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ANALYSIS OF INTERACTION BETWEEN TUNA FISHERIES IN THE CENTRAL AND WESTERN PACIFIC OCEAN

(Paper prepared by the Secretariat)

1.0 INTRODUCTION

Tuna fisheries have traditionally occupied a central position - encompassing cultural as well as nutritional aspects - in the life of many Pacific Island countries. Since the widespread acceptance of 200-mile exclusive economic zones (EEZs), local control of marine resources has become more certain, and tuna fisheries have taken on a new importance. Licensing of distant-water fishing fleets to fish for tuna in the EEZs of some countries has created an important new source of foreign exchange revenue which, for some countries, may be the largest single such source. There are also opportunities for the development of national capability in all aspects of the fishing industry, and many countries have begun to plan development of both tuna fishing fleets and shore-based facilities such as markets, canneries and shipyards. The long term success of these ventures depends ultimately on the magnitude of the tuna resource and the extent to which it can sustain exploitation.

The South Pacific Commission (SPC) is currently involved in tuna fisheries development through its Tuna and Billfish Assessment Programme. The mandate of the Tuna Programme is to conduct scientific research on tuna and billfish in support of fisheries development in the region. This research is conducted at the request of SPC countries and the results and progress are regularly and closely scrutinized. The customers of the research results are the island states of the region and co-operating regional organisations such as the Forum Fisheries Agency (FFA). The Tuna Programme maintains close and collaborative relations with fisheries

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departments in the island states and with the FFA to ensure that the research results are accurate, timely and useful.

The SPC previously conducted an extensive tagging experiment in the central and western Pacific Ocean. The goals of this experiment were to (a) survey the distribution and assess the abundance of skipjack and baitfish resources, (b) analyse the structure and dynamics of skipjack populations, and (c) obtain information on the migration patterns of skipjack in the region as a means of determining the effects of neighbouring fisheries on one another. Over 150,000 tuna were tagged and released between 1977 and 1980 throughout the South Pacific Commission region. The information derived from the 6,200 skipjack tags returned and the biological data collected during the course of tagging activities were used to meet these goals.

It was shown that skipjack are capable of extensive migrations and that there are no clearly differentiated geographic stocks. The standing stock of skipjack in the region as a whole was estimated to be very large and could be exploited at a rate many times the pole-and-line harvest at the time (220,000 tonnes per year). Reports on the skipjack and baitfish resources of individual countries and territories were prepared and are in use by fisheries officers and planners throughout the region. These reports indicate that while the skipjack resources of the whole region are very large, a significant proportion of the annual production is harvested in some countries. Analysis of interaction based on migrants between widely separated pole-and-line fisheries for which data were available indicated very low levels of interaction between existing fisheries.

In the relatively short time that has elapsed since the previous tagging work was initiated, a number of radical changes have occurred in the tuna fisheries of the Pacific Ocean. Lured in part by the large stocks estimated by the SPC, large scale purse-seining has been introduced with impressive success, and catches have increased from very low in 1978 to over 350,000 tonnes in 1984. At the same time, the importance of pole-and-line fishing has diminished. Nevertheless, aggregate fishing effort has increased and total catches have doubled. The total catch of skipjack by all gears in the region for 1984 was approximately 400,000 tonnes and for yellowfin tuna over 160,000. The purse-seine catch of yellowfin tuna currently exceeds that of the longline fishery, and preliminary analyses of the data in SPC files indicate that purse-seine catches of yellowfin may be adversely affecting the efficiency of the longline fishery. Since the price of longline caught yellowfin is many times greater than that of purse seine caught fish, such interactions have potentially adverse economic impacts.

These dramatic developments have stimulated great concern on the part of island states for the potential interaction between fisheries of all types. In recognition of this concern, the Twenty-Third South Pacific Conference in October 1983, representing all 26 countries and territories of the SPC, assigned highest priority to the "assessment of interaction between fisheries" in the work of the Tuna and Billfish Assessment Programme. Further, a meeting of coastal states and distant-water fishing nations, convened in June 1984 to increase the inputs to the Tuna Programme, also expressed great concern over various aspects of interaction between tuna fisheries.

In order to better assist countries of the region in planning their fisheries development, the SPC is proposing a tagging programme to be conducted by the Tuna and Billfish Assessment Programme; this programme is expressly designed to provide practical answers to the questions raised by fisheries interaction. Specifically, three aspects will be addressed: (a) interaction between artisanal and industrial fisheries operating in coastal waters, (b) interaction between fisheries of all types operating in adjacent EEZs, and (c) interaction between different gear types operating on the same fishing ground.

1.1 Objectives

The objectives of the tagging programme are:

(a) to use a generalised quantative description of the movements of skipjack and yellowfin to estimate interactions between tuna fisheries in areas where several different fisheries operate concurrently;

(b) to further use the description of tuna movements to predict interactions for projected fishery developments;

(c) to provide estimates of yellowfin tuna population parameters for selected areas of currently intense fisheries;

(d) to provide updated estimates of skipjack tuna population parameters for selected areas where fishing has increased since 1980;

(e) to provide assessments of the potential for further expansion of tuna fishing in the region.

1.2 Benefits

(a) Countries will be provided with an additional tool for determining the optimum development and management plans of tuna fisheries within their zone.

(b) Countries will be able to determine the extent to which distant-water fishing fleets may operate within their EEZs without significantly impeding operations of their national fleets.

(c) It will be possible to gauge the impact on tuna fisheries of the major changes in fishing practices that have occurred since 1980.

(d) Estimates of yellowfin tuna population parameters will be available.

(e) Participation in the field operations by fisheries staff of the countries in which the Programme operates will afford the opportunity for technology transfer in various aspects of fishing, novel bait fishing techniques, and fisheries research.

2.0 PROGRAMME OVERVIEW

Fisheries scientists have at their disposal a number of different methods for evaluating fisheries. These methods all have advantages and disadvantages and the scientist must choose which method is appropriate for a particular situation. The simplest methods depend on the analysis of a time series of catch and fishing effort data spanning many years (usually more than 10) from a relatively stable fishery with no major changes in technology. This approach does not normally yield explicit estimates of the potential for interaction between fisheries. Furthermore, a sufficiently long time series of data for the SPC region does not exist, and fisheries in this region have sustained radical changes in technique. Other methods of fishery evaluation augment the basic catch and effort data with other information, such as sizes of the fish expoited by the fishery. This alternative does not require such an extensive time series and may also provide some indication of the potential for fisheries interactions. Unfortunately, it is difficult to apply this technique to the rapidly growing species of tropical tuna which form the bulk of the catch in the SPC region, and the appropriate size information is not available.

Another option is to augment the basic catch and effort data with information derived from a tagging and recapture study. In this approach, tagged fish are released into a larger population of untagged fish. When the tagged fish are recaptured by the various fisheries, the tags are returned to the investigators. The rate of return of tags provides a direct estimate of the population dynamics of the fish. Where tag return rates are obtained from several different fisheries, direct estimates of fishery interaction can also be obtained. A further important advantage of tagging is that, for tropical tunas, results can be obtained in a much shorter period of time. Virtually all tags that will be returned can be expected within three years of their date of release, and reasonably accurate preliminary results can be obtained from the first six months of tag returns. It is for these reasons that tagging is the method of choice for timely assessment of the problem of fishery interaction.

This new tagging study will benefit from the experience of the Skipjack Survey and Assessment Programme, will employ many of the same methods, but will be quite different in purpose and execution. Whereas the previous study was designed to extensively survey skipjack over a wide area, the new study will be conducted intensively on both skipjack and yellowfin in a small number of carefully selected areas where recent changes in fisheries may be expected to have had the greatest impact. Considerable progress has recently been made by Tuna Programme staff in the mathematical analysis of fisheries interaction, and general design of the tagging experiment will be guided by the results of these analyses. Detailed planning will depend on the availability of tuna and baitfish, and will be developed using information provided by fisheries officers and fishermen in the areas of operation.

The following guidelines (not in order of priority) will be considered when determining areas of intensive tag release:

(a) Areas where two or more major distant-water fleets are operating.

(b) Areas where two or more different fishing gears are used by national fisheries of an island state.

(c) Areas where there are well developed artisanal fisheries which can be conveniently sampled.

It is planned to release about 20,000 tagged tuna each year for two years. Since skipjack are more commonly caught than yellowfin, extra efforts will be expended to ensure that sufficient yellowfin tuna are tagged. The tagging schedule will also be governed to a large extent by the need to investigate certain specific phenomena related to the fishery which may be detected as the programme progresses. The schedule for the second year would be revised in light of the findings from the first.

Tagging programmes are dependent on the co-operation of fishermen and cannery workers to return recaptured tags. Rewards will be offered and lotteries conducted to provide extra inducements for returning tags. Extra effort will be expended to ensure that tags are recovered at ports of unloading and canneries.

Analysis of interaction, using tag return data, requires complete and reliable catch and fishing effort information in the regions of research. The tagging programme will depend extensively on the regional fisheries data base maintained by the SPC.

Participation by observers from countries visited is an important aspect of the programme. Extra accommodation will be provided on the tagging vessel and observers will be encouraged.

3.0 FIELD ACTIVITIES

The project has been designed to increase the understanding of the tuna movements in the survey areas with a view to formulating a general quantative description of movement. Tagging will be the method of choice for this purpose. Other survey procedures and research activities will be pursued concurrently in order to provide general information on the tuna populations in the regions studied. A live-bait pole-and-line commercial tuna fishing boat will be chartered for use as the principal research vessel.

Research efforts will be concentrated in areas of greatest fishing activity. Priority will be given to releasing the greatest number of tagged fish, but where flexibility exists, tags will be released in spatial and temporal patterns most suited to quantitive estimation of the parameters of fisheries interactions. Theoretical calculations show that release locations can be critical in order to recover sufficient tags for analysis of interaction.

All observed fish schools will be recorded and identified whenever possible by school type, species composition and estimated school size. The chumming success rate and other characteristics of the school behaviour will also be recorded where possible. Although priority will be given at all times to the tagging operations rather than the taking of commerical catches, the hooking rates from each area will be determined and will be used in comparing catches made by commercial vessels operating in the same area at that time.

Field activities will be governed by the following guidelines:

(a) Both yellowfin and skipjack will be tagged, and extra efforts will be made to ensure that as many yellowfin as possible are tagged.

(b) Numbered yellow dart tags will be applied by the same techniques used in the Skipjack Programme.

(c) All fish released will be measured in the tagging cradle.

(d) Three tagging teams will operate on the vessel simultaneously.

(e) Special provisions will be made for tagging large yellowfin.

(f) If exceptionally good catches are anticipated, and if normal operations permit, a number of fish will be double-tagged to reconfirm shedding rates and comparative mortalities.

From the tuna which are poled but not tagged and released the following data will be collected by species:

(a) length frequency distribution of each school fished;

(b) length/weight relationship;

(c) gonad samples from each school for fecundity studies.

As operations permit, scientists from other institutions will be encouraged to collaborate in related studies of tuna biology and oceanography. Collaboration could be in the form of actual visits by scientists or through provision of equipment to be operated by SPC staff.

4.0 ANALYSIS AND PRESENTATION OF RESULTS

Activities of the field programme will be constantly monitored to assist in directing operations and ensuring that programme objectives are being met. All data will be stored and processed in the computing facilities at the South Pacific Commission headquarters in Noumea. Tag return data will be analysed by the staff of the Tuna and Billfish Assessment Programme in order to parameterize tuna migration using mathematical treatments similar to those employed to design the tag release.

A timetable for the tagging work is difficult to predict precisely because progress depends almost exclusively on fishing conditions. The first step is the location of a suitable vessel and negotiation of a satisfactory charter agreement. Informal requests for information from charter sources have been made, and it is expected that the field work could begin and tags released after a period of four to six months from a confirmed commitment of funding. Initial tag returns from some fisheries could be expected within one month of release, and from other fisheries after a lag of six months. Preliminary scientific results, somewhat biased by the absence of long-term migrants, could be derived from analysis of the tag return data received during the first six to eight months after release. Analysis of tag return information is considered a continuing process. As more tags are returned, conclusions based on early returns will be evaluated and calculations revised accordingly. After a period of 24 months from release, very few tags would be expected and a definitive scientific analysis could be concluded. Progress reports will be issued on a timely basis.

A tentative timetable for the first year of the Programme expressed in months from commitment of funding is given below.

Milestone	Month
First tags released	6
First tags returned	7
Preliminary results	15
Majority of tags returned	30
Final report	36

This timetable is indicative of what could be expected from the first year of the Programme. Preliminary results from the second year of the programme, to begin at approximately month 18, would be available for incorporation into the report by month 36.

The full benefits of this work will depend on the availability of economic data which are beyond the scientific scope of the study. It will be necessary to combine the biological results and conclusions based on analysis of tag return data with information on prices and economic performance of the fishing industry. At present, this information is not available to the SPC as analyses of this type are generally reserved to the national governments and administrations in the region. Therefore the SPC scientists will work in close collaboration with economic planners from the appropriate bodies, such as the Forum Fisheries Agency, in ensuring that the biological results are relevant to the development needs and that the full benefits of the Programme are realized. It is anticipated that, as the biological interpretations are improved as results accumulate, the economic evaluation would also improve.

5.0 BUDGET

The proposed budget for two 10-month periods of tagging is shown below. Costs for the first year are analysed in greater detail in subsequent paragraphs, and a projection for the second year is presented. This budget depends on the commitment of approximately one third of the existing Tuna and Billfish Assessment Programme resources to various aspects (planning, computer support, logistics, analysis of results) of the tagging Programme.

		US$ YEAR 1	YEAR 2
1.	Vessel	966,000	988,000
2.	Salaries	175,000	185,000
3.	Travel - duty	87,000	91,000
4.	Travel - Appointment, leave and termination	8,000	9,000
5.	Equipment	67,000	35,000
6.	Tag rewards	30,000	30,000
7.	Computer costs	3,000	2,000
8.	Exchange loss	1,000	1,000
9.	Miscellaneous	14,000	15,000
	TOTAL	1,351,000	1,356,000

5.1 Vessel Charter

Vessel charter is the major expense of the programme. The approximate cost of a 250-tonne Japanese pole-and-line vessel is anticipated to be US$90,000 per month. More precise charter costs will be provided after initial contacts with chartering companies. Charter costs include Japanese officers and operational expenses. Associated costs are modifications to vessel and victualling. Modifications to vessel include construction of laboratory, modifications to accommodation, installation of specialised communication equipment, and provision for poling large tuna.

Vessel charter (10 months)	900,000
Modifications	30,000
Victualling	36,000
Total	966,000

5.2 Salaries

Salaries include those of an experienced fishing crew and gross costs (salaries and benefits) to SPC of additional professional scientific staff.

5.2.1 Fishing crew

As the Skipjack Programme had considerable success with a Pacific Island fishing crew, the recruitment of a similar local crew is foreseen.

15 crew at $400/month X 10 months	60,500
Incentives	1,500
Insurance	4,000
Total	66,000

5.2.2 Professional staff

Fisheries Scientist X 1 at P3 (two others to be supplied from existing Tuna Programme establishment)	30,300
Fisheries Experimental Officer X 3 at T3	63,500
Research Assistant at A4	15,200
Total	109,000

5.3 Travel - Duty

The major component of duty travel is the cost of transferring fishing crew between place of recruitment and vessel at beginning and end of Programme, and rotation of professional staff.

5.4 Travel - Appointment, Leave and Termination

This item reflects costs of relocating professional staff to Noumea.

5.5 Equipment

Equipment includes tags, scientific supplies (microscope, microcomputer, tape recorders), and fishing gear (poles, lures, nets, SCUBA, etc.).

5.6 Tag Rewards

The tag rewards are based on a reward equivalent to the value of about $10 per tag returned, plus lotteries. This relatively major cost is indicative of the effort to be expended in ensuring the return of recaptured tags.

5.7 Computer costs

The bulk of the computer costs will be absorbed by the Tuna and Billfish Assessment Programme. The costs shown here include incremental maintenance and material costs.

5.9 Miscellaneous

This item includes communication costs between vessel and Noumea, initial purchase of bait in Japan, gear shipment, etc.

6.0 REFERENCES

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