daily, at least over the size range of fish injected (51-83 cm). Demonstration that the daily ring method can be successfully used to age North Pacific albacore opens the way to validation of other, less time consuming ageing techniques, and accurate evaluation of age composition of catches.

Total ring counts from otoliths of 50 albacore in a 30-50 cm length range show that length at first birthday is about 40 cm for fish belonging to the proposed southern substock. For the northern substock, counts from only 3 specimens indicate a corresponding length of about 35 cm. Further readings are required to confirm estimates.

Progress on development of ageing techniques which utilize dorsal finrays was discussed. Samples of both otoliths and dorsal fin-rays have been collected for the purpose of validating age estimates from the latter. Results are expected later in 1982.

3. Sonic Tracking

The use of acoustic tracking to study swimming depths and diurnal behavior was continued in 1982. Two albacore were tracked from a U.S. exploratory longline vessel about 1200 miles west of southern California (NPALB/82/5). These fish exhibited similar day-night behavior, in that during daylight they swam near the bottom of the mixed layer (depths of 146-152 m) and made vertical excursions of only 15 m. At or near sunset they rose to a depth of about 107 m and from there made frequent vertical excursions of 30 m. Additional information on sonic tracking done in 1981 is given in discussion of oceanographic research.

4. Albacore Physiology

Using a continuous flow respirometer aboard a research vessel at sea, measurements were made of albacore oxygen consumption rate, VO_2 (NPALB/82/3). Mean total VO_2 for 6 fish weighing from 6 to 13 kg was 2,114 mlh^{-1} in water temperature of 15-19°C, a figure slightly below the average for skipjack swimming in 23-25°C water, but more than twice that for sockeye salmon measured at 15°C. As expected, tunas have much higher metabolic rates than other active fishes.

Additional tests on albacore swimming in the respirometer confirmed the adverse effects of prolonged exposure to temperatures cooler than 12°C and to O^2 saturation levels less than 55%.

5. Stock Structure

Discussions on stock structure were limited to results of electrophoretic studies. Studies conducted in 1981 revealed the presence of a single locus, phosphoglucose isomerase (PGI-A), that was highly polymorphic. A follow-up study on the allele frequencies at the PGI-A locus was conducted in 1982 (NPALB/82/6) and showed that there were no statistically significant allele frequency differences between fish taken in offshore (138°-142°W; 32-33°N) and inshore areas off southern California. Results are consistent with the interpretation that the offshore (winter-caught) fish share a common gene pool with fish which migrate into the U.S. fishery south of 40°N during summer and fall months. However, to be meaningful, statistically different allele frequencies must be demonstrated at the PGI-A locus for fish not in the hypothesized southern substock.

Work by Graves and Laurs (Southwest Fisheries Center Admin. Report No.LJ-82-11) is being conducted to determine if electrophoretic characters can be used to differentiate possible north Pacific albacore substocks. To assist in this study, frozen eye tissues will be collected from various areas and seasons during the coming year.

6. Pacific Albacore Simulation Model

The SWFC is developing a simulation model for the North Pacific albacore population. This model has been under development since late 1980 and is to be used to test hypotheses concerning the interactions between the fish, fisheries and environment.

The model forms a framework for organizing information on population dynamics, migration dynamics, life history information, economic information and environmental parameters and processes. The model is not intended to be a statistical forecasting model but rather will serve as a vehicle for evaluating hypotheses concerning albacore behavior and their dynamics. The mathematical concepts associated with the model were reviewed; participants then discussed progress in the model's development. To date, initial runs on a computer system have been made and preliminary input fishery parameters have been estimated. Prior to exacting simulations, a sensitivity analysis (NPALB/82/8) was conducted to: (1) insure that the model functions correctly; (2) identify omitted compartments and mechanisms; (3) identify unnecessary compartments and mechanisms; and (4) determine how changes of known magnitude in the input parameters affect the age- and gear-specific quarterly catches predicted by the model. Near completion is a computer program that will compare these model-predicted catches with actual recorded catches and generate an R^2 fit index for each simulation.

Participants also discussed the future development of the model, which will occur in two phases. In the first phase, the fishery will be simulated over a sequence of years, both individually and as multiple-year simulations. These simulations will involve fishery data alone. In the second phase, the albacore model wil be used for hypothesis testing by including, for example, environmental or economic indices as input to the model and determininig to what extent their inclusion reduces the variance between observed and predicted results.

7. Oceanographic Research

An investigation of small-scale movements and aggregation of albacore in relation to oceanic temperature and color boundaries was conducted by the Southwest Fisheries Center in cooperation with the American Fishermen's Research Foundation. Ocean color and infrared satellite data, collected contemporaneously with observations made from ships at sea were used to investigate the small-scale migration patterns of albacore tuna in relation to oceanographic conditions.

NIMBUS-7 Coastal Zone Color Scanner (CZCS) and NOAA-6 satellite AVHRR data were collected at the S.I.O. Remote Sensing Facility in conjunction with field experiments where a) acoustic telemetering methods were used to track

the horizontal and vertical movements of free-swimming albacore, and b) XBT observations were made to determine subsurface ocean thermal structure. Three albacore were tracked for approximately 24 hours and one for 15 hours. The results showed: a) total distances tracked ranged from about 40 to 60 km with all fish remaining in the same parcel of warm water that was separated from waters to the north and inshore by a 4°F temperature gradient as shown by infrared thermal imagery, b) tracked fish spent most of the time in waters within and below the thermocline, and only small amounts of time in the upper mixed layer, c) the fish exhibited marked vertical excursions in depth with the range being larger during daytime hours than during nighttime hours, d) the fish spent the majority of the time in waters with temperatures considerably lower (about 45° to 60°F) than what has been generally believed to be preferred temperature range for albacore (60° to 66°F) and e) when undergoing vertical changes in depth, the fish frequently within a 20-minute period passed through a vertical gradient of temperature amounting to 12° to 15°F, or about 3+ times greater than the horizontal temperature gradient at the surface indicated by ship measurements and the IR thermal imagery.

These findings indicate that the causal factor(s) involved in the aggregation of tuna on the warm side of ocean surface temperature fronts, a phenomenon which has been observed on scientific cruises, is well known by fishermen, and has economic significance, is probably not related to thermal-physiological mechanism(s) as has been previously suspected. Instead it appears that a behavioral mechanism(s) related to feeding may be responsible. Ocean color movements made by the CZCS in conjunction with the tracking study provide data which support this hypothesis.

The diffuse attenuation coefficient (k), a measure of water clarity measured by the CZCS, showed a gradient pattern, with lower values of k in the warm waters and higher values in the cooler waters. The distribution of color boundaries indicated by the ratio of blue:green color bands measured by the CZCS was also similar to the gradient pattern observed in the diffuse attenuation coefficient (k).

The results show that the albacore remained in water that had higher clarity than adjacent waters. This suggests that water clarity as it affects the tuna being able to see its prey may play a key role in the mechanism(s) underlying the aggregation of tuna on the warm clear side of ocean surface thermal fronts.

8. Environmental Modeling

Oceanographic and environmental indices are being investigated and quantified to serve as model inputs to the North Pacific albacore simulation modeling effort introduced previously. Progress was made in assembling oceanic climatological time series for use in developing environmental indices that will be candidates in the modeling efforts. In the subtropical North Pacific environmental variations may have an influence upon larval survival. One available data series is Wyrtki's island sea level differences, which may be useful in evaluating the influence of variations in ocean currents on spawning success. A second one in the subtropics is O'brien's wind stress model. Further considerations are needed to determine if output of the

O'brien model can be applied as environmental input to the albacore model. Thirdly, published atlases of satellite-observed cloud patterns may offer evidence of changing wind regimes.

Climatological variations in the western Pacific may influence availability and vulnerability of albacore in the western Pacific and timing of the fishery in the eastern Pacific. Wyrtki has a temperature time series across the Kuroshio, Kawabe relates a sea level difference series to variations in the Kuroshio meander and Kawaii has data on patterns in the Kuroshio extension. In the eastern Pacific, Saur's Honolulu to San Francisco XBT time series may be used to test hypotheses on availability and vulnerability.

Review of Current Fisheries

1. U.S. Fishery

a. Jig/bait Fisheries

U.S. albacore landings were considerably higher in 1981 than during the previous two seasons, amounting to 15,500 tons in 1981 as compared to 6,600 tons and 8,200 tons in 1979 and 1980 respectively. The 10-year average is about 20,000 tons.

In 1981 an estimated catch of 3900 mt was taken by U.S. vessels operating further offshore than they have done in past years. This includes the fishing area in the central north Pacific area as well as fishing areas 800 to 1200 miles off the North American coast. The landings made in 1981 are in part due to: 1) early catches in mid-June off California and early July off Oregon; 2) good fishing in waters 800 to 1200 miles off the coasts of Oregon and Washington; 3) high catches were under-represented in 1979 and 1980; and 4) late-season catches of albacore larger than 13.6 kg (30 pounds) off central California.

Size composition of albacore in the 1981 catch is presented in NPALB/82/1. The catch north of about 40°N was dominated by fish 60 to 70 cm in length; the catch south of 40°N had a smaller proportion of fish in the 60 to 70 cm length range and relatively more fish in the 45 to 55 cm and 75 to 85 cm ranges.

b. Recreational Fishery

The available private and commercial passenger vessel (PCPV) statistics for the U.S. west coast were summarized in NPALB/82/7. PCPV catches have ranged from near zero mt (1959) to an estimated 1,700 mt in 1962. Since 1975, catches have averaged about 500 mt per year. Catches reported are minimum estimates due to incomplete data collection. Effort, in units of angler-trips, was estimated to be 975,000 in 1981. The 1981 catch is not yet available. Most of the PCPV effort was centered south of Monterey, California, but high catches are made off Oregon and Washington when fish are available near shore.

c. Experimental-longline Fishery

Exploratory longlining operations by six chartered U.S. fishing vessels were conducted in January-February 1982 in an area centered 1000 to 1500 miles west of San Diego (reported in NPALB/82/5). A total of 112 sets was made on the survey. Each of the vessels typically set 800 to 1400 hooks in and about the thermocline depths of 116 to 233 meters. The total catch was 322 mt albacore and 3.6 mt of bigeye tuna. The mean catch per set was equivalent to 3.2 albacore per 100 hooks (3.4 with bigeye included) and varied from 1.6 to 4.8 among the six vessels. Fuel consumption was 40% to 50% below that typical of trolling operations.

The results of the study show that the U.S. albacore fishery can operate during winter months in an area not traditionally fished, which could be an important alternative to other winter fisheries or to remaining idle. The large disparity between the catch rates of the vessels, which employed different gear settings and operational methods, shows that we have much to learn about methods, gear and distribution to improve catch rates.

2. Canadian Fishery

A total of 46 Canadian jig-boats participated in the 1981 fishery, but the catch was relatively small (202 mt). The low catch was due in part to effort diversion by the salmon fishery, and to higher fuel costs. For the first time in more than six years vessels operated far south, off the United States coast. This was due partly to a new treaty which permitted Canadian landings of albacore at four U.S. ports, and partly because the main concentrations of albacore stayed largely offshore and to the south of British Columbia. In a 64-day trip, one vessel (120 ft) operated as far south as 32°N and as far west as 178°W and landed 39 mt. Another vessel experimented with purse-seining albacore but caught only 2.7 mt.

3. Japanese Fishery

Current progress of Japanese albacore fisheries in the North Pacific was described and pertinent fishery data were presented in NPALB/82/9. The total albacore catch from the Japanese fisheries was 66,000 mt in 190, a 5% increase over the 1979 catch. The 1981 catch is expected to be at the same level. While the 1981 pole-and-line fishery recorded the lowest albacore catch since 1971, the drift gillnet fishery experienced the highest albacore catch since its inception. The 1980 longline fishery remained at about the average level of the past 10 years.

d. Pole-and-line fishery

The summer pole-and-line fishing season (April-August) progressed rather poorly in 1981. Some good fishing success was encountered in the cooler water zone just outside the Kuroshio Current area from April to mid-June with the predominance of fish about 72-76 cm. However, the fishing conditions in the overall offshore "Frontal" area were generally poor; most of the catch was composed of 50-76 cm fish. The autumn pole-and-line fishing season

(September-December) was also poor. Thus the season's total pole-and-line catch was low at about 26,000 mt. This low 1981 catch was attributed partly to reduced effort and poor availability. The 1982 summer pole-and-line fishery started in the usual southern area "Around Nishinochima" and fishing conditions on the nearshore albacore fishing grounds (26-28°N, 139-143°E) remained poor until mid-May. In the middle of May, fishing success improved, reaching a level that was better than that of the previous season, toward the western part of "Frontal" area.

b. Longline fishery

The North Pacific Japanese albacore longline fishery operates primarily in the winter season. The 1980 longline albacore catch was 14,700 mt, about the same as the 1979 catch. In 1981, fishing began in the central North Pacific area north of 30°N in late September and expanded in the area between 145°E and 160°W as the season progressed. Later in the fishing season, January-March, the hook rates (catch in number of fish per 100 hooks) in the nearshore waters off Japan ranged from 1.5-3.5, only about 50% of recent years' average, reflecting the poorer fishing conditions to be seen in the subsequent pole-and-line fishing season. Catch level in 1981 is assumed to be about the same as that of recent years (14,700 mt in 1980).

c. Drift gillnet fisheries

Japanese drift gillnet fisheries capture various fish species such as squid, pomfret, billfishes and tunas. The albacore are caught mainly by the large-meshed drift gillnet fishery (OME-AMI:Mesh size about 18 cm). During the summer months of 1981, OME-AMI fishing effort was directed mainly at albacore in the area north of 35°N between the date line and 150°W. The 1981 albacore catch is estimated to be a record high of between 15,000-20,000 mt. It was reported that very small albacore are caught incidentally by the squid gillnet fishery, and there are reports that some of these fish are being dumped because they are below minimum market size.

Condition of the Stock

Production model analysis based on updated abundance indices and effective effort statistics, and assuming a single stock, gave estimates of MSY ranging from 92,000 mt to 166,400 mt, depending largely on the assumed shape of the equilibrium yield-effort relationship. This range of estimates is consistent with past results. Critical assumptions underlying the production model analysis may be difficult to satisfy, as discussed in past workshops.

Yield-per-recruit analysis results were qualitatively the same as those found in past workshops, i.e., yield-per-recruit is maximized by harvesting albacore only after they reach a relatively large size. A contrast between the yield-per-recruit results and observed longline CPUE statistics with respect to expected decline in abundance of spawning stock was noted. The discrepancy could be explained by an increasing trend in recruitment or by a lower fishing mortality rate than was assumed in the yield-per-recruit analysis.

Based on statistics and analyses currently available, the stock appears to be healthy. However, close monitoring is required, especially in view of increased effort in the drift gillnet fishery, about which very little is known, and because of the declining catch-per-effort in the major fisheries. Reliable assessment of the North Pacific albacore stocks remains a crucial task, beset by numerous problems. In particular, the measurement of effective effort is necessary, but is exceedingly difficult in the surface fisheries, where oceanographic processes and weather conditions strongly influence fish availability and catchability. Further, stock recruitment processes are not understood, and many questions about stock structure remain unanswered. As pointed out in past workshops, these subjects should be placed high on the research agenda of the participating laboratories. In the meantime, sensitivity analyses are needed to better define the robustness of current assessment procedures and the direction and magnitude of possible biases.

The Far Seas Fisheries Research Laboratory, Shimizu, Japan, offered to host the Eighth North Pacific Albacore Workshop during the fall of 1983.

CENTRAL AND WESTERN PACIFIC SKIPJACK AND YELLOWFIN TUNAS

Tuna Fishing Data from the Mariana Archipelago Analyzed

Dr. Jeffrey J. Polovina, Leader of the Resource Assessment Investigation of the Mariana Archipelago Program, and research assistant Nathaniel T. Shippen have completed an administrative report entitled, "Estimates of the catch and effort by Japanese longliners and baitboats in the Fishery Conservation Zone of the Mariana Archipelago." This report presents historical catch and effort data from Japanese longliners for the period 1965-79 and from baitboats for the period 1970-79, and an analysis of the data.

For the period 1965-79, the total annual tuna catches from Japanese longliners in the FCZ around Guam ranged from 9 to 1,334 metric tons (MT), and from 71 to 576 MT in the FCZ around the Commonwealth of the Northern Mariana Islands (CNMI). The tuna catches for the period 1976-79 were above average as compared with those of the period 1965-75 in the FCZ around Guam and the CNMI. The catch was composed predominantly of albacore, Thunnus alalunga, yellowfin tuna, T. albacares, and bigeye tuna, T. obesus. During the latter part of the 1969-79 period, there was an increase in the catch, effort, and catch per unit of effort in the lower portion of the archipelago (lat. 11°-16°N).

The most abundant tuna in the archipelago appears to be the skipjack tuna, Katsuwonus pelamis. The annual total tuna catches from Japanese baitboats for the period 1970-79 ranged from 300 to 2,059 MT for the FCZ around Guam and from 2,554 to 12,564 MT for the FCZ around the CNMI. Skipjack tuna comprise over 90% of the tuna caught by the baitboats. The middle latitudes (16°-21°N) provided consistently good catches.

IN SUPPORT OF DOMESTIC REQUIREMENTS

WESTERN PACIFIC REGIONAL FISHERY MANAGEMENT COUNCIL

Number of Fishing Vessels in Hawaii Determined

In response to a need expressed by the Western Pacific Regional Fishery Management Council (Council) for data requirements related to the western Pacific billfish fishery management plan, the Southwest Fisheries Center, Honolulu Laboratory, has been working on a vessel inventory project. On hand now is a contractor-delivered computer tape of vessels registered and documented in American Samoa, Guam, Hawaii, and the Commonwealth of the Northern Mariana Islands.

Dr. Robert A. Skillman, Leader of the Fishery Management Research Program, Thomas S. Hida, Fishery Biologist, and Research Assistant Bernard M. Ito of the Honolulu Laboratory prepared an administrative report, "A note on the number of fishing vessels in Hawaii," based on the vessel inventory project data. The data included in this report provided an answer to a question raised by the Council on whether there has been an increase in domestic fishing effort for billfish over the period 1979-81. The data document that there was an 8.1% increase in commercial fishing vessels, an 11.1% increase in charter fishing vessels, and a 2.3% decrease in recreational vessels.

Recreational Fishing Data Collected

Further to the needs of the Council, fishery biologist Thomas Hida has been collecting data on the recreational fishery in Hawaii from various sources. He has been contacting recreational fishing clubs for the purpose of obtaining data on catch and effort. As of July 1982 he had contacted 20 fishing clubs and had received a list of members and boats from 8 of the clubs. Also, detailed catch and operational data were obtained from a military charter fishing boat for the period March 28, 1979 through January 6, 1983, and weigh slips for 1982 have been received from the fishing club. These data were added to the data base in the Honolulu Laboratory data management system. In addition, catch data are being transcribed from the "Hawaii Fishing News" for entry into the data management system. Data were also updated for the Hawaiian Billfish Tournament and the International Billfish Tournament. These data are being summarized and analyzed by Hida and research assistant Nathaniel Shippen for a report on recreational fishing for the Council meeting in May 1983.

Socio-Economic Research Underway for Input into Fishery Management Plans

Samuel G. Pooley, Industry Economist, has been involved in various socio-economic projects in response to a need for updating the Council's billfish management plan and a need expressed by the Council for new data on domestic catches of billfishes, mahimahi, wahoo, and sharks. Eight key wholesale fish dealers were identified as sources of the required data. Data collected from

the wholesalers were entered into the Honolulu Laboratory data management system, and computer summaries of 1979-81 landings and revenues were prepared for the Council.

Pooley reported that progress has been made on several socio-economic studies that are being carried out under contract. First, a final report describing the marketing of mahimahi and wahoo (ono) in Hawaii was received from the contractor. Second, regarding the survey of costs and earnings of deep-sea handline and tuna longline vessels in Hawaii, the contractor has delivered the data on magnetic tape and is now starting on the second phase of the contract which involves developing an economic model of these fisheries. Third, the fielding format for the experimental valuation of recreational fishing has been developed and the contractor is expected to field the study this month.

A document describing the Fishery Management Research Program's (FMRP) socio-economic research plans will be issued shortly as an administrative report. The document presents the goals, objectives, and proposed activities of FMRP research in economics and relates these plans to needs with respect to fishery management plans and general monitoring of fisheries in the region.

PACIFIC COOPERATIVE MARINE GAME FISH TAGGING

Since 1954, billfish have been tagged by fishermen particating in cooperative marine game fish tagging programs in many of the major sportfishing areas of the Pacific. The marine game fish tagging program is currently supported by the National Marine Fisheries Service in cooperation with the International Game Fish Association. James Squire, Fishery Biologist at the La Jolla Laboratory, coordinates the program.

A total of 1,006 billfish Pacific-wide were reported tagged and released in 1982, a decline from the 1,207 tagged in 1981. The 1,006 fish included 778 striped marlin (71% of total), 185 sailfish (18%), 28 black marlin (3%), and 16 blue marlin (2%). One swordfish was also tagged and released.

In 1981, the total catch of striped marlin off southern California was about 1,500 fish. This was an excellent fishing year but only 73 fish were tagged and released. In 1982, the catch was smaller by about 500 fish, but because of the additional emphasis by the National Coalition of Marine Conservation on tagging billfish in this area, a total of 82 fish were tagged and released.

A total of 19 billfish tags (17 striped marlin and 2 blue marlin) were reported recovered in 1982 off the coast of Baja California Sur, Mexico, a substantial increase over the 9 reported recovered in 1981. Three of the recoveries were by recreational anglers or sport fishing boat captains, 15 were by Japanese or Korean longliners, and one was recovered by a tuna purse seiner.

Striped Marlin Tracked for 24 Hours Near San Diego

The first extended tracking of a striped marlin, tetrapturus audax was conducted by fishery biologists Dave Holts and Earl Weber on September 21; the fish was tagged with a depth sensitive ultra-sonic transmitter and tracked for 24 hours. The experiment is part of a study aimed at gaining an understanding of the daily horizontal and vertical movement patterns of the striped marlin, swordfish (Xiphias gladius) and thresher shark (Alopias uulpinus). By identifying differences in the daily activity profiles of these pelagic species, the research may assist in resolving conflicts between local sportsmen and the swordfish/thresher shark gillnet fishery. The biologists hope to obtain up to five, 24 hour tracks of each of the species involved.

The marlin was caught and tagged at the edge of a small bank, 28 miles southwest of Point Loma, San Diego. From there it swam north and northwest for 7 hours at about 1.3 knots. The fish then remained fairly immobile, moving only 3 miles in the next 7-hour period between 7:00 p.m. and 2:00 a.m. Between 2:00 a.m. and noon, it moved generally west across deep water to another bank, averaging about 1.7 knots. Its westerly direction of travel was generally "up swell" and into the wind. Tailing "down swell" and basking ("sleeping") behaviors were expected but not observed.

The depth-of-swim profile indicated that the fish stayed at or above 10 m for most of the 24-hour tracking period. At the start of the tracking period the bottom of the mixed oxygen layer was at 12 m. The marlin made only five excursions below 30 m, four of which were between midnight and 5:00 a.m. The deepest was to 74 m just after 3:00 a.m. Tracking was terminated after the 24-hour period.

Richard Johnson, owner and operator of the tracking vessel Marie B, volunteered his time and services for the marlin portion of the study. By the end of September, 14 fishing trips to local marlin waters were completed with two marlin successfully tagged. The first tagged marlin was lost after 15 minutes. This is generally considered a poor year for the striped marlin catch; to date, less than 200 have been landed at the San Diego Marlin Club. Normally by this time of year an average of about 360 striped marlin have been landed.

PACIFIC INTERNATIONAL BILLFISH ANGLER SURVEY

The amount of information available on the catch per unit effort (catch per angler day) for the recreational billfish fishery is small compared to information available for the commercial fisheries. To help close this gap, the Pacific Billfish Angler Survey has been conducted annually since 1969 to determine the trend in billfish catch per angler day for various locations throughout the Pacific. The information derived from this survey is summarized by geographical areas and species caught, and is available to anyone interested in the trend of billfish fishing. These data have been used

by Governments and organizations in development of management plans for billfish fisheries common to their country's waters.

Interest in the trend of billfish catch rates in the Pacific, resulting from data collected by the Billfish Angler Survey, has been growing. The declining trends in catch rate for species such as striped marlin and black marlin have concerned many anglers. In some areas of the Pacific, regulations have been instituted in an attempt to reverse these trends, and the angler survey may provide data relative to the future effects of such regulations.

The 1981 billfish angler survey resulted in data for 11,123 angler days and a total catch of 4,465 billfish (striped, blue and black marlin, Pacific sailfish and shortbilled spearfish). In 1980, a total of 14,943 angler days were reported with a corresponding catch of 5,905 billfish. The 1981 survey response base decreased by 3,820 angler days and the reported number of billfish caught was down by 1,440 fish from 1980.

The Pacific-wide billfish catch rate for 1981 was 0.40 billfish per angler day, or 2.49 days per billfish, unchanged from 1980. Billfish anglers reported a large catch of striped marlin off southern California in 1981, as reflected by a substantial increase in southern California striped marlin catch rates: 0.17 fish per day or 5.58 days per fish in 1981, compared to the long-term average of 0.10 fish per day or 10 days per fish.

Striped marlin catch rates decreased for Baja California Sur, Mexico, from 0.69 fish per day in 1980 to 0.51 fish per day in 1981. Blue marlin catch rates increased slightly in the Hawaii region, while black marlin catch rates declined from a 1980 rate of 0.54 fish per day (1.86 days/fish) to 0.43 fish per day (2.34 days/fish) in 1981.

1972 MARINE MAMMAL PROTECTION ACT

The Southwest Fisheries Center is responsible for research on dolphins involved in the U.S. tuna purse-seine fishery. Since 1971 it has conducted a series of studies directed particularly at the population biology of spotted and spinner dolphins. Highlights for 1982 are: a number of biological studies were executed, a survey to census dophins along 10°N latitude was completed, and techniques for improving precision of estimates of population parameters were developed.

Biological studies that were executed include delineation of dolphin stocks, age-determination, analysis of growth and analysis of reproduction. Two new methods are being investigated for delineating stocks: a nonmetrical technique using skull characteristics is being developed in cooperation with U.S.S.R. scientists and a mitochondrial DNA technique that allows examination of degree of relatedness among dolphins from different areas is being tested. Preparation and readings for age of 1800 samples of spotted dolphin teeth were completed and analysis of the data is underway. The analysis is directed at growth and age-specific reproductive rates.

From May to August 1982, the NOAA resarch vessel, David Starr Jordan, executed a survey in the eastern tropical Pacific for the purpose of censusing dolphins. The survey was concentrated on 10°N latitude and resulted in sighting of 342 marine mammal schools.

A new computerized tracking system, developed to improve precision of sighting angles and location of marine mammal schools sighted on vessel surveys, was "road-tested" for the first time duirng the Jordan cruise. In the past, researchers have had to rely on manual techniques for calculating positions of dolphin schools in relation to the research ship. The new tracking system uses a computer which is rigged to specially mounted, high-powered (25X) binoculars and gyrocompass. Observers use the binoculars to sight schools of dolphins, and the computer records the position of the schools in relation to the line along which the ship is moving. Using the angle between the ship's line of travel and the position of the dolphins, and taking into account the swimming speed of the dolphins and movement of the vessel, the computer can calculate the distance of the school from the ship and eliminate any potential distortion in the sighting data caused by the movement of the ship itself. The sighting information is used to estimate the density of dolphins in a given geographical area.

Another research study that has received attention is the impact upon estimates of dolphin population sizes of the avoidance of observation ships by dolphins before the dolphins are detected by the ship's observers. The dolphin assessment program has conducted a 40-day experiment aboard a NOAA research ship and helicopter in the eastern tropical Pacific (ETP) during March-April 1983, to record avoidance behavior. Marine mammal experts aboard the ship-based helicopter searched ahead of the ship and recorded behavior of the animals as the ship approached. These data will be used to adjust statistical biases in data used to estimate population sizes.

Additional data were gathered in 1983 using another NOAA research ship to further define dolphin stock boundaries and abundance estimates. Marine mammal survey effort was concentrated in the area south of the equator from Peru to the Marquesas Islands. Marine mammal experts searched the ocean's surface to note the occurrence of dolphins. The species of dolphins, the number in each school and its geographic position were recorded for each sighting. These data will be used to determine estimates of population abundances, stock ranges, and estimates of mean school size of animals in the ETP south of the equator.

Analysis of data collected during a 2-month aerial survey is being completed. A report of the experiment including summaries of the data is now available. Analysis of the effects of sun glare, sea states and observer upon the estimates of dolphin school densities is being completed. If these variables do have an impact, it will take the form of underestimates of the number of dolphin schools in the ETP. This data will be used to determine the severity of the bias.

In preparation for a review of the status of the eastern tropical Pacific dolphin stocks in 1984, the SWFC has organized and scheduled a series of review panels that will meet in 1983 and 1984 to review SWFC dolphin research results. These panels consist of expert scientists chosen for their knowledge on topics to be reviewed. So far three panels have met to review SWFC results concerning data sources and definition of species ranges, age determination and precision, and identification of sub-specific stocks and definition of their boundaries.

TUNA BEHAVIOR AND PHYSIOLOGY STUDIES

Work Continued on the Magnetic Compass Sense of Tunas

Michael M. Walker, University of Hawaii graduate student, continued research on the magnetic compass sense of tunas. The behavioral experiments on the ability of yellowfin tuna, T. albacares, to detect changes in the Earth's magnetic field were completed and a manuscript describing the results has been prepared. Continuing this line of research, Walker is now attempting to identify the magnetic receptor organ in tunas. He has successfully extracted, isolated, and photographed magnetite crystals from yellowfin tuna. The magnetite crystals were positively identified as such through a transmission electron microscope. He has also been able to tentatively identify structures that appear to be nerves innervating the suspected magnetic receptor organ in yellowfin tuna.

Other Behavioral Experiments Carried Out

Dr. Kim Holland, Hawaii Institute of Marine Biology, University of Hawaii, is continuing behavioral experiments on the reactions of tunas to natural prey odors, various molecular weight fractions of natural prey odors, and artificial odors (mixtures of amino acids). Holland is working with yellowfin tuna, kawakawa, Euthynnus affinis, and skipjack tuna. He has determined an odor preference hierarchy for yellowfin tuna and is trying to do the same for kawakawa and skipjack tuna for comparison.

In conjunction with Dr. Holland's work, Dr. Richard W. Brill, Leader of the Experimental Ecology of Tunas Program, has been developing techniques to measure the electrical responses of the nasal receptor organ in tuna to odor stimuli. This procedure involves measuring small (0.2 mV or less) direct current electrical potential changes in response to odor presentation. Dr. Brill has been successful in routinely using the procedure in mullet. Although the initial attempts to record "electro-olfactograms" (a quantitative measure of the stimulatory effectiveness of an odor) in mullet were successful, Dr. Brill's attempts to do the same in tuna have been unsuccessful. Work on this project is currently suspended pending a review of methodologies.

Christopher Boggs, University of Wisconsin graduate student, is currently continuing studies on bioenergetics of tunas. Boggs has been using the novel technique of clipping the pectoral fins of yellowfin tuna as a method of inducing an increase in the fish's swimming speed on a sustained basis. This technique will allow him to measure the energy consumption of these animals at elevated swimming speeds.

Finally, Dr. Steve Perry, University of Toronto; Dr. Chuck Daxboeck, Pacific Gamefish Foundation; Dr. Brian Emmett, University of British Columbia; and Dr. Brill have begun a series of experiments on lactate metabolism and acid base regulation following exhausting exercise in tuna. This project may have important implication with respect to the "burnt tuna" problem that currently reduces the value of an important fraction of the catches of large yellowfin tuna destined for the fresh fish market.

Dr. Brill has also been conducting a series of experiments to measure the standard metabolic rate, i.e., the metabolic rate at zero overt muscular activity, of kawakawa. Results so far show that standard metabolic rate of kawakawa is not significantly different from that of skipjack tuna. Additional experiments have shown that, unlike active metabolic rate, the standard metabolic rate of kawakawa is highly temperature sensitive.

Tuna Successfully Tracked Off Kona, Hawaii

Fishery biologist Dr. Richard Brill and Lt. (jg) J. Scott Ferguson, NOAA Corps, conducted fish tracking and other experiments around fish aggregating devices (FAD) off Kailua-Kona in June 1982. The experiments were conducted on board the Honolulu Laboratory's R/V Kaahele'ale. Plans were to determine the short-term movements of large yellowfin tuna and blue marlin, Makaira nigricans, in relation to oceanographic conditions by using depth-sensitive acoustic tags and expendable bathythermographs.

A successful 24-hour track of bigeye tuna caught at 200 m was recorded on cassette tape. The fish ranged from 300 m to the surface at night and generally stayed at 250 m during the day with occasional excursions to the surface. The fish swam around an FAD and tended to prefer 15°C water. An attempt to tag a blue marlin failed when the fish leaped out of the water and threw the tag. The fish was recaptured but a serious eye inury precluded retagging.

Cooperating scientists from the University of Hawaii, Dr. Kim Holland, and Reuben Yost, Zoology Department, tested the effectiveness of natural prey odor released around one of the FADs. Five days of trials with prey odors were run and the tests indicated strong responses from triggerfish, Balistidae, a good response from tunas, Thunnus sp., and a moderate response from skipjack tuna.

HAWAIIAN TUNA FISHERIES

Hawaiian Skipjack Tuna Fishery Monitored

The Honolulu Laboratory is continuing to monitor the Hawaiian pole-and-line skipjack tuna fishery. Since 1978 the total state landings have been estimated by extrapolating the landings made at the tuna cannery at Kewalo Basin by vessels belonging to a boat owners' cooperative. In 1982 it was estimated that the total landings of skipjack tuna amounted to about 1,800 MT. These landings were approximately 2,300 MT below the 1964-79 long-term average. The landings in this fishery have been declining from at least 1976 when the landings were an estimated 4,000 MT.

Since at least about the middle of 1982 the fishermen reported that Pearl Harbor was producing almost no bait and that they were having difficulty finding bait in Kaneohe Bay. Because of the persistent bait shortage problem an informal baitfish workshop cosponsored by the Southwest Fisheries Center, Honolulu Laboratory and the Hawaii Division of Aquatic Resources (HDAR) was held at the Kewalo Research Facility on April 14, 1983. The 71 persons attending the workshop represented leaders of the Hawaiian skipjack tuna industry, boat owners, boat captains, interested fishermen, and scientists from the Honolulu Laboratory, HDAR, the Naval Ocean Systems Center, and the University of Hawaii's Hawaii Institute of Marine Biology. The participants discussed short-term solutions to the current critical bait shortage, particularly for the 1983 summer fishing season, and long-term solutions and goals to assure sustained bait production for the future well-being of the Hawaiian skipjack tuna fishery.

MISCELLANEOUS

WORLD TUNA PRODUCTION AND TRADE*

World Catch Trends and Potential

The world catch of tuna has doubled over the last 20 years, growing from 0.7 million metric tons in 1960 to 1.7 million metric tons in 1980 (Table 1). The rate of growth, however, has been declining. Average annual growth slowed from 5.2% in 1960-70 to 3.7% in 1970-80.

Table 1.--World catch of tuna by country, 1960, 1970 and 1980*

Country	1960	1970	1980
	Thousand metric tons		
Japan	459.9	493.9	704.3
United States	135.1	219.8	225.7
Philippines	11.2	0.3	79.2
Republic of Korea	-	74.8	110.2
Spain	10.9	64.2	89.9
France	31.4	49.5	72.1
Papua New Guinea	-	2.4	26.9
Mexico	0.4	10.2	33.7
Ecuador	19.1	12.5	26.7
Canada	0.2	9.0	0.3
Panama (1)	-	5.6	-
Indonesia	-	12.1	57.2
Peru	27.2	16.1	0.9
Other	36.0	243.2	314.5
Total	731.4	1,213.6	1,741.8

* Includes albacore, yellowfin, skipjack, bigeye and bluefin.
(1) Catch by Panamanian-flag vessels is not necessarily landed in Panama, but landed elsewhere or exported.

SOURCE: FAO Yearbooks of Fishery Statistics.

Japan is the world's leading tuna producer and accounts for about 40% of the world catch. The United States is second, with about 13% of the total. Other countries, however, are increasing their shares of world catch, namely the Republic of Korea, Philippines, Spain, France, Indonesia, and Papua New Guinea.

The United States is the world's leading importer of tuna. Japan is the United States' leading foreign supplier, but other countries have become increasingly important. The United States imported raw tuna from 38 countries or areas in 1982. The Philippines, Taiwan, and Thailand in recent years have expanded their canning operations and their exports of canned tuna to EEC and U.S. markets.

*Principal contributors to this report were John Vondruska and Richard Kinoshita, Industry Economists, National Fishery Economics Program.

Most of the growth in world catch of tuna has been through increased landings of skipjack and yellowfin (Figure 1). Catches of albacore, bigeye and bluefin tuna have remained relatively stable or even declined. Assessment of the status of 25 species or stocks of the world's tuna and billfish suggests that the possibilities of further increases in total world catch are limited. Catches of many species or stocks of tuna are at or near the maximum sustainable yield (MSY).

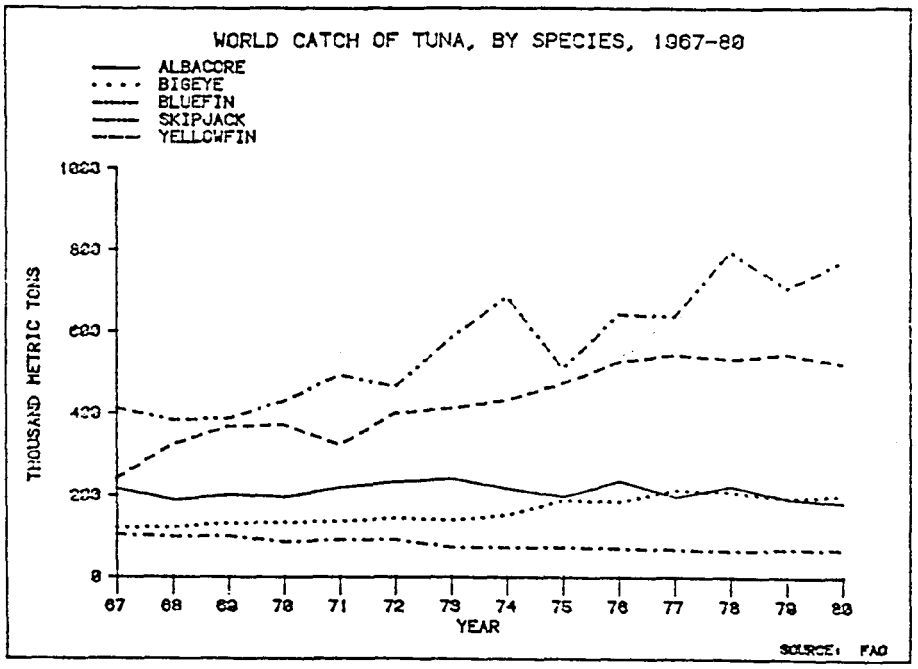

Figure 1

World Trade and Consumption

The United States, European Economic Community (EEC), and Japan together accounted for 89% of world tuna consumption in 1980. The Japanese are the world's leading consumers of tuna, preferring fresh and frozen tuna (the sashimi market), whereas canned tuna dominates in the United States and EEC markets. Japan is the world's leading tuna harvester, and also a leading supplier of both raw frozen and canned tuna to the United States. Nonetheless, Japan imports sizeable quantities of tuna. Two-way trade in tuna occurs between the United States and Japan because of differences in the species composition of catches and consumer preferences. Japanese consumers prefer bigeye and bluefin, which command the highest prices in Japanese markets, whereas U.S. consumers put a premium on albacore.

The United States imports more tuna than any other country or area, followed by the EEC. Net imports in 1980 (imports minus exports) were 184,000 metric tons in the EEC, and 409,000 for the United States, while Japan is a net exporter.

World Production and Trade of Canned Tuna

World production of canned tuna grew more than a third from 1970 to 1980, according to FAO data. Production totaled 567,000 metric tons in 1980, of which the United States accounted for about one-half. Other major producers were Japan, Italy, Spain, and France.

Countries adjacent to the traditional fishing grounds of the U.S. tuna fleet in the Eastern Tropical Pacific produce small amounts of canned tuna, with Mexico packing about one-half of the total. Collectively, these countries produced under 5% of the world production in 1980.

International trade of canned tuna is fairly small, but in recent years it has been growing. Mexico, the Philippines, Thailand, and Taiwan have greatly expanded exports. Because of an embargo by the United States, Mexico's production is being exported to other countries or being consumed domestically.

FADs to be Placed in Southern California Waters

The use of anchored buoys as "fish-aggregating-devices" (FADs) was pioneered in the U.S. by the Hawaii Laboratory of the Southwest Fisheries Center (SWFC). After initial success in Hawaiian waters in commercial and recreational fisheries, the use of FADs spread to many of the islands in the Central and South Pacific. Perhaps the most successful employment of FADs is in the tuna purse seine fishery in the Philippines, where for many years "payaos", rafts constructed of bamboo, have been used to aggregate tunas.

Off the coast of California, bluefin tuna show up regularly in summer and fall, and are caught by purse seiners working out of San Pedro and Port Hueneme. Researchers at the SWFC's Tiburon laboratory believe that FADs deployed at strategic areas may attract and hold the fish, providing the commercial bluefin fishery with a more efficient means of locating tuna. In addition, various recreational species may be attracted to and held by the devices. A cooperative project to install FADs has been initiated by the Fishermen's Cooperative Association of San Pedro, the Southwest Region of NMFS, and the Tiburon Laboratory.

The staff of the Fisheries Development Task at Tiburon is assembling equipment and materials needed to build two FADs. They will be deployed in the vicinity of Sixty Mile bank around June 27, 1983, by the NOAA research vessel David Starr Jordan. The locations will then be monitored to assess the effectiveness of the devices in aggregating fish and contributing to sport and commercial catches. If this pilot project proves to be successful, it is expected that industry will expand it by placing more FADs off California.

PUBLICATIONS

SWFC PUBLICATIONS ON TUNA AND TUNA-RELATED SUBJECTS

MAY 1, 1982 to APRIL 30, 1983

Au, David and Wayne Perryman. 1982. Movement and speed of dolphin schools responding to an approaching ship. Fish. Bull. U.S. 80(2): 396-401.

Eight dolphin schools of the species Stenella attenuata, S. longirostris, and S. coeruleoalba were approached by ship and observed from a helicopter in the eastern Pacific to study their responses to the vessel. All schools swam away from the projected track of the approaching ship. Their movement, relative to the ship, followed paths that curved around the ship. Average swimming speeds while avoiding the ship varied from 5.1 to 8.8 knots. In some cases avoidance apparently began at 6 or more miles away from the ship. The effect of this behavior on shipboard censusing of dolphins is discussed.

Bartoo, Norman and Keith Parker. 1982. Stochastic age-frequency estimation using the Von Bertalanffy growth equation. International Commission for the Conservation of Atlantic Tunas, Collective Volume of Scientific Papers, XVII (SCRS-1981), No. 1, 35-43.

The traditional method of estimating age-frequency from length-frequency via the von Bertalanffy growth equation is deterministic and yields biased results. Most of the bias can be removed by incorporating a stochastic element in the von Bertalanffy relationships. The stochastic element is based on estimated probabilities of lengths by intervals at age, the probabilities being estimated from variances in lengths-at-age. Based on age-length samples from the Pacific bonito fishery the stochastic method gives improved age-frequency estimates over those obtained by the deterministic method.

Dahleim, Marilyn E., Stephen Leatherwood, and William Perrin. 1982. Distribution of killer whales in the warm temperate and tropical eastern Pacific. Rep. Int. Whal. Commn. 32:647-653.

Records of killer whale occurrence for the warm temperate and tropical eastern Pacific Ocean are summarized from 11 strandings/collections and 581 observations. Levels of sighting effort are identified and used to interpret trends in distribution and movement. Killer whales occur from the Gulf of California more or less continuously along the Pacific Coast from 35°N to just below 5°S. Nearly all records off California and western Baja California were within 150 nm of the coast. North of 20°N, there were only four widely scattered offshore sightings beyond 150 nm. South of 20°N, 56.6% of all sightings were within approximately 300 nm of the coast and 78.4% within 600 nm. Two

offshore clusters of sightings occurred, (1) 7° to 14°N, 127° to 139°W and (2) within a band between the equator and 5°N from the Galapagos Islands to 115°W. Herds contained up to 75 animals, with a mean of 5.3 animals per herd. An estimated 91% of the herds contained fewer than 10 animals.

Herrick, S. 1982. Size and species compositions of Atlantic tunas from imports landed in Puerto Rico during 1980. International Commission for the Conservation of Atlantic Tunas, Collective Volume of Scientific Papers, XVII (SCRS-1981), 1, 53-67.

Foreign-caught, imported, Atlantic tunas transshipped to Puerto Rico, U.S.A., are routinely sampled for size and species composition by personnel of the Southwest Fisheries Center. During 1980, transshipment landings of French, Ghanaian, Japanese, Korean-Panamanian and Spanish catcher vessels were sampled. Approximately 3,800 yellowfin, 2,300 skipjack, 1,300 bigeye, and 500 albacore tuna were measured for fork length in 1980. The size compositions of the sampled transshipments were estimated and the results presented.

To evaluate the extent to which Puerto Rican transshipment size composition sampling results agree with the results of landings sampled in Tema, Ghana, where the transshipments orginated, goodness-of-fit tests were conducted to compare the results of the respective sampling programs. Estimated length frequencies from sampling yellowfin and bigeye tuna transshipments of the Ghana-based baitboat fleet obtained in Puerto Rico were tested against expected length frequencies, based upon corresponding landings sampling conducted in Tema. The tests indicated that, in the majority of the cases, statistically significant differences exist between the results of the Puerto Rican and Tema sampling programs.

Kaya, Calvin M., Andrew E. Dizon, Sharon Hendrix, Thomas K. Kazama, and Martina K.K. Queenth. 1982. Rapid and spontaneous maturation, ovulation, and spawning of ova by newly captured skipjack tuna, Katsuwonus pelamis. Fish. Bull., U.S. 80:393-396.

Lo, Nancy, C.H., Joseph E. Powers, and Bruce E. Wahlen. 1982. Estimating and monitoring incidental dolphin mortality in the eastern tropical Pacific tuna purse seine fishery. Fish. Bull., U.S. 80(2):396-401.

Parks, W., F.X. Bard, P. Cayre, S. Kume, A. Santos G. 1982. Length-weight relations for bigeye tuna captured in the eastern Atlantic Ocean. International Commission for the Conservation of Atlantic Tunas, Collective Volume of Scientific Papers, XVII (SCRS-1981), 1:214-225.

Parameters of the allometric length-weight relations were estimated for bigeye tuna (Thunnus obesus) captured in the eastern

Atlantic Ocean. Data were stratified by area, gear and season of capture and by sex. Data were for captures between 30°N and 20°S latitudes and between 30°W longitude and the coast of Africa; data were from all quarters of the year. Data were from 1957 to 1979 with data from 1971 to 1974 comprising 75% of the total. Data were for captures by surface and longline gear.

Analyses of covariance were used to test for differences in length-weight relations related to area, gear, season and sex. Results are tentative due to the lack of data for many strata.

Results were mixed for difference related to area. For those strata for which data are available, there were no significant differences in length-weight relations related to gear of capture. Results showed significant differences related to season capture. Results were mixed for differences related to sex. For some strata differences were significant, for some they were not significant.

Perrin, W.F., and C.W. Oliver. 1982. Time/area distribution and composition of the incidental kill of dolphins and small whales in the U.S. purse-seine fishery for tuna in the eastern tropical Pacific, 1979-1980. Rep. Int. Whal. Commn. 32:429-444.

Data are presented for 4,642 spotted dolphins, Stenella attenuata; 1,745 spinner dolphins, S. longirostris; 99 striped dolphins, S. coeruleoalba, 1,535 common dolphins, Delphinus delphis; two bottlenose dolphins, Tursiops truncatus; one Pacific white-sided dolphin, Lagenorhynchus obliquidens, and one false killer whale, Pseudorca crassidens. Possible source of biases in the samples are discussed.

Perrin, W.F., T.D. Smith and G.T. Sakagawa. 1982. Status of populations of spotted dolphin, Stenella attenuata, and spinner dolphin, S. longirostris, in the eastern tropical Pacific. FAO Fisheries Series No. 5, vol. IV:67-83.

This paper reports progress on assessing the status of three populations of two species of dolphins of the genus Stenella involved in the purse-seine fishery for tuna in the eastern tropical Pacific Ocean. The types of data used, the methods used to collect and analyze them and the main assumptions and other sources of uncertainty in the study - as well as the measures taken in some cases to account for these - are summarized.

The size of the population of offshore spotted dolphins (S. attenuata sub-species) in 1974 was first estimated to be 2.3-4.9 million, based on an aerial survey. The annual capacity for increase (total births minus natural deaths) was estimated to be 1.4-4.0%, and the annual rate of observed incidental mortality, based on an estimated kill in 1974 of 79,900-97,300 animals was estimated to be 1.6-4.2%. Comparison of these rates indicated

that the number of spotted dolphins killed in the fishery in 1974 was at or near the population size between 3.1-3.5 million dolphins (a preferred, central estimate from a larger range), of which 72,000 were killed in the tuna fishery - this gives an incidental fishing mortality rate of 2.1-2.3%. This rate was compared with the annual capacity for increase as originally estimated and with an independently figured estimate of the incidental mortality rate the population could tolerate. The population size of a second dolphin involved in the tuna fishery, the eastern spinner dolphin (S. longirostris sub-species) was given in revised estimates to be between 1.1-1.2 million (also a preferred, central estimate). The number of animals killed incidentally in 1974 was estimated to be 21,000 animals. The resulting incidental mortality rate, 1.8-1.9%, was compared with an estimated annual reproductive rate of 8.3%, the low value of which indicates no apparent response of the population to exploitation. For both the offshore spotted dolphin and the eastern spinner dolphin, the revised estimates indicate that if the sizes of their populations were increasing or decreasing under the levels of fishing mortality in 1974, they were probably doing so at low rates. The impact of the tuna fishery on the whitebelly spinner population (S. longirostris sub-species) has not yet been assessed. There is a need for increased acquisition of relevant biological and catch data, expanded surveys of population size and estimation of certain life history parameters.

Polacheck, Tom. 1982. Local stability and maximum net productivity levels for a simple model of porpoise population sizes. NOAA Technical Memorandum, NMFS, NOAA-TM-NMFS-SWFC-17, 14 pp.

Polacheck, Tom. 1982. The relationship between changes in gross reproductive rate and the current rate of increase for some simple age structured models. NOAA Technical Memorandum, NMFS, NOAA-TM-NMFS-SWFC-19, 9 pp.

Polacheck, Tom. 1983. Possible effects of sampling biases on reproduction rate estimates for porpoise in the eastern tropical Pacific. NOAA Technical Memorandum, NMFS, NOAA-TM-NMFS-SWFC-26.

Sakagawa, Gary T., and Philip E.K. Symons. 1982. The International Skipjack Year Program of the International Commission for the Conservation of Atlantic Tunas. Fisheries, 7(3):12-17.

A four year research program to obtain information for assessing the condition of the Atlantic skipjack tuna, Katsuwonus pelamis, population for developing plans for the rational exploitation of the resource was initiated by the International Commission for the Conservation of Atlantic Tunas (ICCAT) in 1979. The program has so far contributed to the development of a new fishery off Brazil, completed exploration of potential fishing areas in the Caribbean Sea and off Angola, sponsored tagging of 27,000 fish, and generated a considerable amount of fishery statistics and

biological information. Analysis of the data and information is planned for 1982 and a scientific meeting is planned for 1983 to review the results and relate them to the needs of the ICCAT.

Shomura, Richard S. and Walter M. Matsumoto. 1982. Structured flotsam as fish aggregating devices. NOAA Technical Memorandum, NMFS, NOAA-TM-NMFS-SWFC-22, 9 p.

A modern adaptation of an old fishing technique is gaining recognition in the Pacific and elsewhere as an effective means to increase fishing productivity in the open sea. The use of manmade, free floating, and anchored floating devices to aggregate pelagic fishes for subsistence, recreational, and commercial fishing has increased markedly in recent years; estimates of deployed and planned units exceed 1,000. These devices have been anchored in depths ranging from several hundred to several thousand fathoms. This report reviews the development and present use of fish aggregating devices in the Pacific and Indian Oceans.

Smith, Tim D. 1982. Testing methods of estimating range and bearing to cetaceans aboard the R/V David Starr Jordan. NOAA Technical Memorandum, NMFS, NOAA-TM-NMFS-SWFC-20, 30 pp.

Smith, Tim D. 1982. Current understanding of the status of small cetacean populations in the Black Sea. FAO Fisheries Series No. 5, vol. IV:121-130.

A fishery using guns and nets for the common dolphin, Delphinus delphis, Azov dolphin Phocoena phocoena, and bottlenose dolphin, Tursiops truncatus, in the Black and Azov Seas has been pursued since about 1870 from the USSR, Turkey, Bulgaria, and Romania. Steadily declining annual Soviet harvests since the maximum Soviet catch of 135,000-140,000 animals in 1938, despite an increased catching effort, led to seasonal management restrictions by the USSR in 1962, and a complete closure of the fishery in the USSR, Romania, and Bulgaria in 1967. The final annual Soviet catches of 5,600-7,400 animals reported for 1964-66 represent a major collapse of the fishery and were accompanied by apparent marked changes in the age and sex composition of the harvest and a change in the species composition from the historically predominant D. delphis to predominantly P. phocoena. The fishery continues in Turkey with recent reported annual catches approaching the 1938 Soviet maximum: the loss rate is estimated to be high because of the use of guns as the harvesting method.

Limited catch statistics are available since 1927, except for Romania, and are generally reported only for all species combined in total metric weight. Analysis indicates that the exploitation rate was probably excessive at the height of the fishery in 1936 (12.5-20.0%) and may remain so today for the Turkish fishery (7.9-100.8%).

Annual Soviet aerial surveys initiated since the 1967 moratorium provide questionable estimates of total population size of Black Sea porpoises. Problems with these estimates and probably also with kill estimates preclude definite understanding of the present state of the population and indicate the need to refine both these statistics. Present observations are confined to recognition that the numbers of porpoise in the Black Sea have declined substantially to marginal levels due to the direct fishery; the present Turkish fishery is important, particularly as it continues now when stocks are probably reduced.

Squire, James L. 1982. Catch temperatures for some important marine species off California. NOAA Technical Report, NMFS SSRF 759, 19pp.

Airborne sea surface temperatures surveys using infrared techniques were conducted monthly off the central and southern California coast, 1963 through 1968, by the National Marine Fisheries Service in cooperation with the U.S. Coast Guard. The resulting temperature data were matched to commercial sportfishing boat catch data to determine the relationship between catch and temperature for the following major sport species: chinook and silver salmon, Oncorhynchus tshawytscha and O. kisutch; yellowtail, Seriola dorsalis; Pacific bonito, Sarda chiliensis; Pacific barracuda, Sphyraena argentea; white seabass, Atractoscion nobilis; and albacore, Thunnus alalunga.

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Katakura, Genji. 1982. The efficiency of calcium chloride brine freezing (Enkalu burain tōketsu no kō). Suisan Shuho (The Fishing and Food Industry Weekly) 946:50-56. (Engl. transl. by Tamio Otsu, 1982, 11 p., Transl. No. 77, available Southwest Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Honolulu, HI 96812.)

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Bartoo, N. and S. Kume (eds.). 1982. Report of the seventh North Pacific Albacore Workshop. SWFC Admin. Rep. LJ-82-28.

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Graves, J.E., and R.M. Laurs. 1982. Phosphoglucose isomerase phenotypes of inshore and offshore populations of North Pacific albacore. SWFC Admin. Rep. LJ-82-11.

Hendrix, Sharon D. 1982. Factors affecting the growth and survival of skipjack tuna, Katsuwonus pelamis, larvae reared in the laboratory. SWFC Admin. Rep. No. H-82-23C.

Hendrix, Sharon D. 1983. The early life history of mahi mahi (Coryphaena hippurus and C. equiselis) and skipjack tuna (Katsuwonus pelamis): A report on the culture and growth of larval fish reared in the laboratory. SWFC Admin. Rep. No. H-83-2C.

Herrick, S.F., Jr. 1983. Proceedings of the 33rd Annual Tuna Conference. SWFC Admin. Rep. LJ-83-02.

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