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REVIEW OF DATA REQUIREMENTS FOR STOCK ASSESSMENT IN WESTERN AND CENTRAL PACIFIC TUNA FISHERIES

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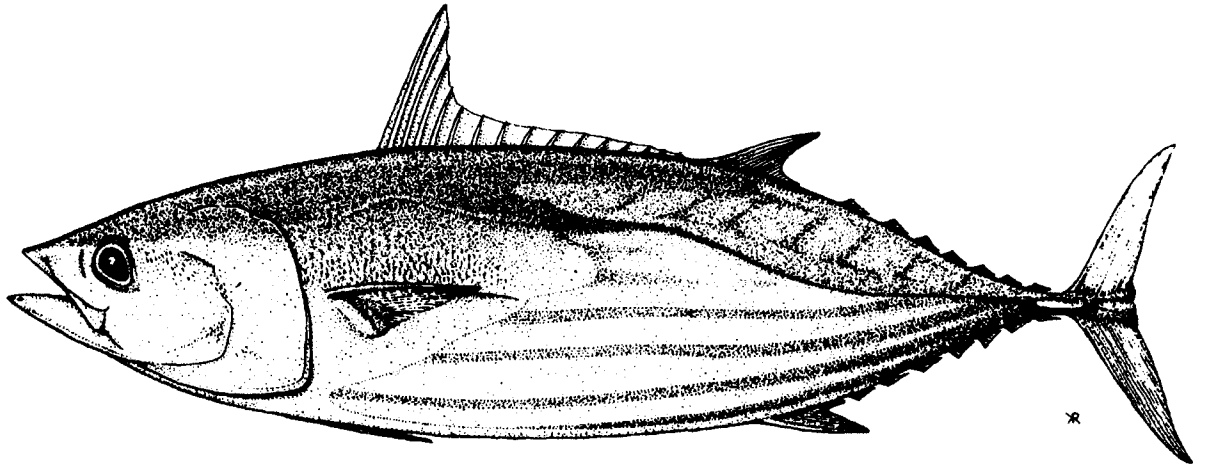

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Introduction

The term "stock assessment" is a gerenal term that encompasses a range of fisheries research problems. The subject can be classified into three categories, each of which pertains to a particular question or class of questions that fisheries managers often ask of scientists. The first question relates to stock status, and might be framed along the following lines:

> *What is the current size of the stock and how has it changed over time in response to fishing?*

This question is often extended from stock size to also incorporate age or size, and recently, spatial structure. The second question, particularly important in developing fisheries is:

> *What is the exploitation potential of the stock?*, or *What levels of long-term sustainable catches are possible?*

Finally, the third question, which is important both in developing fisheries and in fisheries subject to management regulation for rehabilitation or other purposes, is:

> *What will be the effect on the stock and its component fisheries of a particular fishing development or harvesting strategy?*

Increasingly, scientists are being asked to express their answers to these questions in relation to specific biological reference points that have been pre-set to trigger various management responses. Also, scientists are often required to not only provide their "best estimates" as answers to these questions, but also to include some realistic estimate of the uncertainty in the "best estimates", so that the management response can be appropriately precautionary. Data quality is, if not the single most influential factor in determining the extent of uncertainty that will exist in a stock assessment, certainly the factor over which scientists and managers have the greatest control.

Effective stock assessment and the provision of scientific advice generally for fisheries management requires access to various fisheries-related data, information on the biology of target and non-target species and data on a range of environmental factors that are known to influence the abundance or vulnerability of exploited fish stocks. This paper first reviews the types of stock assessment methods currently employed for tuna fisheries in the western and central Pacific Ocean (WCPO) and the data requirements of those methods. The review is restricted to fisheries-related data requirements. We then present recent guidelines for the collection and provision of information and cooperation in scientific research, as laid down by the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (hereafter referred to as the UN Agreement). Finally, we suggest a possible future policy for data collection and provision that is consistent with the assessment needs of the region and with the UN Agreement.

Methods and Data Requirements for Stock Assessment of Tuna in the WCPO

The South Pacific Commission (SPC) has, for the past several years, produced summary reports on the status of the four main stocks of commercially important tunas in the WCPO – skipjack, yellowfin, bigeye and South Pacific albacore (SPC 1995). Preliminary working hypotheses regarding stock boundaries have been adopted for the purposes of data compilation and stock assessment:

Skipjack and yellowfin:	40°N–40°S, Asian Pacific coast (including South China Sea and eastern Indonesia) and Australian east coast to 150°W;
Bigeye hypothesis 1[1]:	40°N–40°S, Asian Pacific coast (including South China Sea and eastern Indonesia) and Australian east coast to the west coasts of the United States, Central and South America;
Bigeye hypothesis 2:	40°N–40°S, Asian Pacific coast (including South China Sea and eastern Indonesia) and Australian east coast to 150°W;
Albacore:	Equator to 50°, 145°E to the west coast of South America.

Several different methods have been used for assessments of these stocks. These fall into four main categories, i.e. indices of abundance based on catch per unit effort (CPUE), surplus production models, tag-recapture models and length-based age-structured models. Each of these types of models and their data requirements are discussed in turn below.

Indices of abundance based on CPUE

Abundance indices based on nominal or standardized CPUE data have been applied to all species. Standardized CPUE time series, despite their many problems, can provide valuable information on variation in stock abundance, and are likely to be used in stand-alone fashion, or as input to other stock assessment models, in the future. The data requirements for standardized CPUE methods (usually so-called General Linear Models or General Additive Models) will depend on the factors incorporated into the statistical model. Factors such as season, area, characteristics of the vessels, their fishing techniques and environmental factors will generally need to be tested for possible inclusion in the final model. In most cases, the construction of such models will require access to individual vessel log book data.

Surplus production models

Surplus production models have also been applied to yellowfin, bigeye and albacore at various times. The time-series version of the surplus production model is currently the technique most relied upon for bigeye. This model requires at least one time series of relative abundance, but

[1] Historically, hypothesis 1 has been preferred in bigeye stock assessments. The question of bigeye stock structure is currently under investigation, and recent bigeye assessments (Miyabe 1995) have also considered hypothesis 2 as a possible alternative stock structure hypothesis.

multiple time series can be utilized by some implementations of the model. These relative abundance time series are most often obtained from the standardized CPUE analyses referred to above. Estimates of total removals from the stock (i.e. catch plus discards), stratified by some time period, are also required. The data requirements for application of this method are therefore similar to those for constructing standardized CPUE time series, with the additional requirement of total fishery removals. Therefore, log book data of high coverage plus independent estimates of total catch (if log book data are incomplete) are required. If discards are significant, representative data on discards may be required from scientific observer programmes. (Log books have been shown to be an unreliable source of information on discards.)

Tag-recapture models

Tag-recapture models have been applied to skipjack and yellowfin, and currently represent the major stock assessment tool for these species. Supporting catch and/or effort statistics are essential for the estimation of mortality rates and related parameters from tagging data. The resolution of the catch and effort data required for such analyses depends on how the tag-recapture model is structured. In the simplest case, only total catch and effort by time period (usually month in the case of skipjack and yellowfin) are required. However, such analyses are increasingly taking account of the spatial dynamics of the population and fisheries, and therefore require catch and effort data by fine-scale geographic strata (1° square or less) and by gear type or fishing technique. Full-coverage log book data provide the best option for supporting analyses of tag-recapture data, although fine-scale aggregated data will also generally suffice. However, it should be noted that individual vessel log book data are extremely valuable for the verification and editing of the tag recapture data and for the estimation of various required parameters, such as reporting rates.

Length-based age-structured models

The final stock assessment method applied to WCPO tuna stocks is length-based age-structured modeling. This approach has been applied with success to South Pacific albacore and is currently showing considerable promise in an application to yellowfin. Ultimately, it is possible that bigeye and skipjack stocks might also be assessable using this methodology. Three categories of fishery data are required – total catch, which is assumed to be accurately measured, estimates of effective effort and length frequency samples. If discards are significant, the estimated quantities and their size composition should also be included. All data must be stratified by time period (usually quarter or month) and fishery (defined by gear type and area). The method is likely to work best if the effort data are pre-standardized, although catchability trends can still be estimated from unstandardized data. Recent implementations of this approach have also incorporated spatial structure (e.g. Fournier and Hampton 1996). While the spatial strata for large-scale problems will generally be coarse, many different stratifications might need to be tried before the best spatial configuration is found. Therefore, the availability of catch, effort and length frequency data at a fine spatial resolution (5° square or better) would considerably assist such analyses. For the pre-standardization of effort, log book data would be required.

By-catch assessment

No assessment of any by-catch species taken in the WCPO tuna fishery has yet been attempted. The main species involved and some indication of relative magnitudes of catch are given in Bailey et al. (1996). However, in most cases, information on levels of catch, size distribution and basic biological parameters is lacking. By-catch data in most cases (an exception being marlin by-catch by longliners) is not recorded on log books, and will generally only be obtainable through scientific observer programmes. The SPC, Forum Fisheries Agency and several of their member countries are now placing observers on licensed fishing vessels, but the coverage will need to be extended and coordinated before reasonable estimates of by-catch are obtained.

Guidelines of the UN Agreement

The UN Agreement contains specific reference (through Article 14) to the collection and provision of information and cooperation in scientific research. Article 14 of the UN Agreement states, *inter alia*:

> 1. States shall ensure that fishing vessels flying their flag provide such information as may be necessary in order to fulfil their obligations under the Agreement. To this end, States shall in accordance with Annex I:
>
> (a) collect and exchange scientific, technical and statistical data with respect to fisheries for straddling fish stocks and highly migratory fish stocks;
>
> (b) ensure that data are collected in sufficient detail to facilitate effective stock assessment and are provided in a timely manner to fulfil the requirements of subregional or regional fisheries management organizations or arrangements; and
>
> (c) take appropriate measures to verify the accuracy of such data.
>
> 2. States shall cooperate, either directly or through subregional or regional fisheries management organizations or arrangements, to:
>
> (a) agree on the specification of data and the format in which they are to be provided to such organizations or arrangements, taking into account the nature of the stocks and the fisheries for those stocks; and
>
> (b) develop and share analytical techniques and stock assessment methodologies to improve measures for the conservation and management of straddling fish stocks and highly migratory fish stocks.

This Article makes quite clear the obligations of States to cooperate in data collection and research. Annex II of the UN Agreement further elaborates the basic principles of data collection, verification, compilation and exchange. The following is a summary of the various Articles contained in Annex I:

Article 1:

- Data collected from fisheries are to cover both areas of national jurisdiction and the high seas;
- Data are to be collected and compiled at a resolution to enable statistically meaningful analysis for conservation and management purposes;

- Vessel-related data are to be collected;
- Data for target, non-target, associated and dependent species should be collected;
- Confidentiality of non-aggregated data shall be maintained, and dissemination of such data shall be on agreed terms;
- Assistance shall be given to developing states to build capacity in data collection and stock assessment.

Article 2:

- Data are to be collected by flag states at an operational level, i.e. log book records by longline set, purse seine set, etc.
- All data should be verified by appropriate means;
- States should compile and provide data in an agreed form to the relevant organization or arrangement;
- The relevant organization or arrangement shall in turn make the data available in agreed form to all interested states.

Article 3:

- States shall make available various categories of data in sufficient detail to facilitate stock assessment. The categories include catch and effort statistics, by-catch and discard statistics, fishing location and time data, size and sex composition data, and various biological and environmental information.

Article 4:

- States should collect various types of vessel-related data, including gear specifications.

Article 5:

- States shall ensure that its vessels submit log book data at frequent intervals to its national fisheries administration, and, where agreed, to the relevant regional fisheries management organization or arrangement.

Article 6:

- States or, as appropriate, regional fisheries management organizations or arrangements should verify fishery data using methods such as vessel monitoring systems, scientific observer programmes, landing and transshipment reports and port sampling.

Article 7:

- Data should be shared through appropriate regional management organizations or arrangements, who shall compile data and make them available to interested States in a timely manner. Confidentiality of non-aggregated data shall be preserved.

The critical elements that emerge from these guidelines is that States signatory to the UN Agreement are obligated to:

1. Collect catch (target and non-target species), effort and other data at a vessel operation level, i.e. log book data;
2. Provide such data for both waters under national jurisdiction and the high seas at a level of resolution enabling effective stock assessment; and
3. Cooperate in scientific programmes to generate other data required for effective stock assessment.

Future Data Needs of WCPO Tuna Fisheries

The tuna fisheries of the WCPO are diverse in terms of the species covered, their geographical ranges, the gear types used and the various national fleets involved. Different stock assessment techniques have been applied, depending on the state of biological understanding of the stock concerned, and the quality, coverage and availability of fishery-related data to support stock assessment. Here, we attempt to outline the key components of a future cooperative scientific data collection programme in the WCPO, supported by an international agreement or regional fisheries management arrangement, and consistent with the guidelines given by the UN Agreement.

Spatial structure is becoming an increasingly important facet of stock assessment because of growing awareness regarding the spatial variability of many stock parameters, the influence of small to large-scale environmental variability on stock abundance and catchability and, in some cases, the changing geographical range of fishing effort as fisheries have evolved over time. From a management point of view, estimating the interaction of fisheries with different spatial distributions of effort is another use for spatially-structured models (e.g. Hampton et al. 1995). Such models typically require fine-scale (both spatial and temporal) catch, effort and other fishery-related data.

We believe that data at the level of the fishing operation, i.e. log book data, provide the most flexible data tool, not only for stock assessment models (spatially structured or otherwise), but for the whole range of fisheries biology research tasks that are required to support stock assessment.

Conclusion 1: **Flag states fishing for tuna in the WCPO should collect catch, effort and other data at the fishing operation level (i.e. log book data) for all commercial tuna fishing activity, regardless of whether such activity takes place in waters under flag state jurisdiction, other national jurisdiction or on the high seas. Such data should be consolidated for all fleets in a confidential database to which scientists would have access under conditions determined by international agreement. Summaries of such data could be made publicly available under conditions also determined by international agreement.**

With recent developments in stock assessment technology, it is possible that length-based age-structured models will be the tool of choice for assessment of WCPO tuna fisheries in the near future. SPC and some national fisheries administrations have been collecting length frequency data from landed tuna catches for many years. These data

have never been consolidated into a common database for use in stock assessment and other research.

Conclusion 2: A length-frequency data repository should be established so that such data can be used in stock assessment and other tuna research projects. Flag states, coastal states and regional agencies should cooperate in developing and implementing regional sampling plans (using observer and/or in-port sampling programmes) for all major species based on integrated sampling designs.

As well as the collection and provision of data to support stock assessment of target species, it is becoming increasingly clear that full documentation of by-catch, and ultimately, stock assessment of major by-catch species, is a responsibility that fisheries will have to bear on a routine basis. The first step in this process will be to establish data collection systems to enable reasonably precise and unbiased estimates of by-catch. Previous experience suggests that such information is not likely to be obtained from fishing vessel log books; scientific observer programmes are the only practical means of collecting reliable data on by-catch and discarded catch of target species.

Conclusion 3: Flag and coastal states should cooperate with regional agencies in the development and implementation of a regional, multi-purpose, scientific observer programme, based on an integrated sampling design. Observers would estimate by-catch and discards by fishing operation, conduct biological sampling of both the target and non-target catch and collect other operational data as appropriate.

While the fishery-related data referred to above form the cornerstone of effective stock assessment, a variety of other information on the biology and ecology of target and non-target species will be required to support effective stock assessment.

Conclusion 4: All interested parties should cooperate in scientific research programmes of relevance to stock assessment of target and non-target species harvested by tuna fisheries in the WCPO.

References

Bailey, K., P. Williams, and D. Itano. 1996. By-catch and discards in western Pacific tuna fisheries: a review of SPC data holdings and literature. Oceanic Fisheries Programme Technical Report No. 35 (in press). South Pacific Commission, Noumea, New Caledonia.

Fournier, D.A. and J. Hampton. 1996. Preliminary analyses of South Pacific albacore catch, effort and length-frequency data, using an age-structured, length-based model with spatial structure. Paper presented at the ICCAT 25th Anniversary Symposium, Ponta Delgarda, Azores, Portugal, 10-18 June 1996.

Hampton, J., T. Lawson, P. Williams, and J. Sibert. 1995. Interaction between small-scale fisheries in Kiribati and the industrial purse seine fishery in the western and

central Pacific Ocean. Paper presented at the 2nd FAO Expert Consultation on Interactions of Pacific Tuna Fisheries, Shimizu, Japan, 23-31 January 1995.

Miyabe, N. 1995. Follow-up study on the stock status of bigeye tuna in the Pacific Ocean. Paper presented at the 8th Meeting of the Standing Committee on Tuna and Billfish, Noumea, New Caledonia, 16-18 August 1995.

SPC. 1995. Status of tuna stocks in the western and central Pacific Ocean. Working Paper 3, 8th Meeting of the Standing Committee on Tuna and Billfish, Noumea, New Caledonia, 16-18 August 1995.