

Skipjack Assessment: Ongoing Requirements¹

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Objectives and results of the South Pacific Commission's skipjack programme; and that of the ICCAT were summarized and compared with emphasis given to the degree to which questions set for each could now be answered. The South Pacific Commission concluded from its program that, in the Pacific, existing skipjack fisheries were having little impact on the total resource, but that in some countries there was heavy localised exploitation. Quantification of the degree of interaction between existing and future fisheries was identified as the major ongoing issue. In a new Tuna and Billfish Assessment Programme, thirteen major areas of resource evaluation were given a priority order by the countries and territories of the Commission. Those affecting skipjack are the following (the number indicates priority among the thirteen items): 1) development of a detailed fisheries statistics program; 2) investigation of the interaction between purse-seine and pole-and-line fisheries, and their effects on stocks; 4) updating evaluation of skipjack resources; 8) investigation of the relationship between environment and abundance of tuna; 9) evaluation of fish aggregating devices for use in tuna fisheries; and 10) investigation of the interaction between surface and longline fisheries.

Bearing in mind the above priorities in the Pacific, the types of skipjack fisheries (subsistence, artisanal, local commercial, and foreign licensing), their history in the Atlantic and the increased management rights and responsibilities of coastal states as a result of acceptance of 200-mile zones, and points made by the other keynote speaker, Dr. B. Rothschild, the author concluded that assessment of interaction amongst skipjack fisheries will also be a major issue in the Atlantic. He suggested that the critical question could be: how well can we define the interaction between fisheries as a basis for the planned distribution of fishing effort? This question can best be answered by continuing to improve detailed catch and effort statistics, but other research tools, particularly tagging, have a vital role to play.

Les objectifs et les résultats du programme listao de la Commission du Pacifique Sud et ceux de l'ICCAT ont été résumés et comparés en mettant surtout l'accent sur les réponses qui peuvent maintenant être apportées aux questions posées. A partir du programme, la Commission du Pacifique Sud a conclu que, dans le Pacifique, les pêcheries de listao actuelles avaient peu d'impact sur le total des ressources, mais que dans certains pays il existait une forte exploitation locale. La quantification du degré d'interaction entre les pêcheries actuelles et futures a été identifiées comme étant la principale question à résoudre. Dans le cadre du nouveau Programme sur l'évaluation des thonidés et des istiophoridés, treize principaux domaines d'évaluation des ressources ont principalement été étudiées par les pays et les territoires de la Commission. Ceux qui touchent le listao sont les suivants (le numéro indique l'ordre de priorité des treize points): 1) mise en place d'un programme sur des statistiques détaillées de pêche; 2) interaction entre les pêcheries de senneurs et de canneurs et leurs effets sur les stocks; 4) mise à jour de l'évaluation des ressources de listao; 8) relation entre le milieu et l'abondance des thonidés; 9) évaluation des dispositifs de concentration à utiliser dans les pêcheries de thonidés; et 10) interaction entre les pêcheries de surface et palangrières.

Compte tenu des priorités signalées ci-dessus pour le Pacifique, les types de pêcheries de listao (de subsistance, artisanale, locale commerciale et à pavillon étranger), leur histoire dans l'Atlantique et les droits et responsabilités croissants des états côtiers en ce qui concerne la gestion suite à l'accord des 200 mille, et des points soulevés par l'autre conférencier clef, le Dr. B. Rothschild, l'auteur en a conclu que l'évaluation de l'interaction entre les pêcheries de listao sera également une importante question à débattre dans l'Atlantique. Il a proposé la question critique suivante: comment pourrions-nous définir l'interaction entre les pêcheries comme base d'une distribution planifiée de l'effort de pêche? La meilleure façon de répondre à cette question est de continuer à améliorer les statistiques détaillées de prise et effort, mais que d'autres instruments de recherche, tel que le marquage, ont un rôle important à jouer.

Se resumieron y compararon los objetivos y resultados del Programa Listado de la Comisión del Pacífico Sur y de ICCAT, destacando hasta qué punto las preguntas planteadas habían sido contestadas. La Comisión del Pacífico Sur sacó como conclusión de su programa que, en el Pacífico, las pesquerías actuales de listado tenían poco impacto sobre el total de los recursos, pero que en algunos países existía una fuerte explotación local. Se ha señalado, como cuestión principal a la que hay que dar solución, la determinación de la importancia del grado de interacción entre las pesquerías actuales y futuras. En el contexto del nuevo programa de evaluación de túnidos y xiphiidae, los países y territorios de la Comisión dieron prioridad a trece ámbitos principales de evaluación de los recursos. Aquellos que afectan al listado son los siguientes (el número indica el orden de importancia entre los trece puntos): 1) desarrollo de un programa de estadísticas de pesca detalladas; 2) investigación de la interacción entre las pesquerías de cerco y caña-liña, y sus efectos sobre los stocks; 4) actualización de la evaluación de los recursos de listado; 8) relación entre el medio y la abundancia de túnidos; 9) evaluación de los dispositivos de agregación en las pesquerías de túnidos y 10) interacción entre las pesquerías de superficie y palangre.

Teniendo en cuenta las prioridades en el Pacífico, antes señaladas, los tipos de pesquerías de listado (a nivel de subsistencia, artesanal, local comercial y pabellón extranjero), su historia en el Atlántico y los crecientes derechos y responsabilidades de los estados costeros, como resultado de la aceptación de las

¹ One of two keynote addresses at the conference on the International Skipjack Year Program.

zonas de las 200 millas, y los puntos señalados por el otro conferenciante clave, Dr. B. Rothschild, el autor concluyó que la evaluación de la interacción entre las pesquerías de listado sería un punto de la mayor importancia en el Atlántico. Propuso que la cuestión crítica sería: ¿hasta donde podríamos definir la interacción entre pesquerías como base para la distribución planificada del esfuerzo de pesca?. La mejor forma de contestar esta pregunta sería proseguir mejorando estadísticas de captura y esfuerzo, pero existen otros instrumentos de investigación, particularmente marcado, que tienen un papel vital que jugar.

It is a great pleasure for me to be present at this concluding symposium of the International Skipjack Year Programme, and to address the topic of the ongoing requirements for skipjack assessment. But before discussing this topic, I would like to express my sincere appreciation to the numerous people who have made my attendance possible, in particular the Executive Secretary of ICCAT, Dr. Rodriguez-Martin, the Programme Coordinator, Dr. Phil Symons, the Chairman of the Standing Committee on Research and Statistics (SCRS), Mr. Jim Beckett, and the Convenor of the Skipjack Subcommittee, Dr. Gary Sakagawa.

Keynote addresses are normally given at the commencement of a conference and I must admit to my anxiety about deviating from the norm and speaking at the conclusion of scientific presentations. However, I prefer to look at the positive side of speaking last and acknowledge that there are advantages to hearing what other people have to say before committing oneself, rather than make the excuse that much of what I had planned to say has already been said. In fact, I have tried to amend my presentation by taking into account the sentiments expressed in the numerous papers presented this week, in particular, the address of the other keynote speaker, Dr. Brian Rothschild. There is, of course, similarity between our two topics, which both relate to skipjack research at the present and in the immediate future.

Because my personal background in skipjack research has been concentrated in the Pacific and not in the Atlantic, I will be drawing heavily on results from another ocean. However, I will, as far as possible, discuss points relevant to both oceans. Of course, there are problems in trying to transpose results from the Pacific to the Atlantic, but then again comparison of the two will hopefully help to raise issues which are relevant to next week's discussion of the future requirements for skipjack research in the Atlantic Ocean. It is timely to take this approach, for next week's discussions should prove critical to future skipjack research programmes in this region, and in the first week of August the South Pacific Commission's Fifteenth Regional Technical Meeting on Fisheries will consider proposals for the future requirements for skipjack research and assessment in the South Pacific.

Let me then expand a little on the topic of the ongoing requirements for skipjack assessment. I have

taken the expression "skipjack assessment" to include all aspects of skipjack resource evaluation and the expression "ongoing requirements" to include evaluation of any factors which might affect these assessments. The word "ongoing" could strictly be interpreted to mean only those aspects which are continuing from the present to the future, but I have taken a slightly broader interpretation. I have used it to imply a review of where we are now and what needs doing for the future. Let us first review where we are now with skipjack assessments.

Skipjack programmes were started in both the Pacific and Atlantic Oceans because of the phenomenal increase in the importance of skipjack to the tuna fisheries in each area. Both programmes were goal-oriented and addressed specific questions. The South Pacific Commission's programme had its conceptual beginning in 1974/75, and the debate on the objectives continued for approximately a year before being agreed as follows:

To provide

- (a) a better understanding of the migrations and stock structure of skipjack, thus determining the degree to which fisheries in different areas exploit the same stock, and hence interact with each other;
- (b) valuable survey information on the general distribution and availability of skipjack and baitfish as the basis for further development and management of these resources within the region;
- (c) better knowledge of the population parameters (growth, mortality, etc.) of each skipjack stock, thus enabling better assessment of the current status of these stocks and of the effect of fishing on them.

There would, of course, be many similarities between the methods used to answer these questions and those methods used in the Atlantic to address the four questions of the ICCAT Skipjack Programme:

1. Can catches be increased by fishing in new areas?
2. Can catches be increased by taking larger fish?
3. What would be the effects of increased catches on existing fisheries?
4. How can better assessments of the stocks be obtained by using information from existing fisheries?

The Pacific Skipjack Programme was created at a time when existing fisheries did not provide much of the information necessary for evaluation of the total resources. There were strong suggestions that the total resources were under-exploited, for the existing fisheries covered only a small part of the total area of the known distribution of skipjack. Therefore, while there were indications that total catches could be significantly increased, the absence of any relationship between effort and catch-per-unit-of-effort necessitated the use of less conventional techniques for evaluating the total resource; thus, the selection of tagging as the primary research tool. The Programme was designed such that the distribution of tags was to cover both fished and unfished areas, and over the three-year period more than 150,000 skipjack and other tunas were tagged and released. Details of this work are given in the numerous South Pacific Commission publications; however, it is worthwhile to reflect on the conclusions of the Programme because of their relevance to next week's discussions. The fairest way to review these conclusions is to consider them in the light of the Programme's basic objectives already mentioned:

- (a) Tag release and recovery data clearly showed movement of skipjack across much of the study area and also demonstrated the relationship between distance of migration and time at liberty. The stock structure of skipjack was described, as discussed earlier this week by A. W. (Sandy) Argue, leading to the conclusion that population structuring, or the lack thereof, was not a major factor to consider in present management strategies. Interactions between the numerous skipjack fisheries were identified and even though their precise evaluation was hampered by the lack of effort and catch data, quantification of the movement of fish between fisheries was possible in some cases.
- (b) Surveys of both skipjack and baitfish resources were completed in each of the twenty three countries and territories for which the South Pacific Commission works. These results were incorporated into the overall assessments for each country.
- (c) Population parameters were estimated from the total regional data set and for individual countries where sizeable skipjack fisheries resulted in the generation of adequate tag recovery data. From the total data set, the standing stock of skipjack in the South Pacific Commission region was estimated to be between 2.4 and 3.7 million tonnes, with a turnover, of which natural mortality was a major component, of between fifteen and twenty percent per month. These figures, in combination, give rise to an estimate of a total throughput in the

thirty million square kilometre area of the Commission of approximately six million tonnes per annum. Fishing mortality was estimated to be a small fraction of the total mortality, such that the overall harvest ratio was about four percent.

Skipjack growth was found to be variable in both time and space and, while difficulties were encountered in accounting for the effects of variability in length at release and time at liberty for tagged fish, ranges in growth increments were established for the region as a whole and for several individual countries.

At the conclusion of the Pacific's Skipjack Programme, it was suggested that existing skipjack fisheries were having little impact on the total resource, but that in some countries there was heavy localised exploitation. There was, therefore, need to distribute fishing effort in accordance with the distribution of the resource if total yields were to be maximised. Even though the total resource was estimated to be large, the potential for increased interaction as fisheries increased was stressed. Quantification of the degree of interaction between existing and future fisheries was identified as the major ongoing issue in skipjack resource assessment.

Because of the value of the results of the Skipjack Programme to the countries of the region and their expressed desire for continuation of this type of resource evaluation, the South Pacific Commission established the Tuna and Billfish Assessment Programme in October 1981. In this Programme even more emphasis was given to the provision of assistance to the developing island countries and, as for the Skipjack Programme, specific goals were identified. The Tuna Programme includes ongoing work on skipjack while also encompassing other major species of the region. The fisheries officers of the countries of the area identified thirteen major areas of tuna and billfish resource evaluation and placed these in priority order as follows:

1. The development of a detailed fisheries statistics programme.
2. Investigation of the interaction between purse seine and pole-and-line fisheries and the effects of each on the stocks.
3. Assessment of billfish stocks.
4. Updating of evaluations of the skipjack resources as the available statistics improve.
5. Assessment of yellowfin and bigeye tuna resources.
6. Evaluation of the biological data necessary for the evaluation of all tuna resources.
7. Baitfish assessments as requested by individual countries.

8. Investigation of the relationship between the environment and tuna abundance.
9. Evaluation of fish aggregation devices for use in tuna fisheries.
10. Investigation of the interaction between surface and longline fisheries.
11. Coordination of observer programmes.
12. Evaluation of the effects on species composition in catches with changes in longline gear.
13. Consideration of alternative fish aggregation devices or techniques.

Of these thirteen priority items, six (Nos. 1, 2, 4, 8, 9 and 10) are directly related to the assessment of skipjack resources and the evaluation of the fisheries based on them, while several others are indirectly related. The ongoing requirements of the countries in 1980/81 were therefore clearly defined and these requirements will remain the guidelines for resource assessments until the conclusion of the Tuna Programme in September 1984. The question of what is required after September 1984 will be addressed at the South Pacific Commission's annual technical meeting on fisheries in Noumea in August of this year.

Having reviewed recent developments in skipjack assessments in the central and western Pacific Ocean, let us turn to the Atlantic. Where then is ICCAT in relation to its four basic questions on skipjack resources? The many papers presented this week have provided the basis for formulating answers to these questions and it is really the task of next week's meeting to derive these answers (see "Report of the Conference", this volume). It is not appropriate for me to try to answer them here. However, in the interests of provoking discussion at next week's meeting, let us preempt these answers a little. Furthermore, let us assume that, like the Pacific, answers can be given to the questions previously presented. In considering ongoing requirements, what then are the next questions?

Before trying to derive specific questions, we must first consider why we need information on the skipjack resources and what are the underlying reasons for future skipjack research. I would assume that the principal reasons are the interests of rational management and hopefully further development of the skipjack resources. The end result, of course, being to optimise returns to the countries involved. I have therefore assumed that the interests of the individual countries dictate the reasons for regional skipjack assessment and that the rôle of international organizations is merely to coordinate these assessments and to provide information in an understandable form to the countries for which we work. It is therefore appropriate, even for international organizations, to consider national objectives as primary. It is also far more

realistic. While we in international organizations may not always like to admit it, political decisions will govern what use is made of our resource assessments and therefore determine their usefulness. Let us look then at the alternatives available to individual countries. In doing so I am biased by my experience with countries in the South Pacific, but believe that there is a great deal of similarity between these and other developing countries.

When evaluating their alternatives, countries need to consider the pros and cons of involvement in skipjack fisheries of any type that might be operated in their waters. The various types of fisheries can be broadly classified into four categories:

1. Subsistence fisheries. These have been of great traditional significance in many developing countries, particularly small island states, and continue to be of immense social importance.
2. Artisanal fisheries. There is a great diversity of activities in this field, but skipjack play an important role in small-scale fisheries of many countries.
3. Local commercial fisheries and joint-ventures. In many developing countries these are dominated by pole-and-line fisheries for skipjack. They constitute major sources of employment and often represent a primary source of export earnings and foreign exchange.
4. Licensing of foreign fishing vessels. Since the acceptance of the principles of 200-mile zones of extended jurisdiction, the generation of licence fees has become a major source of income in many developing states. For example, in the zones of many Pacific island states the catch by distant-water fleets may exceed the gross national product of the island state.

Before evaluating the interests of coastal states in these various types of fisheries, it is appropriate to review the dramatic changes which have occurred in the total skipjack and tuna fisheries of the Pacific in recent years. Prior to 1950, the only skipjack fisheries in the area of the South Pacific Commission were the traditional subsistence fisheries and a few small-scale artisanal fisheries. In the 1950's, longlining was introduced by Asian fleets, but these operated only on larger tuna species caught far from shore and therefore had no detectable impact on the fisheries of island states. In the 1960's came the distant-water pole-and-line fleets from Japan and in the early 1970's, local pole-and-line fisheries began to be developed, largely on a joint-venture basis. In the late 1970's purse seining techniques improved dramatically and fishing effort increased to such an extent

that by the early 1980's the tuna catch by purse seining in the central and western Pacific exceeded that by all other gear types.

As concluded by the South Pacific Commission Skipjack Programme, interaction between these various fisheries increases as catches increase. Countries are therefore faced with the evaluation of three basic types of interaction:

1. Between various types of fisheries within individual countries; for example, between the large distant-water purse seine and pole-and-line fleets, and the subsistence fisheries of any one country.
2. Between countries; this problem increases as fisheries cover more and more of the 200-mile zones of the various coastal states, therefore bringing vessels of neighbouring countries closer together.
3. Between gear types; this is most obvious for yellowfin tuna, where the purse seine and longline fisheries compete for the same resource, yet yield products which sell at totally different prices.

There is no doubt that evaluation of the various forms of interaction will dominate discussions of skipjack fisheries in the western Pacific for some time to come. Problems will increase if catches continue to increase and will, in my opinion, inevitably lead to various forms of skipjack resource allocation, both between gear types within countries and between countries. In fact, many examples of such allocations already exist (e.g. the restriction of purse seining in certain areas of the Northern Marianas, Solomon Islands and Fiji).

The outstanding question which then remains is how to accurately evaluate this interaction. Many traditional techniques will need to be used, but a few new ones will probably need to be developed. A comprehensive understanding of the resources and the fisheries operating on them will be required. The list of possible factors to be investigated would be indeed large and might include any aspect of fish biology or behaviour. However, for the purpose of this discussion, I have restricted consideration to only a few factors as examples and have selected them on the basis of those considered by the other keynote speaker, Dr. Brian Rothschild, who discussed tuna research requirements in the 1980's earlier this week (Rothschild this volume). Before dealing with the individual points in the order raised by Dr. Rothschild, I would like to express my endorsement of the general sentiments he expressed and to stress that I would like to consider different slants on some of the points he raised purely in an attempt to provoke discussion as an aid to next week's deliberations.

Let me start then with one of Dr. Rothschild's general comments: "in providing advice to managers, we need to average our evaluations over time and space in order to highlight for managers the average expected conditions". I agree entirely that the evaluation of average conditions should be an objective for all research conclusions, but I feel it is even more important to understand variance around our estimate of the average, while at the same time describing the natural fluctuations in the resource being evaluated. We need to know the accuracy, or confidence limits, of our estimates based on statistical appraisal of the data used to derive them (the variance) and also to understand how well this estimate reflects overall variability in the resource being measured; for example, is the time period, for which the estimate is derived, indicative of total variability in the population, or is it merely a point estimate within the total range of the population? It is most important for scientists themselves to comprehend the variance of their estimates, for their increased knowledge of the reliability of their estimate increases the confidence in the advice given to managers and hence in their decisions. Understanding the natural variability in resources is particularly important for small countries which have limited resources and may be abnormally disadvantaged by even a single poor season.

Dealing then in turn with the nine points Dr. Rothschild considered to be priority research requirements for tuna in the 1980's:

1. "The need to understand the homogeneity or heterogeneity of stocks". It is obviously of primary importance to understand what units of total population are involved in any management strategy, and this stresses the even more basic need to define what we mean by a stock. Do we mean a fisheries related unit or some fraction of a total population defined in terms of its genetic integrity? This matter has been discussed at length this week and personally I feel that a description based on a fishery unit is far more meaningful for present-day skipjack resource evaluation.
2. "Growth in the context of yield per recruit". A knowledge of growth is an accepted requirement for the assessment of the resources of all fish, and skipjack is no exception. However, one might question whether further knowledge of skipjack growth is a priority requirement. Perhaps as the size of first recruitment of skipjack into most fisheries appears to be equal to, or slightly greater than, the size for maximum yield, further definition of growth is not a priority at this time.
3. and 4. "Natural mortality" and "fishing mortality". One can only completely agree that these two factors are critical for resource evaluation. However, Dr. Rothschild did mention that estimates

were not generally available and he could not think of new ways of obtaining them. I would suggest that the total skipjack attrition estimates from the South Pacific Commission's Skipjack Programme, and some which I have seen presented at this week's meeting, confirm the utility of tagging for this purpose, and provide useable insights into mortality. Perhaps most significantly, they provide comparison of the two types of mortality through the estimation of harvest ratios.

5. "Recruitment". Again, a vital factor and something which must be carefully monitored. To elaborate a little, I would suggest that recruitment needs further definition into between-generation and within-generation components. It might be worthwhile to consider the question that in the absence of a stock recruitment relationship between generations for skipjack (other than obviously if there is no stock, there could be no recruitment), is there much point in expending great effort on investigating biological factors which influence this recruitment? Perhaps this effort could be more usefully directed towards investigation of within-generation interaction, that is between fisheries exploiting the same generation but at different stages of the life-cycle.
6. "Economics". A primary factor in evaluating the impact of resource assessment, but I would argue that social and political factors are of at least equal importance. For example, the social impact of disruption of subsistence fisheries could well be an overriding factor in a political decision determining the use of resource assessment.
7. "Environment". Naturally the relationship between the environment and skipjack resources is of interest to us all, but the investigation of this relationship is almost certainly not cost-effective for all individual developing countries.
8. "Integration of the above". Undoubtedly integration of all of the points raised by Dr. Rothschild would be necessary to obtain comprehensive resource evaluations. I would, however, again stress the need to also integrate social and political objectives into any management strategy based on these resource evaluations.
9. "The need to ask the right questions". I could not agree more with this suggestion and repeat that regional research programmes in the South Pacific have been structured not only to address specific questions, but to do so in priority order. I believe that the Pacific Skipjack Programme provided answers to questions that were posed in 1975 and that the countries for which the South Pacific Commission works have been able to use these answers in planning their fisheries development. The issue

now before us is then: what are the questions most relevant to skipjack resource assessment in 1983?

I have already mentioned that in the Pacific the evaluation of interaction between fisheries has been identified as the major ongoing issue, and I would suggest that interaction is also a major issue in the Atlantic. Perhaps the critical question could be: *how well can we define the interaction between skipjack fisheries as a basis for the planned distribution of fishing effort?* Bearing in mind that the skipjack resources are finite, the planned distribution of effort will inevitably involve allocation. Undoubtedly fisheries will change with time and therefore interactions will vary, making it necessary to constantly revise estimates of interactions — an ongoing activity. Also, undoubtedly there will be differences in political, social and economic objectives of the numerous countries concerned, necessitating evaluation of different interactions.

Personally, I feel that in both the Pacific and Atlantic oceans, the primary tool for answering this question will be detailed catch and effort statistics for, as has often been stated, management really can only manage fishermen, not fish, and it is the relationship between their catch and their effort that influences decisions. I would not endorse the extreme view of some of my colleagues, who feel that because of the primary importance of this relationship, catch and effort data are the only data management really needs, for I do feel that other tools, such as tagging, have a vital role to play. I believe it is important when making management decisions to have a good understanding of the nature of the beast being exploited in the fishery as well as to understand the requirements of those doing the exploiting.

Having stressed the importance of accurate catch and effort statistics to the evaluation of interaction and subsequently to the estimation of resource allocation, I feel it is essential to stress the problems which initiation of resource allocation decisions create for attainment of accurate statistics. Once statistics are used for any purpose other than in the common interest of total resource assessment, then the conflicts of interest between resource user groups create impediments to the free exchange of reliable statistics. In the South Pacific, before the implementation of 200-mile zones and the introduction of licence fees for foreign fishing vessels, statistics were relatively unbiased and freely available. However, recent management decisions initiating the generation of revenue from distant-water fishing vessels have made statistics a negotiable commodity of varying reliability. There is at present an excellent data base for Atlantic skipjack fisheries and every effort should be made to perpetuate it, even though as management policies of coastal states change, it could become increasingly difficult to do so.