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APPENDIX IV
GUIDELINES FOR THE PRESENTATION OF CPUE STANDARDISATIONS AND STOCK ASSESSMENT MODELS

These guidelines attempt to ensure greater transparency and facilitate peer-review of models employed in the provision of advice on the status of the stocks. Scientists presenting stock assessment model runs should provide to the IOTC Secretariat a copy of all input and output files, for all runs presented, and of the executable file or files used within 10 days of the end of each meeting. These will be archived for future testing and replication. Scientists are encouraged to freely share the source code of the methods used. The IOTC Stock assessment expert/s will support CPC's in meeting these guidelines.

While this is not an all encompassing list, these documents should describe:

1) The available catch data and mention, if necessary, data sources or observations not included in the analysis.
2) Available indices of abundance used.
3) Available tag data used
4) Assumptions made on parameter values used as constants.
5) Parameters estimated and priors specified if used in parameter estimation.
6) Population trajectories and dynamics with respect to reference points.
7) Residual diagnostics on both CPUE derived indices (e.g. qq plots, observed versus fitted values, fitted versus residuals scatter plots).
8) Residual plots of model versus observed CPUE, and observed versus actual catch compositions should be presented.
9) When referring to datasets provided by the Secretariat, the date, coverage and precise database should be mentioned.
10) Data sources not previously seen by a Working Party may need a separate document presenting them. This includes standardized CPUE series or other data sources processed prior to use.
11) The population dynamics that are modelled and the techniques used should be clearly presented including a description of the partition, annual cycle, and other relevant population processes.
12) Alternative scenarios and retrospective analyses should ideally be carried and, if included, a description of the motivation for the selection of base and alternative cases should be added, giving detail of how the alternative case assumptions differ from those of the base case.
13) The description of any retrospective analyses should cover the assumptions involved and results obtained.
14) Projections should be similarly documented as detailed below.

Documentation requirement and guidelines

While these guidelines are basic good practices to include in the assessments and background data that go into the assessments (including CPUEs), they are not meant to preclude CPC's from presenting data or assessment models.

Software inspection and archival

- Input and output files of all alternative runs or scenarios presented should be made available during the meeting for inspection by interested members and for later archiving by the IOTC Secretariat. Ideally, these should be stored together with a copy of the software used in the analysis. When this is not possible due to licensing issues, a complete reference of the versions of both software and operating system employed should be made. Similarly, confidential inputs need not be provided but they should be documented and identified.
- Software used should ideally be open sourced using an appropriate license, or at least be made available to interested parties for inspection under a limited license. If closed source software is used, this should be clearly justified and sufficient tests as to its validity and reliability, under similar circumstances as those under which it

will be used in IOTC-related work, should be carried out and its results made available. Even if the software is not available/open sourced, an executable should be part of the documentation so anyone could run the model.
- Comprehensive testing, including testing of the influence of various assumptions, is greatly encouraged in all cases.

Observations

- Describe the available data and mention, if necessary, data sources or observations not included in the analysis. When referring to datasets provided by the IOTC Secretariat, indicate the date, coverage (years, fleets, areas), and precise database (e.g. Nominal Catch, Catch and Effort).
- Data sources not previously seen by a Working Party might need their own document presenting them. This includes standardised CPUE series or other data sources processed prior to use.

Standardised CPUE indices of abundance

- Description of data pre-processing (e.g. treatment of outliers, selection of core areas if applicable).
- Efforts should be made to describe temporal and spatial patterns in the data, identifying gaps or sudden operational changes that that lead to an unbalanced design.
- Software and specific function calls.
- Standard diagnostic plots (e.g. residuals, leverage plots, qq plots, observed versus fitted values, fitted versus residuals scatter plots).
- Parameter values, including error estimates for the final model used.
- For complicated models, a stepwise progression from simpler models should be documented to help identify confounding, and a distinction between statistical significance and practical significance.
- Efforts should be made to circulate these analyses well in advance of the relevant working party to allow discussion, and timely implementation in the stock assessment analyses.

Population dynamics

- Describe the population dynamics that are modelled and the techniques used including a description of the partition (age/length/sex groups, maturity, spatial structure, movement dynamics, if necessary), annual cycle (time steps, growth assumptions, natural and fishing mortality functions, recruitment, and sequence of those), and relevant population processes. Fixed parameters should be identified and documented. Emphasis should be placed in describing the formal statistical methods applied, including modelling methods, and form, limits and assumptions of both free and derived parameters.

Statistical methods

- Describe of the formal statistical methods, including
    1. Software name, version number, bibliographic references and source
    2. Maximum likelihood or objective function
    3. Bootstrap assumptions and MCMC algorithm, if used.
- Describe the free parameters used by the model, including
    1. Name and description of the parameter
    2. Details of the estimation bounds/functional relationships with other parameters
    3. Details of the prior assumed (if any), and source of the prior
    4. Weightings for likelihood terms
    5. Adjustment of variance by scaling/adding process error
    6. Penalties
- Describe the derived parameters used by the model, including
    1. Name, description and definitions of derived parameters (be precise with those that have alternative definitions, e.g., B_0, MSY, B_{MSY})
    2. Details of any bounds/functional relationships with other parameters.
    3. Details of any priors assumed (including source).

Scenarios and retrospective analyses

- Alternative scenarios and retrospective analyses should be carried when possible and, if included, a description of the motivation for the selection of base and alternative cases should be added, giving detail of how the alternative case assumptions differ from those of the base case. Description of any retrospective analyses, should cover the assumptions involved and results obtained. Projections should be similarly documented.

Standards for assessment outputs:

Management quantities:

As **AGREED** by the IOTC Scientific Committee, assessments shall be presented with the minimum set of management quantities, where possible. Examples (Example 1) indicating the derived management quantities with uncertainty are shown below.

EXAMPLE 1: Key management quantities from the XXXX assessment for aggregate Indian Ocean, using a base case with xxxx details xxxx. CI values are 80% from the base case run; and from the ASPIC assessment for the southwest Indian Ocean. n.a. = not available.

Management Quantity	Aggregate Indian Ocean
YYYY catch estimate (most recent)	xx,xxx t
Mean catch from YYYY–YYYY (5-yrs)	xx,xxx t
MSY (80% CI)	xx,xxx (xx,xxx–xx,xxx)
Data period used in assessment	YYYY–YYYY
F_{MSY} (80% CI)	x.xx (x.xx–x.xx)
SB_{MSY} (80% CI)	x.xx (x.xx–x.xx)
$F_{current}/F_{MSY}$ (80% CI)	x.xx (x.xx–x.xx)
$B_{current}/B_{MSY}$ (80% CI)	x.xx (x.xx–x.xx)
$SB_{current}/SB_{MSY}$ (80% CI)	x.xx (x.xx–x.xx)
$B_{current}/B_0$ (80% CI)	x.xx (x.xx–x.xx)
$SB_{current}/SB_0$ (80% CI)	x.xx (x.xx–x.xx)
$B_{current}/B_{0,\ F=0}$ (80% CI)	x.xx (x.xx–x.xx)
$SB_{current}/SB_{0,\ F=0}$ (80% CI)	x.xx (x.xx–x.xx)

Kobe II Strategy Matrix

The Commission has requested that Kobe II management strategy matrices be provided for all stock assessments by the species Working Parties, and for these to be included in the report of the SC:

S16: "*The Commission **NOTED** the provision by the SC of the Kobe II strategy matrix for bigeye tuna, skipjack tuna, yellowfin tuna and swordfish (IO and SWIO) and recognized that it is a useful and necessary tool for management. The Commission **REQUESTS** that such matrices shall be provided for all stock assessments by the species Working Parties, and for these to be included in the report of the SC in 2012 and all future reports*." (para. 33 of the S16 report).

Target reference points: Initial projections should be at a coarse level, i.e. current catch levels, ± 10%, ± 20%, ± 30% and ± 40% (see example 2 below). However, once these initial projections have been run, finer scale projections (e.g. ± 5%) should be undertaken and included in the assessment paper that are related to possible management actions being investigated.

Limit reference points: Initial projections for limit reference points should be at a coarse level, i.e. current catch levels, ± 10%, ± 20%, ± 30% and ± 40% (see example 2 below). However, once these initial projections have been run, finer scale projections (e.g. ± 5%) should be undertaken and included in the assessment paper that are related to possible management actions being investigated.

EXAMPLE 2: Species: Aggregated Indian Ocean assessment Kobe II Strategy Matrix. Probability (percentage) of violating the MSY-based reference points for nine constant catch projections (average catch level from YYYY–YYYY (xx,xxx t), ± 10%, ± 20%, ± 30% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	Alternative catch projections (relative to the average catch level from YYYY–YYYY) and probability (%) of violating MSY-based target reference points ($B_{targ} = B_{MSY}$; $F_{targ} = F_{MSY}$)								
	60% (catch t)	70% (catch t)	80% (catch t)	90% (catch t)	100% (catch t)	110% (catch t)	120% (catch t)	130% (catch t)	140% (catch t)
$B_{2016} < B_{MSY}$	9	13	19	28	40	53	65	82	86
$F_{2016} > F_{MSY}$	3	6	30	56	81	91	98	99	100

$B_{2023} < B_{MSY}$	0	0	1	3	14	41	87	100	100
$F_{2023} > F_{MSY}$	0	0	5	67	92	98	99	100	100

Reference point and projection timeframe	**Alternative catch projections (relative to the average catch level from YYYY–YYYY) and probability (%) of violating MSY-based limit reference points (B_{lim} = 0.4 B_{MSY}; F_{Lim} = 1.4 F_{MSY})**								
	60% (catch t)	**70%** (catch t)	**80%** (catch t)	**90%** (catch t)	**100%** (catch t)	**110%** (catch t)	**120%** (catch t)	**130%** (catch t)	**140%** (catch t)
$B_{2016} < B_{Lim}$	4	6	8	14	20	23	40	45	65
$F_{2016} > F_{Lim}$	3	6	15	15	20	33	45	67	100
$B_{2023} < B_{Lim}$	0	0	0	6	24	26	49	74	100
$F_{2023} > F_{Lim}$	0	0	0	10	22	45	67	96	100

KOBE Plots

1) A KOBE plot must be provided with each stock assessment paper as requested by the Commission Some description describing the axes used (derived quantity, B_{MSY}, SB_{MSY}, F_{MSY}, C_{MSY}, etc). The plot trajectory should be described in recent years (Example 3).
2) Target and limit reference points should also be plotted.

As requested by the Commission and detailed in IOTC Recommendation 12/14 (para. 1):

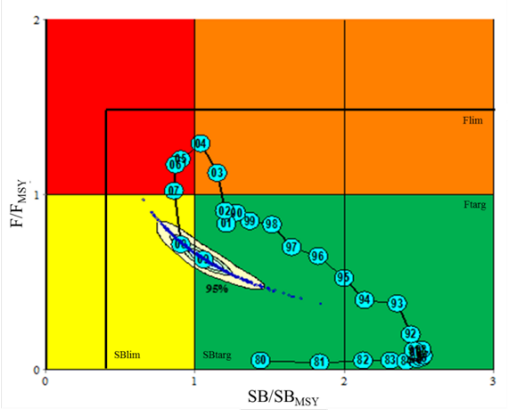
Para 1: *When assessing stock status and providing recommendations to the Commission, the Scientific Committee should apply the following interim target and limit reference points for the species of tuna and tuna-like species listed in **Table 1**. B_{MSY} refers to the biomass level for the stock that would produce the Maximum Sustainable Yield; F_{MSY} refers to the level of fishing mortality that produces the Maximum Sustainable Yield.*

Table 1. Interim target and limit reference points.

Stock	Target Reference Point	Limit Reference Point
Albacore tuna	B_{MSY}; F_{MSY}	40% of B_{MSY}; 40% above F_{MSY}
Bigeye tuna	B_{MSY}; F_{MSY}	50% of B_{MSY}; 30% above F_{MSY}
Skipjack tuna	B_{MSY}; F_{MSY}	40% of B_{MSY}; 50% above F_{MSY}
Yellowfin tuna	B_{MSY}; F_{MSY}	40% of B_{MSY}; 40% above F_{MSY}
Swordfish	B_{MSY}; F_{MSY}	40% of B_{MSY}; 40% above F_{MSY}

If a stock assessment is undertaken for a species other than those listed in IOTC Recommendation 12/14 (shown above) then the following default interim target and limit reference points shall be shown on the Kobe plot:

Stock	Target Reference Point	Limit Reference Point
Other IOTC species	B_{MSY}; F_{MSY}	50% of B_{MSY}; 20% above F_{MSY}



EXAMPLE 3: Species: Model Aggregated Indian Ocean assessment Kobe plot (95% Confidence surfaces shown around YYYY estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year YYYY–YYYY. Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points are shown to be 0.4 and 1.4 of SB_{MSY} and F_{MSY} respectively.

Deadlines for availability of data for stock assessments need to be adhered to:

As **AGREED** by the Scientific Committee in 2011:

1) The SC also **ENCOURAGED** data to be used in stock assessments, including CPUE standardisations, be made available not less than three months before each meeting by CPCs and where possible, data summaries no later than two months prior to each meeting, from the IOTC Secretariat; and **RECOMMENDED** that data to be used in stock assessments, including CPUE standardisations be made available not less than 30 days before each meeting by CPCs.
2) Stock assessment papers need to be provided to the Secretariat for posting to the IOTC website no later than 15 days before the commencement of the relevant meeting.

Issues related to Data Quality and stock status advice

In addition the following statements will be made with regard to data quality:
The assessment was based on TRADITIONAL/DATA POOR stock assessment based approaches. This statement will clarify the following:

TRADITIONAL: Approaches using standard catch per unit effort (CPUE) data and age-length information with possible additional tagging data.

DATA POOR: Using catch based methods using depletion based assumption type models like Stock Reduction Analysis (SRA).

Note, in cases where stock status advice is made using **only** a data poor approach, a clarification that the methods used to determine stock status use data poor techniques and this should not have the same status as the traditional (data rich approaches).

EXAMPLE 4: Differentiation in stock status advice from Data poor versus traditional approaches

***** Data poor stock assessment only. Status should be interpreted with caution due to the high levels of uncertainty. Further testing of how sensitive this technique is to model assumptions and available time series of catches, as well as the trialling of an alternative stock assessment approach needs to be undertaken before stock status can be used for management action; n.a. = not available

Stock Status Advice with multiple runs analysed

In cases where stock status advice would be based on numerous runs analysed, the weight of each run needs to be incorporated in reporting the final results. Some minimal criteria on the overall set of runs examined needs to be incorporated. The following advice could be given:

1) Either a statement quantifying the probability (number of runs/overall runs analysed with weights to each scenario) of being in the green quadrant, red quadrant, yellow quadrant or orange quadrant.
   OR
2) A table in same format as Kobe showing these probabilities of being in each quadrant (shown below, Example 5)

EXAMPLE 5: Percentage of times the stock status is in respective quadrant of the Kobe plot (shown below)

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)	**5%**	**25%**
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)	**10%**	**60%**
Not assessed/Uncertain		

Biological Data (in an Appendix or part of the executive summary):

A reference to biological data needs to be made and this will be in the executive summary following the stock status as an appendix/part of the information that goes along with the stock status. An example of this is shown below:

EXAMPLE 6 (which goes into information in executive summary as either in Appendix or in the main body): Model parameters agreed to by the WPTmT for use in base case stock assessment.

Biological parameters	Value for assessments
Stock structure	Single
Sex ratio	1:1
Age (longevity)	15+ years
Natural mortality	M=0.2207 (/year) constant over ages[1] (or M=0.4 for immature and 0.22 for mature fish). Hybrid approach was recommended of M-0.4 for juveniles that declines to M=0.22 for adult (age 5). M. Pacific values of M=0.3 were also appropriate for examining.
Growth formula	$L(t)=124.10\ [1-e^{-0.164\ (t+2.2390)}]$; Well et al (2013) (N. Pacific)[2] Chen et al. (2012) Sex based growth curve
Weight-length allometry	$W=aL^b$ $a=1.3718 \times 10^{-5}$, b=3.0973 common to sex[3]
Maturity	Age (0-15):0, 0, 0, 0, 0.09, 0.47, 0.75, 0.88, 0.94, 0.97, 0.99, 0.99, 1, 1, 1 Farley et al (2012) (S. Pacific)
Fecundity	Proportional to the spawning biomass
Stock-recruitment	B&H, h=0.7, sigma_R=0.6 (alternative h=0.8, and 0.8 are also appropriate)
Other parameters	
Fisheries	7 (Jpn LL N & S, Twn LL N & S, DN, PS, Other)
Abundance indices	JPN, TWN,CHN, KOR (combined if available)
Selectivity	Fishery specific. Dome-shaped double-normal

[1] Lee and Liu 1992; [2] Well et. al. 2013 (Chen et. al. 2012 was also appropriate and sex specific); [3] Penny 1994