

AN APPROACH TO THE JUVENILE TROPICAL TUNA PROBLEM OF ICCAT

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1. INTRODUCTION

In the tropical tuna fisheries of the eastern Atlantic, three species make up the bulk of the harvest, skipjack (SK = *Katsuwonus pelamis*), yellowfin (YF = *Tunnus albacarus*), and bigeye tunas (BE = *Tunnus obesus*). The surface fisheries, baitboat and purse seine, exploit a mixture of the three species including small and medium sized YF and BE. The subsurface fishery (longline) exploits large YF and BE. It has been documented in the Proceedings of the Eighth regular meeting of the Commission that SK are underexploited and could support increased fishing pressure (ICCAT, 1984). YF and probably BE, on the other hand, are experiencing significant impact from the harvest, and improved yields could likely be obtained by enforcing a lower size limit on the catch of these species (ICCAT, 1984).

The Working Group on Bigeye Size Regulation was organized in 1977 by the Scientific Committee on Research and Statistics (SCRS) and charged with studying the matter of imposing a minimum size limit to bigeye tuna catches. Three specific questions were asked of the working group:

- Question 1. Can the fisheries now catching small bigeye successfully shift bigeye effort to larger fish?
- Question 2. Would imposing a minimum size limit have any adverse effect on recruitment?
- Question 3. Would implementing a size limit result in substantial wastage through dumping?

In 1979, the working group was renamed to the Working Group on Juvenile Tropical Tunas (WGJTT) and the following questions were added to the list:

- Question 4. What would be the effects of applying various management methods to reduce the catch of small YF and BE?
- Question 5. In a management scheme of time-area closures, which strata should be closed to protect juvenile YF and BE?
- Question 6. What would likely happen to yields of all three species under a time-area closure management scheme?

As documentation accumulated on the population status of the three species, it was recognized that because of the mixture of SK, YF, and BE in the catch, there is a conflict between the optimum YF/BE harvest, which requires size regulations, and the optimum SK harvest, which does not. As a result, the WGJTT appears to have taken on the responsibility for an additional question:

- Question 7. What is the best multispecies management scheme in face of the conflict between optimal harvest of SK and optimal harvest of YF and BE?

A precise plan of action for WGJTT to address the above issues has not been clearly enunciated, and there does not always appear to be a clear relationship between these issues and the tasks that have been undertaken by WGJTT. In this paper we outline what we understand to be problems needed to be addressed by WGJTT. We discuss some analyses that would help address the problems, and we review the relevant accomplishments that have been made to date.

We hope this paper will be critically read and discussed among the scientists involved in WGJTT. If such discussion leads to the formulation of a clearer plan of action for WGJTT, then our paper will have served a useful purpose.

2. THE PROBLEM

The juvenile tropical tuna problem outlined above was reviewed in the Multispecies-Tropical section of the B Report of the 1983 meeting of SCRS. We will briefly summarize the problem here.

The YF population is evidently feeling the impact of fishing pressure. Production model analysis showed that the exploitation rate of YF is at or somewhat above the level of maximum sustained yield (MSY). Fishing pressure appears to be causing a reduction in the average size of individuals in the YF population below the optimum for maximum yield-per-recruit. Evidence was presented that the yield-per-recruit of YF could be enhanced between 5% and 40% with the effective enforcement of a minimum size limit. Attempts to find

a stock-recruitment relationship were unsuccessful, implying that fishing is not reducing the reproductive capacity of the YF population. Thus adjustment of fishing pressure to optimize yield appears more of an economic concern than a biological concern at the present time for YF.

The evidence concerning BE was not as complete as for YF, but it was suggested that the picture for BE is substantially the same as for YF though possibly with some quantitative differences.

The situation of SK was dealt with in detail at the final meeting of the International Skipjack Year Program in June 1983. The relevant points are that SK are fast growing, and the SK population has a high turnover rate compared to the exploitation rate. SK are therefore underharvested and optimal yields would be obtained with more fishing pressure than is currently exerted.

The conclusion from the above evidence is that the optimal harvest strategy is different for SK than it is for YF/BE. We feel that this conflict is the fundamental problem that WGJTT should be concerned with. Questions 4 to 7 listed in Section 1 are all related to this problem. Questions 1 to 3, however, should not be dismissed yet. These questions were specifically asked by ICCAT and answers have not been formally reported back to ICCAT. Given the broader responsibility of WGJTT over the original working group, it would be logical to generalize these three questions to include YF as well as BE.

3. WHAT SHOULD BE DONE

The WGJTT should address and discuss all of the questions listed in Section 1. These questions are varied in terms of the level of complexity and effort required to formulate an answer. Questions 1 to 3 could be answered for the most part without additional analytical work. Addressing the loose ends of these questions will be subsumed in addressing Questions 4 to 7, which make up the fundamental problem outlined in Section 2.

To deal with this problem, the first step is to consider, describe and discuss various alternate management options. This is to identify practical options on which the WGJTT must spend most of its time and analytical effort. The WGJTT has already identified at least one such option: an examination and identification of time-area strata where enforcement of area closures would be appropriate.

3.1 Recommending Differential Regulations for Strata

We believe that identification of strata should be generalized to include the possibility of stratum-specific size regulations as well as stratum-specific closure. We suggest that categorizing of strata should be done in a manner similar to the triage principle of wartime medical practice. Combat medics sort casualties into three categories: 1) those whose injuries are slight enough that they will recover even if they receive no medical attention, 2) those who will recover if they receive medical attention but

will die without it, 3) those who will die no matter how much medical attention they get.

In a manner analogous to triage, the time-area strata of the eastern tropical Atlantic tuna fisheries could be sorted into the following three categories:

- Category 1. Strata with negligible numbers of undersized YF/BE. The situation is therefore "healthy" enough in these cases that management regulations are unnecessary.
- Category 2. Strata in which a significant population of undersized YF/BE exists but in which these fish behave differently enough from the SK and large YF/BE strata that fishermen could successfully target their effort on the SK and large YF/BE. In these strata it would perhaps be feasible to enforce size regulations that would effectively prevent overharvest of undersized YF/BE and still allow a good harvest of SK and large YF/BE.
- Category 3. Strata in which significant populations of undersized YF/BE are so thoroughly mixed with SK and large YF/BE that fishermen operating in these strata could not possibly avoid catching the undersized fish. The situation in such strata would not be improved by size regulations. The undersized YF/BE that would be caught if fishing were allowed would presumably have a higher value in the future when they will have grown larger than the value of the large YF/BE and SK that could be harvested now. Such strata should be simply closed to fishing.

3.2 Problems with Categorizing Strata

Before embarking on a scheme such as the one above, there are a number of considerations that should be addressed.

3.2.1 Definition of time-area strata

One question that requires addressing at the outset is how the time-area strata should be defined. Two possibilities seem to have evolved thus far: one month by five-degree square strata, and one month by the larger geographic areas that were discussed at the February 1984 data meeting in Dakar. However, other definitions might be more appropriate in relation to the promulgation and enforcement of management regulations. For example, geographic areas consisting of bands parallel to the coast line might allow easier enforcement of fishery restrictions. It may be that very broad areas, such as the Gulf of Guinea, are more realistic for management purposes.

3.2.2 Category 2 strata

One problem with the identification of category 2 strata (mixed but fishable strata) is that relevant data are sparse. In order for fishermen to target on SK and large YF/BE and avoid undersized YF/BE, there should be a

tendency for the undersized YF/BE to stay in their own separate schools. (We presumably do not care if SK and large YF/BE are mixed together.) To use fishery information to identify strata where undersized YF/BE keep to themselves, it is necessary to have species distribution and size distribution data by school for baitboats and by set for seiners ("single set data"). It is unfortunate that such data are sparse and are not for the most part on the ICCAT data base. Consequently, an adequate identification of category 2 strata is not yet possible, yet these are the only strata in which size regulations have a hope of being effective. Whatever data are available on single schools and single sets need to be assembled and analyzed by WGJTT.

3.2.3 Tolerance for residual undersized catch

In category 2 strata it is likely that undersized YF/BE will not always be completely separated from other fish in the strata. Likewise, category 1 strata are not necessarily going to be entirely free of undersized YF/BE. Therefore, for both categories, there is likely to be a certain number of undersized fish caught if fishing is allowed in these strata. Some or many of the strata could be borderline cases between the categories. How to identify these depends on our tolerance for catch of undersized fish. ICCAT has adopted a tolerance limit, or residual amount of undersized fish allowed in the catch, of no more than 15% of the total catch by numbers. As far as we know, this tolerance level was chosen by rule of precedence (similar to that used in the eastern tropical Pacific tuna fishery) and not as the result of rigorous analysis by SCRS.

We believe that a rigorous analysis is required. A possible approach to such an analysis would be to do the following: for a stratum with a variety of hypothetical proportions of undersized YF/BE, (a) estimate the values (e.g. in dollars) of the catch if fishing is allowed in the stratum, and (b) estimate the values of the future catch of fish now in the stratum if it is closed and the fish are allowed to grow and be caught elsewhere. The proportion of undersized fish in the catch at which the value under (a) is equal to the value under (b) could be argued to be an appropriate tolerance limit to adopt.

3.2.4 Variability

Implicit in this scheme for categorizing strata is the presumption that by looking at historical data, an underlying pattern in species and size distributions and in behavioral conditions will be found against which a pattern of management regulations can be devised. An important question to ask, however, is how long the underlying pattern can be expected to persist. By the time the mosaic of regulations is implemented, will the demographic and behavioral pattern change so that the management scheme is no longer appropriate?

It is thus imperative that we check for variability in the criteria relevant to our scheme. To do this, we should not substitute sample data across strata because this will dampen the variability.

Another problem related to natural variability is that the population structure for YF, BE or SK (age structure and geographic distribution) that we see could be influenced by the history of the fishery. SCRS noted that the yellowfin population is showing signs of moderate to heavy exploitation. Production model analysis suggests the fishery is operating close to MSY. We note that the size composition of the catch and presumably the population are changing also. This matches our expectations. Given that the population structure has been influenced by the fishery, it is likely that age and geographic structure will undergo further changes when fishery regulations are introduced. Simple yield-per-recruit analyses take fishery-induced shifts in age structure into account, but do not consider possible shifts in geographic distribution of the population caused by age structure changes.

All this is to say that our proposed management scheme may have to include "adaptive" management. This means that our scheme should provide for continual monitoring of the situation and adjustment of regulations to suit changing conditions as the populations and fisheries respond to the regulations.

3.3 Effectiveness of Recommendations

Many of the analyses proposed above involve treatment of individual strata mostly in isolation from each other and recommendation of regulations for each stratum. But in addition, the alternative packages of recommendations for the whole region should each be assessed. Some sort of integrative model is necessary. A dynamic model which would include such processes as growth and migration would be ideal. Such a model would recognize where the triage analogy breaks down, namely the fact that the strata are not really independent of each other. Perhaps a model like this may be overly ambitious. Nevertheless, it would be useful to have such a model as a long-term goal to help guide future research activity.

4. WHAT HAS BEEN DONE TO DATE

4.1 Description

Much of the work of WGJTT scientists was alluded to in Section 2 and led to the documentation of the conflict involved in optimizing the yields from the three species. Apart from those analyses, the efforts of the WGJTT have centered on adjusting the existing data to reflect current assumptions on species composition in the landings and substitutions of size frequencies. Efforts have also included selection of growth and natural mortality assumptions.

Correction of purse seine data for 1980 to present was done by first lumping all catches over species within size categories (0-10kg, 10-30kg, >30kg) and then separating species based on species composition samples taken for a segment of the fleets. Length frequencies for the total catch by stratum were estimated from sample data. Substitution between strata for missing data was presumably done. Calculation of skipjack landings prior to 1980 (1969-1979) was done by extrapolating the skipjack to yellowfin ratio for

1980-1982 backwards in time. Calculation of bigeye catches for the same time period was done using the ratio of yellowfin to bigeye for the 1980-1982 period. Some additional assumptions were needed for particular strata where data coverage was poorer.

Correction of baitboat data for species landings up through 1979 was previously done by the SCRS. For 1981 and 1982 for Tema-based vessels, the yellowfin to bigeye catch ratios of the purse seine fleet were used (by size class) to apportion the baitboat catch. Japanese task II data were extrapolated to other fleets up to and including 1980. Individual fleet data were used for later years. Length frequency treatment was as described above.

4.2 Critique

Notwithstanding the actual appropriateness of each assumption (e.g. that the Spanish and French fleets fish similarly enough to allow between-fleet substitutions at will, etc.) which are too numerous to discuss here, the systematic application of the various assumptions to the data will have some significant effects and should impose limitations on the interpretations of the summary statistics.

For example, assuming that the species mix (within strata) in recent years is the same as in previous years means that it will be impossible to look for year-to-year variability in species composition, something highly desirable when considering area closures. This also makes valid systematic changes in species composition over time undetectable. Thus, these substitutions will swamp variability in time and space to such an extent that each individual conclusion must be traced back through the data creation process to check its validity. Further confounding will occur as we substitute purse seine species composition in the latest years for baitboat species composition. In this case differences between gears will not be detected, eliminating a useful management consideration.

Application of the assumed growth and natural mortality functions should have no systematic effect on the qualitative results of the various analyses. However, the quantitative results (i.e. how much percent gain in yield-per-recruit is possible under some option) may be biased up or down.

5. CONCLUSIONS

By way of conclusion, we would like to put forward a few suggestions. Firstly, we believe that WGJTT should formulate and agree upon a clear plan of action. We suggest that this plan should at least address the questions posed by ICCAT and SCRS and listed in Section 1. If a more satisfactory statement of the fundamental problem can be drafted, then such a statement, as well as the original questions, should be the basis of subsequent planning. Section 2 could be a starting point for such a statement. In subsequent planning, the first consideration should be the analyses that should be undertaken to address the problem. This would be the starting point to take up detailed questions, some of which are considered in Section 3, questions such as whether and how to categorize strata, what the resolution of strata should be,

whether cohort analysis is appropriate, what sorts of integrative models are necessary, etc. The final consideration in the plan of action should be the data requirements to support the chosen analyses. Section 3 deals with some of the considerations in this area.

Once a clear plan of action is agreed upon, we would expect that the work of the WGJTT could proceed in a coherent and orderly fashion. We hope this document will stimulate, and perhaps serve as a framework for the formulation of such a plan of action.