

## Second Performance Review of the Indian Ocean Tuna Commission: Assessment of the IOTC Science Process

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### Background

The Indian Ocean Tuna Commission (IOTC) is an intergovernmental organization established under article XIV of the FAO constitution in 1996. The organization is mandated to manage tuna and tuna-like species in the Indian Ocean and adjacent seas with primary objective the conservation and optimum utilization of the stocks for long-term sustainability.

The main functions of the IOTC are to keep under review the conditions and trends of the stocks and to gather, analyze and disseminate scientific information. In addition to this, the IOTC is also a repository for other data relevant to the conservation and management of the stocks and to fisheries based on the stocks covered by the Agreement. Finally, one of the main functions of the IOTC is to encourage, recommend, and coordinate research and development activities in respect of the stocks and fisheries covered by the Agreement, and such other activities as the Commission may decide appropriate. These may include activities connected with transfer of technology, training and enhancement, with the need to ensure the equitable participation of members of the Commission. In particular those from developing countries.

In keeping with agreements reached amongst the 5 tuna Regional Fishery Management Organizations (RFMOs) through the Kobe process, the IOTC has committed to undertake regular reviews of its process, the first of which was conducted in 2008. The Commission agreed that a second Performance Review of the IOTC be initiated in 2014, making use of a Panel composed as follows, with the IOTC Secretariat acting as facilitator of the process:

- Chair with appropriate background
- Contracting Parties from coastal States: Maldives, Mauritius, Oman and Seychelles
- Contracting Parties from DWFN: European Union and Japan
- Science Expert (To be decided by the Panel Members)
- NGOs: PEW and ISSF
- Members from other RFMO's: WCPFC and ICCAT

As the Panel-selected Science Expert for this review process, I herein report to the Panel Membership on my assessment of the IOTC Science Process based upon my recent experience with the Scientific Committee and its Subsidiary Bodies, interviews with other scientists involved, and as documented through the IOTC web site.

Throughout this document, focused recommendations are noted in bold when actions recommended are indicated with an italicized and bolded term “*should*” and which are directed at the Scientific Committee, the Secretariat, or the Members of the IOTC. General recommendations and a summary of my assessment of the IOTC Science Process are presented at the end of the document. I acknowledge the advice and assistance provided by the Scientific Committee leadership and experts with which I consulted. The conclusions drawn and recommendations offered reflect my professional view of circumstances.

### Aims and Objectives

The main task for the [Second Performance Review](#) is to evaluate progress made on the recommendations arising from the first review. In addition, it will focus on the effectiveness of the Commission to fulfill its mandate, in accordance with the [Terms of Reference](#) and criteria, to conduct the

second Performance Review of the IOTC, and notably to the criteria set forth below with regards to the delivery and management of the science process, and advice.

The overall objective of the Science Review is to:

- Carry out an assessment of the IOTC science process as per its mandate.
- Review the recommendations on science from the first performance review, notably through the tables/matrix prepared by the Secretariat.
- Assess the consistency between scientific advice and CCMs adopted.
- Make recommendations on how to improve the IOTC Science including any changes to process.

### **Assessment of the IOTC Science Process as per its Mandate and Review of Progress Made on Prior Recommendations**

In undertaking this assessment, the current Scientific Committee leadership (SC Chair, SC Vice Chair, and Conveners of Working Parties) were solicited via email to provide their views on i) Scientific Committee strengths, weakness, opportunities for improvement and risks to the organization if improvement does not occur, ii) the degree of involvement of CPCs in science in support of the IOTC, and iii) the degree of implementation of Scientific Committee recommendations by the Commission and its Members. Also contacted were the former Data Coordinator and Principle Stock Assessment Scientist from the Secretariat, both of whom have recently resigned, to seek their views on the same topics.

The IOTC [website](#) defines the primary function of the Scientific Committee and its Working Parties as providing the Commission with the information it needs to manage fish stocks under the IOTC mandate, as well as the ecosystems in which the fisheries operate.

The Scientific Committee was established as an advisory body to the Commission. It is constituted of scientists from the IOTC Membership<sup>1</sup>, as well as experts to enhance and broaden the expertise of the Scientific Committee and of its Working Parties.

The main activities of the Scientific Committee include:

- Recommend policies and procedures for the collection, processing, dissemination and analysis of fishery data;
- Facilitate the exchange and critical review among scientists of information on research and operation of fisheries of relevance to the Commission;
- Develop and coordinate cooperative research programs involving Members of the Commission and other interested parties, in support of fisheries management;
- Assess and report to the Commission on the status of stocks of relevance to the Commission and the likely effects of further fishing and of different fishing patterns and intensities;
- Formulate and report to the Commission, as appropriate, on recommendations concerning conservation, fisheries management and research, including consensus, majority and minority views.

#### ***Scientific Committee Structure and Function***

The Scientific Committee (SC) meets annually and provides advice to the Commission on the status of stocks and the management actions necessary to ensure sustainability of the fishery. It is comprised of Working Parties, which may meet in the intercessional period between Science Committee annual meetings and are tasked with analyzing technical problems related to the management goals of the Commission. For example, Working Parties related to the different species analyze the status of the stock and offer options to

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<sup>1</sup> Membership of IOTC is open to Indian Ocean coastal countries and to countries or regional economic integration organizations, which are members of the UN or one of its specialized agencies, and are fishing for tuna in the Indian Ocean. There are currently 32 Contracting Parties (Members), the majority of which are Nation States: Australia, Belize, China, Comoros, Eritrea, European Union, France, Guinea, India, Indonesia, Islamic Republic of Iran, Japan, Kenya, Republic of Korea, Madagascar, Malaysia, Maldives, Mauritius, Mozambique, Sultanate of Oman, Pakistan, Philippines, Seychelles, Sierra Leone, Somalia, Sri Lanka, Sudan, Tanzania, Thailand, United Kingdom, Vanuatu, and Yemen. Additionally, States with a real interest in the Indian Ocean fisheries of tuna and tuna-like species can participate in the IOTC process as a Cooperating non-Contracting Party, which in 2015-16 include: Bangladesh, Djibouti, Liberia, Senegal, and South Africa.

the Scientific Committee for management recommendations to the Commission. The currently active Working Parties of the Scientific Committee are:

- Working Party on Billfish (WPB)
- Working Party on Data Collection and Statistics (WPDCS)
- Working Party on Methods (WPM)
- Working Party on Neritic Tunas (WPNT)
- Working Party on Temperate Tunas (WPTmT)
- Working Party on Tropical Tunas (WPTT)
- Working Party on Ecosystems and Bycatch (WPEB)

It is useful to note that meetings of the Scientific Committee and its Working Parties (in fact the Commission and *all of its subsidiary bodies*) are open to Observers and Invited Experts. At the Scientific Committee level, Invited Experts are selected by the IOTC membership to attend each of the Working Party and/or Scientific Committee meetings. As needed, Consultants also participate in Working Party or Scientific Committee meetings to present stock assessment models or other tasks as requested by the Scientific Committee and funded by the Commission. These positive actions carry the potential for increasing capacity of developing economies to engage in the IOTC scientific process, although such capacity building needs to be long-term in order to lead to sustained engagement of those economies.

The IOTC Scientific Committee structure and function has a number of strengths that are shared with some of the other tRFMOs. Notably, IOTC Scientific Committee (SC) and Working Parties (WP) have a large and diverse participation, usually including CPCs from nations with industrial fleets, CPCs from coastal countries, NGOs, and others. As noted, this structure and function lends itself to a high degree of transparency in the process of how scientific advice is developed for the Commission. In my view, the IOTC Scientific Committee maintains a very positive environment for scientific engagement of a wide range of experts with interest in the status of the Indian Ocean tuna resources. Of course, maintenance or improvement of the Meeting Participation Fund, which is now viewed as a crucial element for fostering scientific engagement of developing economy scientists, will be needed in the long-run especially while substantial capacity gaps remain amongst the developed and developing economy membership. Focusing effort on dedicated training workshops, not just meeting participation, *should* go hand-in-hand with this initiative since meeting participation, while a necessary element, is not always the best environment for capacity building because of the pace of work at the meetings and the lack of basic understanding of concepts in some of the CPCs.

Not all of the Working Parties have the same level of cooperation and collaboration between national scientists from different CPCs and the potential for elevating cooperation and collaboration through more frequent joint research activities *should* be considered. It is useful to note that while developed economy CPC scientists dominate the leadership of the Scientific Committee, there is some diversity amongst the Conveners and vice Conveners of the various Working Parties (about 1/3 from developing economies while the Membership is closer to 2/3 from developing economies). Methods for increasing that diversity, through vice-Convenor positions leading toward Convener positions, *should* also be considered as a means of increasing scientific capacity and engagement in the Scientific Committee. Failing to further address the issue leads to poor understanding and ownership of scientific issues of concern to the IOTC amongst all of the CPCs and a lack of cooperation in developing CMMs to achieve the Commission's goals.

As has occurred at other tRFMOs (*e.g.* ICCAT), at times some IOTC Working Parties have evolved into small science conferences whereby papers are presented which, while interesting, are off topic for the particular Working Party meeting objectives and can consume considerable time, potentially limiting stock assessment reviews and development of management advice during the Working Party meetings. Balancing the need for encouraging broad CPC participation through scientific contributions and achieving the end objective of providing resource management advice is not trivial, but *should* be addressed by the Scientific Committee through a process of reviewing and establishing, as needed, further guidelines for the organization and conduct of meetings. This could be addressed by circulating, in advance of the meetings, guidance from the Chairs of Working Parties through the Secretariat, on the pertinent topics to be covered and the limits for presentations and discussion of the working paper contributions. In some other tRFMOs, this has been addressed through an *ad-hoc* Working Party on organization, composed of leadership of the Working Parties and the Secretariat, serving at the will of the Scientific Committee Chair, to advise on additional guidelines designed to provide for adequate time for achieving Working Party objectives while

also maintaining opportunity for broad CPC participation. Such an *ad-hoc* Working Party can also serve to enhance communication and coordination between the Secretariat and the SC leadership.

### Progress on Prior Recommendations: Structure and Function

The First Performance Review Panel recommended the Scientific Committee consider scheduling meetings of Working Parties and Scientific Committee be investigated based on the experience of other RFMOs, also bearing in mind optimal delivery of scientific advice to the Commission. PRIOTC02-PR01<sup>2</sup> indicates the Scientific Committee considered the large number of meetings of other tRFMOs, which are generally advertised in advance, and concluded it is becoming increasingly difficult to find a schedule of meetings that would be better than the one currently in practice, especially considering that many of the IOTC CPC scientific delegations also participate in other tRFMO scientific committees. It is useful to note that the delivery of advice to the Commission occurs at a somewhat slower pace and with a longer time-gap between development and delivery of that advice than that of the other tRFMOs, which results in potentially longer lags in implementation of and also likely the need to be more conservative in CMMs on the basis of that advice if the Commission wishes to have high likelihood of achieving its conservation objectives for the stocks in question, knowing that implementing a CMM generally will not take place until some time after one is agreed by the Commission. It is also noteworthy that the form of delivery of scientific advice to the Commission at its annual meeting is quite abbreviated compared to the other tRFMOs. This feature can lead to the perception that the IOTC does not rely on scientific advice for formulating CMMs. Allocating significantly longer time to receipt of scientific advice by the Commission can help to alleviate this. It is also useful to consider that the most recent Scientific Committee report indicates that the time allocated to the Scientific Committee report presentations in other tuna RFMOs, such as ICCAT, is substantially longer, and thus, the Scientific Committee requested the Chair of the Commission consider allocating more time for the presentation of the Scientific Committee report, with the aim of ensuring better explanation of the work conducted and the provision of the management advice as requested by the Commission. It is not at all clear that this request was taken on board for the 2015 Commission meeting, but should be in future Commission meetings. One way to address this is for the Scientific Committee to develop a template for the Chair to use in delivering advice to the Commission.

### ***SC Function: Recommending Data Collection and Reporting Policy***

Regarding the first activity of the Scientific Committee noted above, to recommend policies and procedures for the collection, processing, dissemination and analysis of fishery data, its structure is adequate to the task. Most of the recommendations regarding data collection, processing, and dissemination comes through the WPDCS, which is tasked with reviewing the quality of the statistics available for tuna, tuna-like, and other species of interest to the IOTC, and to review the status of collection, processing, and reporting of data, as required by the Commission and consistent with UNFSA Annex I<sup>3</sup> regarding data obligations in

<sup>2</sup> Document IOTC-2015-PRIOTC02-PR01, as available on 14 January, 2015, 1<sup>st</sup> Performance Review: Recommendations and implementation progress. ([PRIOTC docs](#))

<sup>3</sup> [General principles](#)

1. The timely collection, compilation and analysis of data are fundamental to the effective conservation and management of straddling fish stocks and highly migratory fish stocks. To this end, data from fisheries for these stocks on the high seas and those in areas under national jurisdiction are required and should be collected and compiled in such a way as to enable statistically meaningful analysis for the purposes of fishery resource conservation and management. These data include catch and fishing effort statistics and other fishery-related information, such as vessel-related and other data for standardizing fishing effort. Data collected should also include information on non-target and associated or dependent species. All data should be verified to ensure accuracy. Confidentiality of non-aggregated data shall be maintained. The dissemination of such data shall be subject to the terms on which they have been provided.

2. Assistance, including training as well as financial and technical assistance, shall be provided to developing States in order to build capacity in the field of conservation and management of living marine resources. Assistance should focus on enhancing capacity to implement data collection and verification, observer programmes, data analysis and research projects supporting stock assessments. The fullest possible involvement of developing State scientists and managers in conservation and management of straddling fish stocks and highly migratory fish stocks should be promoted.

[Basic fishery data](#)

1. States shall collect and make available to the relevant subregional or regional fisheries management organization or arrangement the following types of data in sufficient detail to facilitate effective stock assessment in accordance with agreed procedures: (a) time series of catch and effort statistics by fishery and fleet; (b) total catch in number, nominal weight, or both, by species (both target and non-target) as is appropriate to each fishery. [Nominal weight is defined by the Food and Agriculture Organization of the United Nations

support of conduct of stock assessments.

A major strength of the IOTC Secretariat has been its ability to cope with work required based upon WPDCS recommendations and Commission-adopted policies regarding data reporting obligations, thanks to a small team of highly motivated and efficient staff. Amongst these notable strengths has been the Secretariat's focus on data gap and quality assessments, which is amongst the best of all of the tuna RFMOs. Demands for reviewing the quality of the statistics available, the status of collection, processing, and reporting of data have been increasing over time and the complexity of the Indian Ocean tuna fisheries (from which about 60-70% of total catch is now from small-scale fisheries that are not adequately monitored by the flag states) imposes a tremendous work-load required in order to assist CPCs in data collection and implementation of monitoring systems. The most recent [work-plan](#) for WPDCS exemplifies this work load demand. While the WPDCS work-plan does not fully identify the cost of addressing the issues identified, the costs are likely very substantial and failure to address them will considerably increase the risk that the Commission will not achieve its objective of ensuring, through appropriate management, the conservation and optimum utilization of IOTC stocks. [Moreno](#), in his review of the statistical systems of the main 10 IOTC Coastal Countries (excluding Pakistan, Comoros and Yemen), estimated that the cost of putting in place statistical systems in line with IOTC requirements in those countries was around \$6 million annually, about 3 times the Commission's annual budget, indicating the need to increase financial and human means within the IOTC. The 2015 Scientific Committee provides specific recommendations on this issue.

Developing economy CPCs (and the whole of the IOTC Membership) have substantially benefitted from extra-budgetary funds to start addressing the failings of data collection and fishery monitoring (in 2013-2014 approximately 85% of the funds the IOTC used for this activity were extra-budgetary), but the full process of acquiring such funding (proposal, deliverables, follow-up, *etc.*) and organizing missions in the field is adding up to the already many missions of the small staff. Should the IOTC remain mostly dependent upon extra-mural funding for these activities, or even if the Members decide to fully fund such activities, the Secretariat staffing dedicated to such activities *should* be elevated. It is also noteworthy that NGOs are pursuing tuna sustainability issues and it may be a good opportunity for the IOTC to engage with them effectively to leverage additional funding for addressing key gaps.

#### Progress on Prior Recommendations: Data Policy

The First Performance Review Panel recommended that the Scientific Committee recommend establishing modifications of data reporting obligations to ensure that the most recent data are available to the working parties and the Scientific Committee. PRIOTC02-PR01 indicates the Scientific Committee recommended a reporting deadline for CPCs for submission of information on their flag vessels of June 30, every year. The timeline for coastal CPCs who license foreign vessels was established at 15<sup>th</sup> February every year. The timing of the Working Parties for conduct of assessments undergoes review annually to ensure that assessments can be completed and results reported to the Scientific Committee and subsequently to the Commission, each year. None-the-less, there remains at least a 1 year lag in data available for an assessment. Recent analysis of CPC compliance with these deadlines and data obligations as defined in IOTC Resolution 10/02 ([Data Reporting Obligations recently superseded by Resolution 15/02](#)) and for which the Secretariat produces guidelines for the CPCs ([Guidelines for reporting data to the IOTC](#)) shows some improvement over the past 5 years, however CPCs meeting data reporting obligations still remains quite low (typically <50% see Figure 1 and Table 1).

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as the live-weight equivalent of the landings]; (c) discard statistics, including estimates where necessary, reported as number or nominal weight by species, as is appropriate to each fishery; (d) effort statistics appropriate to each fishing method; and (e) fishing location, date and time fished and other statistics on fishing operations as appropriate.

2. States shall also collect where appropriate and provide to the relevant subregional or regional fisheries management organization or arrangement information to support stock assessment, including: (a) composition of the catch according to length, weight and sex; (b) other biological information supporting stock assessments, such as information on age, growth, recruitment, distribution and stock identity; and (c) other relevant research, including surveys of abundance, biomass surveys, hydro-acoustic surveys, research on environmental factors affecting stock abundance, and oceanographic and ecological studies.

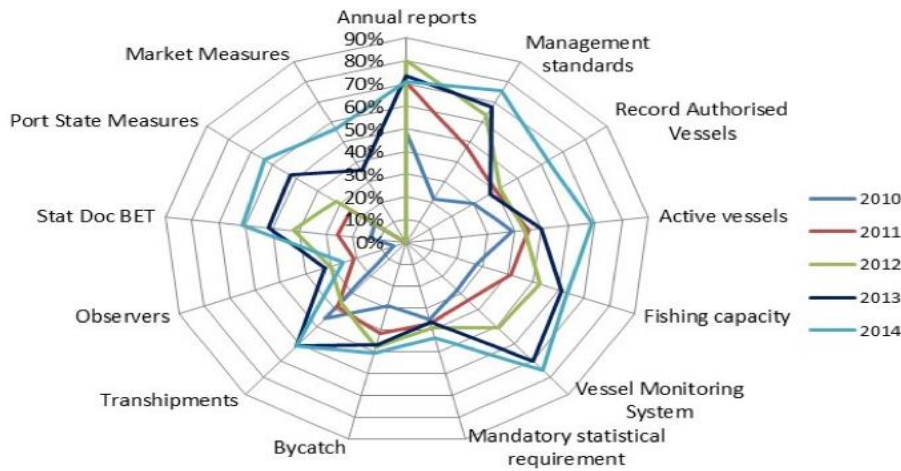


Figure 1. A spider diagram of the general level of CPC compliance rates from 2010-2014 with various IOTC CPC reporting obligations including Mandatory Statistical Requirements, Bycatch, and Scientific Observers. While some improvements over the time frame are evident, these three categories, in particular, and which support the IOTC science enterprise, show quite low rates of compliance. The qualities of the data that are reported are not evaluated in this summary. Graphic provided by R Payet at July, 2015 ABNJ Tuna Project Steering Committee Meeting, Rome, Italy.

Area	Phase	Year	Compliance	Comments
I	EUROPEAN ECONOMIC AREA	2010	Green	
	EUROPEAN ECONOMIC AREA	2011	Green	
	EUROPEAN ECONOMIC AREA	2012	Green	
	EUROPEAN ECONOMIC AREA	2013	Green	
	EUROPEAN ECONOMIC AREA	2014	Green	
	EUROPEAN ECONOMIC AREA	2010	Green	
	EUROPEAN ECONOMIC AREA	2011	Green	
	EUROPEAN ECONOMIC AREA	2012	Green	
	EUROPEAN ECONOMIC AREA	2013	Green	
	EUROPEAN ECONOMIC AREA	2014	Green	
II	EUROPEAN ECONOMIC AREA	2010	Green	
	EUROPEAN ECONOMIC AREA	2011	Green	
	EUROPEAN ECONOMIC AREA	2012	Green	
	EUROPEAN ECONOMIC AREA	2013	Green	
	EUROPEAN ECONOMIC AREA	2014	Green	
	EUROPEAN ECONOMIC AREA	2010	Green	
	EUROPEAN ECONOMIC AREA	2011	Green	
	EUROPEAN ECONOMIC AREA	2012	Green	
	EUROPEAN ECONOMIC AREA	2013	Green	
	EUROPEAN ECONOMIC AREA	2014	Green	
III	EUROPEAN ECONOMIC AREA	2010	Green	
	EUROPEAN ECONOMIC AREA	2011	Green	
	EUROPEAN ECONOMIC AREA	2012	Green	
	EUROPEAN ECONOMIC AREA	2013	Green	
	EUROPEAN ECONOMIC AREA	2014	Green	
	EUROPEAN ECONOMIC AREA	2010	Green	
	EUROPEAN ECONOMIC AREA	2011	Green	
	EUROPEAN ECONOMIC AREA	2012	Green	
	EUROPEAN ECONOMIC AREA	2013	Green	
	EUROPEAN ECONOMIC AREA	2014	Green	

2007 Data Provision				
NC	CE	SF	Total	
29	13	4	46	
6	14	9	29	
14	22	36	72	
59.2%	26.5%	8.2%	31.3%	
12.2%	28.6%	18.4%	19.7%	
28.6%	44.9%	73.5%	49.0%	

2013 Data Provision				
NC	CE	SF	Total	
34	26	5	65	
4	8	13	25	
15	19	35	69	
64.2%	49.1%	9.4%	40.9%	
7.5%	15.1%	24.5%	15.7%	
28.3%	35.8%	66.0%	43.4%	

Table 1 Status of mandatory data reports across CPCs at the time of the First Performance Review and at the time of the Second Performance Review. Some marginal improvement is noted, although the proportion of CPC's failing to meet obligations remains high. There is no evaluation of the quality of the data reported in this summary. Color codes: Green – fully compliant, yellow – partially compliant, red – not compliant. Abbreviations: NC – nominal catch reporting, CE – catch effort reporting, SF – size frequency reporting, Total – all reporting obligations

The First Review Panel recommended that the Commission task the Scientific Committee with exploring alternative means of communicating data to improve timeliness of data provision. It also noted a need to improve the quality and quantity of the data collected and reported by the Members, including the information necessary for implementing the ecosystem approach. PRIOTC02-PR01 indicates this recommendation was partially completed, but ongoing, as development of novel tools and approaches to this issue are evolving. PRIOTC02-PR01 also noted a study IOTC commissioned in 2011 to determine the feasibility of near real-time reporting for various fleets but determined at that time, near real-time reporting



was not generally possible for most CPCs. However, recent developments in other tRFMOs, like the WCPFC, could indicate that the feasibility is much improved and that there are simultaneous developments that could be useful for coastal, semi-industrial, and artisanal vessels that could be further investigated. In the context of the IOTC area, much of the catch comes from small-scale fisheries for which port sampling programs are most needed, and, as noted above, would require substantial, sustained investment (perhaps \$6 million or more annually). The Secretariat and co-financiers have considerably invested in capacity building for data collection (in partnerships with Overseas Fisheries Cooperation Foundation of Japan, Comision de l’ocean indien-SmartFish EU funded Project, and the Bay of Bengal Large Marine Ecosystems Project, funded by several institutions and executed by the FAO: [capacity-building-data](#)) plus others, including extraordinary contributions from the EU. While data availability from coastal states fisheries harvesting IOTC species within coastal state EEZ remains generally poor, there have been improvements related to these investments and other innovative methods for data validation. One of the innovative approaches was documented in a recent workshop report on Albacore catch estimation ([Indonesia Albacore Catch Estimation](#)) wherein industry supplied purchase data were used to estimate albacore catches by Indonesian vessels fishing in the Indian Ocean. Continued substantial investment and innovation will likely be necessary for further improvement in provision and quality of data in support of the Commission’s objectives.

The First Review Panel further recommended the Scientific Committee define the requirements for a regional scientific observer program to enhance data collection for target and non-target species and to ensure a unified approach be established based upon experience of other RFMOs making use of regional standards for data collection, data exchange and training. PRIOTC02-PR01 indicates that this is partially complete and still under way, noting that Resolution 11/04 provides CPCs with the necessary framework for putting in place national scientific observer programs. The Regional Observers Scheme commenced July 1st 2010, and is based on national implementation and required implementation by 2013 for the CPC fleet segments identified. The Secretariat coordinated the preparation of standards for data requirements, training and forms for both at-sea observation and land-based (port) sampling. Implementation by CPCs has been limited to date and compliance with this Resolution, including provision of reports, is low ([2015 Compliance Report, Observer Program Update](#), and Figure 1, above). Although capacity building assistance has been available and more is anticipated, the regional scientific observer program is not yet adequate to meet the objective of the program, “to collect verified catch data and other scientific data related to the fisheries for tuna and tuna-like species in the IOTC area of competence” for all of the CPC fleet segments, at this time.

Considering land-based (port) sampling, much of the focus of the IOTC-OFCF Project has been assisting developing countries to set-up and to implement such programs. For instance, in Indonesia a Pilot was implemented to create a blueprint of a system that Indonesia can use as a basis to sample its entire artisanal fishery. This activity is ongoing, and while the investment in such projects has been significant, it falls short of that estimated to achieve adequate sampling across all of the small-scale fisheries for which port sampling programs are most needed.

Another recommendation from the First Review Panel jointly directed at the Standing Committee on Administration and Finance via Scientific Committee and for approval by the Commission was to elevate the Secretariat’s capacity for data dissemination and quality assurance, including through the employment of a fisheries statistician. PRIOTC02-PR01 indicates this recommendation was partially completed & ongoing by filling a Fisheries Statistician position in the Secretariat’s Data Section of the Secretariat in September 2012. Further efforts continue to be made to improve data dissemination, including through a planned online data atlas. In support of this, an online data query, developed under contract, is scheduled for delivery to the IOTC in early 2016, but the development of the online atlas is follow-on to this task, and is awaiting identification of funding before proceeding. It is noteworthy, that recent turn-over in staffing at the Secretariat **will require** back-filling for the Secretariat’s Data Section Director and Principal Stock Assessment Analyst, both of whom have resigned their positions in the past months. The Secretariat has advertised vacancies for both positions and is undergoing a selection process for the Data Section Director. The vacancy announcement for the Principal Stock Assessment Analyst is limited to a 1-year contract, which may significantly reduce the interest in the position by qualified persons. Due to inadequate responses to

the initial vacancy announcement, the announcement was modified for an extended period and readvertised (D. Wilson, *pers comm.*, November 2015).

### ***Facilitating Scientific Exchange and Review***

Considering the Scientific Committee's role of facilitating the exchange and critical review among scientists of information on research and operation of fisheries of relevance to the Commission, the structure of the Scientific Committee appears adequate to the task. However, the functioning of the Scientific Committee could be improved in view of fostering exchange and critical review among scientists from all the CPCs. Traditionally, and as in several other tRFMOs, the greatest engagement in the Scientific Committee comes from developed economy CPCs, and in this case, mostly European and Asian scientific parties. As noted, Scientific Committee and Working Party meetings are open to both Observers and Invited Experts in addition to CPC scientific delegations, which can access financial support from the IOTC Meeting Participation Fund, if those scientists are from developing economies. This approach carries the potential for increasing scientific capacity of developing economies to engage in the IOTC scientific process, although such capacity building needs to be long-term in order to lead to sustained engagement of scientists from those economies, also needed are sustained initiatives for joint investigations and workshops on basic concepts.

Limited science being done in the coastal states is a major weakness in the collective ownership and understanding about the stock status and the CMMs being developed to manage them. Fostering more engagement of coastal state scientists into the Scientific Committee through the activities instituted in the past few years *should* be maintained or accelerated. Institution of research activities within those developing economies by partnering national scientists with developed economy CPC scientists *should* be explored. As above, leveraging NGO and other partnerships designed to engage CPC scientists on research of particular concern to IOTC stocks *should* be considered an opportunity to further foster this engagement. Equally, if not more important in this regard, is the need to raise the level of awareness of coastal states to devote sufficient resources to implement the measures they agree to at the Commission level, among them data collection and reporting requirements.

### ***Provision of Scientific Advice***

A consideration of the Scientific Committee's function to formulate and report to the Commission, as appropriate, on recommendations concerning conservation, fisheries management and research, including consensus, majority and minority views, follows. While the structure of the Scientific Committee is adequate to this task, there is a need to improve its functioning so that there is broad understanding amongst CPC scientists and managers of what is being recommended. At issue is the needs to further involve CPCs in IOTC Science and in implementing Scientific Committee Recommendations. As noted above, the degree of engagement of developing economy CPCs in the Scientific Committee and its Working Parties is sub-optimal and there is concern that engagement by developed economy CPCs is diminishing. It is noteworthy that science capacity building workshops have been undertaken by the Secretariat, which resulted in a number of recommendations that *should* be taken on board ([Science Capacity Workshop](#)), with the aim of fostering further engagement. While these recommendations do not strictly relate to the scientific process, they are strongly related in the context of linking IOTC science to policy development. A number of developing (and developed) economies do not maintain a strong (or even any) linkage between scientists engaged in the IOTC Scientific Committee and those involved in Commission policy development. Mechanisms to encourage such linkages, like the aforementioned workshops or through further leveraging of NGO or other funding sources, *should* be further considered. It is also of concern that the degree of developed economy CPC support of the Scientific Committee may be diminishing. In particular, there exist underlying policies linking professional development and advancement of scientists within their national systems to elements other than those required for routine fishery monitoring and stock assessment tasks needed to make the IOTC Scientific Committee function, thus diminishing incentives for these scientists to engage. This of course, relates to the internal policies of the Members, but the implication of diminishing scientific support to the IOTC from the Membership, is the *need to elevate* the scientific staff at the Secretariat, which is already at too low a level compared to the other tRFMOs, in my view. While the IOTC uses an in-house stock assessment expert supplemented by Consultants to carry out some of the stock assessment work, the increasingly common use of highly parameterized, integrated



statistical modeling platforms carries with it the need for higher levels of effort for review and re-examination than can usually be fully accomplished at single Working Party review session. Should the Working Parties continue to make use of these modeling frameworks, Terms of Reference for Consultancies and organization of the Working Party meetings *should* be modified to better reflect these features. Following the ICCAT practice of data preparatory meetings preceding assessment review meetings *should* be considered as an approach that could help in this regard.

Relative to the Scientific Committee's function to assess and report to the Commission on the status of stocks of relevance to the Commission and the likely effects of further fishing and of different fishing patterns and intensities, my views follow. Again its structure seems sufficient, but to complete much of its status of stocks evaluations, the Scientific Committee requires supplementation by Consultants and/or Experts, which implies insufficient expertise available from CPCs and/or staffed at the Secretariat. While an effective way of achieving a substantial workload in the short-run, it is less desirable to depend on this formulation in the long-run, than having available on-board expertise to complete the work, especially from the viewpoint of establishing a 'corporate memory'. Unfortunately, many of the stock assessments and subsequent management advice on tuna stocks in the Indian Ocean, are heavily dependent on fisheries data that are known to be poorly estimated for a high fraction of the overall catch, and quite possibly both unreliable and highly uncertain, which in turn, impacts data inputs to stock assessments leading to uncertainties that are not yet well quantified and quite possibly misleading. The available information for the main tuna stocks would indicate that they are in relatively healthy condition, at least in the recent past, possibly as a partial result of the piracy effect off the Somalia coast which has now been largely resolved, but the expected impact of realizing capacity development plans of the coastal states implies this condition will not be sustained without strong management actions. There are also a number of stocks, including several billfish and some neritic tunas for which the catch-effort data are more uncertain, but are considered to be under too high a rate of exploitation to meet the Commission's conservation objectives for those stocks. There are still other stocks from the list of IOTC species including neritic tunas, sharks and other bycatch species, for which information is very limited, especially, but not exclusively so, in the northern Indian Ocean. Much of the stock status inference is based on poorly estimated catch for several of the main species and most of the coastal species and the assessments carried out likely under-represent uncertainties related to this (and other) issues. The Scientific Committee *should* work towards quantifying uncertainty in catch and how that uncertainty may influence stock assessment outcomes. Those quantified uncertainties that are available are inadequately communicated to the Commission in the Stock Status Summary Tables (*e.g.* Appendix Figure 1) presented in the species executive summaries.

Several approaches to provision of scientific advice have been adopted by the tRFMOs (see [Lodge et.al.](#), for a summary). At one end of the spectrum, IATTC makes use of a full-time scientific and data management/collection staff to carry out all scientific analysis and development of scientific advice to the Commission. ICCAT mainly relies upon a Scientific Committee comprised of national scientific delegations and working groups focused on different species or fisheries groupings, which meet during the intercessional period to conduct stock status evaluations and draft scientific advice for review and adoption by the Scientific Committee at its annual meeting, supplemented by a smaller number (than the IATTC) of scientific experts and data management personnel on the ICCAT staff, for this purpose. The WCPFC is intermediate to the IATTC and ICCAT cases, making use of a Scientific Committee to annually review the assessment work of a science and data management service provider with a relatively large staff, the Secretariat of the Pacific Community's Oceanic Fisheries Program, which conducts analysis used for formulating draft scientific advice for the Commission. CCSBT also utilizes a Scientific Committee comprised of national delegations, supplemented by an Advisory Panel to provide external input to its stock assessment and scientific processes. It has also appointed an independent chairperson for the Scientific Committee to facilitate gaining consensus amongst the national scientific delegations in developing scientific advice for southern bluefin tuna (SBT) and ecologically related species impacted by the SBT fisheries.

Relying solely upon national scientific delegations can lead to loss of objectivity (politicization) and since some member countries have much greater scientific capacity and engagement than others, can also lead to lowering credibility of the advice produced, especially in the eyes of Members with limited or no scientific capacity. On the other hand, relying on a full-time staff to achieve the data management and analyses required would be both costly and resource-intensive and, depending on the degree of transparency in

process, potentially also lead to lowering credibility of the advice provided in the eyes of Members. In any formulation, it is important to take steps to assure maintaining a high level of objectivity, both through application of transparent processes and in the frequent use of independent peer review of process.

The IOTC formulation is closer to the ICCAT model than the others, although the staff dedicated to the stock assessment theme is too small given the complexity of the fisheries and the demands of the Commission for stock status advice for the now substantial number of stocks. The use of Consultants and Invited Experts to address assessment and/or other quantitative issues of concern is moving in the direction of a WCPFC ‘service provider’ approach and *should* be continued or intensified, at least in the near term. Additionally, given the increasing demand of the Commission on the Scientific Committee, the IOTC scientific team *should* be at least 3-4 full-time scientists working on CPUEs, assessments, MSE, ecosystem models, bycatch issues, *etc.* While a thorough evaluation of the cost-benefits of the different models used for provision of scientific advice at the different tRFMOs is beyond the scope of this review, a critical cost-benefit evaluation *should* be undertaken to further inform the IOTC on the formulation which could best serve its needs.

#### Progress on Prior Recommendations: Provision of Scientific Advice

The First Review Panel recommended that for species with little data available, the Scientific Committee should be tasked with making use of more qualitative scientific methods that are less data intensive. PRIOTC02-PR01 indicates the Scientific Committee is in the process of addressing this issue. Data poor approaches are being applied to a number of stocks of billfish and neritic tuna and plans have been developed to consider options to rank stock status determinations for data-poor stocks using a ‘Tier’ approach to assist in the interpretation of the level of uncertainty in the evaluation methods applied. At the 2014 Scientific Committee meeting, a proposal from the WPB to adopt a process to determine if a ‘Tier’ approach to providing stock status advice will likely enable the IOTC working parties to better communicate the levels of uncertainty present in the indicators used for monitoring the condition/status of IOTC stocks by categorizing the types of assessments conducted. The Scientific Committee indicated that further evaluation of these approaches should be conducted for consideration at the 2015 SC meeting. It is useful to note that other fishery research organizations are focusing more on techniques that could lead to robust management advice in data-limited circumstances. There are now available an assemblage of data limited approaches ([DLMtools](#)) and recent reviews of these approaches ([Caruthers et.al., 2014](#) and [Geromont and Butterworth, 2015](#)) that *should* be taken up for potential application for the data limited (as well as data rich, but information poor) stocks in the IOTC domain.

The First Review Panel also recommended that resources of the IOTC Secretariat should be increased in consultation with the Scientific Committee on needed level of support. PRIOTC02-PR01 indicates some progress was made through the recruitment of the stock analysis expert, who has since resigned the position, and that additional professional staffing and resources are required to meet the needs of the Scientific Committee. It is noteworthy that the vacancy for a replacement stock analysis expert has been advertised, but not yet filled. The Secretariat has proposed budgets that include additional resources for projects requested by the Scientific Committee and Commission, but it is unclear if these proposals were entirely successful. In fact, due to budget shortcomings, in 2015, owing to arrears and other issues, the Standing Committee on Administration and Finance noted concern about decreased administrative and operating budget for 2016 and beyond that could entail reduction of some important activities undertaken by the Secretariat, notably concerning science and compliance that could create problems in meeting IOTC objectives in the short term with unknown negative effects in the long term. The degree to which these concerns can be eliminated is unclear, but an implication is that achieving the IOTC objectives may well require even heavier dependence upon extra-mural funding sources, which could well be directed away from goals of the Commission. It is noteworthy that at present, approximately 85% of the data capacity building initiatives funded in 2013-2014 came from outside of the IOTC operating budget ([Capacity building - data](#)). With the advent of other projects, that contribution level may well increase.

The First Review Panel also noted, as part of a total quality assurance approach, the need to enhance the quality of scientific advice and the technical soundness of the papers being considered by the Scientific Committee and its Working Parties, and to encourage publication of IOTC scientific papers in relevant journals, including future consideration of establishing a scientific editorial board within the Scientific

Committee to assist in that advancement. PRIOTC02-PR01 indicates that the SC actively encourages national scientists to publish in peer-reviewed journals, as is the case following the Tuna tagging Symposium held in 2012. It also notes that work on this issue is partially completed and ongoing, citing that the guidelines for presentation of stock assessment papers were revised and agreed to by the Scientific Committee in 2010, 2012 and again in 2014, as a result of the Commission adoption of [Recommendation 14/07](#) *To standardize the presentation of scientific information in the annual Scientific Committee report and in Working Party reports*. To date, it does not appear that the Scientific Committee has fully adopted the elements of the recommendation, in particular elements related to paragraph 1, therein. In concert with the above issue, the First Review Panel also noted that guidelines for the presentation of user-friendly scientific reports to the Commission in terms of stock assessments should be developed. In this respect, Kobe plots were considered to be the most desirable method of graphical presentation, especially to a non-technical audience. PRIOTC02-PR01 indicates this issue has been partially completed & ongoing, noting that all recent stock assessment results have been presented to the Commission using the Kobe plot, and the species Working Parties are progressing in presenting the Kobe matrix. The 2010 through 2014 Scientific Committee reports included Kobe Matrices for stock assessments, where available. The format of the Working Party reports and the resultant Executive Summaries continues to be refined to improve readability and content. The elements noted in Recommendation 14/07 were generally applied to Working Party meeting reports in 2014. Of course, the Scientific Committee *should* strive to improve the way it communicates information about stock status and future prospects for the stocks to the Commission (as noted in Recommendation 14/07), including the uncertainties and risks to achieving operational objectives under alternative management approaches. Improvements in the way uncertainty in stock status and future prospects under different management approaches are characterized for the Commission *should* be undertaken by the Scientific Committee. As noted above, quantified uncertainties that are available are inadequately communicated to the Commission in the Stock Status Summary Tables (e.g. Appendix Figure) presented in the species executive summaries. Representing stock status evaluations in a color scheme that reflect the distribution of outcomes across the 4 Kobe quadrants would better signify the quantified uncertainties. In addition, application of a reduced form of a Kobe 2 Strategy Matrix in the form now commonly used by the Scientific Committee provides limited information for consideration by the Commission. A more informative presentation, such as adopted by ICCAT's Scientific Committee (Figure 2, below) and/or a graphical alternative *should* be considered for standard application by the Scientific

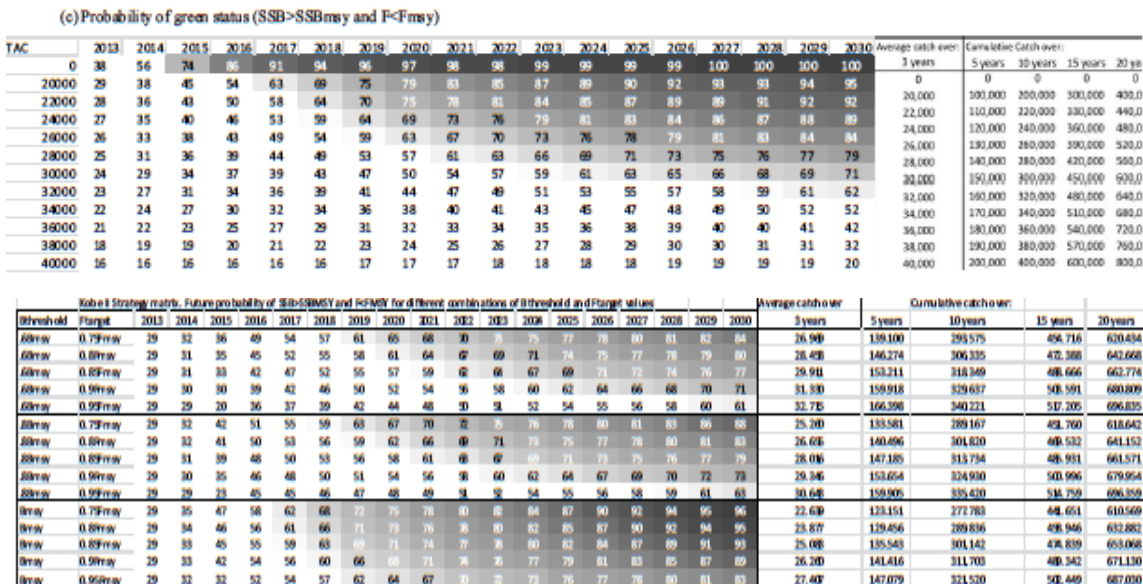


Figure 2. The Kobe 2 Strategy Matrix tabular formulation adopted by ICCAT's Scientific Committee provides information on the estimated probability of achieving the ICCAT Convention Objective over time with a range of management options (both catch and effort control). This formulation provides a wide range of options for the Commission to use in determining its tolerable risks over which time frame for achieving the Convention Objective.

Committee.

Also as part of a total quality assurance approach, the First Review Panel identified ongoing peer review by

external experts needs to be incorporated as standard business practice of Working Parties and the Scientific Committee. PRIOTC02-PR01 indicated that this issue is partially addressed by the Scientific Committee and continuing to evolve, noting that external experts (Invited Experts) are regularly invited to provide additional expertise at Working Party meetings, although this does not constitute a formal process of peer review. The Scientific Committee in 2010 and 2011, agreed that once stock assessment models were considered robust, that peer review would be advantageous and funds will be requested to undertake peer reviews of stock assessments. The Scientific Committee reviewed the processes for Invited Experts, Consultants and Peer Review at its 14th Session in 2011. Subsequently, in 2014, the Scientific Committee established revised guidelines for Invited Experts and Consultants involvement in the standard practice of the Working Parties. The Scientific Committee recommended and the Commission accepted that at least one ‘Invited Expert’ be brought to each of the science Working Parties in 2015 and in each subsequent year, so as to further increase the capacity of the Working Parties to undertake the work detailed in the Program of Work. The Secretariat facilitates their participation. Additionally, the Secretariat facilitates participation of Consultants, selected to attend Working Party meetings to present stock assessment models or other tasks as requested by the Scientific Committee and funded by the Commission as both the Scientific Committee and Commission agreed that the hiring of stock assessment Consultants to assist in building capacity among the various Working Parties, by supplementing the skill set available within the IOTC Secretariat and CPCs to develop stock assessment approaches for the various stocks. The Scientific Committee has yet to formalize a peer review process for its stock assessments. It is notable that many of these elements are called for under Recommendation 12/15, which among other items encourages the Commission to strengthen peer review mechanisms within the IOTC Scientific Committee by participation of invited experts in the IOTC Scientific Committee activities. Formalizing the process *would likely* institute peer review as a standard business practice for the Scientific Committee.

The First Review Panel further recommended that IOTC (the Scientific Committee and Commission) in adopting of conservation and management measures should consider developing a framework to take action in the face of uncertainty in scientific advice. The IOTC has resolved to implement the precautionary approach to fisheries management as outlined in UNSFA<sup>4</sup> with [Resolution 12/01](#), including development of stock-specific reference points. PRIOTC02-PR01 indicated this is in progress, noting that the Scientific Committee has agreed that the development of a Management Strategy Evaluation process be initiated to provide better advice that would incorporate explicit consideration of uncertainty. In furthering this issue, the Commission has adopted [Resolution 14/03](#) to facilitate understanding of the roles and responsibilities of the Commission and Scientific Committee in this regard. Frameworks for taking action have been agreed by the Commission (Resolution 15/10) including defining a set of provisional reference points for some of the IOTC target stocks and the Commission and Scientific Committee have embarked on a dialogue process ([Dialogue](#)), supplemented by capacity building workshops ([Capacity Building - Science](#)) that address these issues. As noted above, considerable external funding through the GEF/FAO ABNJ Tuna

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<sup>4</sup> 3. In implementing the precautionary approach, States shall: (a) improve decision-making for fishery resource conservation and management by obtaining and sharing the best scientific information available and implementing improved techniques for dealing with risk and uncertainty; (b) apply the guidelines set out in Annex II and determine, on the basis of the best scientific information available, stock-specific reference points and the action to be taken if they are exceeded; (c) take into account, *inter alia*, uncertainties relating to the size and productivity of the stocks, reference points, stock condition in relation to such reference points, levels and distribution of fishing mortality and the impact of fishing activities on non-target and associated or dependent species, as well as existing and predicted oceanic, environmental and socio-economic conditions; and (d) develop data collection and research programmes to assess the impact of fishing on non-target and associated or dependent species and their environment, and adopt plans which are necessary to ensure the conservation of such species and to protect habitats of special concern.

4. States shall take measures to ensure that, when reference points are approached, they will not be exceeded. In the event that they are exceeded, States shall, without delay, take the action determined under paragraph 3 (b) to restore the stocks.

5. Where the status of target stocks or non-target or associated or dependent species is of concern, States shall subject such stocks and species to enhanced monitoring in order to review their status and the efficacy of conservation and management measures. They shall revise those measures regularly in the light of new information.

6. For new or exploratory fisheries, States shall adopt as soon as possible cautious conservation and management measures, including, *inter alia*, catch limits and effort limits. Such measures shall remain in force until there are sufficient data to allow assessment of the impact of the fisheries on the long-term sustainability of the stocks, whereupon conservation and management measures based on that assessment shall be implemented. The latter measures shall, if appropriate, allow for the gradual development of the fisheries.

7. If a natural phenomenon has a significant adverse impact on the status of straddling fish stocks or highly migratory fish stocks, States shall adopt conservation and management measures on an emergency basis to ensure that fishing activity does not exacerbate such adverse impact. States shall also adopt such measures on an emergency basis where fishing activity presents a serious threat to the sustainability of such stocks. Measures taken on an emergency basis shall be temporary and shall be based on the best scientific evidence available.



Project as well as other sources is being used to progress these discussions and the IOTC Secretariat *should* look to leverage additional funding to support this process. Of note are some of the recommendations stemming from the capacity building workshops dealing with the issues, which give focus on target areas for improving the prospects for further progressing on the issue:

- a. Instituting mechanisms for assisting in translation of IOTC CMMs into national legislation;
- b. Increasing timely opportunities for managers to interact with scientists on the advice provided in the Scientific Committee Report;
- c. Capturing NGO support in improving the Science to management communication process – capacity building;
- d. Increase IOTC Secretariat involvement in the pre-Commission coastal States meetings to enhance their capacity;
- e. Assistance in drafting of proposals for Conservation and Management Measures that translate science advice to management actions.

There has been some concern expressed regarding inconsistency amongst Working Parties in the method by which advice is formulated and further that there is inadequate understanding by Commissioners of that advice. This may result, at least in part, from a lack of connectivity between science advisors and Commission membership, especially in small, developing economy CPCs. Certainly, adopting the framework defined in [Recommendation 14/07](#) provides information in a format the Commission has requested, which can assist in understanding. Additional means of providing management advice in an easily understood format *should* be pursued by the Scientific Committee, also as called for under Recommendation 14/07, such as can result through the adoption of robust Harvest Control Rules, evaluated through Management Strategy Evaluations, that best achieve management objectives agreed by the Commission. Consistency across Working Parties in framing management advice could be enhanced through the use of a separate process to review stock status evaluations and formulate management advice, a role currently taken on by the Scientific Committee Plenary. Such an approach has been adopted by [ICES](#), but comes with a substantial cost in terms of time (and finances) required to formulate advice for clients. It could be useful for the Scientific Committee to consider an intermediate process for enhancing consistency across Working Parties by assembling the SC leadership immediately prior to the annual Scientific Committee Plenary to review the advice formulated by the Working Parties at intercessional meetings. Continuation of efforts in improving the science-management dialogue, minimizing technical jargon and through the use of facilitated discussion, can also assist in greater understanding of the advice offered and *should* be pursued.

## Best Practices Assessment

In addition to the functions identified by the IOTC, it is useful to also consider the functioning and practice of the IOTC Scientific Committee against a number of recommendations made regarding tRFMO Scientific Committee ‘Best Practices’ (where appropriate) which evolved through the Kobe process. These were generally identified in the 2010 Joint tRFMO Meeting to Share Best Practices on the Provision of Scientific Advice held in Barcelona ([tRFMO Technical Experts Workshop](#)), and the Kobe III discussion of tRFMO science which in combination recommended, among other items (*in italics*):

- *All members of t-RFMOs are called upon to give a top priority to the provision of data of good quality in a timely manner, according to the existing mandatory data requirements of tuna RFMOs, in order to facilitate the work of tuna RFMOs scientific bodies in the provision of scientific advice based on the most recent information.*

Although the IOTC Scientific Committee recommended and the Commission has adopted policies in keeping with this Best Practice, non-compliance by a significant proportion of the Members prevents the IOTC from achieving this.

- *Lags in the submission of fishery data should be reduced making a full use of communication technologies (e.g. web based) and efforts should be undertaken that basic data formats are harmonized.*

Lags exist in the timing of submission of data used in assessments relative to potential actions taken on the basis of the assessment in the IOTC, although this is a characteristic of many of the tRFMOs. Typically, an IOTC assessment conducted would be relying on catch, effort, and size data from the previous calendar year although that is not always the case (IOTC policies establish June 30<sup>th</sup> for reporting fishery data from the prior year, but a relatively large number of Members do not meet the reporting deadline), so that an assessment conducted in the 3<sup>rd</sup> quarter of the year would be relying on data from the fisheries as they were sampled >1 year prior. Additionally, the timing of developing Scientific Committee advice and the uptake of that advice by the Commission (in the subsequent year) implies that any Conservation and Management Measures adopted on the basis of that advice would typically not take immediate effect, resulting in a multi-year lag between the information used for stock status determinations and any new actions required by a CMM, during which time significant changes in stock and/or fishery condition can result.

- *Efforts should be undertaken so that basic data used in stock assessment (catch, effort and sizes by flag and time/area strata) provided by members should be made available via the websites of tuna RFMOs or by other means.*

The IOTC web site generally provides for public access to most of the data used in stock assessments as a matter of policy adopted by the Scientific Committee and endorsed by the Commission. While not obvious from examining the IOTC website, which is perhaps the best amongst the tRFMO websites, particular input and output streams for assessment model runs (and software) used for supporting stock status evaluations are maintained at the Secretariat and are available to interested parties, upon request. For transparency purposes, the Secretariat *should* consider adding this notation to the website and identifying the process by which interested parties could obtain such information.

- *Fine scale operational data should be made available in a timely manner to support stock assessment work, and confidentiality concerns should be addressed through RFMOs rules and procedures for access protection and security of data.*

The IOTC has established data confidentiality policies and fine-scale operational data are available from some fleets in support of stock assessments. Only recently has progress been made on joint analysis of fine scale operational level data from distant water longline fleets operating in the Indian Ocean, although, to my knowledge, these data are not generally held at the IOTC Secretariat. Steps to maintain these data used for joint analysis at the Secretariat, with sufficient protection of confidentiality, *should* be taken.

- *Tuna RFMOs should ensure adequate sampling for catch, effort and size composition across all fleets and especially distant water longliners for which this information is becoming limited.*

The IOTC has adopted data collection and reporting obligations with which, if CPCs fully complied, would assure adequate sampling of catch, effort and size composition across the fleets. Compliance with these obligations is low.

- *Tuna RFMOs should cooperate to improve the quality of data, in particular for methods to estimate: (1) species and size composition of tunas caught by purse seiners and by artisanal fisheries and (2) catch and size of farmed tunas.*

IOTC Scientists and the Secretariat participated in a workshop with participants from other tRFMOs to develop approaches for addressing this recommendation in 2009 ([Workshop Report](#)). The approaches developed for the Atlantic and Indian Ocean tropical tuna purse seine fleets have been standardized on the basis of the discussions and research conducted on the topic after the workshop. At the moment, farming tuna is not an issue for the IOTC. Artisanal (and semi-industrial) fisheries, on the other hand, represent a substantial proportion of the catch of a number of tuna stocks in the Indian Ocean and these fisheries are inadequately monitored.

- *Tuna RFMOs should use alternative sources of data, notably observer and cannery data, to both validate the information routinely reported by Parties and estimate catches from non-reporting fleets.*



The IOTC Secretariat and Scientific Committee have used (and are expected to continue using) cannery data to validate information reported by Parties. Observer data are not yet generally available to the Scientific Committee, but *should* be used for this and other purposes, once they are generally available.

- *Regular large scale tagging programs should be developed, along with appropriate reporting systems, to estimate natural mortality growth and movement patterns by sex, and other fundamental parameters for stock assessments.*

The IOTC instituted a large-scale tagging program, the IOTTP, from 2002 to 2009 which was comprised of an EU-funded large scale project implemented by the Commission de l’Océan Indien (COI), the Regional Tuna Tagging Project (RTTP-IO) and a series of smaller-scale project in Maldives, India, Mayotte, Indonesia funded by the EU, the Government of Japan and the People’s Republic of China. The tagging data-base is applied in stock assessments for several stocks and a number of lessons were learned for future tag-recapture studies. In general, the first large-scale tagging project in the Indian Ocean is viewed as a step towards sustainability in the IOTC process ([Symposium](#)) which first leads to improved assessments, thanks to the tagging data, and which fosters motivation to realize the Commission’s intent of moving towards full implementation of the precautionary approach with a concise formulation of management objectives and acceptable risks.

- *Archival tagging should be an ongoing activity of tagging programs as it provides additional insights into tuna behavior and vulnerability.*

As in other oceans, archival tagging applications are being utilized for tuna and tuna-like species in the Indian Ocean. As of yet, though, integration of such tagging studies directly into stock assessment modeling formulations is lagging due to a number of reasons ([Electronic Tagging](#)) and efforts to make full use of this technology in stock assessment *should* be pursued.

- *Spatial aspects of assessment should be encouraged within all tuna RFMOs in order to substantiate spatial management measures.*

The IOTC Scientific Committee has applied spatially structured stock assessment models where sufficient data for such are available. However, data supporting estimating movement and other model parameters that might also be spatially variable are generally limited. The application of simulation testing methods such as through the Management Strategy Evaluation processes already underway at the IOTC Scientific Committee can be used to evaluate the sensitivity of scientific advice to alternative hypotheses regarding spatial structuring of the stocks of interest to the IOTC.

- *The use of high-resolution spatial ecosystem modeling frameworks should be encouraged in all tuna RFMOs since they offer the opportunity to better integrate biological features of tuna stocks and their environment.*

While the Scientific Committee, through its Working Party on Ecosystems and Bycatch *should* pursue application of ecosystem modeling frameworks, the primary focus of WPEB in the recent past has been on bycatch (sharks, in particular) and scientific observer data collection ([WPEB Workplan](#)). One opportunity that could be pursued is utilization of funding through the GEF/FAO ABNJ Tuna Project to initiate development of ecosystem modeling approaches in the Indian Ocean. As was done in ICCAT’s Scientific Committee, it could be beneficial to separate the bycatch element from the ecosystem element in this Working Party if pursuing the ecosystem component in such a manner is elevated in priority.

- *Tuna RFMOs should promote peer reviews of their stock assessment works.*

The IOTC Scientific Committee has yet to formalize a mechanism for regular peer review of its stock assessments and *should* work toward institutionalizing peer review as a regular aspect of its aim to maintain a high standard of quality assurance.

- *Tuna RFMOs should use more than one stock assessment model and avoid the use of assumption-rich models in data-poor situations.*

The IOTC Scientific Committee has applied different and multiple stock assessment models to the available data for individual stocks. In general, this has not yet led to regularly integrating advice and characterization of uncertainty in that advice across the different plausible model formulations applied. The Scientific Committee *should* further pursue such approaches in formulating advice carrying this forward into characterizing uncertainty in stock condition and in future prospects through the Kobe Plots and Kobe II Strategy Matrices, to the degree possible.

- *Chairs of Scientific Committees should jointly develop checklists and minimum standards for stock assessments.*

While the SC chairs have not agreed on a joint checklist and minimum standards for stock assessments, it is noteworthy that the IOTC Scientific Committee has agreed guidelines for stock assessment and cpue standardizations ([SA Guidelines](#))

- *Recognizing that a Management Strategy Evaluation (MSE) process needs to be widely implemented in the tRFMOs in the line of implementing a precautionary approach for tuna fisheries management.*

The IOTC Scientific Committee through its Working Party on Methods ([WPM Workplan](#)) has embarked on developing MSE approaches for a range of the target species, which the Commission has endorsed in Resolution 15/10, agreed in May 2015. During development of these approaches, a dialogue between scientists and managers needs to take place to establish limits not to be breached as well as time frames and risks associated with achieving management objectives. Such a process was envisioned and agreed by the Commission in Resolution 14/03.

#### *Communication by tuna RFMOs*

- *Standardized executive summaries should be developed for consideration by all tuna RFMOs to summarize stock status and management recommendations.*

The IOTC Scientific Committee has adopted a standardized format for its executive summaries, in line with the recommendation and generally consistent with IOTC Recommendation 14/07. However, as noted above, uncertainty seems understated in the summaries provided, at least on the IOTC web site, a shortcoming that *should* be addressed by the Scientific Committee and Secretariat. The IOTC Scientific Committee in formulating its advice *should* strive to integrate advice across plausible hypotheses about stock dynamics, taking into account and quantifying, to the degree possible, uncertainty in model inputs and assumptions.

- *Emphasizing the potential of the Kobe II Strategy Matrix (K2SM) to communicate efficiently among all stakeholders and to assist in the decision-making process according to different levels of risk, but also recognizing that substantial uncertainties still remain in the assessments, Kobe III participants recommended that the Scientific Committees and Bodies of the tRFMOs develop research activities to better quantify the uncertainty and understand how this uncertainty is reflected in the risk assessment inherent in the K2SM.*

The IOTC Scientific Committee has adopted guidelines for presentation of stock assessment and projections ([SA Guidelines](#)), which identify the necessity of both the Kobe Plot and K2SM for communicating advice to the Commission. The K2SM formulation specified in these guidelines could be considered a K2SM-lite since it provides information on only a limited subset of future projections. A more informative presentation, such as adopted by ICCAT's Scientific Committee (Figure 3, above), or the International Pacific Halibut Commission's [Decision Table](#) format, for example, and/or graphical alternatives (also used at ICCAT) which provide for a fuller array of possible futures should be considered

for standard application by the Scientific Committee, consistent with Recommendation 14/07. It is useful to note that a recent (March, 2015) [Workshop](#) focusing on the treatment of uncertainty and the estimation of risk in providing science advice to tRFMOs, concluded that progress was being made in general through improved data collection, adoption of target and limit reference points, and analyses of the performance of alternative harvest control rules through management strategy evaluations. The workshop concluded that good progress is being made overall, including in the IOTC, especially through the processes of dialogue between scientists and managers that have been initiated (at least in IOTC, ICCAT, and WCPFC). The Workshop also recognized that substantial work is going on in individual member countries of RFMOs (e.g. Australia and Maldives), and by other projects (e.g. ABNJ and related work by NGOs), which should be coordinated and help to facilitate the work of the IOTC. Of note are recommendations on process for that can assist the IOTC in moving forward:

- Commit and understand different roles.
- Broaden participation.
- Make dialogue an important part of the process.
- Consider informal format and expert facilitators.
- Carry out capacity building.
- Develop good communication tools.
- Communicate uncertainty in a way that helps decision-making.
- Consider potential ecosystem changes

### **Consistency Between Scientific Advice and CMMs Adopted**

In general, the CMMs adopted take into account available scientific advice as evidenced in their preamble language. As part of “Best Practice”, the Working Parties and Scientific Committee are provided opportunity to review and comment on CMMs related to the work and scientific advice of the Committee during their respective meetings. CMMs agreed have been generally considering the main tuna stocks and defining MCS obligations, several have also been adopted regarding measures intended to mitigate fishery impacts on bycatch. As noted above, the form of delivery of scientific advice to the Commission at its annual meeting is quite abbreviated compared to the other tRFMOs, which can lead to the perception that the IOTC does not rely on scientific advice for formulating CMMs. It is also noteworthy that the most recent Scientific Committee report indicates that the time allocated to the Scientific Committee report presentations *should* be longer than currently available.

In my experience, tRFMO Scientific Committee members are generally unaware of the process by which the various Commissions, including the IOTC, take into consideration scientific advice when agreeing CMMs, which can lead to a general perception by the SC membership that that advice is ignored. Encouraging Scientific Committee members, especially those in leadership roles supporting the Chair of the Scientific Committee, to witness the Commission process could provide the Scientific Committee membership a better basis for considering the consistency between their scientific advice and the CMMs adopted.

The available information for the main IOTC tuna stocks would indicate that they have been in relatively healthy condition, at least in the recent past, likely as a partial result of the piracy effect off the Somalia coast, which has now been largely resolved, but the expected impact of realizing capacity development plans of the coastal states ([Estimates of Capacity](#)) implies this condition will not be sustained without strong management actions, quite possibly in the near future. In fact, yellowfin tuna in the Indian Ocean are now (based upon the 2015 stock assessment) estimated to be both overfished and undergoing overfishing. There are also a number of stocks, including several billfish and neritic tunas for which the catch-effort data are more uncertain, but which are considered to be under too high a rate of exploitation to meet the Commission’s conservation objectives for those stocks. There are still other stocks from the list of IOTC species including neritic tunas, sharks and other bycatch species, for which information is very limited, especially, but not exclusively so, in the northern Indian Ocean. These outcomes have led the Scientific Committee to recommend action be taken to reduce the fishery impact on a number of these stocks. [Resolution 12/01](#), obliges the IOTC to apply the precautionary approach, in accordance with relevant

internationally agreed standards, in particular with the guidelines set forth in the UNFSA<sup>5</sup> indicates that more focus on the IOTC stocks for which information is more uncertain or inadequate *should* be undertaken. In spite of Resolution 12/01, such precaution has not yet been clearly applied in CMMs, possibly due to short-term views of some CPCs.

To date, the majority of agreed CMMs directed toward fishery management (other than defining MCS obligations) have mainly concerned fishing capacity limitations, although fleet development plans addressing aspirations of developing economy CPCs imply the capacity limitations are “soft” limits. Such input controls are generally considered effective only to the degree they can effectively limit fishing effort. Limiting vessel numbers (capacity controls), absent other controls, will not likely achieve the Commission’s objectives. Experience in other fisheries indicates input controls are frequently ineffective when used alone without adequate controls on output, as well. Progressing on the utility of additional control mechanisms can and *should* be part of the Management Strategy Evaluation process the IOTC has already embarked upon.

## Assessment Summary and Major Strategic Recommendations

The IOTC Scientific Committee is structured and generally functions in a way that can produce best science and is generally in line with the “Best Practices” identified in the Kobe Process. However, the Committee is limited in the type and credibility of advice that can be provided largely due to the failure of CPCs in meeting data collection and reporting obligations and, in some cases, due to limited involvement of developing economies in the Scientific Committee processes. Some adjustments and enhancements should be considered to improve the credibility of science advice provided by the Committee as supported by the Secretariat, including (also see above text and the table of Recommendations provided in the Appendix):

- Continue substantial investment and innovation in data collection and capacity building will be necessary for further improvement in provision and quality of data in support of the Commission’s objectives. A major strength of the IOTC Secretariat has been its ability to cope with work required based Scientific Committee recommendations and Commission-adopted policies regarding data reporting obligations, thanks to a small team of highly motivated and efficient staff. Amongst these notable strengths has been the Secretariat’s focus on data gap and quality assessments, which is amongst the best of all of the tuna RFMOs. Demands for reviewing the

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<sup>5</sup> [Article 6. Application of the precautionary approach](#)

1. States shall apply the precautionary approach widely to conservation, management and exploitation of straddling fish stocks and highly migratory fish stocks in order to protect the living marine resources and preserve the marine environment.

2. States shall be more cautious when information is uncertain, unreliable or inadequate. The absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures.

3. In implementing the precautionary approach, States shall: (a) improve decision-making for fishery resource conservation and management by obtaining and sharing the best scientific information available and implementing improved techniques for dealing with risk and uncertainty; (b) apply the guidelines set out in Annex II and determine, on the basis of the best scientific information available, stock-specific reference points and the action to be taken if they are exceeded; (c) take into account, *inter alia*, uncertainties relating to the size and productivity of the stocks, reference points, stock condition in relation to such reference points, levels and distribution of fishing mortality and the impact of fishing activities on non-target and associated or dependent species, as well as existing and predicted oceanic, environmental and socio-economic conditions; and (d) develop data collection and research programmes to assess the impact of fishing on non-target and associated or dependent species and their environment, and adopt plans which are necessary to ensure the conservation of such species and to protect habitats of special concern.

4. States shall take measures to ensure that, when reference points are approached, they will not be exceeded. In the event that they are exceeded, States shall, without delay, take the action determined under paragraph 3 (b) to restore the stocks.

5. Where the status of target stocks or non-target or associated or dependent species is of concern, States shall subject such stocks and species to enhanced monitoring in order to review their status and the efficacy of conservation and management measures. They shall revise those measures regularly in the light of new information.

6. For new or exploratory fisheries, States shall adopt as soon as possible cautious conservation and management measures, including, *inter alia*, catch limits and effort limits. Such measures shall remain in force until there are sufficient data to allow assessment of the impact of the fisheries on the long-term sustainability of the stocks, whereupon conservation and management measures based on that assessment shall be implemented. The latter measures shall, if appropriate, allow for the gradual development of the fisheries.

7. If a natural phenomenon has a significant adverse impact on the status of straddling fish stocks or highly migratory fish stocks, States shall adopt conservation and management measures on an emergency basis to ensure that fishing activity does not exacerbate such adverse impact. States shall also adopt such measures on an emergency basis where fishing activity presents a serious threat to the sustainability of such stocks. Measures taken on an emergency basis shall be temporary and shall be based on the best scientific evidence available.

quality of the statistics available, the status of collection, processing, and reporting of data have been increasing over time and the complexity of the Indian Ocean tuna which imposes a tremendous work-load required in order to assist CPCs in data collection and implementation of monitoring systems. Developing economy CPCs (and the whole of the IOTC Membership) have substantially benefitted from extra-budgetary funds in addressing the failings of data collection and fishery monitoring, but the full process of acquiring such funding (proposal, deliverables, follow-up, *etc.*) and organizing missions in the field is adding up to the already many missions of the small Secretariat staff. Should the IOTC remain mostly dependent upon extra-mural funding for these activities, or even if the Members decide to fully fund such activities, the Secretariat staffing dedicated to such activities should be elevated.

- Institute regular independent peer review of the Scientific Committee processes for providing scientific advice since in any formulation used for provision of scientific advice, it is important to take steps to assure maintaining a high level of objectivity, both through application of transparent processes and in the frequent use of independent peer review. The IOTC formulation for providing stock assessment advice is closer to the ICCAT model than the other tRFMO formulations, although the Secretariat's staff dedicated to the stock assessment theme is too small given the complexity of the fisheries and the demands of the Commission for stock status advice for the now substantial number of IOTC stocks, many of which have unknown status. The use of Consultants and Invited Experts to address assessment and/or other quantitative issues of concern is moving in the direction of a WCPFC 'service provider' approach and should be continued or intensified, at least in the near-term. Additionally, given the increasing demand of the Commission on the Scientific Committee, the IOTC scientific team should be at least 3-4 full-time scientists working on CPUEs, assessments, MSE, ecosystem models, bycatch issues, *etc.*
- Continue to seek means to engage developing economy CPC scientists in the work of the Scientific Committee and to establish linkages between developing economy CPC scientists and their Commissioners to engender a better understanding of what the science advice means. This should include continuing the IOTC process of dialogue between scientists and managers and draw upon the substantial work going on in individual member countries and other projects (*e.g.* ABNJ and related work by NGOs), which should be coordinated through the Secretariat to help to facilitate the work of the IOTC.
- Continue to focus on the treatment of uncertainty and the estimation of risk in providing science advice to IOTC through improved data collection, adoption of target and limit reference points, and analyses of the performance of alternative harvest control rules (and control measures) through management strategy evaluations.

Appendix Figure 1. Stock summary table from IOTC–2014–SC17–R[E] indicating in which Kobe quadrant the stock is estimated to be. Binning in this way, although a simple style for presentation, fully ignores the quantified uncertainty associated with the evaluation summarized. Summary as of mid-Oct, 2015.

Status summary for species of tuna and tuna-like species under the IOTC mandate, as well as other species impacted by IOTC fisheries.

Stock	Indicators	Prev <sup>1</sup>	2010	2011	2012	2013	2014	Advice to the Commission
<b>Temperate and tropical tuna stocks:</b> These are the main stocks being targeted by industrial, and to a lesser extent, artisanal fisheries throughout the Indian Ocean, both on the high seas and in the EEZ of coastal states.								
Albacore <i>Thunnus alalunga</i>	Catch 2013: 38,297 t Average catch 2008–2013: 37,525 t MSY (1,000 t) (80% CI): 47.6 (26.7–78.8) F <sub>MSY</sub> (80% CI): 39.2 (25.4–50.7) SB <sub>MSY</sub> (1,000 t) (80% CI): 0.69 (0.23–1.39) F <sub>2012</sub> /F <sub>MSY</sub> (80% CI): 0.21 (0.11–0.33) SB <sub>2012</sub> /SB <sub>MSY</sub> (80% CI): SB <sub>2012</sub> /SB <sub>1950</sub> (80% CI):	2007						Catches have increased substantially since 2007, attributed to the Indonesian and Taiwan,China longline fisheries although there is substantial uncertainty remaining on the catch estimates. It is considered that recent catches are approaching MSY levels. Fishing mortality represented as F <sub>2012</sub> /F <sub>MSY</sub> is 0.69. Biomass is considered to be at or very near to the SB <sub>MSY</sub> level (SB <sub>2012</sub> /SB <sub>MSY</sub> = 1.09). Considerable uncertainty remains in the assessments, indicating that a precautionary approach to the management of albacore should be applied by reducing fishing mortality or capping total catch levels to those taken in 2012 (34,000 t).
Bigeye tuna <i>Thunnus obesus</i>	Catch in 2013: 109,343 t Average catch 2009–2013: 105,924 t MSY (1,000 t) (range): 132 (98–207) F <sub>MSY</sub> (range): n.a. (n.a.–n.a.) SB <sub>MSY</sub> (1,000 t) (range): 474 (295–677) F <sub>2012</sub> /F <sub>MSY</sub> (range): 0.40 (0.27–0.54) SB <sub>2012</sub> /SB <sub>MSY</sub> (range): SB <sub>2012</sub> /SB <sub>0</sub> (range):	2008						No new stock assessment was carried out in 2014, thus, stock status is determined on the basis of the 2013 assessment and other indicators presented in 2014. All the runs (except 2 extremes) carried out in 2013 indicate the stock is above a biomass level that would produce MSY in the long term (i.e. SB <sub>2012</sub> /SB <sub>MSY</sub> > 1) and in all runs that current fishing mortality is below the MSY-based reference level (i.e. F <sub>2012</sub> /F <sub>MSY</sub> < 1). Current spawning stock biomass was estimated to be 40% of the unfished levels. Catches in 2013 (≈109,000 t) remain lower than the estimated MSY values from the 2013 stock assessments. The average catch over the previous five years (2009–13; ≈106,000 t) also remains below the estimated MSY.



Stock	Indicators	Prev <sup>1</sup>	2010	2011	2012	2013	2014	Advice to the Commission
Skipjack tuna <i>Katsuwonus pelamis</i>	Catch 2013: 424,580 t Average catch 2009-2013: 401,132 t MSY (1,000 t) (80% CI): F <sub>MSY</sub> (80% CI): 684 (550-849) SB <sub>MSY</sub> (1,000 t) (80% CI): 875 (708-1,075) C <sub>2013</sub> /C <sub>MSY</sub> (80% CI): 0.62 (0.49-0.75) SB <sub>2013</sub> /SB <sub>MSY</sub> (80% CI): 1.59 (1.13-2.14) SB <sub>2013</sub> /SB <sub>0</sub> (80% CI): 0.58 (0.53-0.62)							The 2014 stock assessment model results did not differ substantively from the previous assessments. All the runs indicate the stock is above a biomass level that would produce MSY in the long term (i.e. SB <sub>2013</sub> /SB <sub>MSY</sub> > 1) and that the current proxy for fishing mortality is below the MSY-based reference level (i.e. C <sub>current</sub> /C <sub>MSY</sub> < 1). Current spawning stock biomass was estimated to be 57% of the unfished levels. Catches in 2014 (~424,000 t) remain lower than the estimated MSY values from the 2014 stock assessments. The average catch over the previous five years (2009-13; ~401,000 t) also remains below the estimated MSY.
Yellowfin tuna <i>Thunnus albacares</i>	Catch 2013: 402,084 t Average catch 2009-2013: 339,359 t MSY (1,000 t) (80% CI): n.a (n.a.-n.a.) F <sub>MSY</sub> (80% CI): 881 (784-986) SB <sub>MSY</sub> (1,000 t) (80% CI): 1.24 (0.91-1.40) F <sub>curr</sub> /F <sub>MSY</sub> (80% CI): 0.38 (0.28-0.38) SB <sub>curr</sub> /SB <sub>MSY</sub> (80% CI): SB <sub>curr</sub> /SB <sub>0</sub> (80% CI):	2008						No new stock assessment was carried out in 2014, thus, stock status is determined on the basis of the 2012 assessment and other indicators presented in 2014. Total catch has continued to increase with 400,292 t and 402,084 t landed in 2012 and 2013, respectively, well in excess of previous MSY estimates (~17% above the MSY level of 344,000 t), in comparison to 327,453 t landed in 2011 and 299,713 t landed in 2010. Therefore it is difficult to know whether the stock is moving towards a state of being subject to overfishing.
<b>Billfish:</b> These are the billfish stocks being exploited by industrial and artisanal fisheries throughout the Indian Ocean, both on the high seas and in the EEZ of coastal states. The marlins and sailfish are not usually targeted by most fleets, but are caught and retained as byproduct by the main industrial fisheries. They are important for localised small-scale and artisanal fisheries or as targets in recreational fisheries.								
Swordfish (whole Indian Ocean) <i>Xiphias gladius</i>	Catch 2013: 31,804 t Average catch 2009-2013: 26,510 t MSY (1,000 t) (80% CI): 39.40 (33.20-45.60) F <sub>MSY</sub> (80% CI): 0.138 (0.137-0.138) SB <sub>MSY</sub> (1,000 t) (80% CI): 61.4 (51.5-71.4) F <sub>2013</sub> /F <sub>MSY</sub> (80% CI): 0.34 (0.28-0.40) 3.10 (2.44-3.75)	2007						The SS3 model, used for stock status advice indicated that MSY-based reference points were not exceeded for the Indian Ocean population as a whole (F <sub>2013</sub> /F <sub>MSY</sub> < 1; SB <sub>2013</sub> /SB <sub>MSY</sub> > 1). All other models applied to swordfish also indicated that the stock is above a biomass level that would produce MSY and current catches are below the MSY level. Spawning stock biomass in 2013 was estimated to be 58-89% of the unfished levels

Stock	Indicators	Prev <sup>1</sup>	2010	2011	2012	2013	2014	Advice to the Commission
	SB <sub>2013</sub> /SB <sub>BMSY</sub> (80% CI): 0.74 (0.58–0.89) SB <sub>2013</sub> /SB <sub>1950</sub> (80% CI):							
Swordfish (southwest Indian Ocean) <i>Xiphias gladius</i>	Catch 2013: 7,349 t Average catch 2009–2013: 7,265 t MSY (1,000 t) (80% CI): 9.86 (9.11–10.57) F <sub>MSY</sub> (80% CI): 0.63 (0.59–0.70) B <sub>MSY</sub> (1,000 t) (80% CI): 12.68 (12.52–12.78) F <sub>2013</sub> /F <sub>MSY</sub> (80% CI): 0.89 (0.61–1.14) B <sub>2013</sub> /B <sub>MSY</sub> (80% CI): 0.94 (0.68–1.23) B <sub>2013</sub> /B <sub>1950</sub> (80% CI): 0.16 (n.a.)							The assessments carried out in 2014 produced substantially conflicting results (ASIA, BBDM and ASPIC). The southwest Indian Ocean region has been subject to localised depletion over the past decade and biomass remains below the level that would produce MSY (B <sub>MSY</sub> ). In 2013, 7,349 t of swordfish catches were recorded from this region, which equals 110% of the recommended maximum catch of 6,678 t agreed to by the SC in 2013. If catches are maintained at 2013 levels, the probabilities of violating target reference points in 2016 are ≈ 81% for F <sub>MSY</sub> and ≈ 40% for B <sub>MSY</sub> .
Black marlin <i>Makaira indica</i>	Catch 2013: 14,400 t Average catch 2009–2013: 11,962 t MSY (1,000 t) (80% CI): 10.2 (7.6–13.8) F <sub>MSY</sub> (80% CI): 0.25 (0.08–0.45) B <sub>MSY</sub> (1,000 t) (80% CI): 37.8 (14.6–62.3) F <sub>2013</sub> /F <sub>MSY</sub> (80% CI): 1.06 (0.39–1.73) B <sub>2013</sub> /B <sub>MSY</sub> (80% CI): 1.13 (0.73–1.53) B <sub>2013</sub> /B <sub>1950</sub> (80% CI): 0.57 (0.37–0.76)							This is the second time that the WPB has applied a Stock Reduction Analysis technique to black marlin and further testing of how sensitive this technique is to model assumptions and available time series of catches needs to be undertaken. However, the WPB considers that the assessment is the best information currently available and as such, should be used to determine stock status, with the intention that alternative techniques be applied in 2015 to validate the results.
Blue marlin <i>Makaira nigricans</i>	Catch 2013: 13,834 t Average catch 2009–2013: 11,531 t MSY (1,000 t) (80% CI): 11.70 (8.02–12.40) F <sub>MSY</sub> (80% CI): 0.49 (n.a.) B <sub>MSY</sub> (1,000 t) (80% CI): 23.70 (n.a.) F <sub>2011</sub> /F <sub>MSY</sub> (80% CI): 0.85 (0.63–1.45) B <sub>2011</sub> /B <sub>MSY</sub> (80% CI): 0.98 (0.57–1.18) 0.48 (n.a.)							No new assessment was undertaken in 2014. Thus, stock status is based on the previous assessment undertaken in 2013, as well as indicators available in 2014. In 2013, an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicated the stock is currently being exploited near maximum levels and that the stock is at the optimal biomass level. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a data poor stock assessment method: Stock Reduction

Stock	Indicators	Prev <sup>1</sup>	2010	2011	2012	2013	2014	Advice to the Commission
	B <sub>2011</sub> /B <sub>1950</sub> (80% CI):							Analysis using only catch data. Total reported landings increased substantially in 2012 to 17,252 t, well above the MSY estimate of 11,690 t. In 2013 reported catches declined slightly to 13,843 t, still above the MSY level. Given the sharp increase in reported catches over the last two years, that are well above the MSY level, the stock is likely to have moved to a state of being subject to overfishing.
Striped marlin <i>Tetrapturus audax</i>	Catch 2013: 4,429 t Average catch 2009-2013: 3,667 t MSY (1,000 t) (80% CI): 4.41 t (3.54-4.58) F <sub>MSY</sub> (80% CI): 12.43 t (n.a.) B <sub>MSY</sub> (1,000 t) (80% CI): 1.28 (0.95-1.92) F <sub>2011</sub> /F <sub>MSY</sub> (80% CI): 0.18 (n.a.) B <sub>2011</sub> /B <sub>MSY</sub> (80% CI): 0.416 (0.2-0.42) B <sub>2011</sub> /B <sub>0</sub> (80% CI):							No new assessment was undertaken in 2014. Thus, stock status is based on the previous assessment undertaken in 2013, as well as indicators available in 2014. In 2013 an ASPIC stock assessment confirmed the preliminary assessment results from 2012 that indicated the stock is currently subject to overfishing and that biomass is below the level which would produce MSY. Two other approaches examined in 2013 came to similar conclusions, namely a Bayesian State Space model, and a Stock Reduction Analysis using only catch data. The ASPIC model indicated that the stock has been subject to overfishing for some years, and that as a result, the stock biomass is well below the B <sub>MSY</sub> level and shows little signs of rebuilding despite the declining effort trend. In 2013 reported catches declined to 4,429 t, still above the MSY level.
Indo-Pacific Sailfish <i>Istiophorus platypterus</i>	Catch 2013: 29,750 t Average catch 2009-2013: 28,087 t MSY (1,000 t) (80% CI): 27.84 (24.70-35.00) F <sub>MSY</sub> (80% CI): 0.27 (0.16-0.39) B <sub>MSY</sub> (1,000 t) (80% CI): 95.2 (62.89-127.73) F <sub>2013</sub> /F <sub>MSY</sub> (80% CI): 1.19 (0.66-1.72) B <sub>2013</sub> /B <sub>MSY</sub> (80% CI): 1.12 (0.88-1.37) B <sub>2013</sub> /B <sub>0</sub> (80% CI): 0.56 (0.44-0.69)							Data poor methods for stock assessment using Stock reduction analysis (SRA) techniques indicate that the stock is not overfished and close to or exceeding maximum sustainable yield levels. However, as this is the first time that the WPB used such a method on Indo-Pacific sailfish, further testing of how sensitive this technique is to model assumptions and available time series of catches needs to be undertaken before the WPB uses it to determine stock status.
<p><b>Neritic tunas and mackerel:</b> These six species have become as important or more important as the three tropical tuna species (bigeye tuna, skipjack tuna and yellowfin tuna) to most IOTC coastal states with a total estimated catch of <b>623,242 t</b> being landed in 2013. They are caught primarily by coastal fisheries, including small-scale</p>								

Stock	Indicators	Prev <sup>1</sup>	2010	2011	2012	2013	2014	Advice to the Commission
industrial and artisanal fisheries. They are almost always caught within the EEZs of coastal states. Historically, catches were often reported as aggregates of various species, making it difficult to obtain appropriate data for stock assessment analyses.								
Bullet tuna <i>Auxis rochei</i>	Catch 2013: 11,724 t Average catch 2009–2013: 10,598 t MSY (1,000 t) (80% CI): unknown F <sub>MSY</sub> (80% CI): unknown B <sub>MSY</sub> (1,000 t) (80% CI): unknown F <sub>2012</sub> /F <sub>MSY</sub> (80% CI): unknown B <sub>2012</sub> /B <sub>MSY</sub> (80% CI): unknown B <sub>2012</sub> /B <sub>0</sub> (80% CI): unknown							No quantitative stock assessment is currently available for bullet tuna in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock status indicators can be used. Aspects of the fisheries for bullet tuna combined with the lack of data on which to base a more formal assessment, are a cause for considerable concern. Stock status in relation to the Commission's B <sub>MSY</sub> and F <sub>MSY</sub> target reference points remains uncertain, indicating that a precautionary approach to the management of bullet tuna should be applied.
Frigate tuna <i>Auxis thazard</i>	Catch 2013: 88,974 t Average catch 2009–2013: 91,974 t MSY (1,000 t) (80% CI): unknown F <sub>MSY</sub> (80% CI): unknown B <sub>MSY</sub> (1,000 t) (80% CI): unknown F <sub>2012</sub> /F <sub>MSY</sub> (80% CI): unknown B <sub>2012</sub> /B <sub>MSY</sub> (80% CI): unknown B <sub>2012</sub> /B <sub>0</sub> (80% CI): unknown							No quantitative stock assessment is currently available for frigate tuna in the Indian Ocean, and due to a lack of fishery data for several gears, only preliminary stock status indicators can be used. Aspects of the fisheries for frigate tuna combined with the lack of data on which to base a more formal assessment are a cause for considerable concern. Stock status in relation to the Commission's B <sub>MSY</sub> and F <sub>MSY</sub> target reference points remains uncertain, indicating that a precautionary approach to the management of frigate tuna should be applied.
Kawakawa <i>Euthynnus affinis</i>	Catch 2013: 168,954 t Average catch 2009–2013: 150,387 t MSY (1,000 t) (80% CI): 144 (113–167) F <sub>MSY</sub> (80% CI): 0.51 (n.a.) B <sub>MSY</sub> (1,000 t) (80% CI): 217 (168–152) F <sub>2012</sub> /F <sub>MSY</sub> (80% CI): 0.97 (0.62–1.61) B <sub>2012</sub> /B <sub>MSY</sub> (80% CI): 1.13 (0.64–1.4) B <sub>2012</sub> /B <sub>0</sub> (80% CI): 0.57 (0.32–0.7)							Analysis using a Stock Reduction Analysis approach for a second year indicates that the stock is near optimal levels of F <sub>MSY</sub> , and stock biomass is near the level that would produce MSY (B <sub>MSY</sub> ). Due to the quality of the data being used, the simplistic approach employed in 2014, combined with the rapid increase in kawakawa catch in recent years, measures need to be taken to slow the increase in catches in the IOTC area of competence. A separate analysis done on a sub-population (north-west Indian Ocean region) in 2014 indicated that that stock may be experiencing overfishing, although spawning biomass is likely to be above the level to produce MSY.
Longtail tuna <i>Thunnus tonggol</i>	Catch 2012: 160,532 t 139,971 t							Stock Reduction Analysis techniques indicate that the stock is being exploited at a rate that exceed F <sub>MSY</sub> in recent



**Sharks:** Although sharks are not part of the 16 species directly under the IOTC mandate, sharks are frequently caught in association with fisheries targeting IOTC species. Some fleets are known to actively target both sharks and IOTC species simultaneously. As such, IOTC Contracting Parties and Cooperating Non-Contracting Parties are required to report information at the same level of detail as for the 16 IOTC species. The following are the main species caught in IOTC fisheries, although the list is not exhaustive.

Blue shark <i>Prionace glauca</i>	Reported catch 2013: Not elsewhere included (nei) sharks <sup>2</sup> : 23,197 t Average reported catch 2009–2013: 46,728 t Not elsewhere included (nei) sharks <sup>2</sup> : 24,447 t MSY (range): 49,318 t unknown								
Oceanic whitetip shark <i>Carcharhinus longimanus</i>	Reported catch 2013: Not elsewhere included (nei) sharks <sup>2</sup> : 230 t Average reported catch 2009–2013: 46,728 t Not elsewhere included (nei) sharks <sup>2</sup> : 317 t MSY (range): 49,318 t unknown								
Scalloped hammerhead shark <i>Sphyrna lewini</i>	Reported catch 2013: Not elsewhere included (nei) sharks <sup>2</sup> : 128 t Average reported catch 2009–2013: 46,728 t Not elsewhere included (nei) sharks <sup>2</sup> : 91 t MSY (range): 49,318 t unknown								
Shortfin mako <i>Isurus oxyrinchus</i>	Reported catch 2013: Not elsewhere included (nei) sharks <sup>2</sup> : 1,572 t Average reported catch 2009–2013: 46,728 t Not elsewhere included (nei) sharks <sup>2</sup> : 1,364 t MSY (range): 49,318 t unknown								
Silky shark <i>Carcharhinus falciformis</i>	Reported catch 2013: Not elsewhere included (nei) sharks <sup>2</sup> : 3,573 t Average reported catch 2009–2013: 46,728 t Not elsewhere included (nei) sharks <sup>2</sup> : 3,843 t MSY (range): 49,318 t unknown								

There is a paucity of information available for these species and this situation is not expected to improve in the short to medium term. There is no quantitative stock assessment and limited basic fishery indicators currently available. Therefore the stock status is highly uncertain. The available evidence indicates considerable risk to the stock status at current effort levels. The primary source of data that drive the assessment (total catches) is highly uncertain and should be investigated further as a priority.



	Average reported catch 2009-2013: Not elsewhere included (nei) sharks <sup>2</sup> : MSY (range): unknown							
Bigeye thresher shark <i>Alopias superciliosus</i>	Reported catch 2013: Not elsewhere included (nei) sharks <sup>2</sup> : 0 t Average reported catch 2009-2013: Not elsewhere included (nei) sharks <sup>2</sup> : 46,728 t 75 t 49,318 t MSY (range): unknown							
Pelagic thresher shark <i>Alopias pelagicus</i>	Reported catch 2013: Not elsewhere included (nei) sharks <sup>2</sup> : 0 t Average reported catch 2009-2013: Not elsewhere included (nei) sharks <sup>2</sup> : 46,728 t 75 t 49,318 t MSY (range): unknown							

<sup>1</sup> This indicates the last year taken into account for assessments carried out before 2010; <sup>2</sup>The point estimate is the median of the plausible models investigated in the 2013 SS3 assessment; <sup>3</sup> most recent years data 2010; <sup>4</sup> most recent years data 2011.

Colour key	Stock overfished ( $SB_{year}/SB_{MSY} < 1$ )	Stock not overfished ( $SB_{year}/SB_{MSY} \geq 1$ )
Stock subject to overfishing ( $F_{year}/F_{MSY} > 1$ )		
Stock not subject to overfishing ( $F_{year}/F_{MSY} \leq 1$ )		
Not assessed/Uncertain		

## Appendix. Recommendations made in the text of the Review.

Major Strategic Recommendations	RESPONSIBILITY
<ul style="list-style-type: none"> <li>Continue substantial investment and innovation in data collection and capacity building will be necessary for further improvement in provision and quality of data in support of the Commission’s objectives. A major strength of the IOTC Secretariat has been its ability to cope with work required based Scientific Committee recommendations and Commission-adopted policies regarding data reporting obligations, thanks to a small team of highly motivated and efficient staff. Amongst these notable strengths has been the Secretariat’s focus on data gap and quality assessments, which is amongst the best of all of the tuna RFMOs. Demands for reviewing the quality of the statistics available, the status of collection, processing, and reporting of data have been increasing over time and the complexity of the Indian Ocean tuna which imposes a tremendous work-load required in order to assist CPCs in data collection and implementation of monitoring systems. Developing economy CPCs (and the whole of the IOTC Membership) have substantially benefitted from extra-budgetary funds in addressing the failings of data collection and fishery monitoring, but the full process of acquiring such funding (proposal, deliverables, follow-up, <i>etc.</i>) and organizing missions in the field is adding up to the already many missions of the small Secretariat staff. Should the IOTC remain mostly dependent upon extra-mural funding for these activities, or even if the Members decide to fully fund such activities, the Secretariat staffing dedicated to such activities should be elevated. Given the increasing demand of the Commission on the Scientific Committee, the IOTC scientific team <i>should</i> be at least 3-4 full-time scientists working on CPUEs, assessments, MSE, ecosystem models, bycatch issues, <i>etc</i></li> </ul>	<p><i>CPCs, Commission, Secretariat, Scientific Committee, NGOs</i></p>
<ul style="list-style-type: none"> <li>Institute regular independent peer review of the Scientific Committee processes for providing scientific advice since in any formulation used for provision of scientific advice, it is important to take steps to assure maintaining a high level of objectivity, both through application of transparent processes and in the frequent use of independent peer review. The IOTC formulation for providing stock assessment advice is closer to the ICCAT model than the other tRFMO formulations, although the Secretariat’s staff dedicated to the stock assessment theme is too small given the complexity of the fisheries and the demands of the Commission for stock status advice for the now substantial number of IOTC stocks, many of which have unknown status. The use of Consultants and Invited Experts to address assessment and/or other quantitative issues of concern is moving in the direction of a WCPFC ‘service provider’ approach and should be continued or intensified, at least in the near-term. Additionally, given the increasing demand of the Commission on the Scientific Committee, the IOTC scientific team should be at least 3-4 full-time scientists working on CPUEs, assessments, MSE, ecosystem models, bycatch issues, <i>etc.</i></li> </ul>	<p><i>Scientific Committee, Secretariat</i></p>

<ul style="list-style-type: none"> <li>Continue to seek means to engage developing economy CPC scientists in the work of the Scientific Committee and to establish linkages between developing economy CPC scientists and their Commissioners to engender a better understanding of what the science advice means. This should include continuing the IOTC process of dialogue between scientists and managers and draw upon the substantial work going on in individual member countries and other projects (<i>e.g.</i> ABNJ and related work by NGOs), which should be coordinated through the Secretariat to help to facilitate the work of the IOTC.</li> </ul>	<p><i>Scientific Committee, Secretariat, CPCs, NGOs</i></p>
<ul style="list-style-type: none"> <li>Continue to focus on the treatment of uncertainty and the estimation of risk in providing science advice to IOTC through improved data collection, adoption of target and limit reference points, and analyses of the performance of alternative harvest control rules (and control measures) through management strategy evaluations.</li> </ul>	<p><i>Scientific Committee, Commission</i></p>

<b><i>Scientific Committee Structure and Function</i></b>	<b>RESPONSIBILITY</b>
<p>Maintenance or improvement of the Meeting Participation Fund, which is now viewed as a crucial element for fostering scientific engagement of developing economy scientists, will be needed in the long-run especially while substantial capacity gaps remain amongst the developed and developing economy membership. Focusing effort on dedicated training workshops, not just meeting participation, <b><i>should</i></b> go hand-in-hand with this initiative since meeting participation, while a necessary element, is not always the best environment for capacity building because of the pace of work at the meetings and the lack of basic understanding of concepts in some of the CPCs.</p>	<p><i>CPCs</i></p>
<p>Not all of the Working Parties have the same level of cooperation and collaboration between national scientists from different CPCs and the potential for elevating cooperation and collaboration through more frequent joint research activities <b><i>should</i></b> be considered.</p>	<p><i>CPCs</i></p>
<p>It is useful to note that while developed economy CPC scientists dominate the leadership of the Scientific Committee, there is some diversity amongst the Conveners and vice Conveners of the various Working Parties (about 1/3 from developing economies while the Membership is closer to 2/3 from developing economies). Methods for increasing that diversity, through vice-Convener positions leading toward Convener positions, <b><i>should</i></b> also be considered as a means of increasing scientific capacity and engagement in the Scientific Committee. Failing to further address the issue leads to poor understanding and ownership of scientific issues of concern to the IOTC amongst all of the CPCs and a lack of cooperation in developing CMMs to achieve the Commission’s goals.</p>	<p><i>Scientific Committee and CPCs</i></p>

<p>Some IOTC Working Parties have evolved into small science conferences whereby papers are presented which, while interesting, are off topic for the particular Working Party meeting objectives and can consume considerable time, potentially limiting stock assessment reviews and development of management advice during the Working Party meetings. Balancing the need for encouraging broad CPC participation through scientific contributions and achieving the end objective of providing resource management advice is not trivial, but <i>should</i> be addressed by the Scientific Committee through a process of reviewing and establishing, as needed, further guidelines for the organization and conduct of meetings. This could be addressed by circulating, in advance of the meetings, guidance from the Chairs of Working Parties through the Secretariat, on the pertinent topics to be covered and the limits for presentations and discussion of the working paper contributions. In some other tRFMOs, this has been addressed through an <i>ad-hoc</i> Working Party on organization, composed of leadership of the Working Parties and the Secretariat, serving at the will of the Scientific Committee Chair, to advise on additional guidelines designed to provide for adequate time for achieving Working Party objectives while also maintaining opportunity for broad CPC participation. Such an <i>ad-hoc</i> Working Party can also serve to enhance communication and coordination between the Secretariat and the SC leadership.</p>	<p><i>Scientific Committee</i></p>
<p><b><i>Recommending Data Collection and Reporting Policy</i></b></p>	<p>RESPONSIBILITY</p>
<p>Developing economy CPCs (and the whole of the IOTC Membership) have substantially benefitted from extra-budgetary funds to start addressing the failings of data collection and fishery monitoring (in 2013-2014 approximately 85% of the funds the IOTC used for this activity were extra-budgetary), but the full process of acquiring such funding (proposal, deliverables, follow-up, <i>etc.</i>) and organizing missions in the field is adding up to the already many missions of the small staff. Should the IOTC remain mostly dependent upon extra-mural funding for these activities, or even if the Members decide to fully fund such activities, the Secretariat staffing dedicated to such activities <i>should</i> be elevated. It is also noteworthy that NGOs are pursuing tuna sustainability issues and it may be a good opportunity for the IOTC to engage with them effectively to leverage additional funding for addressing key gaps.</p>	<p><i>CPCs, Secretariat &amp; NGOs</i></p>
<p><b><i>Facilitating Scientific Exchange and Review</i></b></p>	<p>RESPONSIBILITY</p>
<p>Limited science being done in the coastal states is a major weakness in the collective ownership and understanding about the stock status and the CMMs being developed to manage them. Fostering more engagement of coastal state scientists into the Scientific Committee through the activities instituted in the past few years <i>should</i> be maintained or accelerated. Institution of research activities within those developing economies by partnering national scientists with developed economy CPC scientists <i>should</i> be explored. As above, leveraging NGO and other partnerships designed to engage CPC scientists on research of particular concern to IOTC stocks <i>should</i> be considered an opportunity to further foster this engagement. Equally, if not more important in this regard, is the need to raise the level of awareness of coastal states to devote sufficient resources to implement the measures they agree to at the Commission level, among them data collection and reporting requirements.</p>	<p><i>Scientific Committee, CPCs, Secretariat, &amp; NGOs</i></p>

<i>Provision of Scientific Advice</i>	RESPONSIBILITY
<p>Science capacity building workshops have been undertaken by the Secretariat, which resulted in a number of recommendations that <i>should</i> be taken on board (<a href="#">Science Capacity Workshop</a>), with the aim of fostering further engagement. While these recommendations do not strictly relate to the scientific process, they are strongly related in the context of linking IOTC science to policy development. A number of developing (and developed) economies do not maintain a strong (or even any) linkage between scientists engaged in the IOTC Scientific Committee and those involved in Commission policy development. Mechanisms to encourage such linkages, like the aforementioned workshops or through further leveraging of NGO or other funding sources, <i>should</i> be further considered.</p>	<p><i>Scientific Committee, CPCs, Secretariat, &amp; NGOs</i></p>
<p>It is also of concern that the degree of developed economy CPC support of the Scientific Committee may be diminishing. In particular, there exist underlying policies linking professional development and advancement of scientists within their national systems to elements other than those required for routine fishery monitoring and stock assessment tasks needed to make the IOTC Scientific Committee function, thus diminishing incentives for these scientists to engage. This of course, relates to the internal policies of the Members, but the implication of diminishing scientific support to the IOTC from the Membership, is the <i>need to elevate</i> the scientific staff at the Secretariat, which is already at too low a level compared to the other tRFMOs, in my view.</p>	<p><i>CPCs, Secretariat</i></p>
<p>The Scientific Committee requires supplementation by Consultants and/or Experts, which implies insufficient expertise available from CPCs and/or staffed at the Secretariat. While an effective way of achieving a substantial workload in the short-run, it is less desirable to depend on this formulation in the long-run, than having available on-board expertise to complete the work, especially from the viewpoint of establishing a ‘corporate memory’. While the IOTC uses an in-house stock assessment expert supplemented by Consultants to carry out some of the stock assessment work, the increasingly common use of highly parameterized, integrated statistical modeling platforms carries with it the need for higher levels of effort for review and re-examination than can usually be fully accomplished at single Working Party review session. Should the Working Parties continue to make use of these modeling frameworks, Terms of Reference for Consultancies and organization of the Working Party meetings <i>should</i> be modified to better reflect these features. Following the ICCAT practice of data preparatory meetings preceding assessment review meetings <i>should</i> be considered as an approach that could help in this regard.</p>	<p><i>Scientific Committee</i></p>
<p>The use of Consultants and Invited Experts to address assessment and/or other quantitative issues of concern is moving in the direction of a WCPFC ‘service provider’ approach and <i>should</i> be continued or intensified, at least in the near term. Additionally, given the increasing demand of the Commission on the Scientific Committee, the IOTC scientific team <i>should</i> be at least 3-4 full-time scientists working on CPUEs, assessments, MSE, ecosystem models, bycatch issues, <i>etc.</i> While a thorough evaluation of the cost-benefits of the different models used for provision of scientific advice at the different tRFMOs is beyond the scope of this review, a critical cost-benefit evaluation <i>should</i> be undertaken to further inform the IOTC on the formulation which could best serve its needs.</p>	<p><i>Scientific Committee, Secretariat</i></p>

<p>Much of the stock status inference is based on poorly estimated catch for several of the main species and most of the coastal species and the assessments carried out likely under-represent uncertainties related to this (and other) issues. The Scientific Committee <i>should</i> work towards quantifying uncertainty in catch and how that uncertainty may influence stock assessment outcomes.</p>	<p><i>Scientific Committee</i></p>
<p>The Scientific Committee <i>should</i> strive to improve the way it communicates information about stock status and future prospects for the stocks to the Commission (as noted in Recommendation 14/07), including the uncertainties and risks to achieving operational objectives under alternative management approaches. Improvements in the way uncertainty in stock status and future prospects under different management approaches are characterized for the Commission <i>should</i> be undertaken by the Scientific Committee. Quantified uncertainties that are available are inadequately communicated to the Commission in the Stock Status Summary Tables presented in the species executive summaries. Representing stock status evaluations in a color scheme that reflect the distribution of outcomes across the 4 Kobe quadrants would better signify the quantified uncertainties. In addition, application of a reduced form of a Kobe 2 Strategy Matrix in the form now commonly used by the Scientific Committee provides limited information for consideration by the Commission. A more informative presentation, such as adopted by ICCAT’s Scientific Committee and/or a graphical alternative <i>should</i> be considered for standard application by the Scientific Committee.</p>	<p><i>Scientific Committee</i></p>
<p>There are now available an assemblage of data limited approaches (<a href="#">DLMtools</a>) and recent reviews of these approaches (<a href="#">Caruthers et.al., 2014</a> and <a href="#">Geromont and Butterworth, 2015</a>) that <i>should</i> be taken up for potential application for the data limited (as well as data rich, but information poor) stocks in the IOTC domain.</p>	<p><i>Scientific Committee</i></p>
<p>The Scientific Committee has yet to formalize a peer review process for its stock assessments. It is notable that many of these elements are called for under Recommendation 12/15, which among other items encourages the Commission to strengthen peer review mechanisms within the IOTC Scientific Committee by participation of invited experts in the IOTC Scientific Committee activities. Formalizing the process <i>would likely</i> institute peer review as a standard business practice for the Scientific Committee.</p>	<p><i>Scientific Committee</i></p>



<p>The Commission has adopted <a href="#">Resolution 14/03</a> to facilitate understanding of the roles and responsibilities of the Commission and Scientific Committee. Frameworks for taking action have been agreed by the Commission (Resolution 15/10) including defining a set of provisional reference points for some of the IOTC target stocks and the Commission and Scientific Committee have embarked on a dialogue process (<a href="#">Dialogue</a>), supplemented by capacity building workshops (<a href="#">Capacity Building - Science</a>) that address these issues. Considerable external funding through the GEF/FAO ABNJ Tuna Project as well as other sources is being used to progress these discussions and the IOTC Secretariat <i>should</i> look to leverage additional funding to support this process. Of note are some of the recommendations stemming from the capacity building workshops dealing with the issues, which give focus on target areas for improving the prospects for further progressing on the issue:</p> <ul style="list-style-type: none"> <li>f. Instituting mechanisms for assisting in translation of IOTC CMMs into national legislation;</li> <li>g. Increasing timely opportunities for managers to interact with scientists on the advice provided in the Scientific Committee Report;</li> <li>h. Capturing NGO support in improving the Science to management communication process – capacity building;</li> <li>i. Increase IOTC Secretariat involvement in the pre-Commission coastal States meetings to enhance their capacity;</li> <li>j. Assistance in drafting of proposals for Conservation and Management Measures that translate science advice to management actions.</li> </ul>	<i>Secretariat</i>
<p>There has been some concern expressed regarding inconsistency amongst Working Parties in the method by which advice is formulated and further that there is inadequate understanding by Commissioners of that advice. This may result, at least in part, from a lack of connectivity between science advisors and Commission membership, especially in small, developing economy CPCs. Certainly, adopting the framework defined in <a href="#">Recommendation 14/07</a> provides information in a format the Commission has requested, which can assist in understanding. Additional means of providing management advice in an easily understood format <i>should</i> be pursued by the Scientific Committee, also as called for under Recommendation 14/07, such as can result through the adoption of robust Harvest Control Rules, evaluated through Management Strategy Evaluations, that best achieve management objectives agreed by the Commission.</p>	<i>Scientific Committee</i>
<p>Consistency across Working Parties in framing management advice could and <i>should</i> be enhanced through the use of a separate process to review stock status evaluations and formulate management advice, a role currently taken on by the Scientific Committee Plenary. It could be useful for the Scientific Committee to consider a process for enhancing consistency across Working Parties by assembling the Scientific Committee leadership immediately prior to the annual Scientific Committee Plenary to review the advice formulated by the Working Parties at intercessional meetings.</p>	<i>Scientific Committee</i>
<p>Continuation of efforts in improving the science-management dialogue, minimizing technical jargon and through the use of facilitated discussion, can also assist in greater understanding of the advice offered and <i>should</i> be pursued.</p>	<i>Scientific Committee, Commission</i>

Best Practices Assessment	RESPONSIBILITY
<p>The IOTC web site generally provides for public access to most of the data used in stock assessments as a matter of policy adopted by the Scientific Committee and endorsed by the Commission. While not obvious from examining the IOTC website, which is perhaps the best amongst the tRFMO websites, particular input and output streams for assessment model runs (and software) used for supporting stock status evaluations are maintained at the Secretariat and are available to interested parties, upon request. For transparency purposes, the Secretariat <b>should</b> consider adding this notation to the website and identifying the process by which interested parties could obtain such information.</p>	<p><i>Secretariat</i></p>
<p>The IOTC has established data confidentiality policies and fine-scale operational data are available from some fleets in support of stock assessments. Only recently has progress been made on joint analysis of fine scale operational level data from distant water longline fleets operating in the Indian Ocean, although, to my knowledge, these data are not generally held at the IOTC Secretariat. Steps to maintain these data used for joint analysis at the Secretariat, with sufficient protection of confidentiality, <b>should</b> be taken.</p>	<p><i>Secretariat</i></p>
<p>The IOTC Secretariat and Scientific Committee have used (and are expected to continue using) cannery data to validate information reported by Parties. Observer data are not yet generally available to the Scientific Committee, but <b>should</b> be used for this and other purposes, once they are generally available.</p>	<p><i>Scientific Committee</i></p>
<p>As in other oceans, archival tagging applications are being utilized for tuna and tuna-like species in the Indian Ocean. As of yet, though, integration of such tagging studies directly into stock assessment modeling formulations is lagging due to a number of reasons (<a href="#">Electronic Tagging</a>) and efforts to make full use of this technology in stock assessment <b>should</b> be pursued.</p>	<p><i>Scientific Committee</i></p>
<p>While the Scientific Committee, through its Working Party on Ecosystems and Bycatch <b>should</b> pursue application of ecosystem modeling frameworks, the primary focus of WPEB in the recent past has been on bycatch (sharks, in particular) and scientific observer data collection (<a href="#">WPEB Workplan</a>). One opportunity that could be pursued is utilization of funding through the GEF/FAO ABNJ Tuna Project to initiate development of ecosystem modeling approaches in the Indian Ocean. As was done in ICCAT’s Scientific Committee, it could be beneficial to separate the bycatch element from the ecosystem element in this Working Party if pursuing the ecosystem component in such a manner is elevated in priority.</p>	<p><i>Scientific Committee, Secretariat</i></p>
<p>The IOTC Scientific Committee has yet to formalize a mechanism for regular peer review of its stock assessments and <b>should</b> work toward institutionalizing peer review as a regular aspect of its aim to maintain a high standard of quality assurance.</p>	<p><i>Scientific Committee</i></p>

<p>The IOTC Scientific Committee has applied different and multiple stock assessment models to the available data for individual stocks. In general, this has not yet led to regularly integrating advice and characterization of uncertainty in that advice across the different plausible model formulations applied. The Scientific Committee <i>should</i> further pursue such approaches in formulating advice carrying this forward into characterizing uncertainty in stock condition and in future prospects through the Kobe Plots and Kobe II Strategy Matricies, to the degree possible.</p>	<p><i>Scientific Committee</i></p>
<p>The IOTC Scientific Committee has adopted a standardized format for its executive summaries, in line with the recommendation and generally consistent with IOTC Recommendation 14/07. However, as noted above, uncertainty seems understated in the summaries provided, at least on the IOTC web site, a shortcoming that <i>should</i> be addressed by the Scientific Committee and Secretariat. The IOTC Scientific Committee in formulating its advice <i>should</i> strive to integrate advice across plausible hypotheses about stock dynamics, taking into account and quantifying, to the degree possible, uncertainty in model inputs and assumptions.</p>	<p><i>Scientific Committee, Secretariat</i></p>

<b>Consistency Between Scientific Advice and CMMs Adopted</b>	<b>RESPONSIBILITY</b>
<p>The form of delivery of scientific advice to the Commission at its annual meeting is quite abbreviated compared to the other tRFMOs, which can lead to the perception that the IOTC does not rely on scientific advice for formulating CMMs. It is also noteworthy that the most recent Scientific Committee report indicates that the time allocated to the Scientific Committee report presentations <i>should</i> be longer than currently available.</p>	<p><i>Scientific Committee, Commission</i></p>
<p>Scientific Committee members are generally unaware of the process by which the various Commissions, including the IOTC, take into consideration scientific advice when agreeing CMMs, which can lead to a general perception by the SC membership that that advice is ignored. Encouraging Scientific Committee members, especially those in leadership roles supporting the Chair of the Scientific Committee, to witness the Commission process <i>should</i> provide the Scientific Committee membership a better basis for considering the consistency between their scientific advice and the CMMs adopted.</p>	<p><i>Scientific Committee</i></p>
<p><a href="#">Resolution 12/01</a>, obliges the IOTC to apply the precautionary approach, in accordance with relevant internationally agreed standards, in particular with the guidelines set forth in the UNFSA indicates that more focus on the IOTC stocks for which information is more uncertain or inadequate <i>should</i> be undertaken. In spite of Resolution 12/01, such precaution has not yet been clearly applied in CMMs, possibly due to short-term views of some CPCs.</p>	<p><i>Commission, CPCs</i></p>
<p>To date, the majority of agreed CMMs directed toward fishery management (other than defining MCS obligations) have mainly concerned fishing capacity limitations, although fleet development plans addressing aspirations of developing economy CPCs imply the capacity limitations are “soft” limits. Such input controls are generally considered effective only to the degree they can effectively limit fishing effort. Limiting vessel numbers (capacity controls), absent other controls, will not likely achieve the Commission’s objectives. Experience in other fisheries indicates input controls are frequently ineffective when used alone without adequate controls on output, as well. Progressing on the utility of additional control mechanisms can and <i>should</i> be part of the Management Strategy Evaluation process the IOTC has already embarked upon.</p>	<p><i>Scientific Committee, Commission</i></p>

