Consultation with the purse seine industry regarding the process of adoption of Harvest Strategies and Harvest Control Rules for IOTC's tropical tunas

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Abstract

The Sustainable Indian Ocean Tuna Initiative (SIOTI) is a large-scale purse seine Fisheries Improvement Project (FIP) in the Indian Ocean. Pre-assessments for the purse seine fishery MSC certification have identified a series of critical improvement goals. Two of them refer to the adoption of harvest strategies (HS) and harvest control rules (HCR) for the three tropical tuna species in the Indian Ocean. This work is a contribution from SIOTI to the ongoing discussions on the IOTC Management Strategy Evaluation (MSE) process for the implementation of harvest strategies in the IOTC. This analysis aims at presenting the contribution and recommendations of SIOTI partners and purse seine owners in relation to the process of MSE and HS. The results are collated from two type of questionnaires and indicate that in general the industry prefers stock status and safety indicators to evaluate harvest strategies. There is not a clear indicator on the preferred type of harvest control rule (based vs. empirical). These results need to be taken with caution because the few questionnaires received from the industry. Also note that the current paper does not reflect the views of all SIOTI members since questionnaires are not yet completed for 15 of the 42 vessels in SIOTI. An updated paper will be available in 2019 once the questionnaires are completed by all SIOTI partners.

Keywords

Management Strategy Evaluation, Harvest Strategies, tropical tunas, consultation, purse seine, industry, Fishery Improvement Project (FIP)

Introduction

The Sustainable Indian Ocean Tuna Initiative (SIOTI) is a large-scale Fisheries Improvement Project (FIP). SIOTI provides a detailed action plan for most of the European Union (EU), Seychelles and Mauritius-flagged purse seine vessels targeting pelagic tunas in the Indian Ocean. These industries catch the three tropical tuna stocks of the Indian Ocean: skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*) and bigeye (*Thunnus obesus*). SIOTI aims at complying with defined standards for responsible fisheries of Marine Stewardship Council Certification (MSC). For that, based on pre-assessments and a scoping report for the fishery benchmarked to the Marine Stewardship Council (MSC) Standard, six critical Improved Performance Goals (IPGs) were identified.

Harvest strategies and control rules are addressed in IPG2 and IPG3, respectively. The goal of IPG2 is for '*a robust and precautionary harvest strategy to be in place for all three-target species by year 5 of the FIP*'. A number of FIP activities were identified to support this goal in year 1, relating to engagement with stakeholders and CPCs (Contracting Parties, and Cooperating non-Contracting Parties, Entities or Fishing Entities), promotion of best practice, collaboration with related initiatives and support to the IOTC program of work. The goal of IPG3 is for *'a well-defined and effective harvest control rule (HCRs) in place by year 5 for all three target species and evidence suggests that they are effective in reducing exploitation levels where necessary*'.

The main objective of this analysis is to contribute to the IOTC MSE process from SIOTI partners and ship owners in relation to the elements needed for the adoption of harvest strategies and harvest control rules. This information will be embedded in the IOTC process to facilitate the adoption of HCR rules that will be used for determining management measures for the key stocks. To collect the contribution and recommendations of partners and ship owners two questionnaires were distributed to them (see questionnaires in Appendix I and Appendix II). Throughout this document we describe the method used to collect information from the industry and the analyses of responses.

The current paper does not reflect the views of all SIOTI members since questionnaires are not yet completed for 15 of the 42 vessels in SIOTI. A updated paper will be available in 2019 once the questionnaires are completed by all SIOTI partners.

Methodology

The opinion and recommendations of the SIOTI partners and ship owners were collated from questionnaires. A first questionnaire was designed (see APPENDIX 1) and it was sent to the fleet associations. The SIOTI partners expressed the difficulty of the technical terms of this first questionnaire, and only one partner filled the questionnaire. We do not include the results of this questionnaire. Then, to facilitate the ship owner answers, a second and simpler questionnaire was designed (APPENDIX 2). Partners still expressed the difficulty of this second questionnaire. To ease and clarify, the questionnaire was presented to several ship owners and partner representatives in a meeting held in Sukarrieta (Spain) in June 26, 2018. After some clarifications five questionnaires of the second version were received.

Results

Overall, six questionnaires were completed by individual owners but we will analyze the results based on the two purse seine associations that submitted results. Thus, two questionnaires were received from association A1 and another four were received from association A2.

Association 1 (A1): The summary of the questionnaires answered by A1 are in Table 2.

A1 (2 groups) - SUMMARY						
The harvest strategy should be:	1	2	3	4	5	DN
Robust	0%	0%	0%	0%	100%	0%
Realistic	0%	0%	0%	0%	100%	0%
Will maintain the stock in perpetuity	0%	0%	0%	50%	50%	0%

The harvest strategy should be able to...	1	2	3	4	5	DN
Maximise Gross Value Added	0%	0%	0%	0%	50%	50%
Maximise yield in value	0%	0%	0%	50%	50%	0%
Maximise Net Present Value	0%	0%	0%	0%	0%	50%
Maximise yield in tonnes	50%	0%	50%	0%	0%	0%
Maximise present yield for human consumption	0%	0%	0%	50%	50%	0%
Maximise willingness to invest in the future fisheries	0%	0%	0%	50%	0%	50%
Maximise stability	0%	0%	0%	50%	50%	0%
Maximise employment on viable fishing units	0%	0%	0%	0%	50%	50%
Maximise catch in tonnes	50%	50%	0%	0%	0%	0%
Maximise social yield	0%	0%	0%	0%	50%	50%
Maximise fishing community viability	0%	0%	0%	0%	50%	50%
Maximise resilience	0%	0%	0%	0%	0%	50%
Maximise GVA over the entire value chain	0%	50%	0%	0%	0%	50%

performance statistics to evaluate HS in IOTC	1	2	3	4	5	DN
Status: Maximise probability of maintaining stock in a good status	0%	0%	0%	0%	100%	0%
Safety: Maximise the probability of the stock remaining above the biomass limit	0%	0%	0%	0%	100%	0%
Yield: Maximise catches across regions and gears	0%	50%	0%	0%	0%	50%
Abundance: Maximise catch rates to enhance fishery profitability	0%	0%	50%	0%	0%	50%
Stability: Maximise stability in catches to reduce commercial uncertainty	0%	0%	0%	0%	50%	50%

What I would like in relation to HS is...	Explanation
SKJ	
BET	
YFT	

What kind of management control would you prefer?	YES	NO	DN
A) Output (i.e. limit the catch, assign quotas)	100%	0%	0%
B) Input (effort limitations, time-area closures)	50%	100%	0%
C) A combination of the previous two.	50%	50%	0%

Regular meetings with relevant government stakeholders Hold meetings with delegation members 3-4 times per year with the purpose of emphasizing the importance of the harvest strategy process or to kept informed of current ideas and proposals.	1	2	3	4	5	DN
SKJ	0%	0%	0%	50%	50%	0%
BET	0%	0%	0%	50%	50%	0%
YFT	0%	0%	0%	50%	50%	0%

What are, in your opinion, the most suitable HCRs:	1	2	3	4	5	DN
Model based: HCR using the stock assessment derived estimates of biomass and fishing mortality	0%	0%	50%	50%	0%	0%
Model-free indicators: are calculated using trends in observed data, rather than stock assessment derived estimates of biomass and fishing mortality	0%	50%	50%	0%	0%	0%
Constant TAC (total allowable catch) along the time.	0%	50%	0%	0%	0%	0%

What I would like in relation to HCR is...	Explanation
SKJ	
BET	
YFT	

There is a consensus on the need for robust HCR as stakeholders Intersessional discussions on HCRs and tools between IOTC members and organizations.	1	2	3	4	5	DN
SKJ	0%	0%	0%	50%	50%	0%
BET	0%	0%	0%	50%	50%	0%
YFT	0%	0%	0%	50%	50%	0%

On-going engagement with coastal states and IOTC over HCR development will be successful. Discussions held regarding the assessment of HCRs and tools for all stocks, including how to address the assessment's findings have occurred through inter-sessional discussions and formally through the IOTC meeting process.	1	2	3	4	5	DN
SKJ	50%	0%	0%	50%	0%	0%
BET	50%	0%	50%	0%	0%	0%
YFT	50%	0%	50%	0%	0%	0%

Options: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5=Strongly agree, DN = I don't know.

Table 1. Summary of results for A1.

- Association 1 (A1) *strongly agrees* with the statement of the harvest strategy should be robust and realistic. Regarding to the sentence '*will maintain the stock in perpetuity*', it *agrees*, and they '*hope scientific evaluation and rules are applied monitored and controlled*'.
- According to A1 the harvest strategy should be able to:
    - *Strongly agree:* Maximise gross value added, maximise yield in value, maximise present yield for human consumption, maximise stability, maximise employment on viable fishing units, maximise social yield, maximise fishing community viability.
    - *Agree*: maximize present yield for human consumption, maximize stability
    - *Neither agree nor disagree*: Maximize yield in tons.
    - *Disagree*: Maximize catch in tons.

  There are several terms that, according to A1, would need to be clarified (Gross Value Added, Net Present Value, willingness to invest in the future fisheries, employment on viable fishing units, social yield, fishing community viability, resilience, GVA over the entire value chain). For this reason, A1 does not evaluate these statements.
- A1 *strongly agrees* with the candidate performance statistics to evaluate HS in IOTC should be the status (Maximize probability of maintaining stock in a good status), and safety (Maximize the probability of the stock remaining above the biomass limit). The response was that in the case of yield, abundance and stability the objectives were not clear.
- What A1 would like in relation to HS is to increase the added value and quality of the fish and to limit catches of juveniles. Also, they highlight that the key parameter to focus on Management Strategy Evaluations on SKJ is that "*the absence of reliable CPUE time series from purse seine and Maldivian pole and line strongly affects the current assessment of stock status*". For BET and YFT they comment that "*there is uncertainty of catches by some CPC's fleets due to lack or poor quality of statistics*".

- <u>*Harvest Control Rules -*</u>

- Regarding management control, all of them the prefer output controls like catch limits or quotas, 50 % agree also with the effort limitation and 50 % say YES to the combination of both and the other 50% say NO to the combination of both.
- There is not a strong agreement on the answers about the most suitable HCR. One of the responses indicates that most suitable HCR is the Model Based HCR (*agree and neither agree nor disagree)*, then the Model free indicators (*Neither agree nor disagree and disagree*) and finally a constant TAC (*disagree*). According to their responses both model based and model free indicators, should be used complementarily and not exclusively.
- What A1 would like in relation to HCR is to be '*clear, robust and efficient for sustainability purposes'* and to have a supply vessel limitation and stablish the quota based on anteriority.
- A1 *agrees* that there is a consensus on the need of robust HCR as stakeholder.

Association 2 (A2)

The summary of the questionnaires answered by A2 are in Table 2.

A2 - SUMMARY

The harvest strategy should be:	1	2	3	4	5	DN
Robust	0%	0%	0%	0%	100%	0%
Realistic	0%	0%	0%	0%	100%	0%
Will maintain the stock in perpetuity	0%	0%	0%	50%	50%	0%

The harvest strategy should be able to…	1	2	3	4	5	DN
Maximise Gross Value Added	0%	0%	0%	0%	50%	50%
Maximise yield in value	0%	0%	0%	50%	50%	0%
Maximise Net Present Value	0%	0%	0%	0%	0%	50%
Maximise yield in tonnes	50%	0%	50%	0%	0%	0%
Maximise present yield for human consumption	0%	0%	0%	50%	50%	0%
Maximise willingness to invest in the future fisheries	0%	0%	0%	50%	0%	50%
Maximise stability	0%	0%	0%	50%	50%	0%
Maximise employment on viable fishing units	0%	0%	0%	0%	50%	50%
Maximise catch in tonnes	50%	50%	0%	0%	0%	0%
Maximise social yield	0%	0%	0%	0%	50%	50%
Maximise fishing community viability	0%	0%	0%	0%	50%	50%
Maximise resilience	0%	0%	0%	0%	0%	50%
Maximise GVA over the entire value chain	0%	50%	0%	0%	0%	50%

performance statistics to evaluate HS in IOTC	1	2	3	4	5	DN
Status: Maximise probability of maintaining stock in a good status	0%	0%	0%	0%	100%	0%
Safety: Maximise the probability of the stock remaining above the biomass limit	0%	0%	0%	0%	100%	0%
Yield: Maximise catches across regions and gears	0%	50%	0%	0%	0%	50%
Abundance: Maximise catch rates to enhance fishery profitability	0%	0%	50%	0%	0%	50%
Stability: Maximise stability in catches to reduce commercial uncertainty	0%	0%	0%	0%	50%	50%

What I would like in relation to HS is…	Explanation
SKJ	
BET	
YFT	

What kind of management control would you prefer?	YES	NO	DN
A) Output (i.e. limit the catch, assign quotas)	100%	0%	0%
B) Input (effort limitations, time-area closures)	50%	100%	0%
C) A combination of the previous two.	50%	50%	0%

Regular meetings with relevant government stakeholders Hold meetings with delegation members 3-4 times per year with the purpose of emphasizing the importance of the harvest strategy process or to kept informed of current ideas and proposals.	1	2	3	4	5	DN
SKJ	0%	0%	0%	50%	50%	0%
BET	0%	0%	0%	50%	50%	0%
YFT	0%	0%	0%	50%	50%	0%

What are, in your opinion, the most suitable HCRs:	1	2	3	4	5	DN
Model based: HCR using the stock assessment derived estimates of biomass and fishing mortality	0%	0%	50%	50%	0%	0%
Model-free indicators: are calculated using trends in observed data, rather than stock assessment derived estimates of biomass and fishing mortality	0%	50%	50%	0%	0%	0%
Constant TAC (total allowable catch) along the time.	0%	50%	0%	0%	0%	0%

What I would like in relation to HCR is…	Explanation
SKJ	
BET	
YFT	

There is a consensus on the need for robust HCR as stakeholders Intersessional discussions on HCRs and tools between IOTC members and organizations.	1	2	3	4	5	DN
SKJ	0%	0%	0%	50%	50%	0%
BET	0%	0%	0%	50%	50%	0%
YFT	0%	0%	0%	50%	50%	0%

Table 2: Synthesis or the results of A2.

- *Harvest Strategies -*

- In general, A2 members *strongly agree* or *agree* with the statement that the harvest strategy should be robust, realistic and will maintain the stock in perpetuity.
- According to A2 members, the harvest strategy should be able to:
    - *Strongly agree*: Maximize yield in tons, maximize willingness to invest in the future fisheries, maximize stability, maximize employment on viable fishing units and maximize catch in tons.
    - *Agree*: Maximize yield in value, maximize net present value and maximize present yield for human consumption.
    - *Neither agree nor disagree*: Maximize the social yield and maximize fishing community viability.
    - *Disagree*: There is one response of A2 disagree with 'Maximize stability'.

  It seems that the term Gross Value Added is not clearly understandable by surveyed groups.
- Most of the responses from A2 *strongly agree* with the candidate performance statistics to evaluate HS in IOTC should be the safety (Maximize the probability of the stock remaining above the biomass limit), and they *agree* with the stock status (Maximize probability of maintaining stock in a good status). In case of Yield, Abundance and Stability indicators, there is a high variability in the responses.
- What surveyed groups would like (75%) in relation to HS is to maintain $B_{MSY} \geq 1$ in the case of the three main target species. Additionally, there is one comment that they would like, in relation to HS, *'closely monitor the stock status to safeguard the situation'*.

- *Harvest Control Rules -*

- Within A2 group, there is variability in the responses of the following question: '*What kind of management control would you prefer?*' In general terms, most of the responses prefer output management control more than input controls. None of them would like a combination of two (input and output).

- The 75% of the responses of A2 group *strongly agree* with the following statement: '*Regular meetings with relevant government stakeholders: Hold meetings with delegation members 3-4 times per year with the purpose of emphasizing the importance of the harvest strategy process or to kept informed of current ideas and proposals*'.
- There is not a strong agreement on the answers about the most suitable HCR. The 75% of the responses strongly *disagree* with a constant TAC. The 50% of the answers *strongly agree* with Model free indicators, and only 25% with model-based HCR.
- A2 made the following comments about what they would like to see in relation to HCR:
    - SKJ, BET AND YFT: '*To be made clear by the IOTC the implementation methods'*.
- The 100% of the responses *neither agree or disagree* with '*There is a consensus on the need for robust HCR as stakeholders' Intersessional discussions on HCRs and tools between IOTC members and organizations*.' in case of SKJ and BET. The response varies in case of YFT, where the 50% *strongly agree*.
- In A2 the 75% *neither agree* or *disagree* with the following statement '*On-going engagement with coastal states and IOTC over HCR development will be successful. Discussions held regarding the assessment of HCRs and tools for all stocks, including how to address the assessment's findings have occurred through inter-sessional discussions and formally through the IOTC meeting process*.' The 25% *strongly disagrees*.

Discussion

The summary of this report is built upon the responses of two SIOTI partners and a total of six questionnaires.

- According to the responses of questionnaire one the best performance statistics to evaluate HS are those related to the status and safety. To a lesser extent those related to yield, abundance and stability.
- There is a *general agreement* on that the harvest strategy should be robust, realistic and will maintain the stock in the perpetuity.
- Also that the harvest strategy should be able to maximize yield in value, maximize present yield for human consumption and maximize stability.

- The candidate performance statistics to evaluate HS in IOTC should reflect safety and A1 also *strongly agrees* with the stock status indicators.

- Regarding to '*What I would like in relation to HS is…*', A1 commented that '*there is uncertainty about HCR´s robustness and if it will maintain the stock in a sustainable level, it must be encouraged*'. What A2 would like is to maintain $B_{MSY} \geq 1$ and '*closely monitor the stock status to safeguard the situation*'.

- According to A1, there is a concern about the absence of reliable CPUE time series that strongly affects the current assessment of stock status.

- In general, the purse seine industry prefers Output (i.e. limit the catch, assign quotas) management controls rather than input control.

- There is also *general agreement* with the following statement *'Regular meetings with relevant government stakeholders. Hold meetings with delegation members 3-4 times per year with the purpose of emphasizing the importance of the harvest strategy process or to kept informed of current ideas and proposals*'.

- The most suitable HCR is model based for A1 and model free or model based for A2. In general, the constant TAC is the least preferred option.

- A1 *agrees* with the statement '*There is a consensus on the need for robust HCR as stakeholders*'. A2 neither agree or disagree except on the case of YFT where the 50% *strongly agree*.

- A1 *agrees* with the statement '*On-going engagement with coastal states and IOTC over HCR development will be successful*' in the case of SKJ, but *neither agree or disagree* in the case of BET or YFT. A2 neither *agrees or disagrees* for the three target stocks. Additionally, according to one response of A2, '*HCR development doesn't need coastal states participation, only scientific or technical staff*'.

The ratio of responses received was low for the first questionnaire (only one response submitted). For the second questionnaire, two were received from A1 and four from A2. In principle these % of responses are low. Therefore, these results will need to be taken with caution.

According to SIOTI partners, both questionnaires were difficult to understand by ship owners. They have several doubts in relation to technical terms and they found difficult to answer.

Acknowledgments

This study has been conducted for the Sustainable Indian Ocean Tuna Initiative (SIOTI).

Appendix I

Questionnaire for SIOTI partners in relation to the FIP Improved Performance Goals

The aim of this questionnaire is to collect information about the concerns and recommendations of SIOTI partners in relation to IOTCs endeavor to adopt Harvest Strategies (HS) for the key stocks (SKJ (Skipjack tuna; *Katsuwonus pelamis*), YFT (Yellowfin tuna; *Thunnus albacares*) and BET (Bigeye tuna; *Thunnus obesus*) under its purview and their evaluation using Management Strategy Evaluation (MSE).

If considered necessary or feasible, a position paper would be prepared to submit to plenary in support of continuing the progress in developing harvest strategies for yellowfin and bigeye. The position paper will include references to the current rebuilding plan for the yellowfin stock, as well as to the Harvest Control Rule (HCR) in force for skipjack. Note that the Harvest Strategy or Management Procedures (MP) consist in three components: Data sources, methods of analyses and decision framework (including HCRs).

Following the Action Plan of the FIP, the questionnaire for IPG 2 and IPG 3 is displayed.

IPG 2: Harvest strategies

Harvest strategies are the series of human actions undertaken to monitor the stock, assess its state, make management decisions and implement the management advice. This section is a consultation about the harvest strategies. According to the SIOTI action plan, the IPG2 goal is to have a robust and precautionary harvest strategy in place for all three target species by year 5 of the FIP.

For year 1 of the FIP the most important action is to "*Design of an explicit harvest control strategy for YFT, BET and SKJ (for both free-school and associated fishing strategies).*"

As SIOTI partner, answer the questions below and explain your concerns or recommendations in relation to the different issues presented.

Options: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5=Strongly agree.

The harvest strategy of SKJ (Resolution 16/02) is:	1	2	3	4	5
Robust					
Realistic					
Will maintain the stock in perpetuity					

An explicit harvest strategy will be discussed and agreed within IOTC & formally adopted…	1	2	3	4	5
for SKJ at the end of year 3					
for YFT & BET at the end of year 4					

There are several performance statistics to evaluate HS in IOTC, please, indicate if you agree with them:

Candidate performance statistics to evaluate HS in IOTC	1	2	3	4	5
Status: maximize probability of maintaining stock in the Kobe green zone (see Appendix 1)					
Mean spawner biomass relative to unfished					
Minimum spawner biomass relative to unfished					
Mean spawner biomass relative to BMSY					
Mean fishing mortality relative to target					
Probability of being in Kobe green quadrant[1]					
Probability of being in Kobe red quadrant[2]					
Safety: Maximize the probability of the stock remaining above the biomass limit					
Probability that spawner biomass is above 20% of unfished					
Yield: Maximize catches across regions and gears					
Mean catch					
Mean catch by region and/or gear					
Mean proportion of MSY					
Abundance: maximize catch rates to enhance fishery profitability					
Mean catch rates by region and gear					
Stability: maximise stability in catches to reduce commercial uncertainty					
Mean absolute proportional change in catch					
Variance in catch					
Variance in fishing mortality					
Probability on fishery shutdown					

[1] aim to maintain the stock with a high probability within this quadrant.

[2]aim to end overfishing with a high probability and to rebuild the biomass of the stock in as short a period as possible.

I have the following concerns and recommendations about defining objectives and harvest strategies	
	Explanation
SKJ	
BET	
YFT	

Questions related to accomplishment of activities in IPG2 in year 1 of the FIP.

Year 1	YES	NO

Harvest strategy design Design of an explicit harvest control strategy for YFT, BET and SKJ (for both free-school and associated fishing strategies). End year 1: Strategic options for controlling SKJ, YFT and BET tuna harvest developed.		
What kind of management control would you prefer?		
A. Output (i.e. catch quotas)		
B. Input (effort limitations, time-area closures)		
C. A combination of the two.		

Options: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5=Strongly agree.

Year 1	1	2	3	4	5
Engage with EU/Seychelles, Mauritius & Madagascar scientists and delegations Ensure as far as possible that the Scientific Committee provides advice to the Commission as required by Res. 16-02 (on Target and Limit Reference Points and a decision framework).					
SKJ					
BET					
YFT					

If you disagree, please, explain why.

Year 1	1	2	3	4	5
Regular meetings with relevant government stakeholders Hold meetings with delegation members 3-4 times per year with the purpose of emphasizing the importance of the harvest strategy process or to kept informed of current ideas and proposals.					
SKJ					
BET					
YFT					

If you disagree, please, explain why.

IPG 3: Harvest control rules

This section is a consultation about the harvest control rules (HCRs) and tools. HCR are sets of well-defined rules that can be used for determining annual fish catch quotas or effort. HCRs are one component of HS. Currently, one HCR is in force in IOTC, skipjack's. According to the SIOTI action plan, by year 5 HCR for all three target species fisheries are in place and evidence suggests that they are effective in reducing exploitation levels where necessary.

Questions related to accomplishment of activities in IPG3 for HCRs:

From the three types of referent points (RPs) considered in tuna RFMOs, what is it the most suitable for each stock	SKJ	BET	YFT
MSY based RPs			
Spawning Per Recruit based RPs.			
Depletion based.			

Options: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5=Strongly agree.

The five control parameters of the HCR of SKJ (Resolution 16/02) are suitable (see Appendix II)	1	2	3	4	5
Threshold level: B_{threst} = 40% B_0					
Maximum fishing intensity: I_{max} = 100%					
Safety level_ B_{safety} = 10%B_0					
Maximum catch limit: C_{max} = 9000,000t					
Maximum change in catch limit: D_{max} = 30%					

If you disagree, please, explain why.

The following HCRs are suitable HCR for BET and YFT. For details of each type of HCR see APPENDIX III.	1	2	3	4	5
Model based (SKJ type)					
Indicator based (CPUE)					
Constant TAC.					

I have the following concerns and recommendations about defining objectives and harvest control rules	
	Explanation
SKJ	
BET	
YFT	

General Issues of the IPG3:

Options: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5=Strongly agree.

Year 1	1	2	3	4	5
There is a consensus on the need for robust HCR as stakeholders Intersessional discussions on HCRs and tools between IOTC members and organizations.					
SKJ					
BET					
YFT					

If you disagree, please, explain why.

Year 1	1	2	3	4	5
Holistic implementation HCR development is achieved Monitor work plan development for the implementation of Res. 16-02 (or other proposal for a harvest strategy) to ensure the development, evaluation and agreement of a HCR for yellowfin and bigeye.					
SKJ					

BET					
YFT					

If you disagree, please, explain why.

Year 2	1	2	3	4	5
On-going engagement with coastal states and IOTC over HCR development will be successful. Discussions held regarding the assessment of HCRs and tools for all stocks, including how to address the assessment's findings have occurred through inter-sessional discussions and formally through the IOTC meeting process.					
SKJ					
BET					
YFT					

If you strongly disagree, please, explain why.

ANNEX I: Model based HCRs using Kobe plots

Model based HCRs are often described using Kobe plots (Figure 1). Here, when the stock level is above the precautionary threshold (B_{thresh}), the fishing mortality applied to the stock will be below FMSY (F_{tar}). When the stock falls below B_{thresh} but is above B_{lim}, the fishing mortality will be lower than F_{tar}. When the stock falls below B_{lim}, the fishing mortality will be reduced to a minimum.

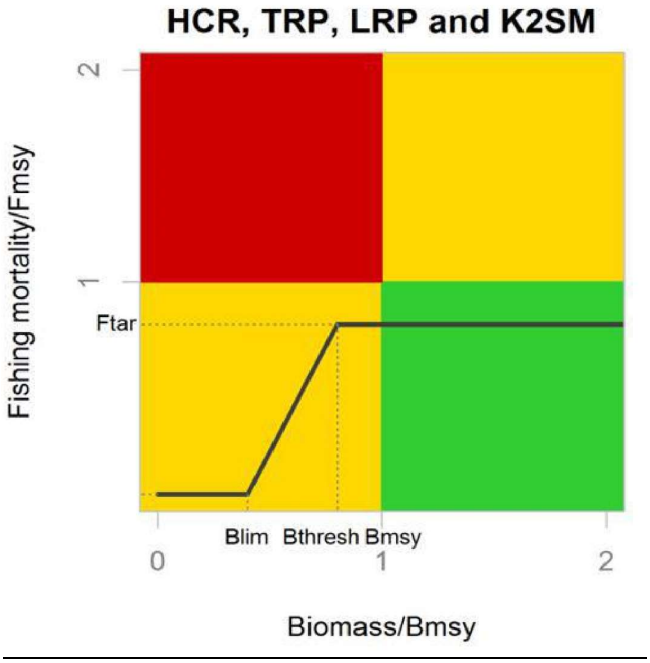
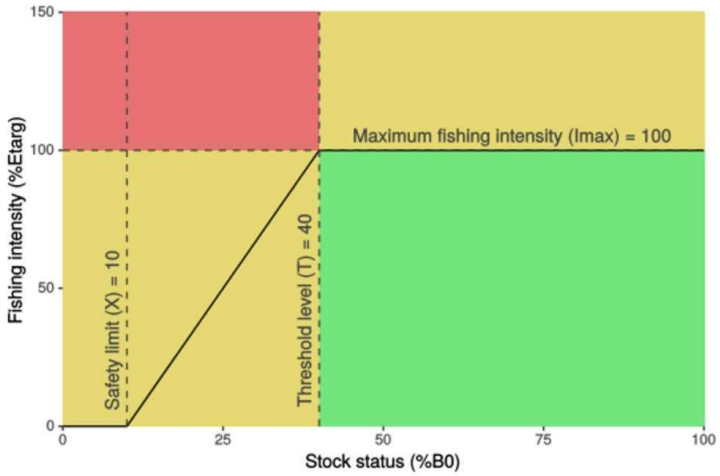


Figure 1: Examples of a) Model based HCR with RPs plotted in a Kobe plot

ANNEX II: Description of the SKJ HCRs

SKJ: Resolution 16/02 On harvest control rules for skipjack tuna in the IOTC area of competence.



ANNEX III: Description of the SKJ HCRs

Model based (SKJ type)

HCR similar to the HCR of SKJ explained in the Resolution 16/02.

CPUE based.

An example of a HCR based on an index (CPUE or survey index) is the HCR of Greenland Halibut (NAFO) [1]: The indicator is the slope of the abundance Index:

$$TAC_{y+1} = \begin{cases} TAC_y \times (1 + \lambda_u \times slope) & if \quad slope \geq 0 \\ TAC_y \times (1 + \lambda_d \times slope) & if \quad slope < 0 \end{cases}$$

Slope: average slope of the Biomass Indicator (CPUE, Survey) in recent 5 years

Where λ_u :TAC control coefficient if slope > 0 (Stock seems to be growing) : λ_u=1

λ_d: TAC control coefficient if slope < 0 (Stock seems to be decreasing) : λ_d=2

TAC generated by the HCR is constrained to ± 5% of the TAC in the preceding year.

Constant catch

$$\text{HCR}_1 : TAC_{y+1} = TAC_y$$

[1] http://www.siofa.org/sites/siofa.org/files/documents/meetings/SAWG%282018%29-01INF07%20SEAFO_EmpiricalHarvestRules.pdf

Appendix II

Questionnaire for SIOTI partners & ship owners in relation to the FIP Improved Performance Goals

The aim of this questionnaire is to collect information about the concerns and recommendations of SIOTI partners & ship owners in relation to IOTCs endeavor to adopt rules that can be used for determining annual fish catch quotas or effort for the key stocks; SKJ (Skipjack tuna; *Katsuwonus pelamis*), YFT (Yellowfin tuna; *Thunnus albacares*) and BET (Bigeye tuna; *Thunnus obesus*).

If considered necessary or feasible, a position paper would be prepared to submit to plenary in support of continuing the progress in developing harvest strategies for yellowfin and bigeye. The position paper will include references to the current rebuilding plan for the yellowfin stock, as well as to the Harvest Control Rule (HCR) in force for skipjack. Note that the Harvest Strategy or Management Procedures (MP) consist in three components: Data sources, methods of analyses and decision framework (including HCRs).

Following the Action Plan of the FIP, several Improved Performance Goals (IPG) were defined to improve the identified deficiencies of the fishery. The questionnaire for IPG 2 and IPG 3 is displayed.

IPG 2: Harvest strategies

Harvest strategies (HS) are the series of human actions undertaken to monitor the stock, assess its state, make management decisions and implement the management advice. This section is a consultation about the harvest strategies. According to the SIOTI action plan, the IPG2 goal is to have a robust and precautionary harvest strategy in place for all three-target species by year 5 of the FIP.

For year 1 of the FIP the most important action is to "*Design of an explicit harvest control strategy for YFT, BET and SKJ (for both free-school and associated fishing strategies).*"

As SIOTI partner & ship owners, answer the questions below and explain your concerns or recommendations in relation to the different issues presented.

Options: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5=Strongly agree, DN = I don't know.

The harvest strategy should be:	1	2	3	4	5	DN
Robust						
Realistic						
Will maintain the stock in perpetuity						

The harvest strategy should be able to…	1	2	3	4	5	DN
Maximise Gross Value Added						
Maximise yield in value						
Maximise Net Present Value						
Maximise yield in tonnes						
Maximise present yield for human consumption						
Maximise willingness to invest in the future fisheries						
Maximise stability						
Maximise employment on viable fishing units						
Maximise catch in tonnes						
Maximise social yield						
Maximise fishing community viability						
Maximise resilience						
Maximise GVA over the entire value chain						

There are several performance statistics to evaluate harvest strategy. Please, indicate if you agree with them.

Candidate performance statistics to evaluate HS in IOTC	1	2	3	4	5	DN
Status: Maximise probability of maintaining stock in a good status						
Safety: Maximise the probability of the stock remaining above the biomass limit						
Yield: Maximise catches across regions and gears						
Abundance: Maximise catch rates to enhance fishery profitability						
Stability: Maximise stability in catches to reduce commercial uncertainty						

What I would like in relation to HS is…	
	Explanation
SKJ	
BET	
YFT	

<u>Questions related to accomplishment of activities in IPG2 in year 1 of the FIP.</u>

What kind of management control would you prefer?	YES	NO	DN
A) Output (i.e. limit the catch, assign quotas)			
B) Input (effort limitations, time-area closures)			
C) A combination of the previous two.			

Options: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5=Strongly agree, DN = I don't know.

Regular meetings with relevant government stakeholders Hold meetings with delegation members 3-4 times per year with the purpose of emphasizing the importance of the harvest strategy process or to kept informed of current ideas and proposals.	1	2	3	4	5	DN
SKJ						
BET						
YFT						

If you disagree, please, explain why.

IPG 3: Harvest control rules

This section is a consultation about the harvest control rules (HCRs) and tools. HCR are sets of well-defined rules that can be used for determining annual fish catch quotas or effort. HCRs are one component of Harvest Strategies. Currently, one HCR is in force in IOTC, skipjack's. According to the SIOTI action plan, by year 5 HCR for all three target species fisheries are in place and evidence suggests that they are effective in reducing exploitation levels where necessary.

Options: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5=Strongly agree, DN = I don't know.

What are, in your opinion, the most suitable HCRs:	1	2	3	4	5	DN
Model based: HCR using the stock assessment derived estimates of biomass and fishing mortality						
Model-free indicators: are calculated using trends in observed data, rather than stock assessment derived estimates of biomass and fishing mortality						
Constant TAC (total allowable catch) along the time.						

What I would like in relation to HCR is…	
	Explanation
SKJ	
BET	
YFT	

Options: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5=Strongly agree, DN= I don't know.

There is a consensus on the need for robust HCR as stakeholders Intersessional discussions on HCRs and tools between IOTC members and organizations.	1	2	3	4	5	DN
SKJ						
BET						
YFT						

If you disagree, please, explain why.

On-going engagement with coastal states and IOTC over HCR development will be successful. Discussions held regarding the assessment of HCRs and tools for all stocks, including how to address the assessment's findings have occurred through inter-sessional discussions and formally through the IOTC meeting process.	1	2	3	4	5	DN
SKJ						
BET						
YFT						

If you strongly disagree, please, explain why.