THE INTERNATIONAL SKIPJACK YEAR PROGRAM OF THE INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS

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ABSTRACT

A four-year research program to obtain information for assessing the condition of the Atlantic skipjack tuna, *Katsuwonus pelamis*, population and 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 27,700 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.

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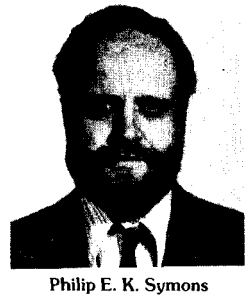

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All of the principal tuna species except the skipjack tuna, *Katsuwonus pelamis* (Fig. 1), are believed to have reached or are fast approaching full exploitation at their maximum sustainable yields. Skipjack tuna is believed to constitute a vast pelagic resource that is underutilized and is viewed as a source for new raw material to meet a growing demand, particularly for canned tuna (Matsumoto 1974). In 1979, the yield of skipjack tuna from the world's oceans was approximately 700,000 tons. It is estimated that this production can be increased by as much as 1.5 million tons if the stocks become fully exploited (Kawasaki 1973). While there has been some doubt that such a large yield is available (Kawasaki 1973), there is evidence that vast areas of the oceans where skipjack tuna occur are not currently fished except by local, small-scale fisheries, and several nations are building large tuna fleets to take advantage of this opportunity. In the Atlantic Ocean, for example, most of the fishing for skipjack tuna is conducted in the eastern part by large purse seiners and baitboats. In the western part, the fishery is less developed and involves primarily local, small boats.

Between 1969 and 1974, the skipjack tuna catch in the Atlantic increased substantially from 28,000 tons to 118,000 tons (Fig. 2), surpassing the catch of any of the other major tuna species(bluefin, yellowfin, bigeye, and albacore). Then, in 1975, it fell sharply to 61,000 tons before recovering to 118,000 tons in 1977. More recently, the catch decreased between 1977 and 1979 and increased since then, recording a record high of 139,000 tons in 1981. About 97% of the catch is from the eastern Atlantic and the skipjack average about 45 cm long.

In 1975, the International Commission for the Conservation of Atlantic Tunas (ICCAT), an organization chartered to maintain the Atlantic tuna stocks at levels permitting maximum sustainable yields, took note of the growing fleet of particularly large purse seiners and the sharp decline in catch. It immediately initiated a special investigation to determine the condition of the stocks. The investigation showed that information upon which to base an adequate assessment was not available although there was a general feeling among scientists that the stocks were not yet fully exploited (ORSTOM 1976). Consequently, the Commission's Standing Committee on Research and Statistics (SCRS) recommended in November 1976 that research be expanded to obtain information for an adequate assessment and for rational exploitation of the resource. A working group was convened in August 1977 to develop a detailed Atlantic-wide research plan for skipjack tuna. The plan (ICCAT 1978) consisted of a set of activities to be executed during a four-year period, starting in 1978, with the goal of answering four questions:

A. Can catches be increased by fishing new areas and new stocks, especially in the western Atlantic?

B. Can catches be increased by fishing larger fish, especially fish over 5 kg?

C. What could be the effects of the above increased fishing on the existing fisheries?

D. How can better assessments of the stocks be obtained by using information from the existing fisheries?

A sum of $685,000 was estimated to be required to support activities of the plan and for coordinating services of the four-year program. In addition, participating countries would provide "matching" support through contribution of vessel time, scientific personnel services, equipment, etc., for executing the activities.

A year later, after some modifications, the Commission approved the plan and budgeted $522,000 for the program to begin in 1979 (ICCAT 1978, 1979). Since then, the SCRS, through a Submcommittee on Skipjack Tuna along with the ICCAT Secretariat and scientists from several countries, has guided the

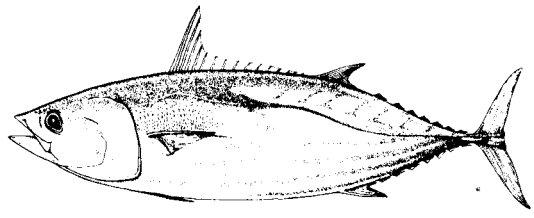

Figure 1. Skipjack tuna, *Katsuwonus pelamis*, is an underutilized resource that could fill growing demands for canned tuna. Individuals can reach a length of 80 cm long but are usually caught in the Atlantic Ocean when about 40–50 cm long.

execution of the plan.

This report describes the progress of the ICCAT International Skipjack Year Program to date and outlines program events that are to follow.

THE PROGRAM, ITS SCHEDULE AND MANAGEMENT

The International Skipjack Year Program is an ICCAT-coordinated research effort that is tailored to address the four questions mentioned above. The program relies on participating organizations to provide the bulk of the resources to execute the activities and the ICCAT Secretariat to provide coordinating services. It is not a program in which participating organizations contribute money to ICCAT which is then parceled out to individual scientists to conduct the research.

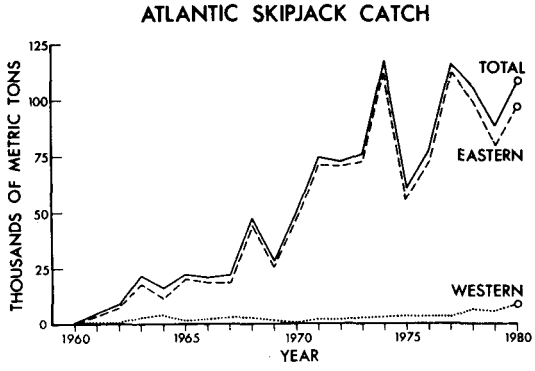

Figure 2. Skipjack tuna catches by regions of the Atlantic Ocean, 1960–1981.

Soon after the Commission approved the program in November 1978, the Secretariat recruited a full-time program coordinator. In April 1979, the coordinator entered on duty and detailed planning of research activities commenced in earnest.

A schedule for the program was first developed in 1977, but was modified in 1978. The final schedule developed for the program consists of four phases, corresponding to each of the four years 1979-1982 of the program (Fig. 3). The first phase, which was largely completed in 1979, involved detailed planning of research activities and preparations for execution of these activities. This was followed by a second phase (1980) which consisted of small-scale experiments to test research designs, and analyses of historical data for improving the designs and

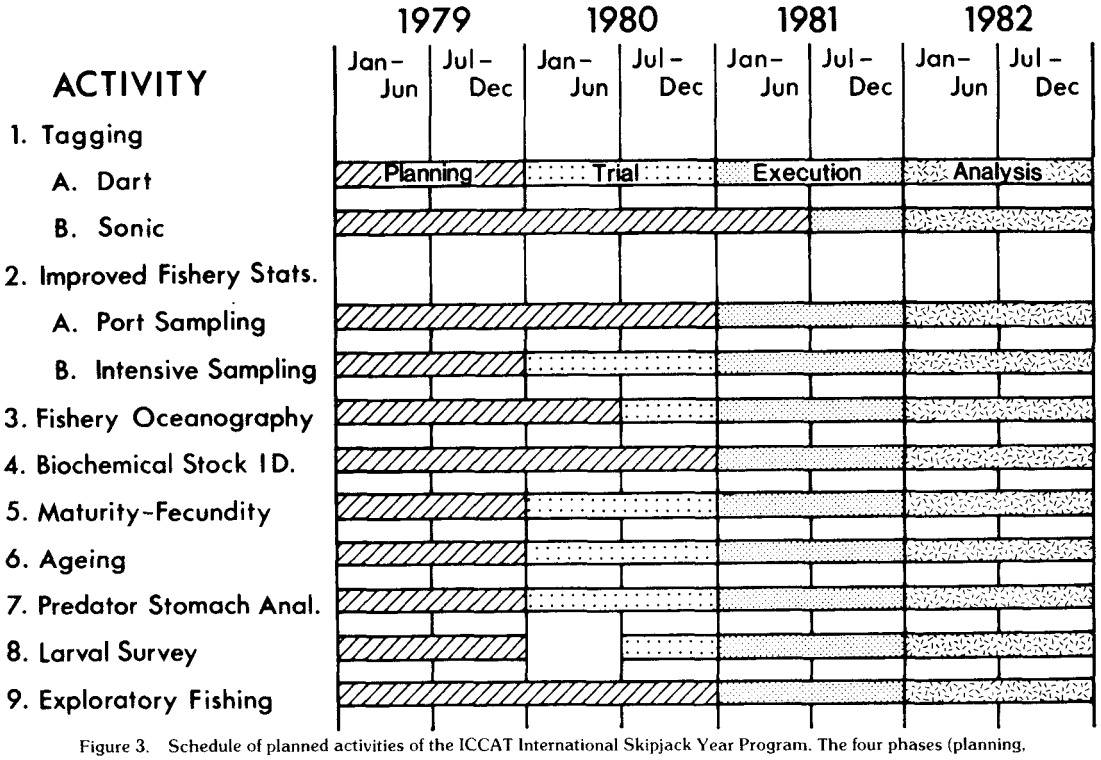

Figure 3. Schedule of planned activities of the ICCAT International Skipjack Year Program. The four phases (planning, trial, execution, and analysis of the program) are shown.

preparations for field experiments. The third phase (1981) involved the execution of all program activities. In the final phase (1982), data and information collected in 1980 and 1981 will be analyzed and evaluated. Dismantling of the program also will begin during this final phase. In 1981, the Commission approved a one-year extension of the program so that a scientific conference to discuss the results of the program can be organized for the summer of 1983.

The program is "steered" by a subcommittee composed of scientists from all participating ICCAT member countries. The current members of the ICCAT are Angola, Benin, Brazil, Canada, Cape Verde, Cuba, France, Gabon, Ghana, Ivory Coast, Japan, Korea, Morocco, Portugal, Senegal, South Africa, Spain, the United States, and the U.S.S.R. One of the scientists on the subcommittee is appointed Convener, to be responsible for calling meetings, for delegating work among members of the Subcommittee and invited scientists, and for serving as the interface between the Subcommittee and the Secretariat. In this capacity the Convener works with the Program Coordinator, a staff member of the ICCAT Secretariat who manages the day-to-day affairs of the program, and the SCRS Chairman, who oversees the scientific affairs of the ICCAT.

PROGRAM ACTIVITIES

Nine activities (Fig. 3) were identified for the program, each designed to provide information to answer the program questions. These activities may be loosely grouped according to the program questions they are designed to address.

Can New Areas Be Fished and Larger Individuals Exploited?

There are four activities aimed primarily at these questions: fishery oceanography, larval surveys, predator stomach analysis, and exploratory fishing.

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Fishery oceanography has two objectives: (1) To investigate the relation between environmental factors (such as temperature, oxygen concentration, sea state) and fishing success. Weather and oceanographic data from many sources—including satellites, oceanographic and merchant vessels, and fishing vessels—are to be collected and analyzed with data on fishing success kept by fishermen or technicians aboard fishing vessels. (2) To identify areas of the Atlantic Ocean where skipjack tuna might occur, but where fisheries are not currently present or developed. Skipjack tuna is primarily a tropical species having broad habitat requirements. Analysis of environmental data on habitat requirements of skipjack tuna will be used to identify areas for development of new fisheries.

Larval surveys are to be conducted to identify new spawning areas where large, adult skipjack tuna may be present. These new areas may be suitable for developing new fisheries.

Analysis of the stomachs of large predators, particularly billfishes (Istiophorids), for the presence of juvenile skipjack tuna provide information on the distribution of juveniles, and more importantly, the possible presence of adult skipjack tuna (Yoshida 1971). This too is another means of identifying new areas where adult skipjack may be available for fishery development.

Activities of fishery oceanography, larval surveys, and predator stomach analysis provide information on where exploratory fishing can be most profitably performed. Exploratory fishing in new areas should provide information on the presence or absence of skipjack tuna and also their abundance in quantities for commercial fishing development (Fig. 4). For this purpose, carefully collected statistics and biological samples are part of the program plan.

Will New Fisheries Affect Existing Fisheries?

Recurrent questions for the management of any fishery are "how many breeding populations make up the exploited stock, and what is the degree of exchange between these populations?" If an exploited stock is composed of separate breeding populations, management strategies may have to be devised for each population individually to obtain desired yields while preventing overfishing or underutilizing one or more populations.

The contribution of larval surveys and predator stomach analyses to the location of spawning grounds and the determination of spawning stock separation has already been mentioned. Other activities which contribute directly to this knowledge are tagging and biochemical stock identification.

The tagging activity consists of two parts: (1) tagging with dart tags and (2) tagging with sonic tags. Dart tags consist of individually numbered spaghetti-shaped, 15-cm lengths of plastic with a barb-like point of hard plastic at one end (Yamashita and Waldron 1958). The point is inserted and anchored in the dorsal muscle of the skipjack in an operation that ideally keeps the live fish out of water no longer than 5 to 7 seconds. From the release and recovery of such tagged fish, information is obtained on movement, age and growth, survival and exploitation rates.

Sonic tags emit an ultrasonic signal that may be coded for transmittal of data, such as depth and temperature. The battery-powered signal is detectable with hydrophones over distances usually less than one kilometer and over a period of several days. The released fish is tracked closely by boat during this period. This activity is designed to investigate the daily movements of skipjack tuna and patterns of swimming behavior (Yuen 1970). This information is important to studies of migration and availability of skipjack tuna to the fisheries.

Biochemical stock identification is an activity that compares the frequency of occurrence of certain proteins among skipjack

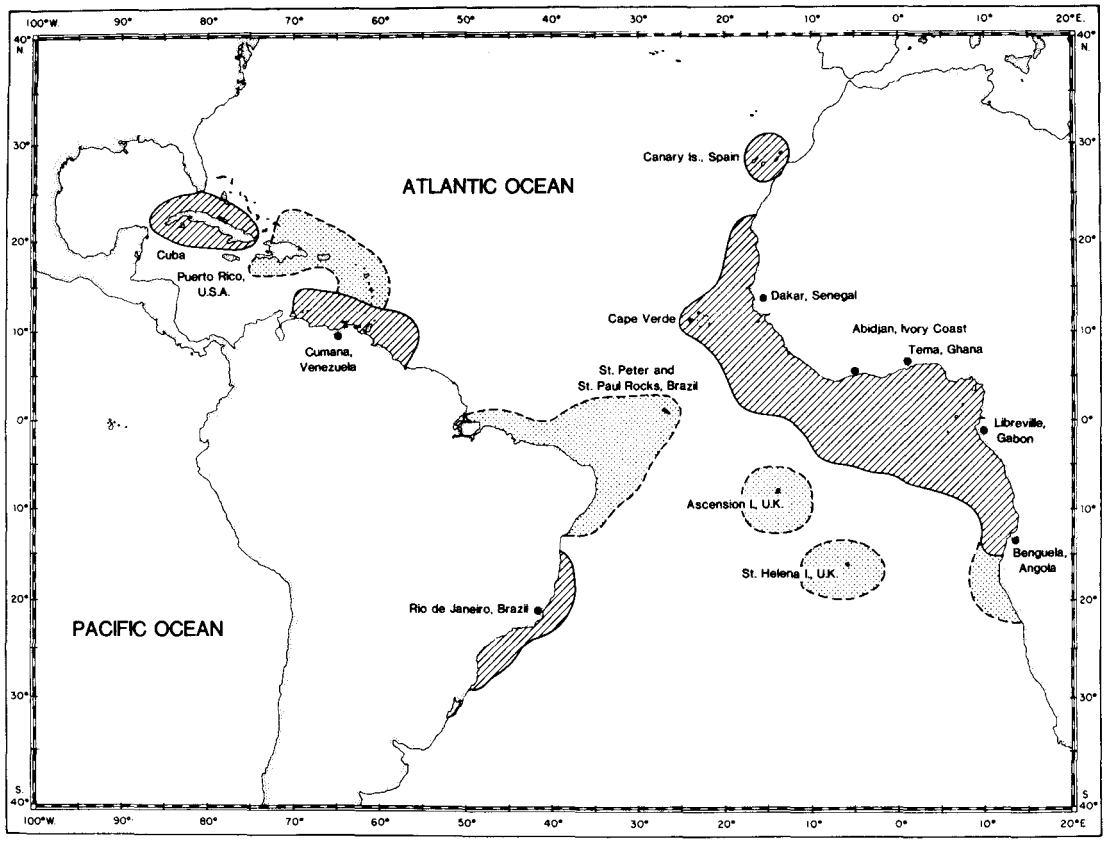

Figure 4. Areas of the Atlantic Ocean where current fisheries for skipjack exist *(hatched)* and where exploratory fishing is suggested *(stippled)*.

tuna of a group caught at one location with the frequency of these proteins in another group caught at the same or another location (Fujino 1970). If the frequencies are sufficiently different between the two groups, they may be from diffierent genetic populations. The sampling design and statistical analysis of data for this activity are complex, but a modest effort will be made to use this tool to detect differences between eastern and western Atlantic skipjack tuna.

How Can Assessments of Stock Condition Be Improved?

There are three activities that are directed primarily at answering this question: a study of maturity-fecundity, age determination, and an activity aimed at improving the collection of fishery statistics. One principle of fishery management is to maintain the spawning stock at a level sufficient to produce young to replace losses from fishing and natural causes. Size, age at maturity, sex ratio, and number of eggs produced by a mature female are types of information that contribute to determining the condition of the spawning stock. These data will be assembled from the maturity-fecundity activity.

Because skipjack tuna is a tropical species, individuals do not show typical annuli on scales or other hard parts as found in individuals of more temperate species. Fine rings on otoliths and bands on dorsal fin spines of skipjack tuna have been reported and used for aging with limited success (Batts 1972; Wild and Foreman 1980). A special study will be initiated with tagged and tetracycline-injected fish to determine timing of formation of rings on otoliths and bands on dorsal fin spines for aging purposes.

Besides the need to determine age and fecundity of skipjack tuna, there is also the need to determine just how much fishing effort is expended annually to catch skipjack tuna, how many fish are caught, and where they are caught. These data are indispensable for developing models from which to assess the effects of exploitation on each population. Currently, catch and fishing effort statistics for skipjack tuna are incomplete, and fishing effort statistics are intermeshed with statistics for yellowfin tuna, *Thunnus albacares*, because the tuna fleets search and catch both species simultaneously (Sakagawa, Coan and Murphy 1977). To resolve this situation, two sub-activities for improving statistics have been devised: increased or improved "port sampling" and "intensive sampling" of vessels.

The port sampling activity has been designed to collect fishery data at every major skipjack tuna landing port in the Atlantic. The catches, the sizes of fish in the catches, and the time spent by vessels in searching and catching skipjack tuna will be measured. This information will be used in stock assessment models as well as in determining the levels of port sampling coverage that is necessary to monitor the fishery accurately on a routine basis.

Intensive sampling, in contrast, is designed to collect fishing operations data aboard purse seiners and baitboats during a short period and within a small fishing area of the eastern Atlantic. These data will be used to study the performance of the different fleets, procedures for accurately measuring fishing effort

on skipjack, and the relationships between abundance, catch-per-unit of effort, fishing effort, and fishing mortality. Collectively, this information will contribute to improving ICCAT's ability to assess more accurately the condition of the skipjack tuna stocks.

THE PRIMARY ACTIVITIES

Of the nine planned activities (Fig. 3), three are of primary importance to the program because they provide a focus for field collection of data and information upon which the other activities depend.

These primary activities are exploratory fishing, tagging, and improved statistics. Vessels used in exploratory fishing, tagging, and intensive sampling can be used to collect fishery oceanography and fishing operations data, gonad samples for the maturity-fecundity activity, blood samples for the biochemical stock identification activity, plankton tows for larval fish examination, and samples of stomachs from large pelagic species for the predator stomach analysis activity. Samples of gonads and stomachs, and tag return information can be collected by persons sampling catches at landing ports.

ACCOMPLISHMENTS IN 1979, 1980, and 1981

Detailed planning of activities and analysis of historical data were completed in 1979. Field trials were performed in 1980 and all activities were executed in 1981, the International Skipjack Year. Complete results on the activities are not yet in and analyses of data and information collected are currently underway; however, the program has already yielded some noteworthy accomplishments, particularly from the primary activities.

Exploratory Fishing

Exploratory fishing is an activity with unique political and industrial sensitivities. Discoverers of new fishing areas naturally feel they should have first rights to the fruits of their investments. If this new fishing area should be within the territorial waters or fisheries conservation zones of foreign nations, the importance of politics is obvious. Moreover, skipjack tuna are migratory and development of new fishing areas can influence fishing performance elsewhere. While this migratory habit of skipjack favors—indeed necessitates—international cooperation for the management of the resource, the nature of exploratory fishing itself tends to favor private undertakings. The role of the ICCAT in this activity, therefore, has been important but limited.

The Commission has functioned thus far as a center for dissemination of plans and information on where and how exploratory fishing should best be carried out. During the planning phase, several areas for skipjack tuna exploration were identified from existing data on larval distribution, catches of local fisheries, performance of past exploratory cruises, and oceanography (Evans, McLain and Bauer 1981). Included in the list was the area off Rio de Janeiro, Brazil (Fig. 4): exploration occurred here in 1978 and 1979 and a new and growing fishery (catch of 20,000 tons in 1981) has developed since then. Other areas identified for exploratory fishing include the Caribbean Sea, an area off the northeast tip of Brazil to the islands of St. Peter and St. Paul Rocks in the western Atlantic, and waters off Angola, St. Helena Island, and Ascension Island in the eastern Atlantic (Fig. 4).

In 1980 and 1981, exploratory fishing cruises were conducted in the Caribbean Sea and off Angola. One cruise (U.S.A.) during February through April 1980 explored the region of the Caribbean Sea from the Dominican Republic to the coast of Surinam (Rinaldo, Evans and Vergne 1980). In 54 days of fishing operations, 143 fish schools were sighted. Skipjack tuna was the primary species in 38% (54 schools) of these schools. Most of the schools consisted of tuna and were 10–20 tons in size.

Nine exploratory fishing cruises (Cuba) were executed off the southeastern coast of Cuba during May to August 1981. Skipjack tuna was found to be low in abundance and of sizes less than 30 cm long (ICCAT 1981).

An exploratory cruise (U.S.S.R) was conducted off Angola in 1980. Only 11 schools of skipjack tuna were sighted during that cruise.

Tagging

An ambitious activity of tagging skipjack tuna with dart tags was conceived for the program, with plans to single- and double-tag as many as 30,000 skipjack tuna in 1980, and 50,000 in 1981 in both the western and eastern Atlantic. The plans also called for as many as 35,000 of the tagged fish to be injected with tetracycline to investigate the rate of deposition of growth rings on spines and otoliths for age determination studies.

To encourage return of recovered tags, ICCAT established awards of $4.00 or a T-shirt (with the emblem of the International Skipjack Year Program) per tag and two $500 annual lotteries. One lottery is for returns from the western Atlantic and the other for returns from the eastern Atlantic.

In 1980, approximately 9,200 fish were tagged, including about 6,000 skipjack tuna by a charted commercial baitboat (Japan) working in the Gulf of Guinea and 1,400 skipjack tuna by a chartered commercial baitboat (U.S.A.) working in the Caribbean Sea. The remainder were released in the eastern Atlantic by commercial vessels (Korea and Spain) on an opportunistic basis and by research vessels (France) temporarily modified for fishing and tagging of skipjack tuna.

While these 1980 efforts did not result in the desired number of tag releases, they were important in providing participating scientists an opportunity to test and perfect their tagging procedures and to conduct ancillary research, particularly research involving collection of biological samples.

In 1981, scientists from nine countries participated in tagging of approximately 18,500 skipjack tuna. All except about 600 fish were tagged in the eastern Atlantic. Major release sites were the Gulf of Guinea, 12,200 fish (Japan and Ivory Coast); around Cape Verde Islands, 2,700 fish (Cape Verde); off Senegal, 2,500 fish (Senegal); around the Canary Islands, 700 fish (Spain); and off Cuba, 600 fish (Cuba).

Tag returns of skipjack tuna released in 1980 and 1981 are being received by ICCAT and are expected to continue through 1983. So far the results show that (1) the recovery rate is variable, from 0 to 18%; (2) most of the tags are recovered in the general area of release; and (3) a few long-distance recoveries within a year of release have been reported. Noteworthy among these is a skipjack that was tagged in the Canary Islands and recaptured off Senegal, a distance of approximately 1,700 km, and five skipjack that were tagged off Ghana and recaptured off Senegal, a distance of approximately 2,800 km.

Lotteries for tags returned in 1980 were held in March 1981, with a winner from the United States and a winner from the Ivory Coast. Lotteries for 1981 returns are scheduled for 1982.

Improved Statistics

Getting this activity underway required two concerted actions: (1) arranging for the placement of trained technicians at landing ports (Port Sampling) and aboard vessels (Intensive Sampling) and (2) preparing detailed instruction manuals for the sampling work so that data are comprehensive and collected in a standardized manner.

Of the 19 member countries of the ICCAT, 17 fish for skipjack tuna, although the landings by local (artisanal) fisheries in some of these countries appear to be small. In addition, there are several non-member countries, particularly in and around the Caribbean Sea, whose artisanal fisheries land some skipjack and where, in at least one country, catches may be landed or transshipped by foreign vessels in quantity. Most member countries planned to sample landings at their major ports at least through 1981, and most were able to mount substantial effort, sometimes in cooperation with another country or with the financial assistance of the ICCAT.

Plans for intensive sampling called for placement of trained observers aboard purse seiners and baitboats fishing in the Annobon area (Gulf of Guinea) during July and August and in the Cape Verde Islands area during August through October in order to collect detailed data on searching and fishing operations and on the catches. For 1980, each member country was asked to place one observer aboard at least one vessel to obtain experience and to polish data collection procedures. For 1981, the year of maximum effort, nine member countries were asked to place observers on 20–25% of their vessels that fish in the experimental areas.

France and Spain were able to place an observer on one purse seiner each in 1980. Japan also placed an observer on a baitboat in 1980. Other countries had difficulty in funding this activity or had difficulty obtaining cooperation from their tuna fishing industries. Because it was evident that this situation would not improve in 1981, plans were scaled down to one experimental area, Annobon, for 1981.

In 1981, data were collected by scientists from France, Senegal, and the Ivory Coast on eight purse seine cruises, Spanish scientists on five purse seine cruises, and Japanese scientists on two baitboat cruises. Data collected on these cruises are being prepared for analyses and are proving to be useful in understanding the searching behavior of the vessels. However, because the number of vessels observed was less than planned, these data probably will not be adequate for performing planned analyses with the same confidence as was hoped.

EVENTS TO FOLLOW

The concept of an International Skipjack Year Program was formulated to encourage a concerted research effort by all interested ICCAT member countries by pooling their resources and performing their research in an integrated manner. In this way, the countries would avoid the costs of extended piecemeal research projects and unnecessary duplication of effort. While the field work for the program officially terminated at the end of 1981 and the program ends officially in December 1983, some field work is continuing into 1982 and improved procedures for data collection are being retained in routine fishery monitoring activities of member countries.

Analysis of data collected in 1980 and 1981 is currently underway and will probably continue for several years after the official termination of the program. A scientific conference is scheduled tentatively for 1983, when the results from the program will be reviewed and related to general stock assessment needs of the ICCAT.

One peripheral issue in ICCAT that will benefit from results of the program is that of appropriate regulations for protecting juvenile tunas from capture in multi-species fisheries while maintaining optimum yield-per-recruit. ICCAT currently has a minimum-size regulation of 3.2 kg (approximately 55 cm) for yellowfin tuna and bigeye tuna, *Thunnus obesus*. Because undersized bigeye and yellowfin tunas often occur in mixed schools with skipjack tuna, fishermen have claimed that the regulation discourages full utilization of the skipjack resource and is not having the desired effect. Mixed schools must either be avoided, or, if fished, the undersized bigeye and yellowfin tunas must be discarded, usually dead. This results in economic loss to the fishermen and loss in potential yield from the bigeye and yellowfin tuna stocks. Attempts have been made to develop models showing how catches would be altered under different sets of alternative regulations, but these have concluded that information was insufficient for proper evaluation of alternatives. When results from the Skipjack Program have been processed, further analyses can be performed to find a solution to this complex, practical problem.

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