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The Adequacy of Current Billfish Fisheries Statistics for Stock Assessment and Management Purposes

by
Richard S. Farman

Foreword

1. Following the recommendation of the last Regional Technical Meeting on Fisheries, Tuna Programme staff have devoted more time to the evaluation of billfish stocks. Efforts have concentrated on the evaluation of the adequacy of current data holdings for stock assessment purposes, and a similar version of the following review paper is a contribution to the Twentieth International Billfish Symposium. It will be published with the proceedings of the workshop (agenda appended) during 1989.

Summary

2. Drawing on the example of the South Pacific, this paper first reviews the extent of statistics typically collected in a billfish fishery, their sources and availability. Catch and effort statistics have been collected as part of longline fisheries data for many years.They are processed and often published by the fishing nation and/or regional or research organisations and as such should be accessible. Because of the nature of the longline fishery, unloading records have been kept in many areas, often coupled with port sampling. These data concerning total catch and length frequency are generally in the custody of fishing associations or research organisations but are seldom available in raw format. In addition, there is a growing body of catch statistics generated by recreational fisheries.

3. In the past, data have been found limiting because of their incomplete coverage, lack of standardisation, non discrimination between some species or simply because they were not available. In order to evaluate the adequacy of the current statistics, it is necessary to determine which management questions have to be answered, which stock assessment methods are appropriate and what are their respective data needs.

4. Assuming from previous assessments, mature to overfished billfish fisheries, the question of whether effort should (and how) be expanded/reduced is addressed. The primary stock assessment concerns are therefore whether current yields are sustainable, what are the trends in abundance and recruitment (is yield per recruit maximised?) and what is happening to the spatial distribution of the catch. The common techniques applied to estimate the necessary parameters rely on catch and effort statistics, length distribution and length at age information.

5. There are some inherent problems with the information collected to date that have precluded all but the coarsest estimations. Foremost is the fact that billfish are mostly non-target species in longline and other fisheries and that complete catch statistics, notably total catch, are often not collected. Also, the interpretation of billfish catch per unit effort is confounded by the fact that effort is targeted at other species, certainly resulting in unpredictable variations in apparent catchability. The existing methods to adjust these statistics require more detailed information than is readily available. Incomplete statistical coverage of the fleets particularly in the high seas areas, is a major obstacle to a full analysis of the spatial distribution of the fishery. In the Pacific for instance, regional longline statistics the majority of which come from a single flag, cover only about 50-65% of the total activity, rendering a biased picture of the fishery. Length-frequency data collected on a regular basis coupled with complete catch data would, if available, provide powerful tools for the estimation of mortality and ultimately, yield per recruit.

6. Although there has been progress in data coverage over the last ten years, principally with respect to the biology of the species, most of the data needed for stock assessment and management purposes are still unavailable precluding in-depth analyses. This situation therefore highlights the need for consultation between research agencies for the joint analysis of complementary data

Introduction

7. Arising from the concern over declining catch rates and growing fisheries, the question of the adequacy of billfish fisheries statistics for stock assessment and hence management purposes has long been outstanding. Earlier consultations have concluded that the detailed information required for the understanding of the effects of fishing on billfish stocks had not been acquired (Anon 1981a, 1981b; Shomura 1980; Shomura and Williams 1974). With the advent of this new symposium, it is pertinent to review what progress has been made to date and assess the current situation. It is the object of this paper to identify existing and potential sources of data that can be used for stock assessment and management purposes and determine the extent of their availability. It will also examine the adequacy of the current holdings with respect to the data needs of the methods available to address management questions.

Existing and potential sources

8. Since billfishes are principally harvested by commercial longline operations, the bulk of the data is comprised of catch statistics. These data are routinely collected by vessel operators and compiled by the fishing nations, mainly Asian countries (Japan, Korea and Taiwan), or regional organisations involved with pelagic fisheries (e.g. International Commission for the Conservation of Atlantic Tunas, Inter-American Tropical Tuna Commission, South Pacific Commission, Indo-Pacific Tuna Programme). Figure 1 shows an example of the standardised longline logsheet adopted for the western Pacific which has been translated into the languages of the various flag vessels operating in the region. Different log sheets are used elsewhere, but the current move is toward the adoption of a single format (for each gear), which is now being discussed at meetings on global tuna statistics. These data are often published, albeit in a variety of summary formats and covering different periods, which makes them theoretically accessible.

Figure 1. Standardised log sheet to report longline catches in the western Pacific.

LONGLINE VESSEL - CATCH REPORT FOR THE WATERS OF .....

VESSEL NAME _____
COUNTRY OF REGISTRATION _____
REGISTRATION NUMBER _____
GROSS REGISTERED TONNAGE _____
LICENCE/PERMIT NUMBER _____
NAME OF CAPTAIN _____

NUMBER OF HOOKS/BASKETS _____
DISTANCE BETWEEN FLOATS (M) _____
LENGTH OF FLOAT LINE (M) _____
LENGTH OF BRANCH LINES (M) _____

BAIT USED (Species)	1	2

	NAME		YYMMDD
DEPARTURE FROM PORT		DATE	
ARRIVAL AT PORT		DATE	
NUMBER OF CREW			

YEAR _____ MONTH _____ LICENCE/PERMIT HOLDER'S SIGNATURE _____

Comments Code
1. Days not fishing
2. In port

DAY	NOON POSITION				NUMBER OF HOOKS	SEA SURFACE TEMPERATURE	Albacore		Bigeye		Yellowfin		Bluefin		Striped marlin		Blue marlin		Black marlin		B.B. Sword fish		Sailfish		Shark		OTHER SPECIES		DISCARDS		COMMENTS
	LAT		LONG				NO.	TOT. WT. (KG)	NO.	TOT. WT. (KG)	NO.	TOT. WT. (KG)	NO.	TOT. WT. (KG)	NO.	TOT. WT. (KG)	NO.	TOT. WT. (KG)	NO.	TOT. WT. (KG)	NO.	TOT. WT. (KG)	NO.	TOT. WT. (KG)	NO.	TOT. WT. (KG)	NO.	TOT. WT. (KG)	TUNA (KG)	OTHERS (KG)	
	DDMM	N S	DDMM	E W																										
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TOTAL																														

9. These statistics however only concern information on the location and amount of the catch and effort, with finer ancillary data, such as individual lengths and weights, and other biological samples are being collected during unloading. These collections are the work of marketing authorities, fishing associations or research groups and their outputs depend greatly on the reason for which they were implemented. Because of its economic nature, the information is often regarded as confidential and as such is seldom, if at all, available in raw format. Furthermore, sampling practices for non- scientific purposes may not be rigorous and a variety of measures are often employed for the same parameter (e.g. dressed/whole weight, round/flat length).

10. Finally, there is a growing body of data generated by recreational fisheries which include both types of information mentioned above. These fisheries generate catch statistics and also provide specimens for biological sampling. With the growing popularity of catch, tag and release competitions, recreational fisheries have also provided an excellent medium for opportunistic tagging. The catch records are kept by fishing groups, clubs or association, but these data have not, until recently and still in only a few areas, been centralised or published and, as such, are not easily accessible. In addition, these data are seldom standardised and provide information of varying quality.

Adequacy of these data for stock assessment and management purposes

Previous evaluations

11. The conclusions of earlier symposia and workshops concerning billfish stocks in the three major oceans noted that, except for catch and effort statistics from some segments of the longline fishery, data required for the purpose of stock assessment were virtually nonexistent (Anon 1981a, 1981b; Shomura 1980; Shomura and Williams 1974), precluding but the coarsest analyses of catch trends or surplus production described by Shaefer (1954). In addition, the available catch and effort data were found limiting because of incomplete coverage, virtual absence in some sectors, non discrimination of some species (notably sailfish *(Istiophorus platypterus)* and shortbill spearfish *(Tetrapturus angustirostris)*) and non standardised reporting practices for catch data. These reflections were prompted by the need for basic biological information and adequate statistics such as: size, sex and age composition, total catch, and catch and effort over several years. It was thus recommended that all nations with billfish fisheries establish sampling programmes and procedures to ensure the collection of statistics on total catch by species, gear, type of operation and ocean region; total nominal effort for the same categories; catch per unit effort (CPUE) by small area-time strata, gear and nature of fishing operations; and size and sex composition of the catches by species and by small area-time strata (Shomura 1980). During the last ten years, there have been significant changes in tropical pelagic fisheries with the redeployment and redirecting of longline effort concurrent with the advent of large scale industrial purse seining. Have there been corollary changes in the way and extent data are collected? What progress has been made over the last ten years in implementing the recommendations of international fora?

Current needs

12. The objectives of stock assessment or management will obviously have a bearing on what data and methods are needed for the analysis of the data and the evaluation of proposed strategies. Let's first review what the current concerns are and see which data are now available to address them. Our reflexion has to be based on earlier assessments which estimated most billfish fisheries to be mature (fully exploited) or overfished (Anon 1981a). This implies that we should be concerned whether effort should (and how) be expanded or reduced and what expected impact these evolutions will have on the stocks and the fisheries. We should thus be addressing the ancillary questions of whether current yields are sustainable, how to maximise yield per recruit and what is happening to the spatial distribution of the catch. The techniques available to answer these questions are determinant in the type of data we need.

Common techniques

13. In principle, there is no way to evaluate how a population responds to exploitation without measuring relative changes in stock size over time. The common approach is to look at the evolution of catch per unit of effort as the fishery progresses, assuming that the unit of effort takes a catch proportional to the stock present in the fishing area. Tagging studies are also used to estimate abundance and exploitation rates as point estimates.

14. Recruitment may be inferred from the age composition of the catch, by back calculation from the catch history of a year class (cohort) or by fitting an average catch curve through the same data and finding the number alive at the beginning. Ancillary techniques have evolved to use similar methods with length-frequency data, assuming that growth is uniform between cohorts.

15. Finally, there are several techniques to estimate the relationships between catch and the exploitation rate. One such method is to assume that all natural processes combine as to produce a net positive rate of biomass (tonnage) growth called surplus production which is the amount that should ultimately be harvested by the fishery. Another approach is the yield per recruit analysis which predicts how the cumulative catch from one age class varies in relation to exploitation.

16. It is beyond the scope of this exposé to cover these methods in more detail, suffice to say that they all make a certain number of assumptions which are often difficult to comply with.

Data requirements

17. The afore-mentioned techniques to measure (or estimate) abundance, especially tagging studies, rely on complete catch and effort statistics, including an estimate of total catch. The definition of effort is particularly important for the analysis of catch rate trends and it needs to be standardised for the various gears and techniques, requiring information on gear configuration only available from log sheets or extensive observer programmes. The spatial distribution of catch or abundance which is also used for this purpose requires complete statistical coverage of the various fisheries.

18. Other methods estimating various parameters such as recruitment, require age composition data. Yield per recruit analysis also requires weight at age and the catch at age.

19. Finally, the estimation of mortality may be obtained from length frequencies, age distribution of the catch or tagging data. From this short exposé, it becomes apparent that our data needs have not changed and that basically we are still confronted with the same problems today as we were 10 years ago, unless there has been a significant improvement in data collection and coverage.

Today's situation

20. The problems associated with the assessment of billfish stocks can be classified into two categories, one inherent to the nature of the fishery and the other to the availability of the data. The problem with the nature of the fishery is the fact that, except for recreational fisheries and some species like striped marlin *(Tetrapturus audax)* and swordfish *(Xyphias gladius)*, billfishes are mostly non-target species. The greatest part of the catch is incidental to the tuna longline fishery and to a lesser extent to the purse seine and gillnet fisheries. It is therefore difficult to determine which part of the fishing effort is being applied to the billfish stocks and to interpret variations in apparent catchability. The competition between the different species of billfish for longline hooks further confounds the interpretation of catch per effort statistics.

21. The adequacy of longline statistics to measure relative abundance in itself can also be questioned. One study suggested that for bigeye, areas of higher catch rates corresponded to areas where the hook depths coincided with layers of optimum temperature and dissolved oxygen content above the requirements of that species, and therefore that they were not necessarily representative of areas of greater fish concentration (Hanamoto 1987). This problem is even more acute for billfishes which often are not the targeted species and we cannot or should not infer relative distribution or abundance from longline statistics alone. We need independent evidence from tagging and biological studies to identify stock structures, habitat preferences and possible migration patterns before we can determine which sections of the different populations are vulnerable to various gears and thus compute the effective effort. In most cases, this information is not available or poorly documented.

22. There has also been a shift to deeper longline gear since the late 1970s which places most hooks below the mixed layer depth where most billfish occur (Sakagawa 1987; Yang and Gong 1986) and these latest statistics are even less likely to be representative of the effective effort exerted on billfishes. The existing methods to adjust and standardise fishing effort require more detailed analysis based on the knowledge of gear configuration and target species. Such data have been available for subsets of a particular fishery and have allowed the estimation of relative efficiency between gear configurations (Yang and Gong 1986; Gong et al. 1986; Honma 1974). They have been found lacking however when attempting a complete stock assessment analysis and it was recommended that all fishing nations collect them in a systematic fashion, and report to a single agency (Conser et al. 1985)

23. This brings us to the problem of data availability. Complete catch statistics, notably total catch, are often not collected. Figure 2a is the purse seine catch form currently in use in the western Pacific showing that there is no provision for recording billfish bycatch. A more detailed form (Figure 2b) that has yet to be implemented, will only record billfishes as a group. Even for longline forms, a recurring problem has been the non discrimination between some species, more often sail and spearfishes but sometimes also blue *(Makaira nigricans)* and black marlin *(Makaira indica)*, because these species are often aggregated under the same category. Data from specialised fisheries like for swordfish or recreational fisheries may not be collected regularly or rigorously and as such may not be available or be of little use to scientific analysis.

Figure 2a. Standardised log sheet to report purse seine catches in the western Pacific.

PURSE SEINE VESSEL - CATCH REPORT FOR WATERS OF ....

	NAME		YYMMDD
DEPARTURE FROM PORT		DATE	
ARRIVAL AT PORT		DATE	

NUMBER OF CREW	

VESSEL NAME ____________________
COUNTRY OF REGISTRATION ____________________
REGISTRATION NUMBER ____________________
GROSS REGISTERED TONNAGE ____________________
NAME(S) OF FISH CARRIER(S) FOR GROUP PURSE-SEINER ____________________

LICENSE/PERMIT NUMBER ____________________
NAME OF CAPTAIN ____________________
LICENSE/PERMIT HOLDER'S SIGNATURE ____________________
YEAR __________ MONTH __________

DAY	NOON OR SET POSITION				SCHOOL TYPE	TIME SET	SKIPJACK		YELLOWFIN		OTHER SPECIES			COMMENTS	DISCARDS		
	LAT		LONG				CATCH	AV. SIZE	CATCH	AV. SIZE	SPECIES NAME	CATCH	AV. SIZE		TUNA	OTHERS	REASON FOR DISCARD
	DDMM	N/S	DDDMM	E/W			(mt)	(kg)	(mt)	(kg)		(mt)	(kg)		(mt)	(mt)	
					( )									( )			( )
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					( )									( )			( )
TOTAL																	

NUMERICAL EXPRESSION OF SCHOOL TYPE, COMMENTS, AND REASON FOR DISCARD

SCHOOL TYPE

1 Log
2 Surface
3 Whale
4 Porpoise
5 Raft
6 Other

COMMENTS

1 A full day in transit between fishing grounds or to or from fishing grounds.
2 A full day not fishing due to breakdown.
3 A full day not fishing due to bad weather.
4 A full day searching for fish but no sets made.
5 Part of day searching for fish but no sets made.
6 Set unsucessful for any reason, e.g. fish dive, roll up.

REASON FOR DISCARD

1 Undesirable species
2 Fish too small
3 Vessel completely loaded
4 Other reason - please specify
....

Figure 2b. Proposed log sheet to report purse seine catches in the western Pacific.

PURSE SEINE VESSEL

CATCH REPORT FOR THE WATERS OF ____________ YEAR______ LOGSHEET #

Vessel Name : ____________
Country of Registration ____________
Vessel Registration Number ____________
Gross Registered Tonnage : ____________
Length of Net : ______ Depth of Net : ______
Number of Crew : ______
For Group Seiner,
Name(s) of Fish Carrier(s) : ____________

Licence/Permit No : ____________
Name of Captain ____________
Name of Fishing Master : ____________
Licence/Permit
Holders Signature : ____________

Aerial Assistance: ☐ Helicopter ☐ Airplane ☐ None

FISH WEIGHT UNITS Tick (✓) one box

	Size Range	CATCH Wt
☐	lbs	short tons
☐	kg	metric tonnes

	PORT NAME	DATE YY	DATE MM	DATE DD
DEPARTURE PORT				
UNLOADING PORT(S)				
ARRIVAL PORT				

NOTE : Please record all sets, even for no catch

DATE MM DD	Beau-fort Scale	Sea Surface Temp.	Vessel Search Time hrs	Aerial Search Time	Activity (code)	SET No.	Set or Noon Position				School Type (code)	Time Set (local)	SKIPJACK		YELLOWFIN		BIGEYE		OTHER SPECIES		WELL NOS	DISCARDS			
							Latitude DD MM	N S	Longitude DDD MM	E W			CATCH Wt	Size Range (Wt)	CATCH Wt	Size Range (Wt)	CATCH Wt	Size Range (Wt)	Species Codes	CATCH Wt		TUNAS Species	TUNAS Wt	Bill-fish No.	Others Wt
						1 or noon																			
						2																			
						3																			
						1 or noon																			
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						1 or noon																			
						2																			
						3																			
												TOTAL CATCH													

ACTIVITY CODES :

0 - A day in which a set was made.
1 - A full day in transit.
2 - A full day not fishing due to breakdown.
3 - A full day not fishing due to bad weather.
4 - A full day searching for fish but no sets made.
5 - Partial day searching but no sets made.
6 - Any other reason for no sets.

SCHOOL TYPE CODES

1 - Foamer/Boiler
2 - Rippler/Breezer
3 - Birds only
4 - Natural log/debris
5 - Free floating raft/payao
6 - Anchored raft/payao
7 - Animals (whales, shark)
8 - Other

SPECIES CODES FOR "OTHERS" AND "DISCARDS"

KAW - Kawakawa, Mackerel Tuna
FRZ - Frigate Tuna, Bullet Tuna
DOT - Dogtooth tuna
ALB - Albacore
RRU - Rainbow Runner
DLF - Dolphinfish, Mahimahi
WAH - Wahoo
SHK - Shark
YFT - Yellowfin Tuna
SKJ - Skipjack
BET - Bigeye
BIL - Billfish
OTH - Other Species

24. Incomplete statistical coverage of the fleets, particularly in the high seas areas, is a major obstacle to a full analysis of the spatial distribution of the fishery which in turn precludes the computation of effective effort and thus the estimation of abundance indices. In the western Pacific for instance, the regional longline database compiled at the SPC is mostly comprised of statistics from a single flag, Japan, and covers only about 50-60% of the total activity (SPC 1986). If we consider the total catch figures published by FAO in areas 61, 71, 77, 81 (minus Philippines and Indonesia) (Anon 1985) as indicative of the total catch for the entire Pacific, SPC holdings for 1984, which were fairly representative coverage wise, comprise only between 1 and 23% of the billfish statistics depending on the species. Since few agencies may have reciprocal arrangements to obtain raw data from other sources and that most fishing nations have discontinued publishing their statistics after 1981, except for total catch figures, it is unlikely that any one organisation can have a complete coverage or time series. A cursory look at the literature seems to indicate similar situations in other areas, maybe better in the Atlantic Ocean under the auspices of the long established ICCAT but probably worse in the Indian Ocean where the centralisation of data has only begun. We are thus faced with the assessment of a resource, billfishes as a group, for which the data may be collected but is not often centralised.

25. These limitations have confined the assessment of billfish stocks to the analysis of catch rate trends and production models, based on subsets of the longline fishery and estimates of oceanwide catches (Anon 1981b; Shomura 1980; Wetherall et al. 1979; Joseph et al. 1974). These procedures rely on computed estimates of total catch and effective effort and the results depend on the extent to which assumptions about relative mortalities can be complied with. Their applicability, particularly to non-target species, may thus be questioned.

26. More powerful techniques such as virtual population and yield per recruit analyses require estimates of growth and mortality coupled with complete age- or size-structured catch data. The latter analysis is probably the most useful technique available to evaluate management options. It has been used successfully for the Atlantic swordfish fishery (Conser et al. 1985), making a strong case for the extensive collection of length measurements. It is particularly important to monitor the harvest of small individuals as it may occur in the purse seine or gill net fisheries. Indeed, traditionally only the larger (older) fish have been harvested and, the stocks were not then, at least in the biological sense, in any danger of collapsing. If a significant proportion of the younger fish was to be removed, it could conceivably reduce the recruitment to larger sizes, as it is feared for the yellowfin *(Thunnus albacares)* and bigeye tuna *(Thunnus obesus)*, which would not necessarily be apparent with the methods currently employed. Furthermore, the direct implications of different management strategies that may be implemented in that case can only be evaluated through yield per recruit analysis. The unavailability of length frequencies more than the lack thereof and the incomplete statistical coverage have prevented the systematic use of this method so far.

27. Still the best techniques available cannot be applied indiscriminately and further knowledge of stock structure is a prerequisite to the identification of the unit stocks to be managed. The limitations of catch statistics for representing the spatial distribution of the population have been presented above; it can only be repeated that such statistics should not be used alone. Tagging studies, while probably providing too few recaptures for stock assessment purposes, would still be useful in that respect.

Conclusions

28. Although there has been some progress in data coverage and acquisition over the last ten years, principally with respect to the biology of the species, it appears that for most species the data requirements for in depth analyses are still not met. The current evaluations based on trends in catch rates and surplus production analyses can provide only the roughest estimates of billfish stock status. Further efforts in the systematic collection of length frequencies for application in more robust methods are warranted. Considering that most of the information is likely to be available from various sources, the situation may not be as bleak as it seems. It does indicate ascertain the need for consultation between research agencies and other data holders for a more comprehensive inventory of the data, with the conduct of joint analyses of complementary data sets a logical final outcome.

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APPENDIX

Draft: 12/87

Program

INTERNATIONAL BILLFISH SYMPOSIUM
Kailua-Kona, Hawaii
August 1-5, 1988

Panel One: The Fisheries Chairman: JACK O'BRIEN, Australia

A. "Trends in the Fisheries" - An overview describing the fisheries, including major trends in harvest methods, catch and effort, etc., with emphasis on using past and present to predict future trends in the fisheries.

1. Atlantic Ocean
   a. Billfishes - GRANT BEARDSLEY, National Marine Fisheries Service, USA
   b. Broadbill Swordfish - STEVE BERKELEY, South Atlantic Fishery Management Council, USA

2. Pacific Ocean
   a. Billfishes - SHOJI UEYANAGI, Tokai University, Japan/RICHARD SHOMURA, National Marine Fisheries Service, USA
   b. Broadbill Swordfish - GARY SAKAGAWA, National Marine Fisheries Service, USA

3. Indian Ocean
   a. Billfishes and Broadbill Swordfish - ERIC SILAS, Central Inst. of Brackish Water Aquaculture, India

B. "Socio-Economic Trends" - An overview of the socio-economics of the fisheries, including trends in values.

1. Commercial (incl. artisanal) - DENNIS KING, ICF Technology, USA
2. Recreational - KARL SAMPLES, University of Hawaii, USA

Panel Two: The Status of the Stocks (Population Estimates)
Chairman:

What do we know, and how do we know it? What is needed? The principal objective of these papers will be to go through the exercise of assessing the stocks in order to identify the gaps in data and the shortcomings in analysis.

A. Atlantic Broadbill Swordfish - PETER MIYAKE/J.C. REY, ICCAT, Spain
B. Pacific Broadbill Swordfish - NORM BARTOO, National Marine Fisheries Service, USA
C. Spearfish and Sailfish - PATRICE CAYRE, France/ARTURO MUHLIA, CICIMAR, Mexico
D. Atlantic Marlins - RAY CONSER, National Marine Fisheries Service, USA
E. Pacific Marlins -

Panel Three: Biological and Statistical Requirements for Management Chairman: DAVID GROBECKER, Pacific Gamefish Research Foundation, USA

A. Stock Identification - ROBERT SKILLMAN, National Marine Fisheries Service, USA
An evaluation of what is known about stock identification and stock structure. Is it adequate for management purposes? Existing study methods will be examined and critique, with recommendations for improvement where appropriate.

B. Vital Statistics - RICHARD FARMAN, South Pacific Commission
An overview of the current status of knowledge of vital statistics (mortality, fecundity, recruitment, age and growth) and the adequacy of fishery statistics (catch, effort, length/frequency) for billfish management.

C. Strategy for Management Modelling - BRIAN ROTHSCHILD, University of Maryland, USA
A review of fishery management institutions reliant upon the modelling approach (cohort analysis, virtual population analysis, etc.). Consider the requirements for success in modelling systems, the adequacy of existing models, and the alternatives.

D. Socio-Economic Information Needs for Management - DAVID ROCKLAND, Sport Fishing Institute, USA
An examination of current methods for assessing the social and economic values of billfish, how the tools for measuring differ for recreational and commercial fisheries, what information is necessary for management decisions, and how it is or can be obtained.

Panel Four: Current and Potential Management Institutions and Procedures Chairman: JAMES JOSEPH, IATTC, USA

A. A History of Mechanisms for Managing Highly Migratory Species - KAZUO SHIMA, Fisheries Agency, Japan

B. A Critical Evaluation of the Effectiveness of Existing Mechanisms - An assessment of the performance of each

mechanism within the the parameters of its stated objectives and responsibilities toward billfish conservation and management.

1. Atlantic - CHRISTOPHER WELD, National Coalition for Marine Conservation, USA
2. Pacific/Indian Oceans - BARBARA ROTHSCHILD, National Marine Fisheries Service, USA

C. Debate - Moderator: JOHN GULLAND, England
A panel discussion intended to highlight the strengths and weaknesses of the various management approaches to billfish/highly migratory species.

1. International Management - AUGIE FELANDO, American Tunaboat Association, USA
2. Regional Management - WADSWORTH YEE, USA
3. A Combination - CARMEN BLONDIN, National Marine Fisheries Service, USA

Panel Five: The Future: Prognosis and Recommendations -
Chairman: PIERRE CLOSTERMANN, Belgium

A. Trends in the Fisheries - JACK O'BRIEN
B. Assessing the Status of the Stocks -
C. Meeting Information Needs - DAVID GROBECKER
D. Strategies for Management - JAMES JOSEPH