



Food and Agriculture
Organization of the
United Nations



Report of the “Furthering Capacity Building for Harvest Control Rules and Management Strategy Evaluation: Indian Ocean Tuna Management Workshop”
National Institute of Fisheries Science, Busan, Republic of Korea, 19th – 21st February 2020

Hilario Murua
International Seafood Sustainability Foundation

8th March 2020



The workshop was part of the “Sustainable Management of Tuna Fisheries and Biodiversity Conservation in Areas Beyond National Jurisdiction” (ABNJ Tuna Project). The overarching project focuses on three component areas:

- 1) Supporting implementation of sustainable and efficient fisheries management and fishing practices,
- 2) Reducing illegal, unreported and unregulated (IUU) fishing through strengthened and harmonized monitoring, control and surveillance,
- 3) Reducing ecosystem impacts from tuna fishing, including bycatch and associated species.

Under Component 1, Capacity Building Workshops for Management Procedures (MPs) and Management Strategy Evaluation (MSE) directed outreach to specific countries are organized. Under a Letter of Agreement with FAO, these workshops are implemented by the International

Seafood Sustainability Foundation (ISSF) with contributions from in-country institutions and regional tuna RFMOs.

Moreover, the IOTC Technical Committee on Management Procedures at its 2019 meeting, considered that MP/MSE involves complex concepts and agreed there is need to capacity building in support of the next TCMP to clarify key issues in Management Strategy Evaluations for IOTC stocks. Furthermore, the TCMP requested that Intersessional capacity building on MSE be conducted to increase understanding of the MSE process and to increase the engagement in the process of adoption of IOTC MPs by all CPCs. The IOTC Secretariat is collaborating with ISSF and FAO in organizing and implementing of CPC specific WSs planned for the region.

Workshop Aims

The goal of this workshop was to create a better understanding among Indian Ocean States regarding Management Strategy Evaluation (MSE) and Management Procedures (MP, also called Harvest Strategies) to ensure sustainable management of tunas. Specifically, in this workshop, to leverage the understanding of IOTC process, in general, but of the IOTC MP discussions, in particular, of Republic of Korea.

Ultimately, the objective of this workshop was to leverage the participation of Republic of Korea in the process of development of tuna MPs within the Indian Ocean. Participation in this workshop will empower Republic of Korea's administration, scientist and industry to meaningfully engage in the process of MP development already occurring at the Indian Ocean Tuna Commission (IOTC).

The Event

The workshop program included revision of the Management Procedure framework and the principles of sound fisheries management. The workshop provided a platform and background knowledge for engagement in the Indian Ocean regional level MP development and adoption of robust MPs which best achieve the objectives of IOTC members and stakeholders.

The workshop provided an introduction to the process of MP development; the elements of a MP, for example management objectives, timeframes and risk; how to interpret the trade-offs between different objectives and the use of MSE to evaluate performance of alternative MPs. But for setting the context and increase the understanding of those complex concepts, the workshop firstly focused on the IOTC Management Framework with the introduction of the provision of fisheries management advice; including the description of the Kobe plots, Target and Limit Reference Points and IOTC Decision Framework as per Resolution 15/10. Although the agenda was comprehensive, the objective was to have an open and lengthy discussion on the various elements that require more attention from participants. The goal was to discuss relevant needs and issues for Republic of Korea specific to Indian Ocean tunas and allow for more in-depth understanding of how the concepts and tools presented in the workshop may assist in increasing

Republic of Korea participation in the process of the IOTC Technical Committee on Management Procedures.

The Workshop was one of capacity building on MPs targeted at decision-makers, scientists, industry and NGO from Republic of Korea. The Workshop was organized by Hilario Murua (ISSF) with the collaboration of Dr. Doo Nam Kim (National Institute of Fisheries Science) and Paul de Bruyn (IOTC) and it was given by Toshihide Kitakado (IOTC Scientific Committee Chair) and Hilario Murua (ISSF). Janne Fogelgren (FAO) also participated in the workshop. The list of participants is included in **Appendix 1**. And the agenda for the workshop is in **Appendix 2**. Unfortunately, several participants from Korean fishery administration and industry, as well as IOTC Secretariat, cancelled their participation in the last minute due to the coronavirus outbreak following Republic of Korean Government advise to avoid large meetings. In any case, the workshop was attended by around 25 participants including fishery administration, scientist, industry and NGOs.

The Workshop was opened by Dr. Doo Hae An, director of Distant-water Fisheries Resources Division of National Institute of Fisheries Science, who emphasizes the importance of this type of Workshop to increase the capacity of Republic of Korea delegation in IOTC discussions on MPs and, hence, to leverage the participation of Republic of Korea in the process of development of tuna MPs within the Indian Ocean. But he underlined that this was not only for IOTC but for all tunaRFMOs as Republic of Korea is an important fishery CPC to all tunaRFMOs (CCSBT, IATTC, ICCAT, and WCPFC). He welcomed participants and he was very supportive of MP development at IOTC.

The workshop was guided by various presentations, but it was planned in a way that presentations would not be the main capacity building tool. Instead the presentations were used to foster discussion and engage participants, and presentations were combined with group activities such as developing conceptual maps between the various concepts and components of stock assessment process and MPs so as to understand their differences. Moreover, a question poll was also used to discuss management objective prioritization, timeframes for actions and tolerable risks of failure in achieving objectives as well as the IOTC management decision framework. Finally, a Shiny Application developed by the ABNJ was used to develop and test different alternative harvest control rules and management procedures to review and understand the trade-off between conflicting objectives related to safety, catch stability, yield, etc.

The first morning was focused on an introduction to the IOTC Management Framework and a brief of IOTC stocks status, the IOTC consensus-based process for adoption of Management Procedures, the status of the Republic of Korean fisheries to understand possible contrasting objectives amongst various stakeholders, and to contrast the differences between current stock assessment approach for providing management advice and that used to test performance of alternative Management Procedures. These presentations were followed by rich discussions that allowed the organizers to gauge the level of understanding among participants to adjust the contents of subsequent presentations and discussions (**all presentations are included in**

Appendix 3). As the knowledge and experience of participants were quite diverse, from those that work in data collection to those attending IOTC or other tuna RFMO tuna stock assessments meetings, others attending as advisors at tunaRFMO Commission meetings, as well as industry and NGO participants; the rest of the day was focused on presenting the basic principles of Management Procedure approach, components and concepts, including Kobe plots, target and limit reference points, the IOTC management decision framework in Resolution 15/10, overview of objectives, timeframes, probabilities and risk, trade-offs, performance statistics, the roles and responsibilities of scientists and managers in MP development and the MP process of dialogue and feedback. At this point, the agenda was adjusted to spend more time reinforcing basic, but fundamental concepts to increase audience understanding and engagement for the second day, and, in general, for their participation in IOTC MP process. The first day was finished with the development of conceptual maps of Stock Assessment and Management Procedure processes (**Figure 1**).

The second morning started with a revision of the conceptual maps elaborated in day 1 and the discussion of the responses to the question poll (**Appendix 4**). The rest of the day was focused on a more detailed presentation of the different components of Management Procedures and the Management Strategy Evaluation and on the Shiny App practical exercises for examining MP and various Harvest Control Rule examples with different objectives to discuss performance statistics and the trade-offs between different objectives. There were many discussions related to objectives (economic, social, biological and ecological), and their prioritization. Participants were very engaged in the 3 exercises at all levels: asking questions, presenting their ideas and the conceptual maps developed, participating in the various activities, developing HCRs/MPs to achieve various fishery management objectives. Overall, the level of knowledge about the MP process improved considerably by the end of the workshop (**Figure 2**).

Conclusion

Based on attendees participation in discussions as well their engagement in the activities, where they showed a good understanding of different concepts of the MPs and developing the conceptual maps of Stock Assessment vs. MP; the objective of the workshop to create a better understanding among Republic of Korean stakeholders of the Indian Ocean Management Strategy Evaluation (MSE) and Management Procedure (MP) process was achieved. The feedback received from fishery administration participants, scientist, industry stakeholders and NGOs was very positive, and all of them underlaid that their comprehension of such complex matters of Management Procedure and Management Strategy Evaluation greatly improved.

Participants recognized that their understanding increased and suggested that similar types of workshops should be organized to address IOTC process of management decision, stock assessment, and other themes to increase their capacity to contribute to the process. Participants showed positive feedback in terms of workshop content and format, and comments and recommendations for improvement were received. Moreover, WWF-Korea showed interest about organizing a second round of MSE/MP workshop involving more participants, which

demonstrates the usefulness of this exercise and their willingness to participate in the implementation of sound Management Procedures in IOTC particularly and tunaRFMOs more generally.

As MSE/MP involves complex concepts and processes, IOTC Technical Committee on Management Procedures at its 2019 meeting underlined the need to organize capacity building workshops on MSE to increase the engagement in the process of adoption of IOTC MPs by all IOTC CPCs. Considering the success of this workshop, ***the group RECOMMENDED that the next Common Oceans ABNJ FAO Tuna project (phase 2) provides support to more MP/MSE capacity building workshops.***



Figure 1. Example of group activity where groups of participants arrange the different elements of Stock Assessment (C and D) and Management Procedure (E and F) in a conceptual map as they understand the process. A: group 1 discussion, B: group 2 discussion, C: group 1 Stock Assessment

conceptual map, D: group 1 Management Procedure conceptual map, E: group 2 Management Procedure conceptual map, F: group 2 Stock Assessment conceptual map.

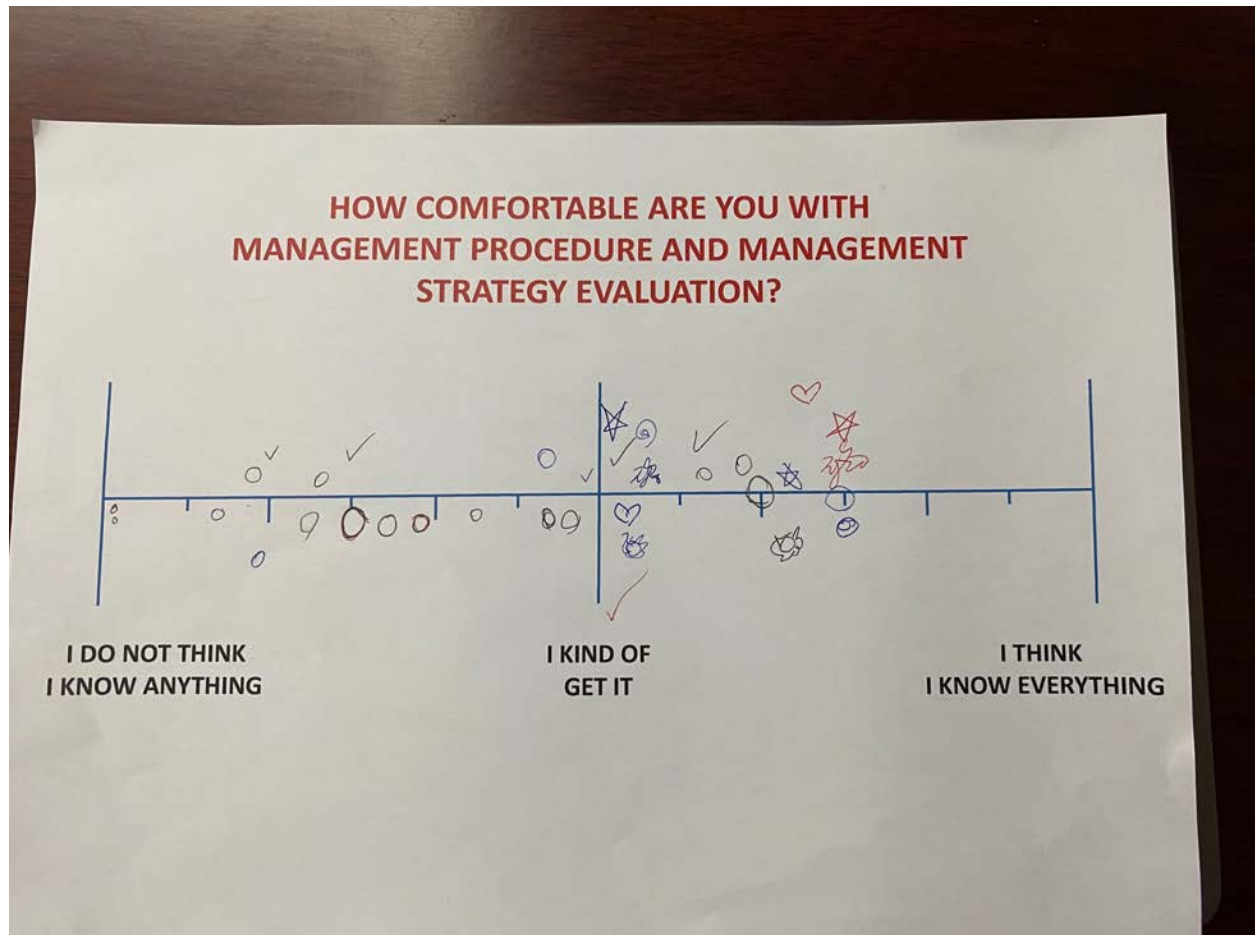


Figure 2. Distribution of participants' own perception of how much they understand Management Procedures at the start of the meeting (black marks) and by the end of the workshop (blue-red marks).

1

Evaluation : *Indian Ocean Tuna Management Workshop*

Feb. 19 - 20, 2020 / National Institute of Fisheries Science

[illegible]



Food and Agriculture
Organization of the
United Nations



Appendix 2. Workshop Agenda



Food and Agriculture
Organization of the
United Nations



iotc ctoi



Furthering Capacity Building for Harvest Control Rules and Management Strategy Evaluation: Indian Ocean Tuna Management Workshop

19-20 February, 2020

National Institute of Fisheries Science, Busan, Republic of Korea

Workshop Context

The workshop is part of the “Sustainable Management of Tuna Fisheries and Biodiversity Conservation in Areas Beyond National Jurisdiction” (ABNJ Tuna Project). The overarching project focuses on three component areas:

- 4) Supporting implementation of sustainable and efficient fisheries management and fishing practices
- 5) Reducing illegal, unreported and unregulated (IUU) fishing through strengthened and harmonized monitoring, control and surveillance
- 6) Reducing ecosystem impacts from tuna fishing, including bycatch and associated species

Under the Component 1, Capacity Building Workshop for Management Procedures and Management Strategy Evaluation directed to specific countries outreach are organized. These workshops are implemented by the International Seafood Sustainability Foundation (ISSF) with contribution from Indian Ocean Tuna Commission (IOTC) and country institutions.

Workshop Aims

The goal of this workshop is to create a better understanding among Indian Ocean States of the Management Strategy Evaluation (MSE) and Management Procedure (MP, also called Harvest Strategies) to ensure sustainable management of tunas.

Ultimately, the objective of this workshop is to leverage the participation of Republic of Korea in the process of development of tuna MPs within the Indian Ocean. Participation in this workshop will empower Republic of Korea to engage meaningfully in the process of MP development that are occurring in the Indian Ocean Tuna Commission (IOTC).

The Event

The workshop program will include discussion of Management Procedure framework and the principles of sound fisheries management. This workshop will provide the platform and background knowledge for participation in the Indian Ocean regional level MP work, and will contribute to the development of robust Management Procedures that are most likely to meet the objectives of IOTC members and stakeholders.

This workshop will provide introduction to the process of MP development; the elements of a MP, for example management objectives, timeframes and risk; how to interpret the trade-offs between different objectives and the use of MSE to evaluate MPs. Although the agenda is comprehensive, the objective is to have an open and lengthy discussion on the various elements that will require more attention from participants. The goal is to discuss relevant needs and issues for Republic of Korea specific to the Indian Ocean tunas and allow for more in-depth understanding of how the concepts and tools presented in the workshop may assist in increasing Republic of Korea participation in the process of the IOTC Technical Committee on Management Procedures.

The Agenda

DAY ONE – 19TH February 2020

0900 – 0930	Introduction & Objectives of the workshop	Hilario Murua (ISSF)
0930 – 1045	Setting the Context • Introduction to IOTC Management Framework and stock status • The IOTC Process on adoption of Management Procedures • Overview of national tuna fisheries • Moving from a 'best assessment' approach to Management Procedures	Hilario Murua (ISSF) Hilario Murua (ISSF) Doo Nam Kim (NIFS) Hilario Murua (ISSF)
1045 – 1115	BREAK	
1115 – 1230	Introduction to the provision of Fisheries Management Advice and Management Procedure approach, components and concepts <u>Fisheries Management Advice</u> • Basic Principles, • Kobe plots, • Target and Limit Reference Points, • IOTC Decision Framework	Hilario Murua (ISSF)
1230 – 1330	LUNCH	
1330 – 1500	Introduction to the provision of Fisheries Management Advice and Management Procedure approach, components and concepts (continue) <u>Management Procedures</u> • Basic Principles, • Objectives, • Timeframe & Risk, • Performance Indicators, • Roles and responsibilities, • Dialogue and feedback mechanism, • Discussion	Hilario Murua (ISSF)

1500 – 1530	BREAK	
1530 – 1615	Going Deeper: MP and Management objectives and performance measures to evaluate MSE results - Objectives - Types of objectives, scale, time-frame, probabilities, etc. - Reference points and how they related to objectives, - Trade-off between objectives - National vs. Regional objectives - Your objectives?	Hilario Murua (ISSF)
1615 – 1715	Questionnaire discussion Recap: Conceptual Map exercise Wrap up and planning 2 nd day	Hilario Murua (ISSF) Hilario Murua (ISSF) Hilario Murua (ISSF)
1730	DAY 1 CLOSE	

DAY TWO – 20TH February 2020

0900 - 0915	OPENING Day 1 reflections & Day 2 overview	Hilario Murua (ISSF)
0915 - 1030	Going Deeper: MP and Management objectives and performance measures to evaluate MSE results - Objectives - Types of objectives, scale, time-frame, probabilities, etc. - Reference points and how they related to objectives, - Trade-off between objectives - National vs. Regional objectives - Your objectives? - How to interpret the results, performance indicators and trade-off figures	Toshihide Kitakado (TUMSAT) /Hilario Murua (ISSF)

1030 - 1100	BREAK	
1100 - 1200	Going Deeper: Management Strategy Evaluation (MSE) and Exploring Management Procedures • Type of HCR, • Create and run various HCRs • Comparing results and tradeoffs: a closer look	Toshihide Kitakado (TUMSAT)/Hilario Murua (ISSF)
1200 - 1230	Going Deeper: discuss an example from IOTC (e.g Bigeye) • Present various MPs as discussed in 2019 TCMP • Comparing results and tradeoffs • Discussion	Toshihide Kitakado (TUMSAT)/ Hilario Murua (ISSF)
1230 - 1330	LUNCH	
1330 - 1500	Stakeholder view • Stakeholder objectives • Trade-offs and performance indicators, how to interpret the results	Hilario Murua (ISSF)
1500 - 1530	BREAK	
1530 - 1600	Putting all pieces together • What we learned • How this applies to upcoming IOTC process	All
1600 - 1630	How did we do? • Workshop evaluation	All
1630 - 1700	Closing	



Food and Agriculture
Organization of the
United Nations



Appendix 3. Presentations



Food and Agriculture
Organization of the
United Nations



Appendix 4. Results of the Question Poll

Furthering Capacity Building for Harvest Control Rules and Management Strategy Evaluation: Indian Ocean Tuna Management Workshop

19-20 February, 2020

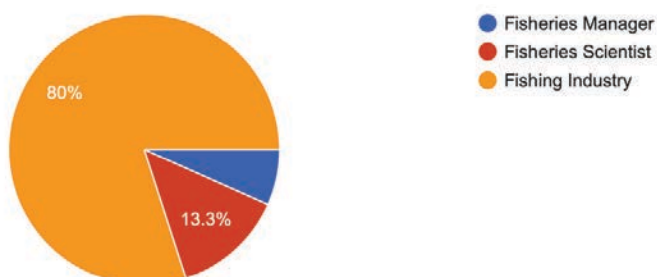
National Institute of Fisheries Science, Busan, Republic of Korea

Busan Workshop Questionnaire (MSE)

17 responses

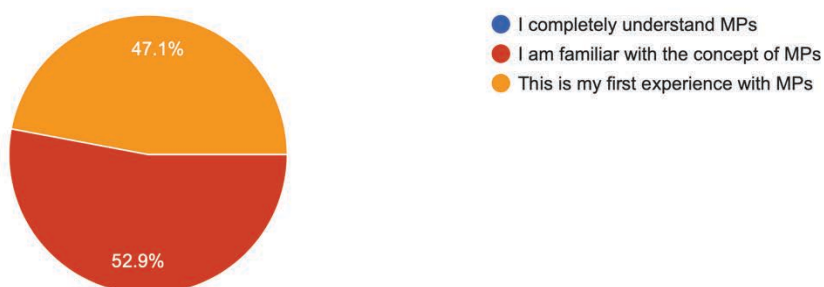
1. What is your position?

15 responses



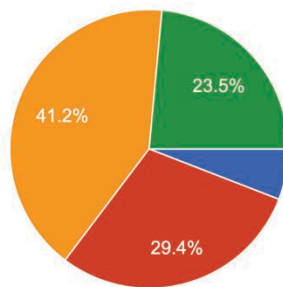
2. How well do you understand what Management Procedures (MPs) are and how they work?

17 responses



3. What does Management Strategy Evaluation mean to you?

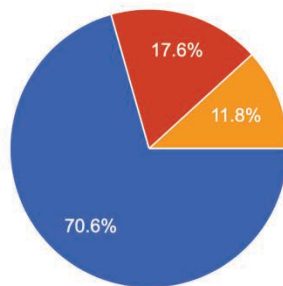
17 responses



- A simulation framework to test defined Harvest Control Rules
- A simulation framework to model all components of the fishery management system
- A simulation framework to provide the best stock assessment
- I need more information

4. Which one of these definitions better explains to you what a Management Procedure is?

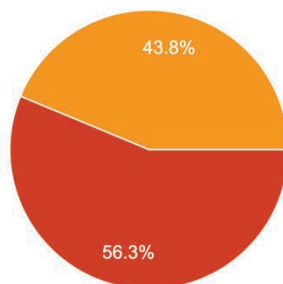
17 responses



- The combination of pre-defined data, together with an algorithm to which such data are input to provide a value for a set of implementable management measures
- A set of rules for CPCs to decide what to do
- A fixed catch ceiling that does not change every year
- A vision for where the fishery should be considering uncertainty

5. What is the difference between the IOTC skipjack Harvest Control Rule and a Management Procedure?

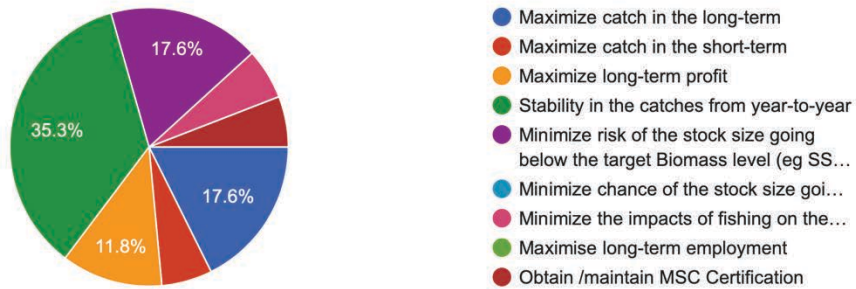
16 responses



- They are equivalent
- A Management Procedure is a component of the Harvest Control Rule.
- The Harvest Control Rule requires consensus on the stock assessment results while in the MP these requirements are agreed in advance.

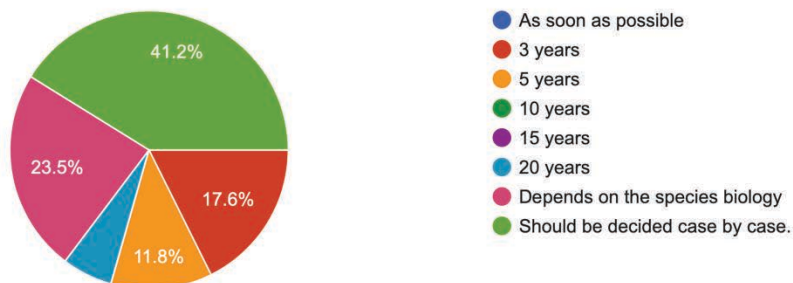
6. Please select your highest priority management objective.

17 responses



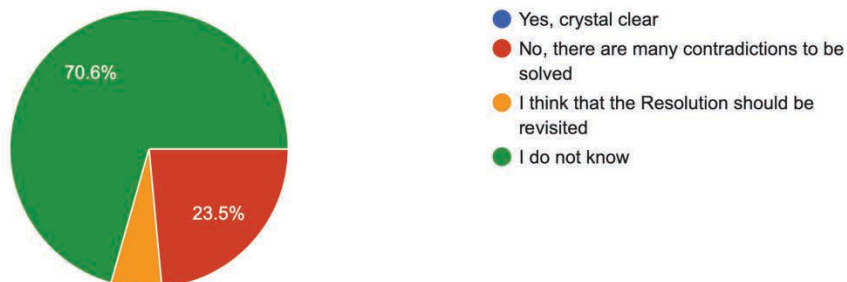
7. What would you consider to be an appropriate timeframe for recovery for an overexploited/overfishing stock

17 responses



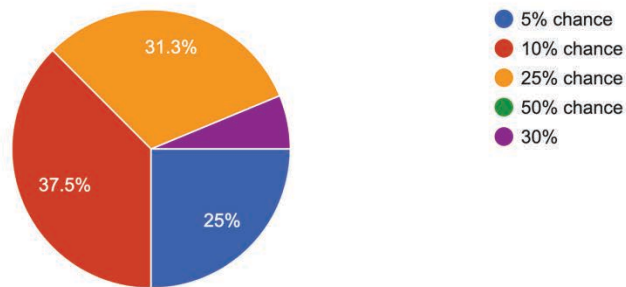
8. Do you consider that the management framework and operational objectives established in Resolution 15/10 are clear

17 responses



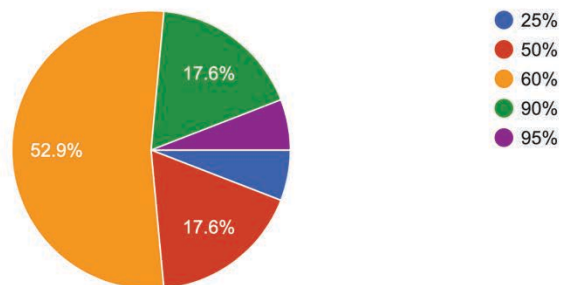
9. How would you define low probability" ?

16 responses



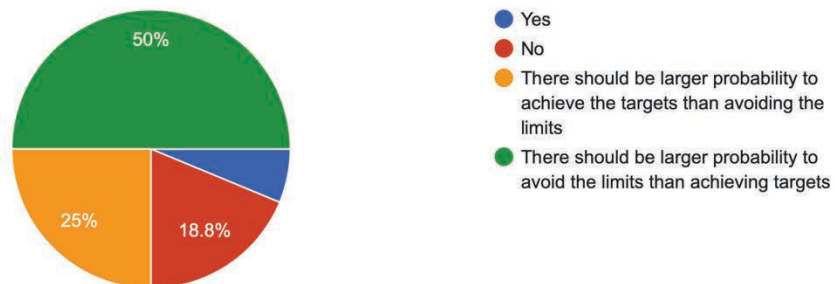
10. What is your interpretation of high probability in this case from Resolution 15/10: "For a stock where the assessed status places it within the lowe...tock with a high probability within this quadrant"?

17 responses



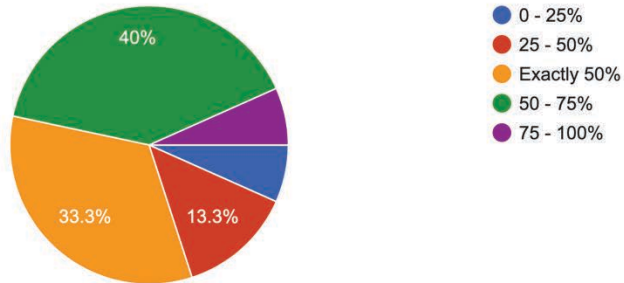
11. Do you think that the "high probability" is the same when related to achieving the targets or avoiding falling below the limits?

16 responses



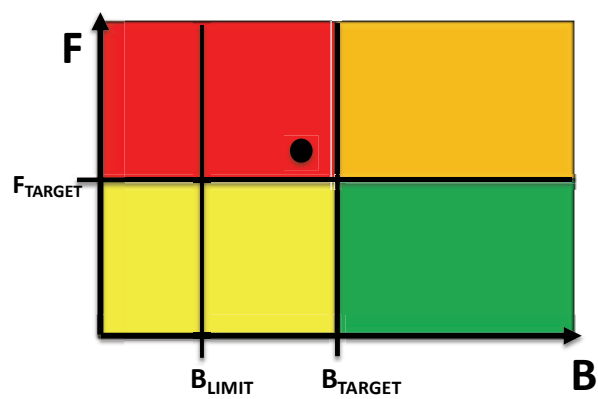
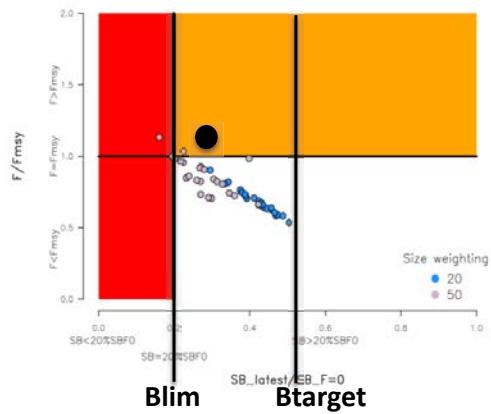
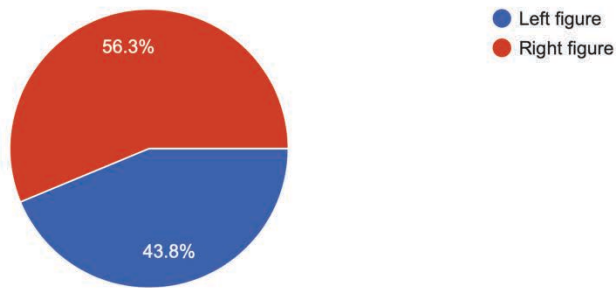
12. On average, the stock should be above B/B_{MSY} and below F/F_{MSY} what proportion of the time?

15 responses



13. Which of the stock below would require more stringent management measures (stock status marked by the circle)?

16 responses





Food and Agriculture
Organization of the
United Nations





Food and Agriculture
Organization of the
United Nations



Furthering Capacity Building for Harvest Control Rules and Management Strategy Evaluation: Indian Ocean Tuna Management Workshop

Hilario Murua (ISSF)
Toshi Kitakado (TUMSAT)
Dan Fu (IOTC)

Busan, Republic of Korea, 19-20 February 2020

Furthering Capacity Building for Harvest Control Rules and Management Strategy Evaluation: Indian Ocean Tuna Management Workshop

The workshop is part of the ABNJ Tuna Project “Sustainable Management of Tuna Fisheries and Biodiversity Conservation in Areas Beyond National Jurisdiction”

The project is focused on three component areas:

1. **Promotion of sustainable management,**
2. Strengthening and harmonizing Monitoring Control and Surveillance,
3. Reducing ecosystem impacts.

Furthering Capacity Building for Harvest Control Rules and Management Strategy Evaluation: Indian Ocean Tuna Management Workshop

- The goal of this workshop is to create a better understanding among Indian Ocean States of the Management Strategy Evaluation (MSE) and Management Procedure (MP, also called Harvest Strategies) to ensure sustainable management of tunas
- Ultimately, the objective of this workshop is to leverage the participation of Republic of Korea in the process of development of tuna MPs within the Indian Ocean.

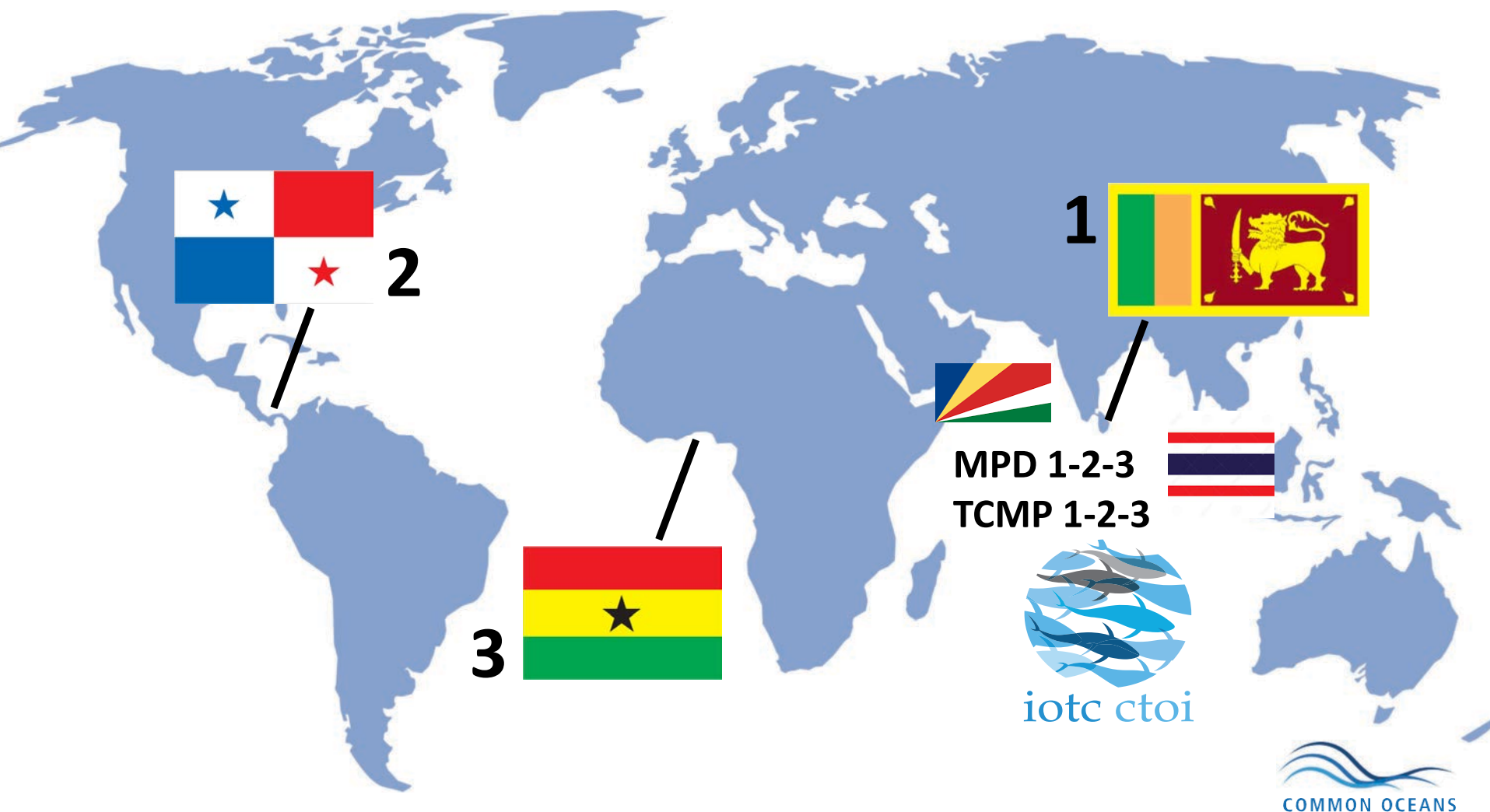
Furthering Capacity Building for Harvest Control Rules and Management Strategy Evaluation: Indian Ocean Tuna Management Workshop

This workshop builds on previous WSs to consider key elements of fisheries management issues currently relevant to IOTC members.

Participation will empower you to engage meaningfully in the ongoing discussions on Management Procedures for Indian Ocean tuna stocks over the coming years



Furthering Capacity Building for Harvest Control Rules and Management Strategy Evaluation: Indian Ocean Tuna Management Workshop



Workshop objectives

- Interpretation of IOTC tuna stock status indicators including Kobe plots and other forms of presentation,
- Understanding of Management Procedures (MPs) and the process of of MP development,
- Their components and application,
 - Management objectives,
 - Timeframes
 - Risk

Workshop objectives

- Open and lengthy discussion on various elements requiring more attention,
- Preparation for discussions about trade-offs between management options,
- **Understanding of roles (scientists, fisheries managers, Secretariat, NGOs, industry),**
- Increase meaningful participation in TCMP/Commission discussions/decisions
- **Gain understanding/confidence to speak in support of management options (including MPs) to meet national/IOTC Goals**

Workshop Format

- Presentations as a guide, but a lot to understand – an ambitious agenda,
- Informal set up, if something is not clear or we move quickly, please request to STOP!!
- Engagement/questions essential,
- Your WS so please free feel to change the course of actions (presentation),
- Hands on during the second day,
- Working in plenary but interaction is key,
- Flexible; if something is not working, we can change it

Workshop Format

- THIS IS A ITERATIVE PROCESS
 - Not be afraid to interrupt,
 - Questions help everybody,
 - Your ideas enrich everybody,
 - We are here to listen, also during coffee.
- THIS IS NOT A LECTURE OR TECHNICAL EXERCISE
 - No strange acronyms,
 - No equations (maybe just one...),
 - No modelling code,
 - No complicate figures/tables

Workshop Format

IN SHORT,
THE WORKSHOP IS
YOURS AND FOR
YOU!!!!

Agenda Day 1 (Morning)

Setting the Context

- Introduction to IOTC Management and stock status– *H. Murua & T. Kitakado*
- IOTC MP process – *H. Murua & T. Kitakado*
- Overview of Republic of Korea tuna fisheries – *Dr. Doo Nam Kim*
- From best assessment to MP– *D. Fu*

COFFEE BREAK

Agenda Day 1 (Morning - continue)

Introduction to the Provision of Management Advice and Management Procedure approach, components and concepts – H. Murua/T. Kitakado/D. Fu

Fishery Management Advice

- Basic principles,
- Kobe plot,
- Target and Limit Reference Points,
- IOTC Decision Framework

LUNCH BREAK

Agenda Day 1 (Afternoon)

Introduction to the Provision of Management Advice and Management Procedure approach, components and concepts – H. Murua/T. Kitakado/D. Fu (Continue)

Management Procedure

- Basic principles,
- Objectives,
- Timeframes and risk,
- Performance Indicators,
- Roles and responsibilities,
- Dialogue and feedback mechanism,
- Discussion

LUNCH BREAK

Agenda Day 1 (Afternoon - cont.)

- *Exercise 1: Conceptual Maps of Stock Assessment vs Management Procedure.*
- *Questionnaire discussion*
<https://forms.gle/qfMysHzz5VqPPqYJA>

CLOSE

Agenda Day 2 (Morning)

Going Deeper: MP and Management objectives and performance measures to evaluate MSE results. *H. Murua/T. Kitakado/D. Fu*

- Objectives
- Types of objectives, scale, time-frame, probabilities, etc.
- Reference points and how they related to objectives,
- Trade-off between objectives
- National vs. Regional objectives
- Your objectives?
- How to interpret the results, performance indicators and trade-off figures

COFFEE BREAK

Agenda Day 2 (Morning continue)

Going Deeper: Management Strategy Evaluation (MSE) and Exploring Management Procedures. *H. Murua/T. Kitakado/D. Fu*

- Types of Harvest Control Rules (HCR)
- Create and run various HCRs
- Comparing results and tradeoffs: a closer look

Going Deeper: Discuss and example from IOTC (e.g Bigeye). *H. Murua/T. Kitakado/D. Fu*

- Present various MPs as discussed in 2019 TCMP
- Comparing results and tradeoffs
- Discussion

Agenda Day 2 (Afternoon)

Stakeholder view– H. Murua/T. Kitakado/D. Fu

- Stakeholder objectives,
- Comparing results and tradeoffs: a closer look.

Putting all pieces together – All

- What we learned,
- How this applies to upcoming IOTC process

Workshop Evaluation

CLOSING

Furthering Capacity Building for Harvest Control Rules and Management Strategy Evaluation: Indian Ocean Tuna Management Workshop

GAMSA HAMIN DA!



Sustainable Management of Tuna Fisheries and Biodiversity Conservation in the Areas Beyond National Jurisdiction



Food and Agriculture
Organization of the
United Nations



Introduction to IOTC Management Framework and stock status

**Furthering Capacity Building for Harvest Control Rules and
Management Strategy Evaluation: Indian Ocean Tuna
Management Workshop**

Busan, Republic of Korea, 19-20 February 2020

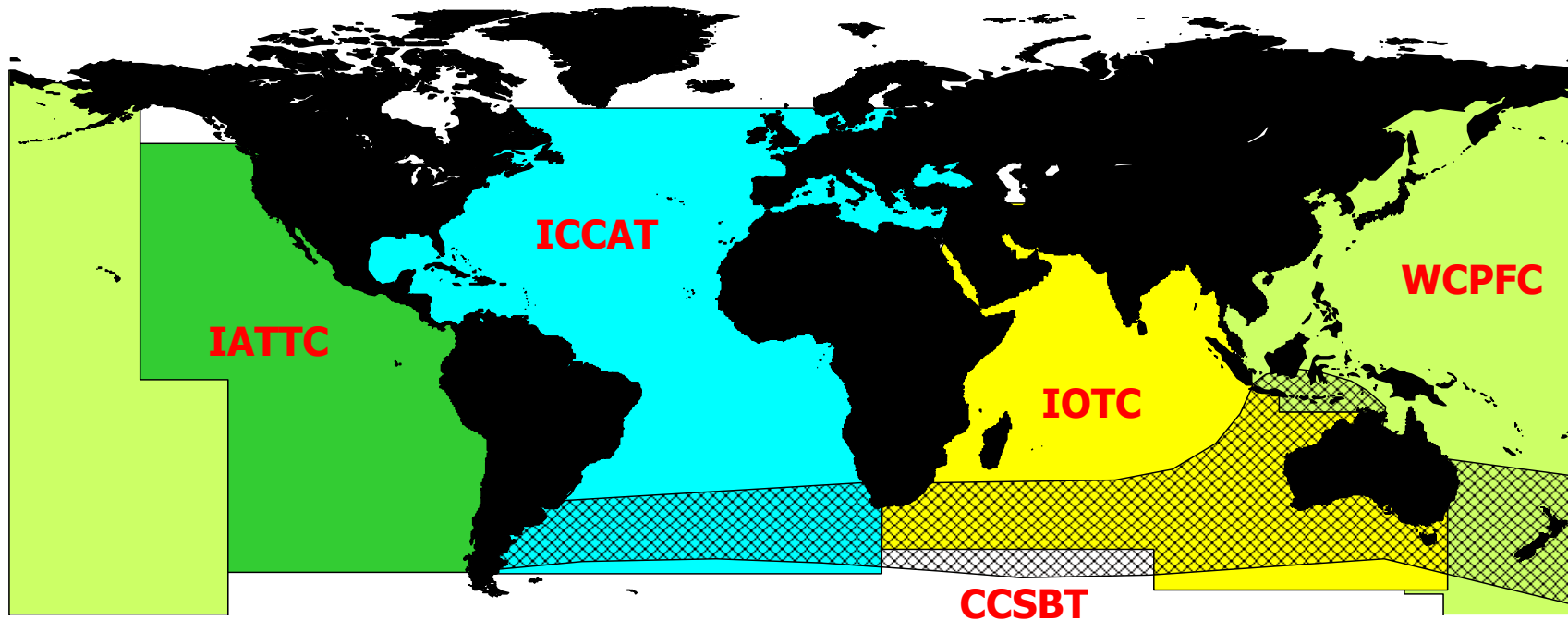
**Dr. Hilario Murua
ISSF**

IOTC MANAGEMENT PROCEDURE HISTORY



iotc ctoi

5 tuna RFMOs



IATTC: Inter-American Tropical Tuna Commission (La Jolla, USA – 1949)

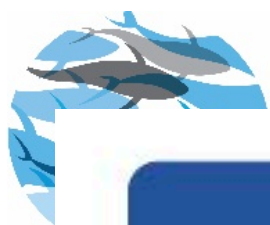
ICCAT: International Commission for the Conservation of Atlantic Tunas (Madrid, España – 1969)

CCSBT: Commission for the Conservation of Southern Bluefin Tuna (Canberra, Australia – 1994)

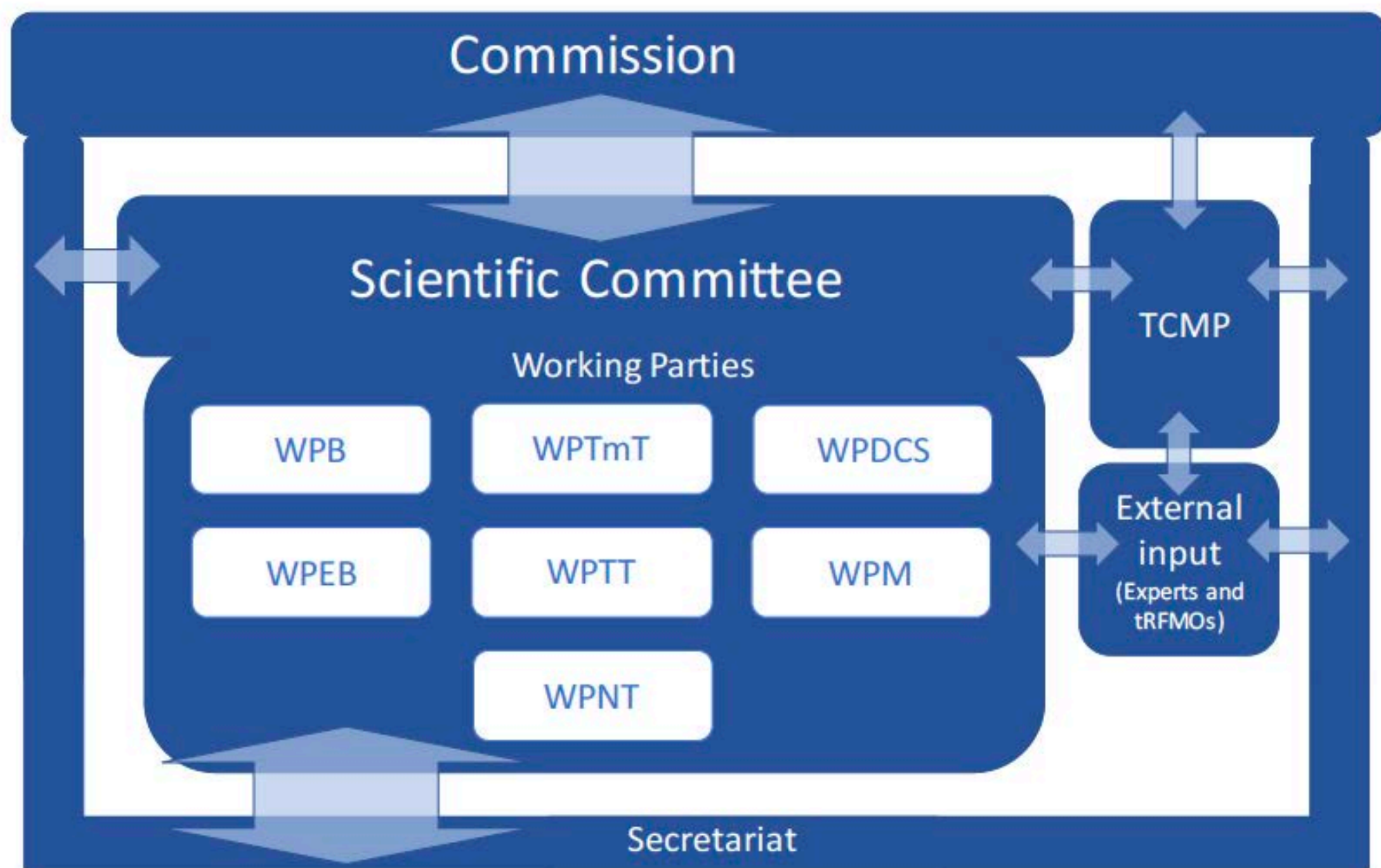
IOTC: Indian Ocean Tuna Commission (Mahé, Seychelles – 1996)

WCPFC: Western and Central Pacific Fisheries Commission (Koror, Micronesia - 2004)





ic



SOME HISTORY

- 2002: First discussion of MSE was in the WPM in 2002, recommending the development of an operating model
- 2009: PRIOTC01 Recommendation 38 to implement Precautionary Approach and uncertainty in the advice as UNFSA; which also calls for an MSE process.
- 2010 COM supported the development of a MSE by the SC as a tool to evaluate conservation and management measures
- 2010 SC Recommended to organize a meeting on MSE between scientist, managers and representatives of the industry
- 2011 COM endorsed the development of a road map for MSE
- 2012
 - Resolution 12/01 on the implementation of the Precautionary Approach
 - Resolution 12/14 on Interim Target and Limit Reference Points
 - Resolution 12/15 on the Best Available Science
- 2013 Resolution 13/10 on Interim Target and Limit Reference Points and a Decision Framework

SOME HISTORY

- 2014
 - 1st Management Dialogue Meeting
 - Resolution 14/03 on Enhancing the Dialogue between Scientist and Managers
- 2015
 - 2nd Management Dialogue Meeting
 - Resolution 15/10 on Target and Limit Reference Points and a Decision Framework
- 2016
 - 3rd Management Dialogue Meeting
 - Resolution 16/02 on HCR for Skipjack
 - Resolution 16/09 on establishing a TCMP
 - MP/MSE Workplan developed by WPM/SC.
- 2017-2018-2019
 - 1st, 2nd and 3rd Technical Committee on Management Procedure
 - MP/MSE Workplan adopted by Commission

2020	ALB/YFT/BET	SKJ	SWO
TCMP	Provide advice to Commission on elements of candidate MPs that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.	Provide advice to the Commission on any outstanding issues resulting from the application of the HCR if required	Provide advice to Commission on elements of candidate MPs that require a decision by the Commission, including the performance of candidate MPs against Commission objectives
COM	Consider work and advice from subsidiary bodies. Decision and adoption of an MP or provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs	Consider work and advice from subsidiary bodies and review Resolution 16/02.	Consider work and advice from subsidiary bodies and provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs
WPs/SC	Undertake MSE to provide advice on the performance of candidate MPs		Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs



RESOLUTION 16/09

ON ESTABLISHING A TECHNICAL COMMITTEE ON MANAGEMENT PROCEDURES

2. The objectives of the TCMP shall be to:
 - a) Enhance the decision making response of the Commission in relation to management procedures, including recommendations made by the Scientific Committee;
 - b) Enhance communication and foster dialogue and mutual understanding between the Scientific Committee and the Commission on matters relating to management procedures; and
 - c) Assist the Commission to obtain and promote the effective use of scientific resources and information.
3. The TCMP shall meet prior to and in conjunction with the annual Commission Session, to facilitate full attendance by CPCs.
4. The outcomes of the TCMP will be considered by the annual Commission Session under a standing agenda item for that purpose, as well as through the Commission's consideration of proposals relating to management procedures.
5. The TCMP shall focus on the presentation of results and exchange of information necessary for the Commission to consider possible adoption of Management Procedures. Standard formats for the presentation of results should be used, to facilitate understanding of the material by a non-technical audience.



RESOLUTION 16/09

ON ESTABLISHING A TECHNICAL COMMITTEE ON MANAGEMENT PROCEDURES

6. The agenda of the TCMP shall place emphasis on the elements of each Management Procedure that require a decision by the Commission. The adoption of Management Procedures is an iterative process that allows for adjustments as the work, and the understanding of the elements involved, progresses.
7. The TCMP should undertake the following:
 - a) Identifying, evaluating, and discussing management procedures for the IOTC fisheries, which help meet the objectives of the IOTC Agreement, including socioeconomics, food security, etc., identified by the Commission, the ecosystem-based approach to fisheries and the precautionary approach for the consideration of the Commission. Specifically, consideration of the following:
 - i. Overarching management objectives to guide the development of management procedures for the IOTC fisheries;
 - ii. Target and Limit Reference Points with reference to [Resolution 15/10](#) on interim target and limit reference points and a decision framework (or any subsequent revision);
 - iii. Harvest Control Rules (HCRs), including: the extent to which HCRs meet management objectives; the probabilities of achieving target reference points, avoiding limit reference points, or rebuilding; the risks to the fishery and the resource at these limit and target reference points; and allowing, in particular, the implementation of a precautionary approach as required by [Resolution 15/10](#) on interim target and limit reference points and a decision framework (or any subsequent revision);

TCMP 03

MSE basic principles

- **Complex issues presented and AGREED to maintain the science related capacity building in the next TCMP to clarify key issues in the Management Strategy Evaluation (MSE).**
- **The TCMP REQUESTED that Intersessional capacity building on MSE be conducted to increase understanding of the MSE process by all CPCs.**

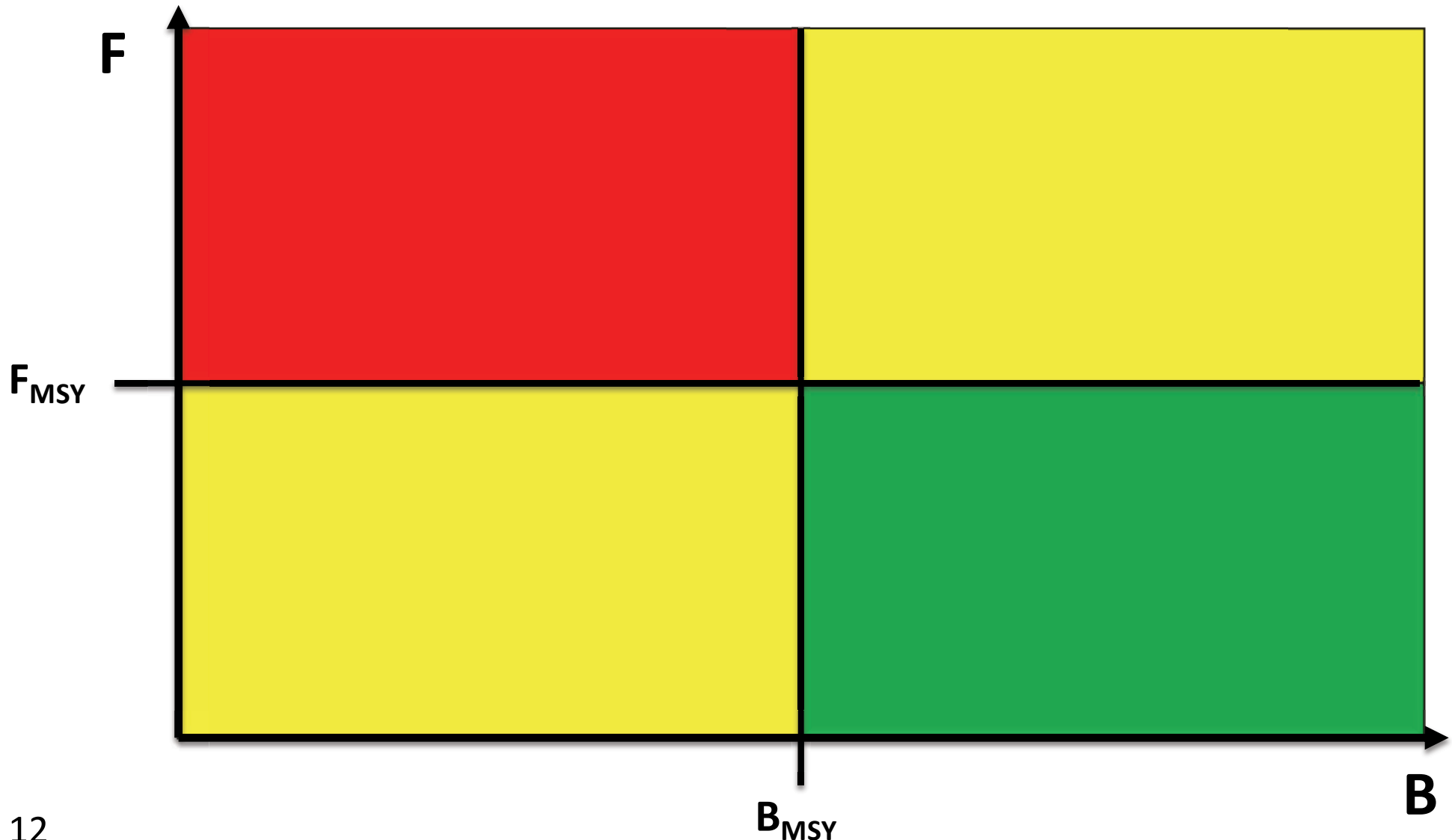
IOTC MANAGEMENT FRAMEWORK



iotc ctoi

IOTC Convention Objective (Strategic or Conceptual)

The Commission shall *promote cooperation among its Members* with a view to ensuring, through appropriate management, the conservation and *optimum utilization of stocks* covered by this Agreement and *encouraging sustainable development of fisheries* based on such stocks.



Resolution 15/10: Reference Points

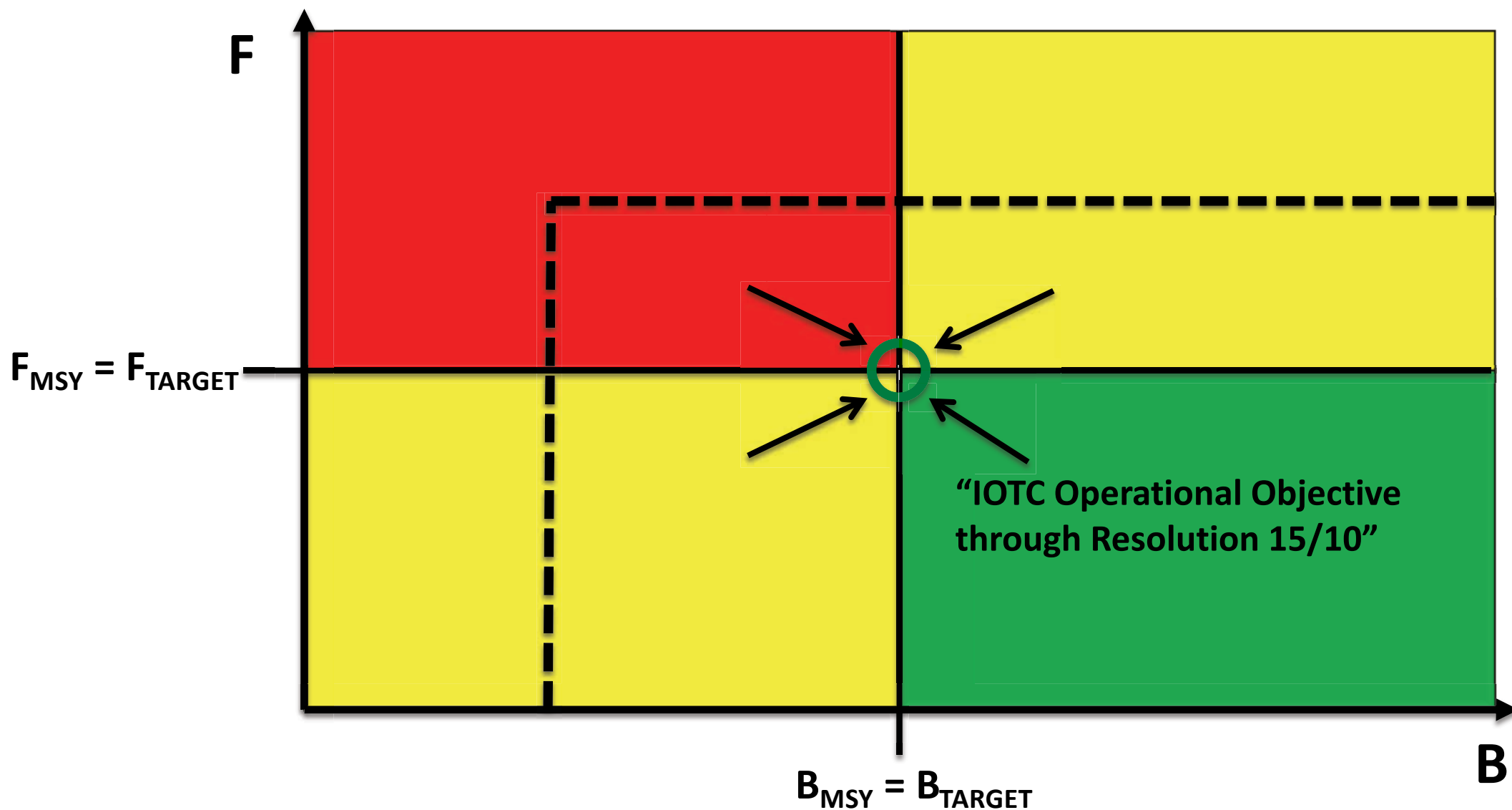
- Interim Target and Limit Reference Points (TRPs and LRPs)**

When assessing stock status and providing recommendations to the Commission, the **IOTC Scientific Committee should, where possible, apply MSY-based target and limit reference points for tuna and tuna-like species.**

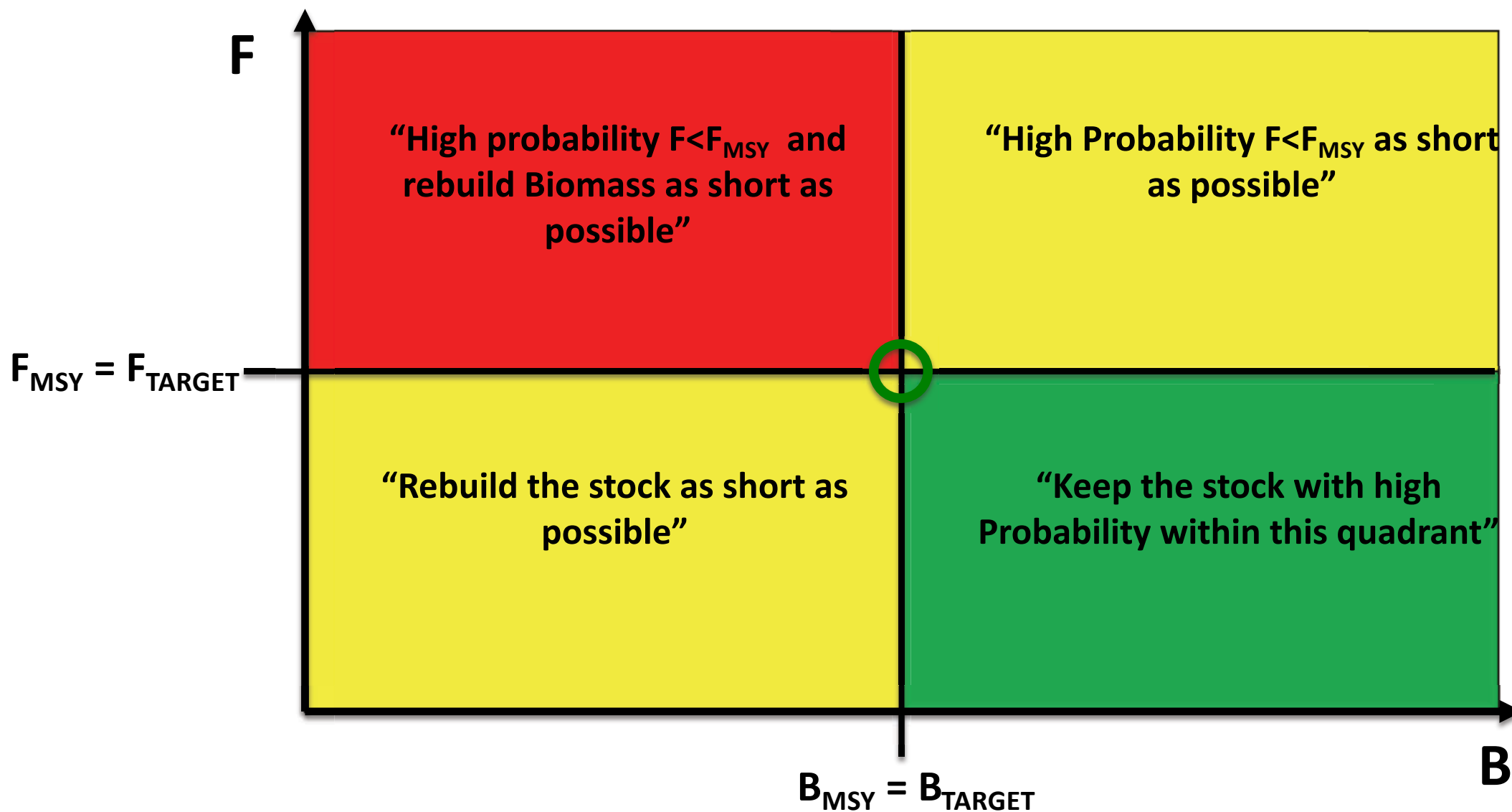
Stock	Target Ref. Point	Limit Ref. Point
Albacore	$B_{\text{target}} = B_{\text{MSY}}$ $F_{\text{target}} = F_{\text{MSY}}$	$B_{\text{lim}} = 0.4 * B_{\text{MSY}}$ $F = 1.40 * F_{\text{MSY}}$
Yellowfin		
Swordfish		
Bigeye		$B_{\text{lim}} = 0.5 * B_{\text{MSY}}$ $F = 1.30 * F_{\text{MSY}}$
Skipjack* (based on B0)		$B_{\text{lim}} = 0.4 * B_{\text{MSY}}$ $F = 1.50 * F_{\text{MSY}}$

* when MSY-based reference points cannot be reliably estimated
RPs relative to B0.

Resolution 15/10: Reference Points (Operational Objectives)



Resolution 15/10: Reference Points (Operational Objectives)



IOTC STOCK STATUS



iotc ctoi

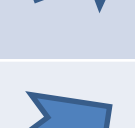


TROPICALS & ALBACORE



Species	Last SA	Status		MSY	Catch 2018	Catch 2014-2018	Catch Trend	Management Advice
		Prev	Last					
Albacore	2019	16	19	35,700	41,603	38,030		Catch reduction
Bigeye	2019	16	19	87,000	81,413	89,720		10 % Catch reduction
Skipjack	2017	14	17	510,100	606,197	484,993		HCR 16/02 – Catch limit = 470,029 t.
Yellowfin	2019	18	19	403,000	437,422	407,377		Res. 19/01



Species	Last SA	STAT US	MSY	Catch 2017	Catch 2013-2017	Catch Trend	Management Advice
Kawakawa	2015		152,000	159,881	157,326		Catches reduce ~10 % ~136,000
Longtail	2017		140,000	138,403	139,856		Catches = 2016 levels 138,403
IP King-mackerel	2016		Unknown	52,455	46,814		Catches < 46,787 (2009-2011)
Narrow-based SP mackerel	2017		130,720	159,370	160,812		Catches reduce 30 % ~ 110,000
Bullet	NO SA		Unknown	11,094	9,959		Catches < 8,870 (2009-2011 average)
Frigate	NO SA		Unknown	74,886	86,157		Catches < 94,921 (2009-2011 average)

BILLFISHES



Species	Last SA	Status	MSY	Catch 2017	Catch 2013-17	Catch Trend	Management Advice
Swordfish	2017		31,590	34,782	31,405		Catch < MSY
Black marlin	2018		12,930	21,250	18,673		Res. 18/05
Blue marlin	2019		9,980	9,969	11,382		7,800 t.
Striped marlin	2018		4,730	3,082	3,587		Catch 1,500 and 2,200
Indo-Pacific Sailfish	2015		23,900	36,911	31,267		Res. 18/05

Korean tuna fisheries in the Indian Ocean

Sung Il Lee

National Institute of Fisheries Science

Background

- ▶ Korean tuna longline fishery first commenced in the Indian Ocean in 1957.
 - targeted YFT, BET along with ALB, SBT
- ▶ Korean tuna purse seine fishery started in 2012.
 - targeted SKJ and YFT
- ▶ Korea has implemented Electronic Reporting system since 2015.

Changes in data reporting and collection system

❖ Legal basis : the Distant Water Fisheries Development Act

Paper logbook
(~ 2012. 11)

- Time for data submission
 - (home-based) within 30 days after completion of operations
 - (foreign-based) within 60 days

Elec. logbook
(2012. 12
~ 2015. 8)

- The Act strengthened
 - fishers report **every month (achieved 100% coverage)**
 - to collect information on **discard/release**
 - to collect bycatch information on **Ecologically Related Species**

Elec. Reporting
(2015. 9 ~)

- The reporting system changed
 - fishermen report **every day** to the NIFS
 - **cross-checked** with data of VMS and CDS

Data contents collected from logbooks through changes of the reporting system

Paper logbook

- Species reported
 - tuna : ALB, YFT, BET, PBF, SKJ, SBT
 - billfish : BUM, MLS, SWO, BLM, WHM, SFA
 - others : not identified
 - sharks : not identified
- Set details and catch
 - fishing date and position
 - fishing effort(hooks, floats)
 - retained catch(No/kg)

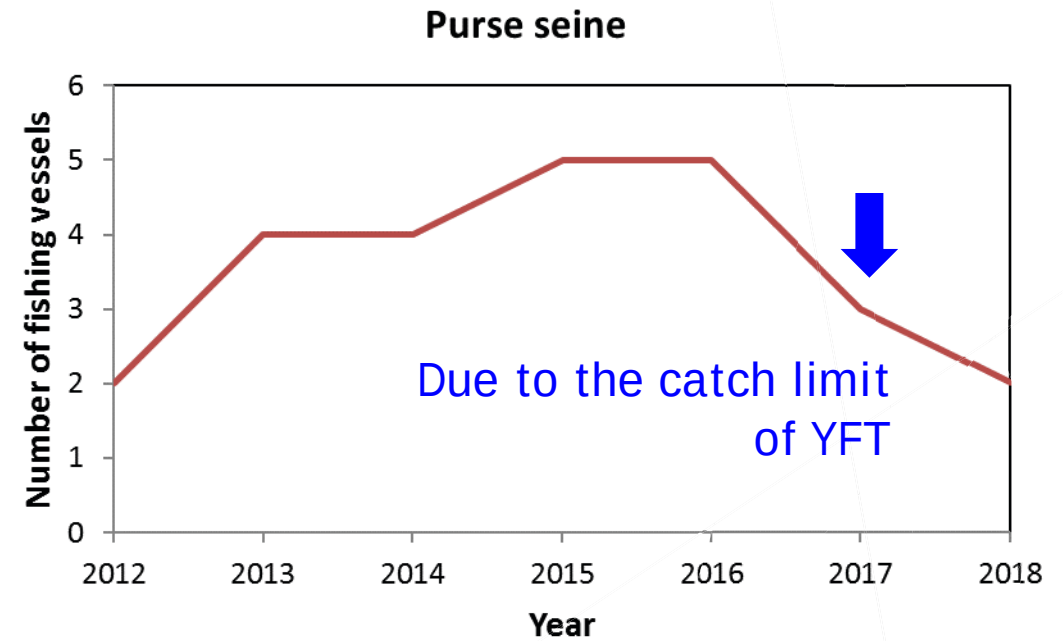
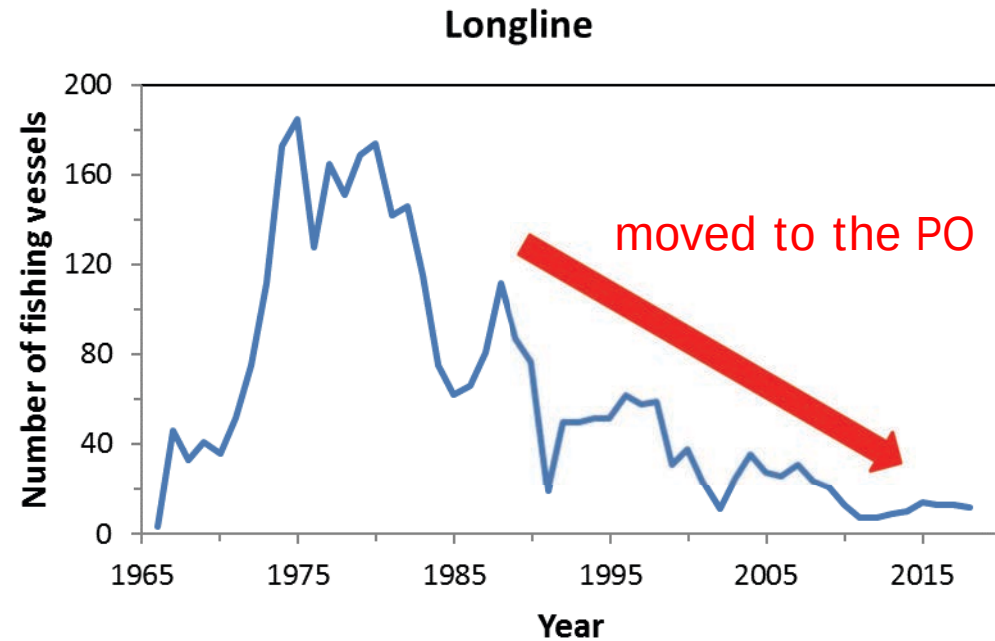
Elec. logbook

- Species reported
 - tuna : same
 - billfish : same
 - others : same
 - **sharks** : BSH, MAK, POR, FAL, OCS, HMS and OSH
 - **sea bird/sea turtle** (added)
- Set details and catch
 - fishing date and position
 - fishing effort(hooks, floats)
 - retained catch(No/kg)
 - **activity code**
 - **No. of discard(live/dead)**
 - **set start time**

Elec. reporting

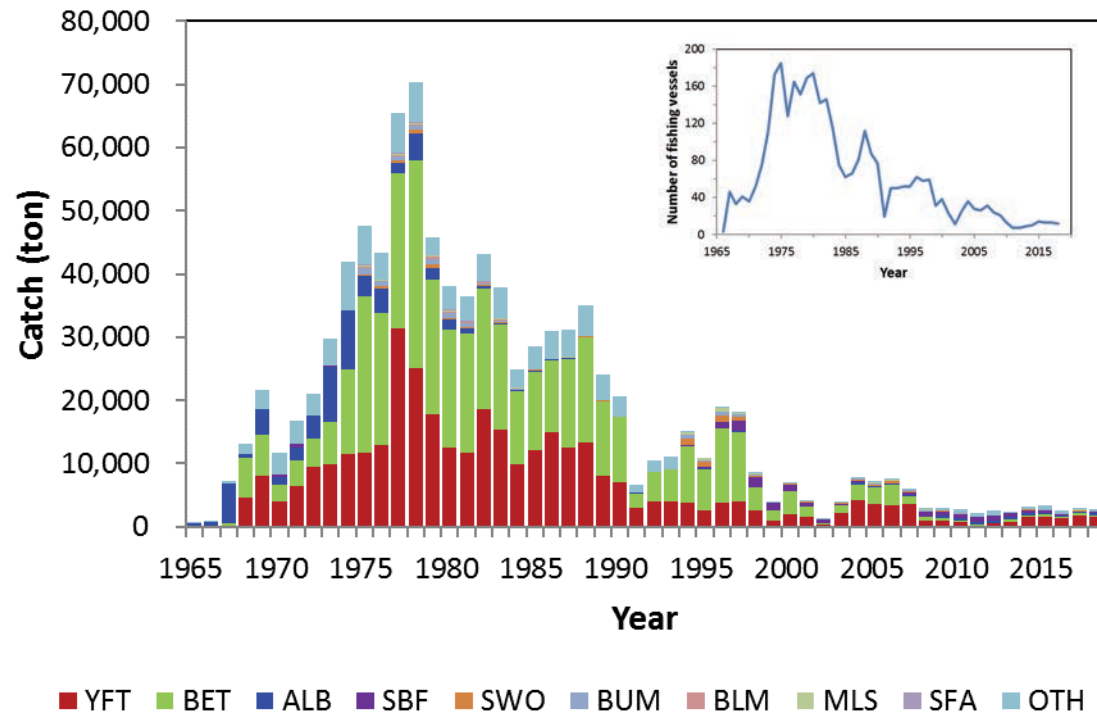
- Species reported
 - ✘ **not only key species but also bycatch species**
- Set details and catch
 - fishing date and position
 - fishing effort(hooks, floats)
 - retained catch(No/kg)
 - activity code
 - No/**kg** of discard(live/dead)
 - set start/**end** time

Changes in the number of longline and purse seine fishing vessels

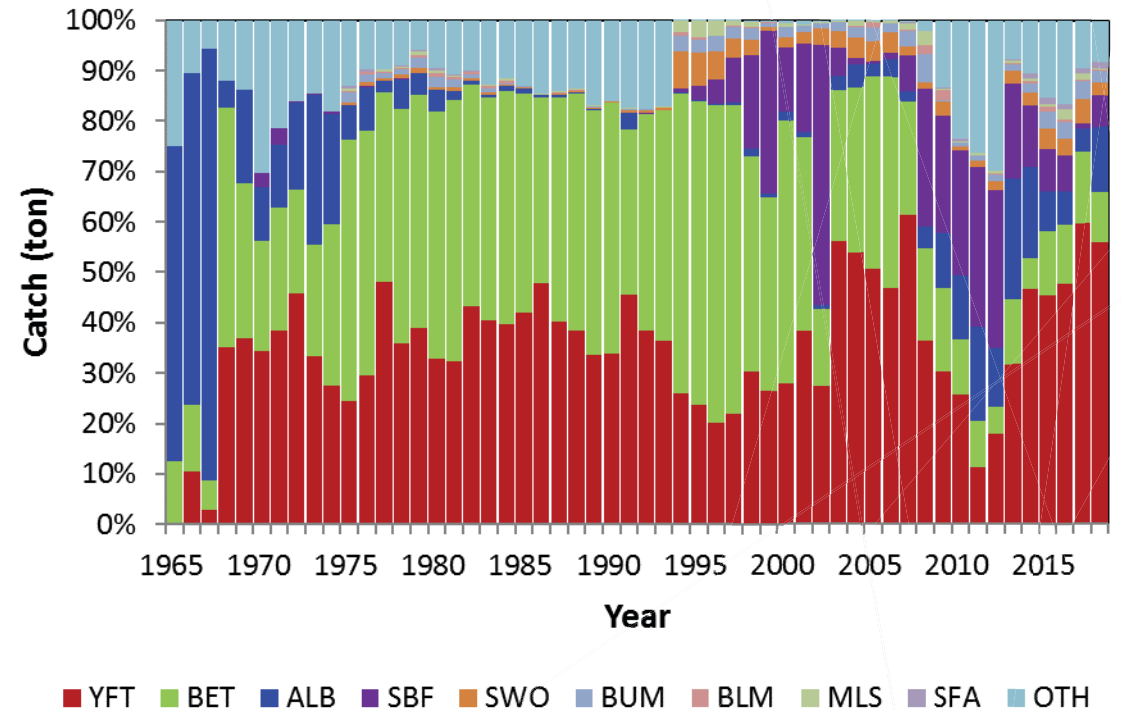


Catch trend of major species of longline fishery

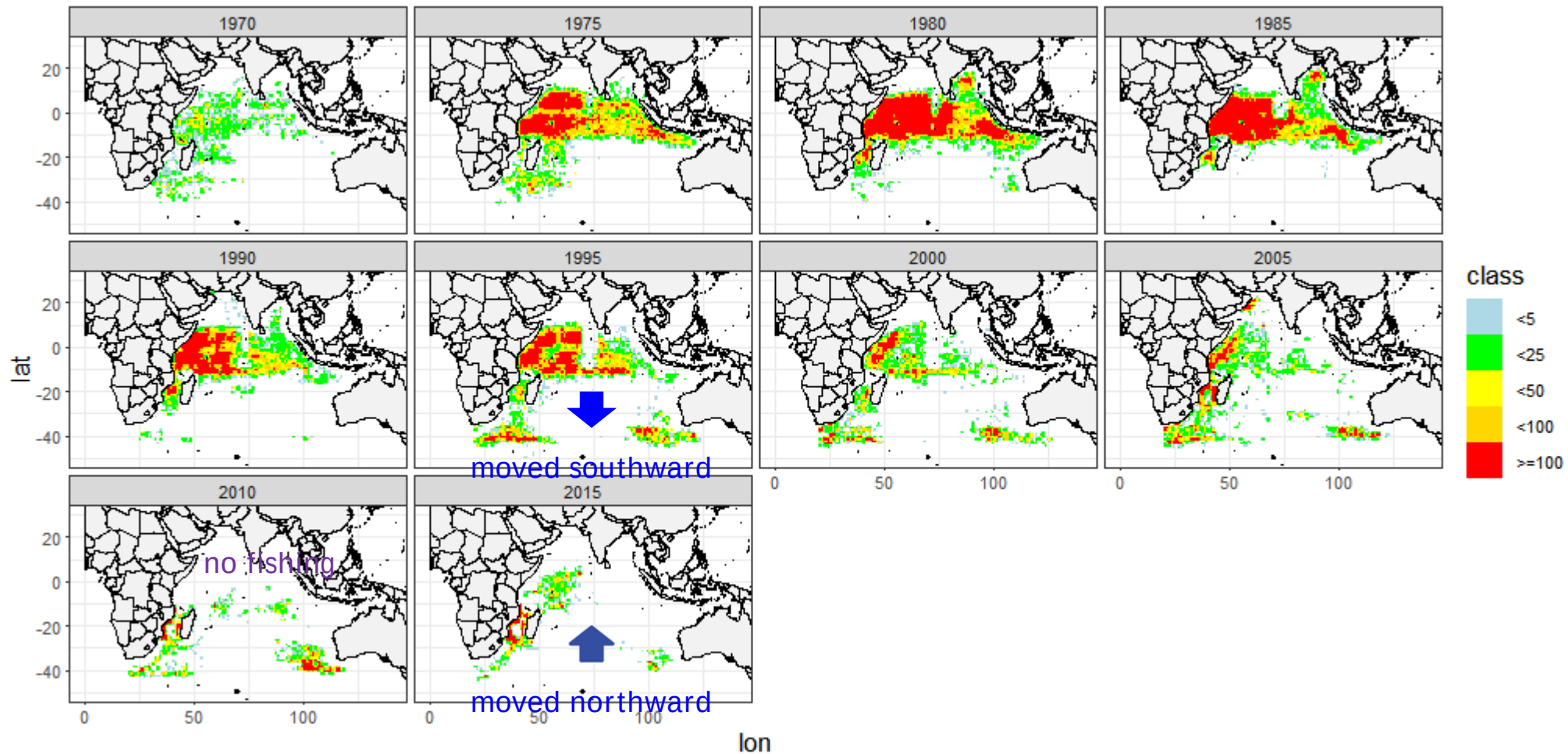
Longline



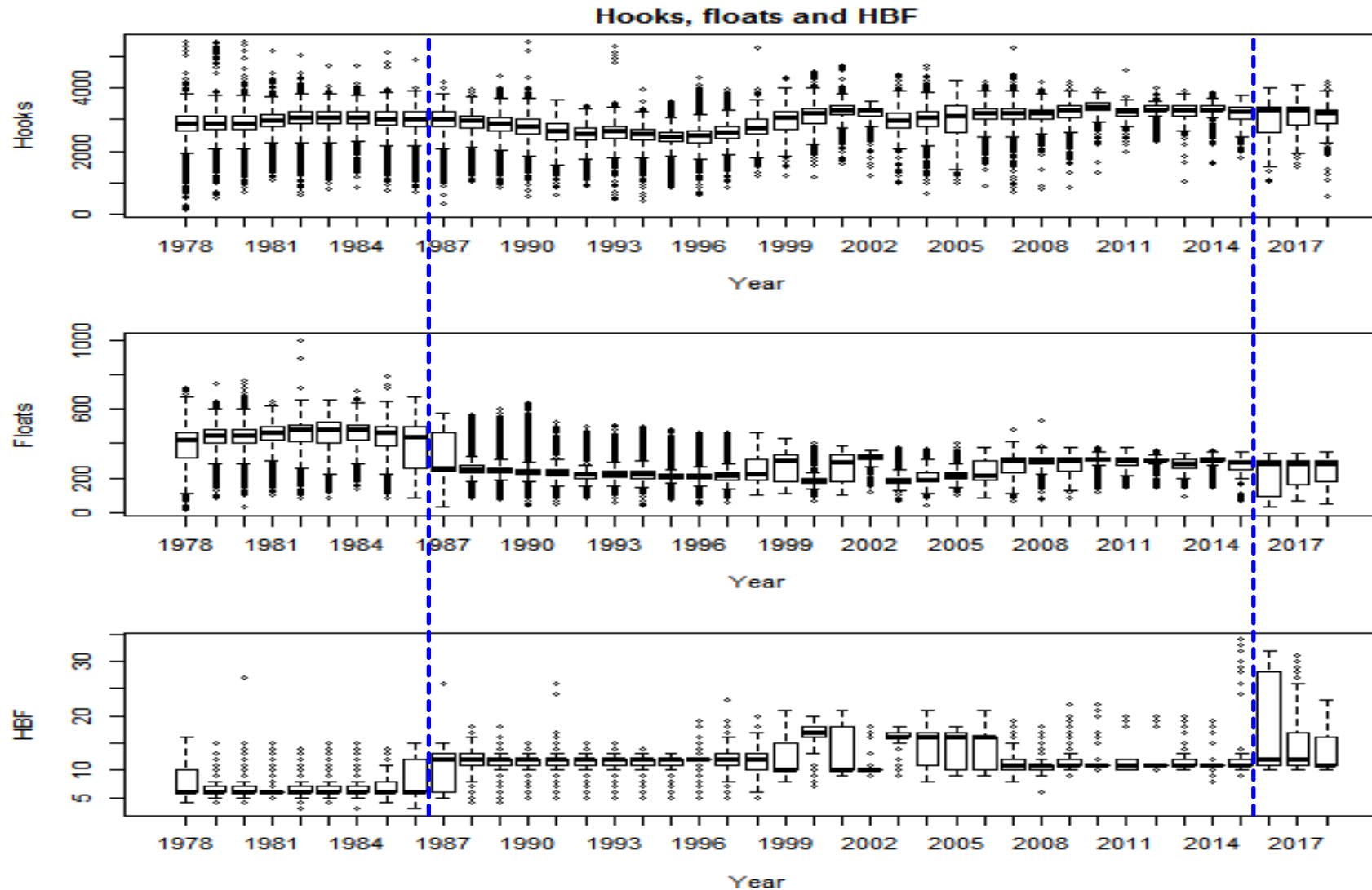
Longline



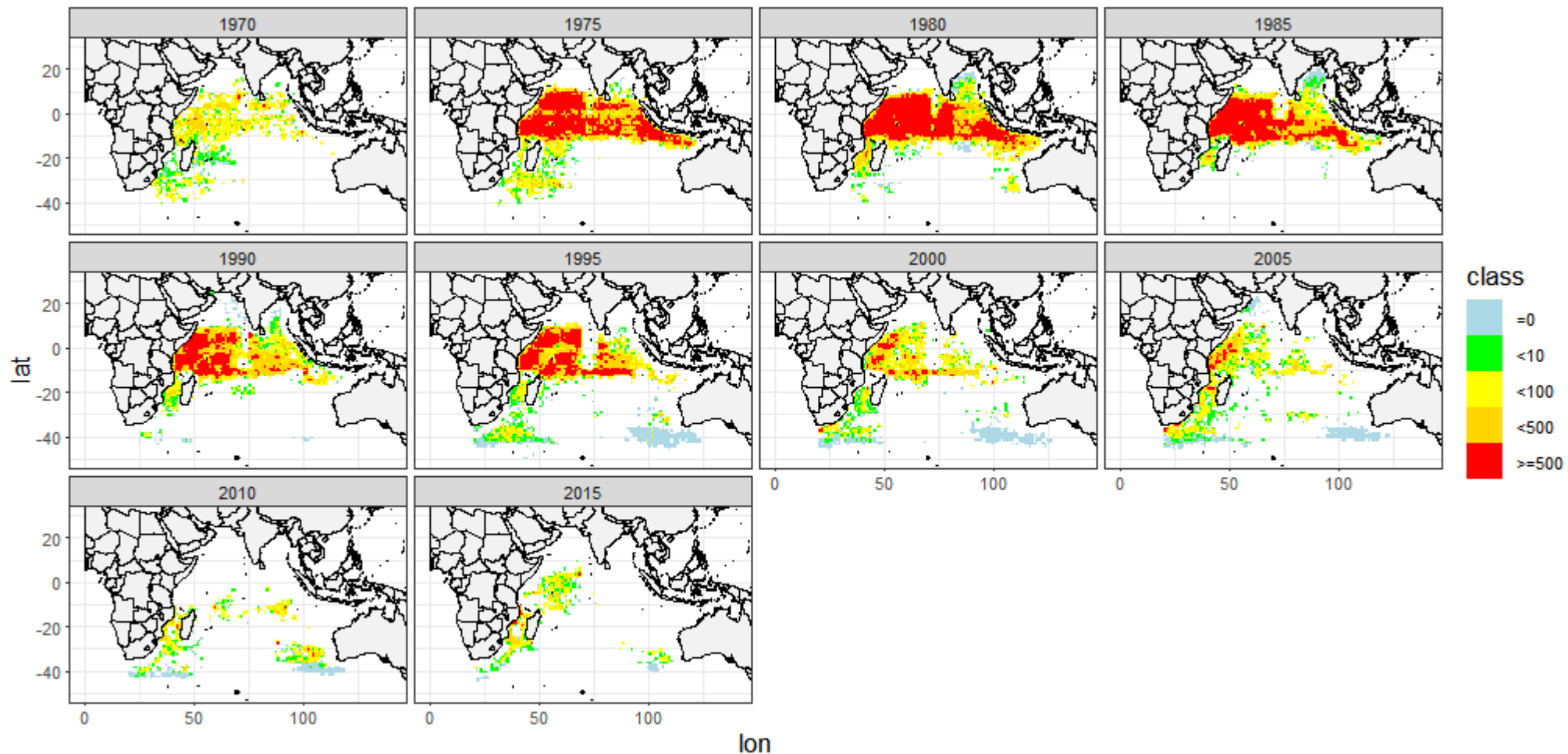
Effort (hooks) distributions of longline fishery



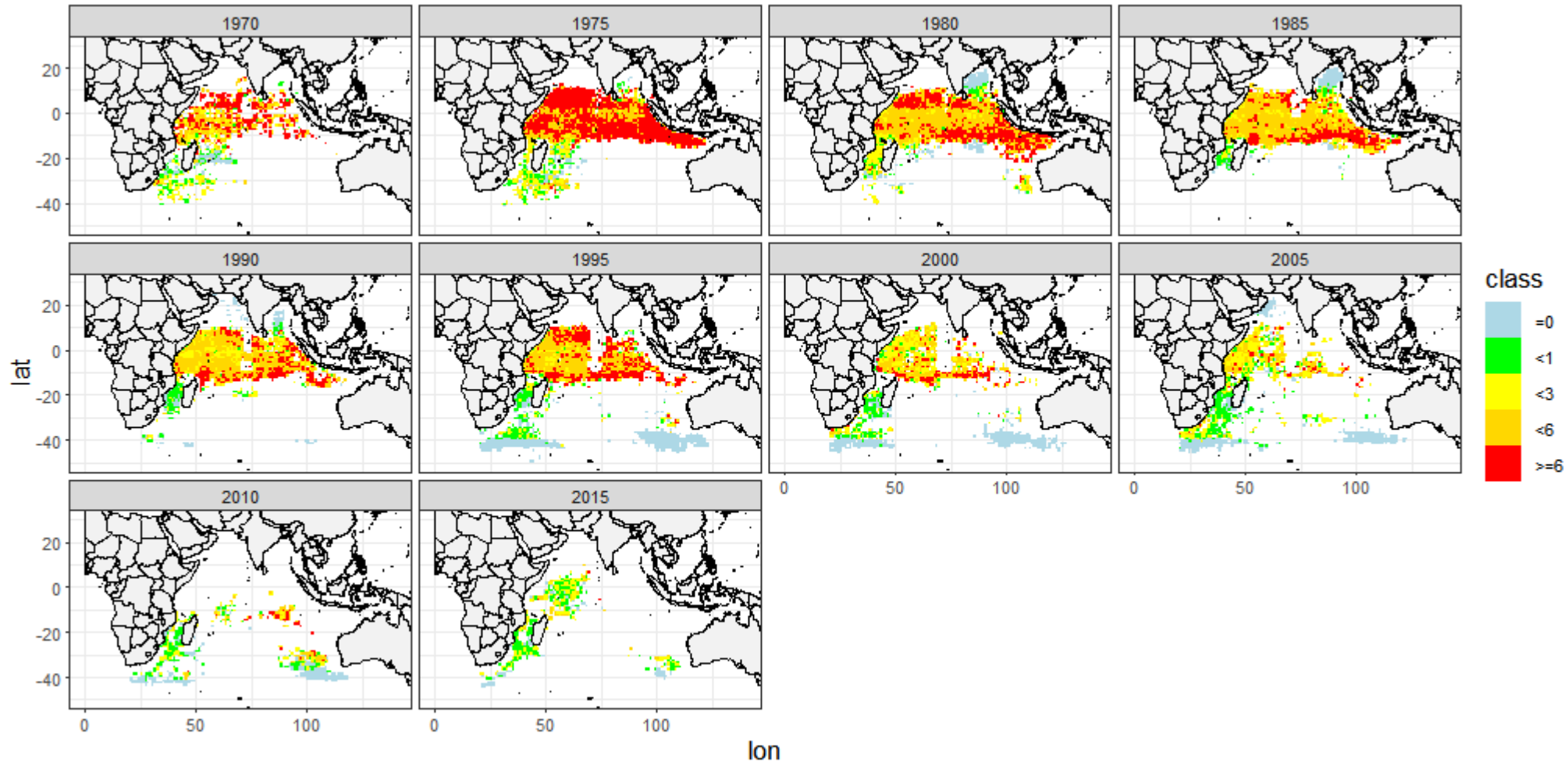
Longline gear configuration



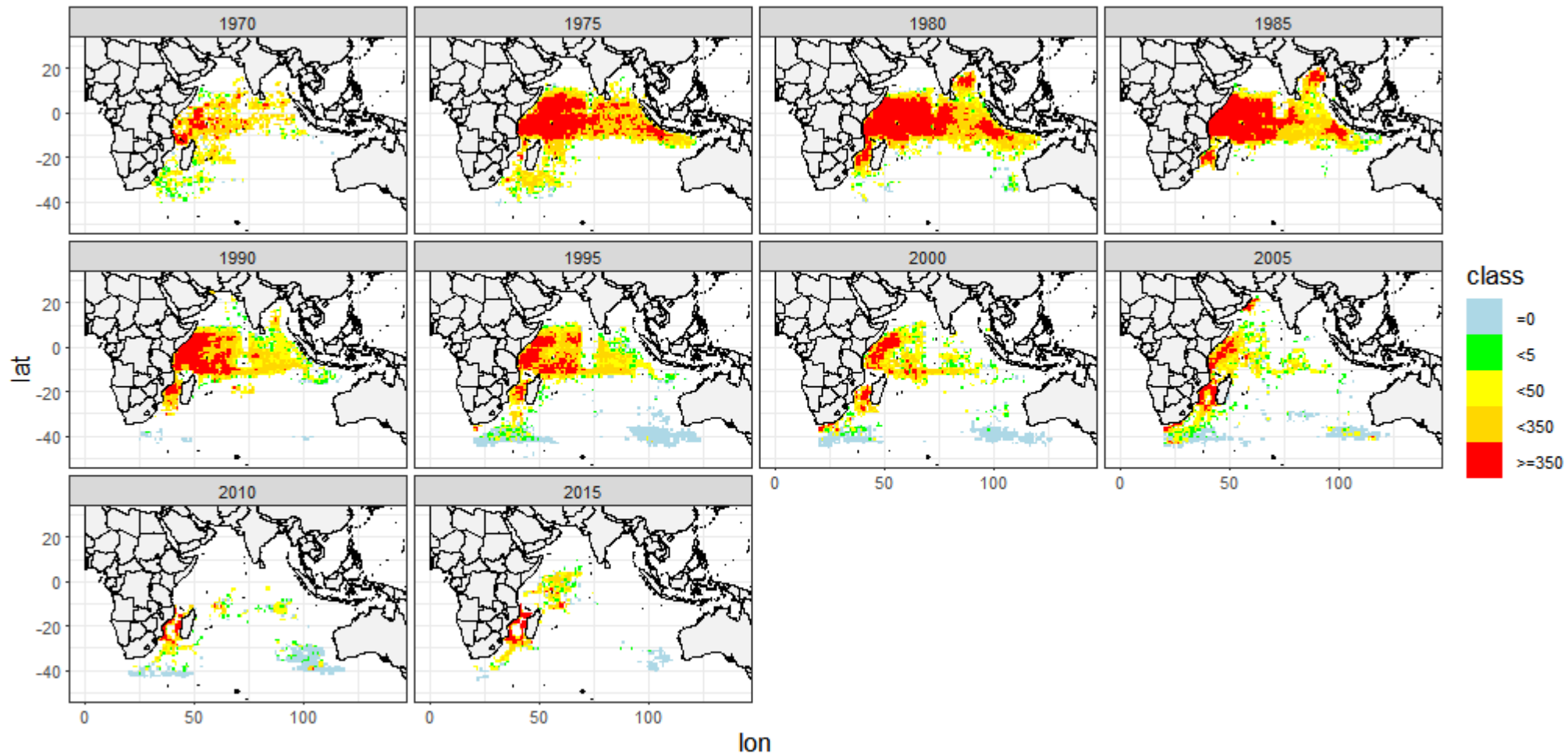
Catch distributions of longline fishery for bigeye



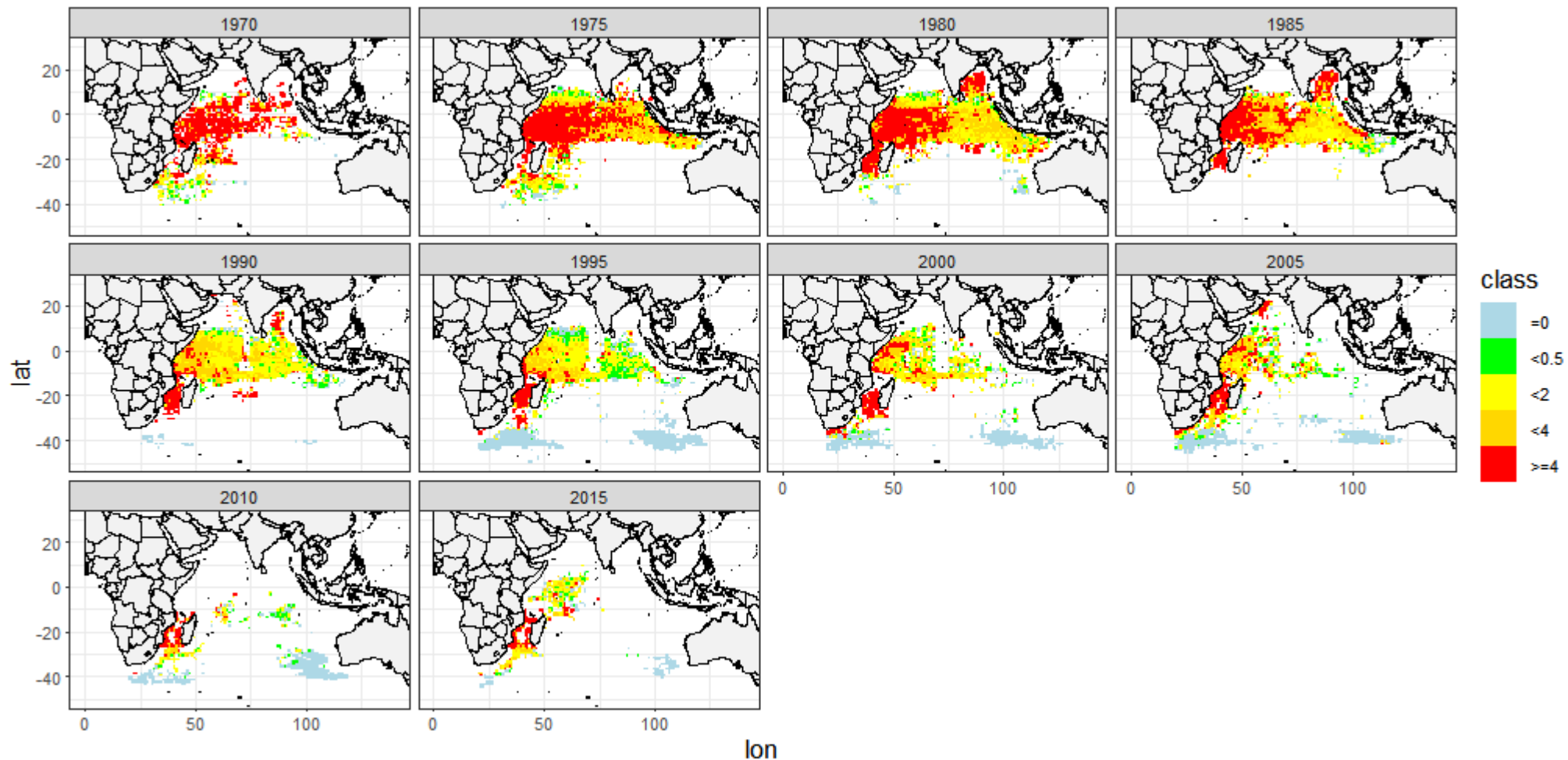
CPUE distributions of longline fishery for bigeye



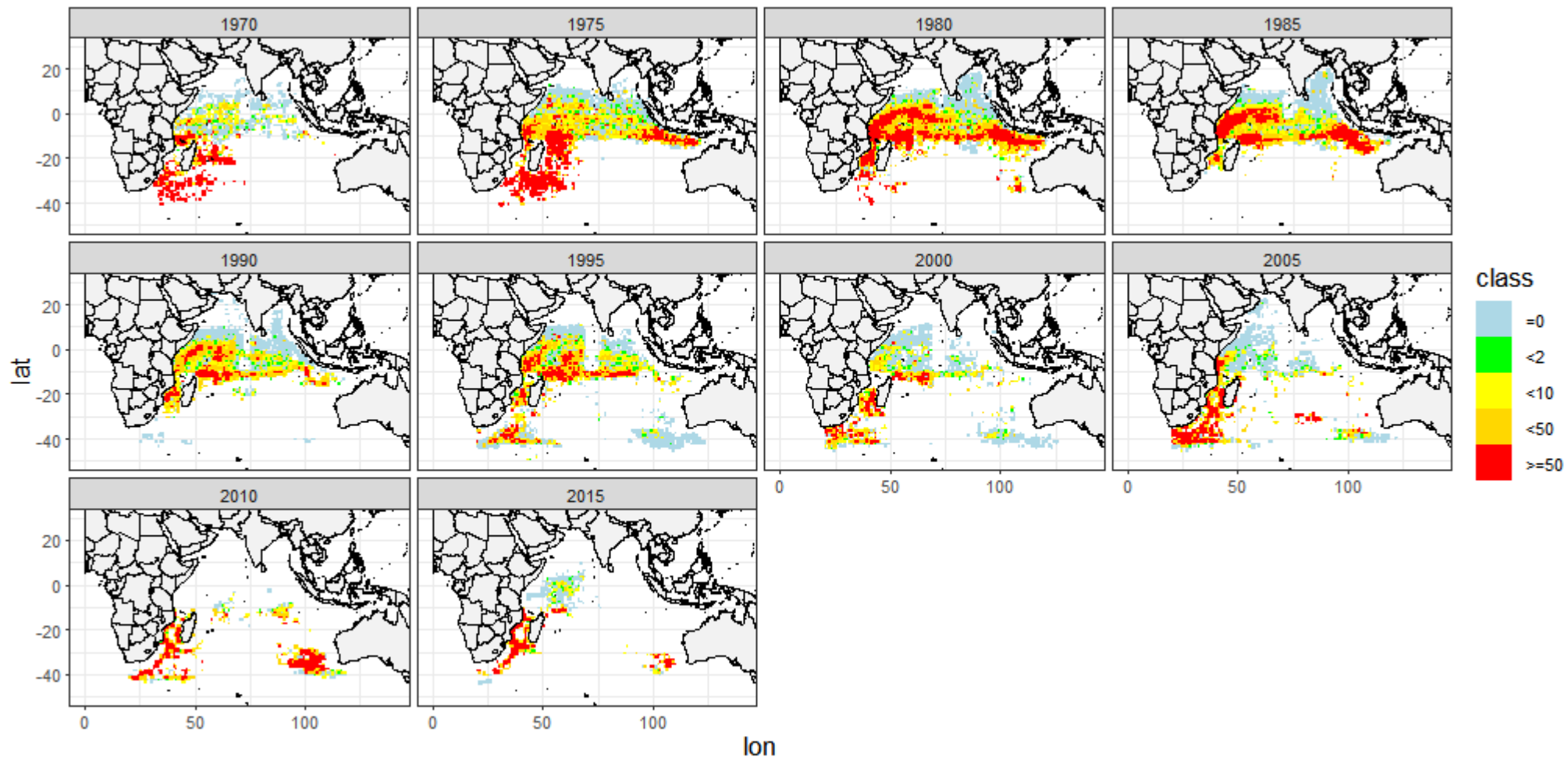
Catch distributions of longline fishery for yellowfin



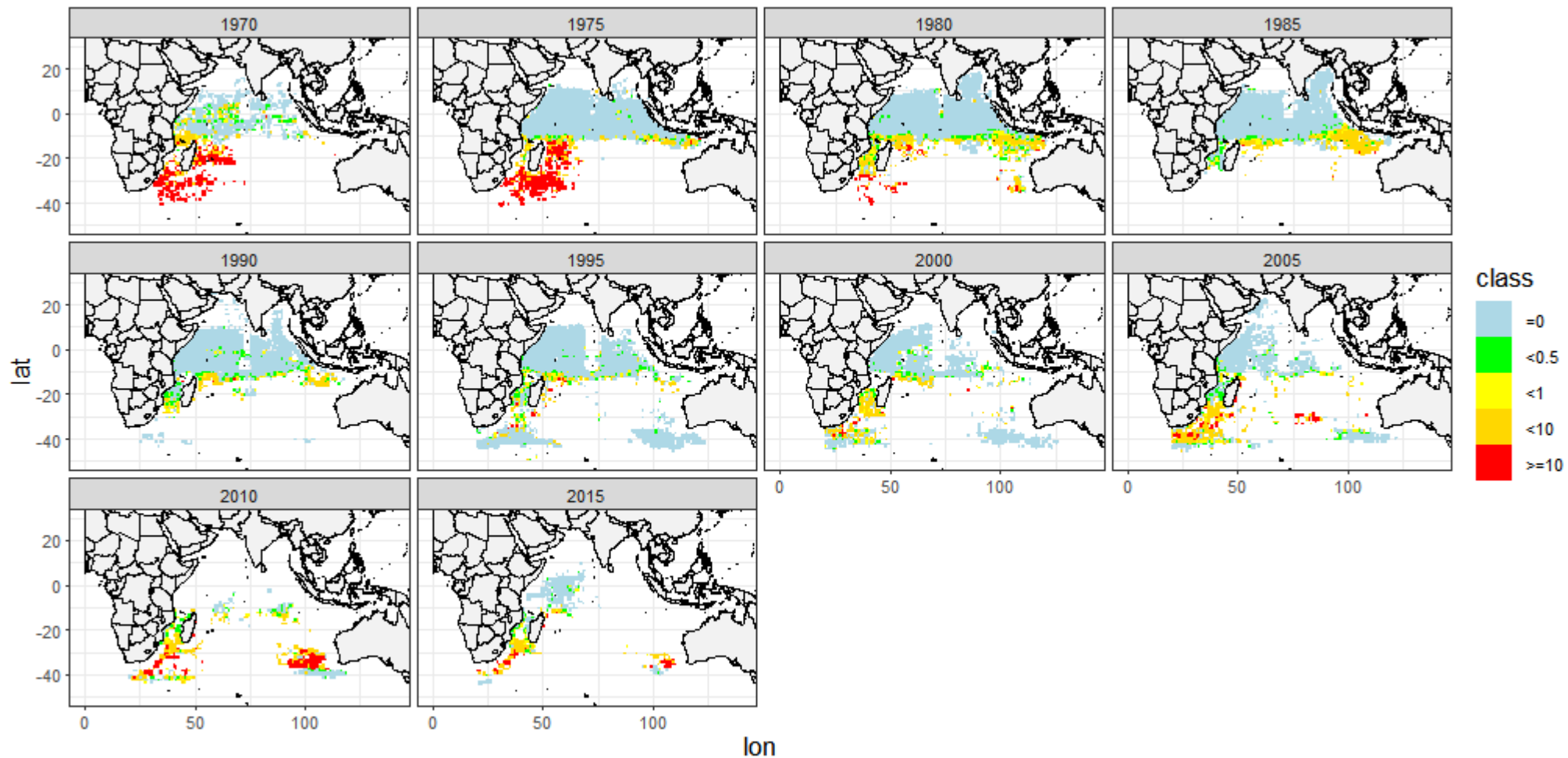
CPUE distributions of longline fishery for yellowfin



Catch distributions of longline fishery for albacore

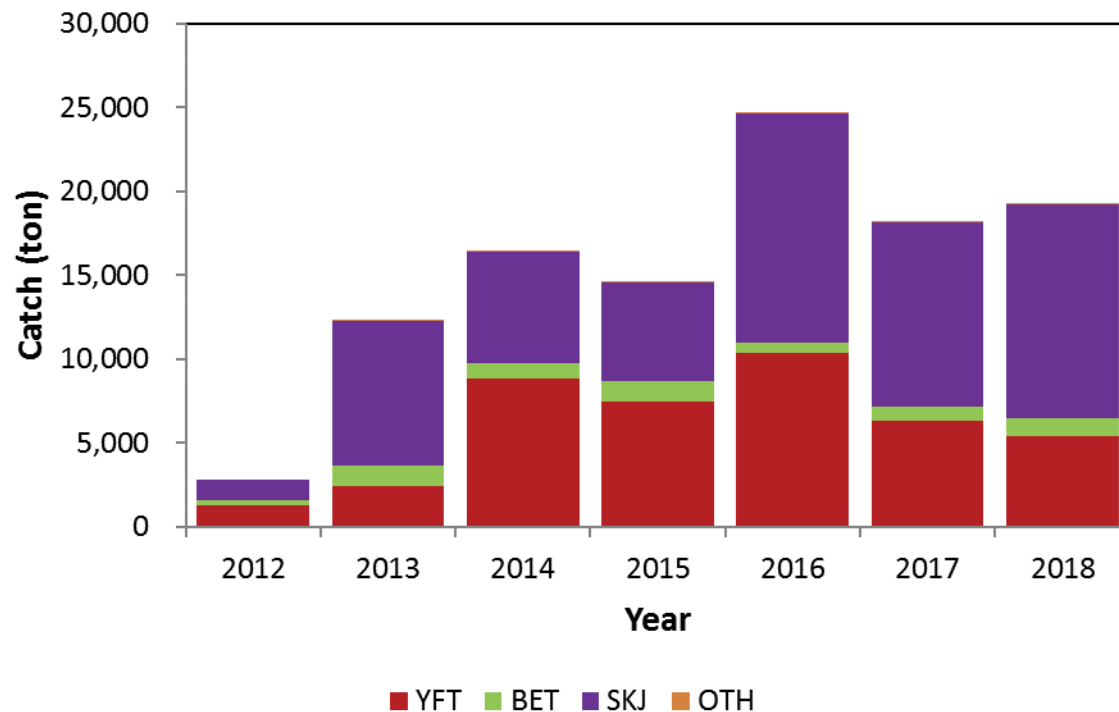


CPUE distributions of longline fishery for albacore

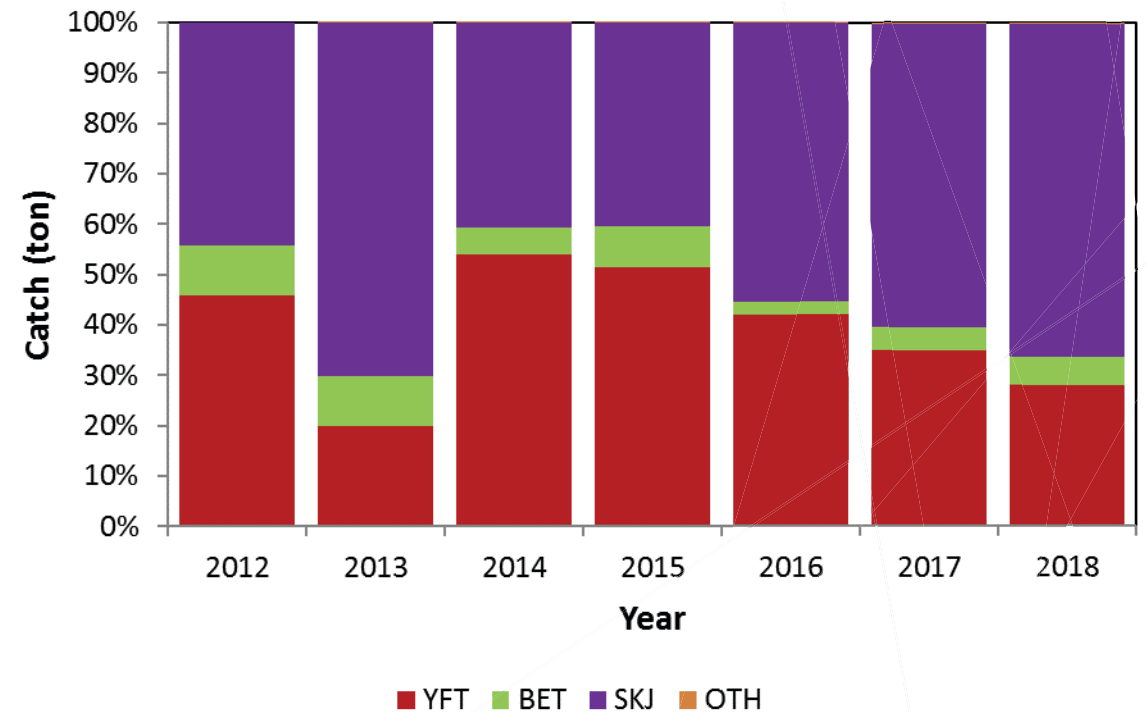


Catch trend of major species of purse seine fishery

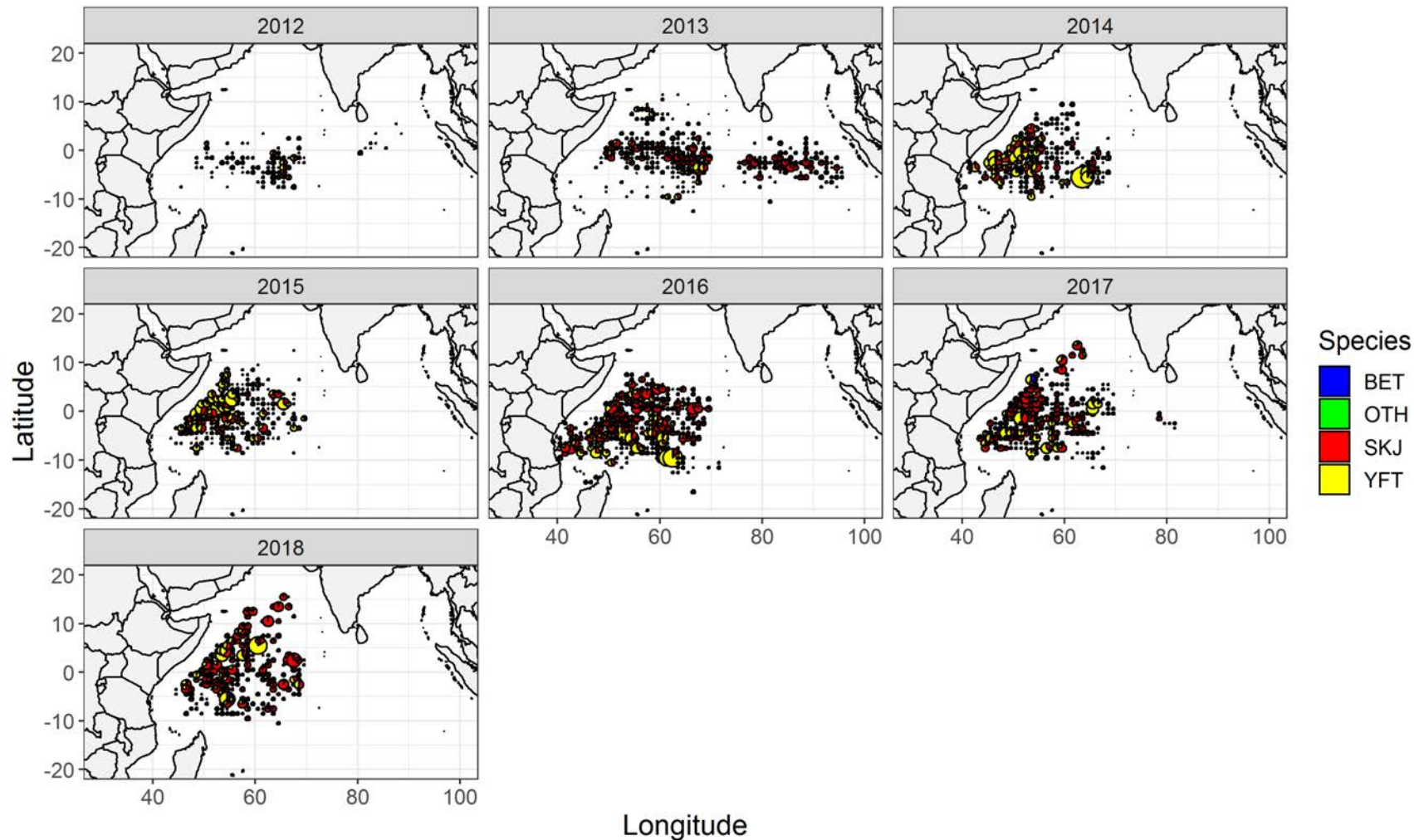
Purse seine



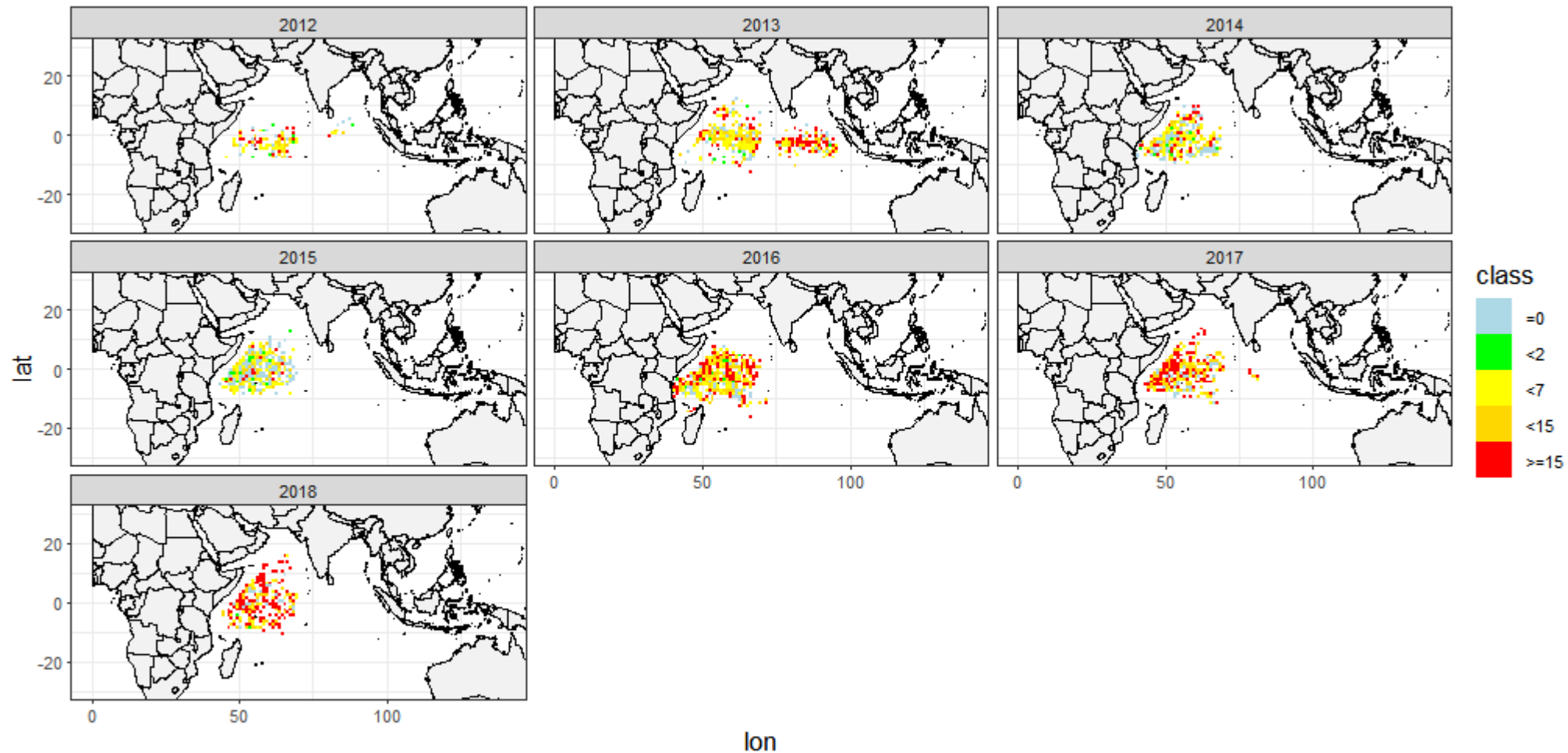
Purse seine



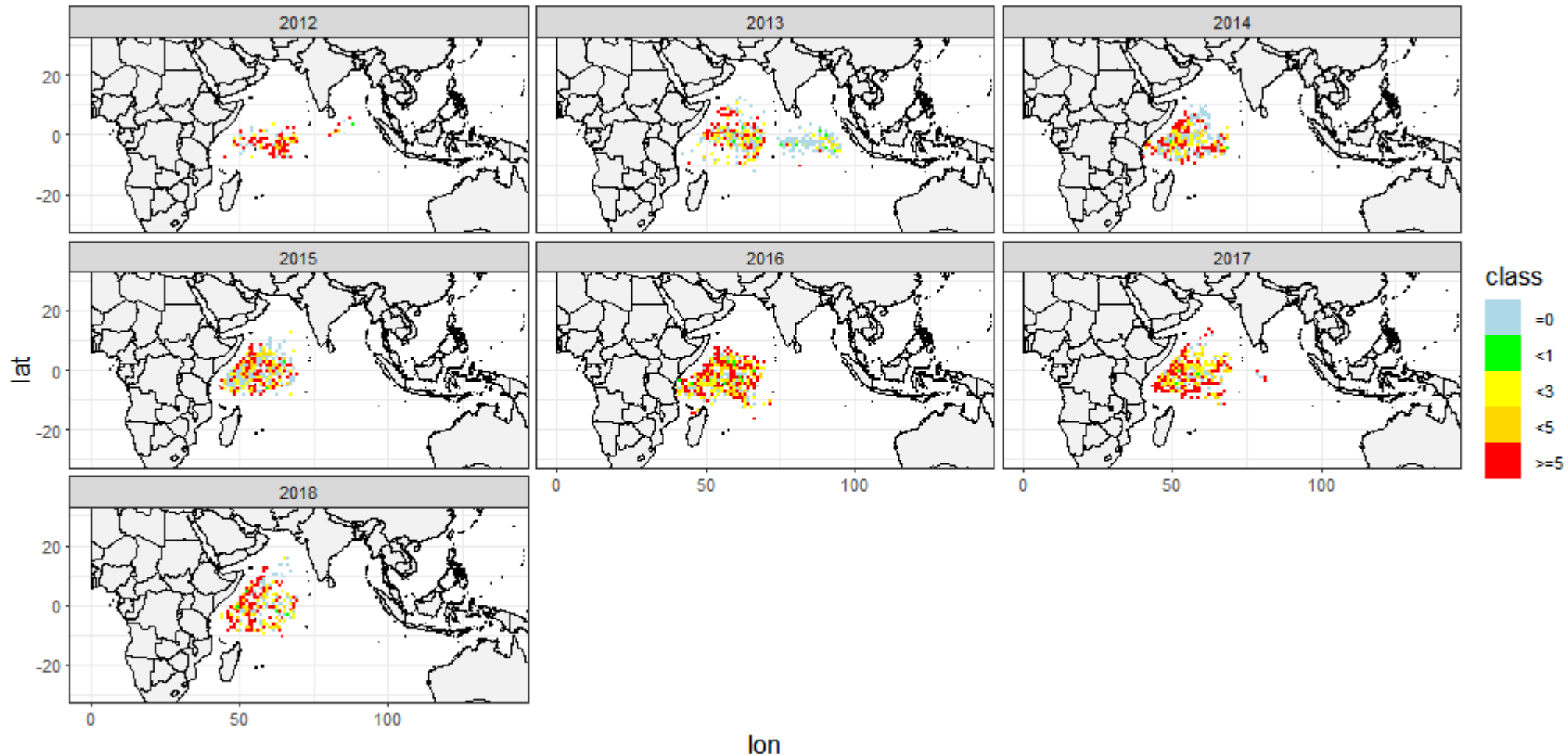
Distributions of catch by species of purse seine fishery



CPUE distributions of longline fishery for skipjack



CPUE distributions of longline fishery for yellowfin



Thank you !



Food and Agriculture
Organization of the
United Nations



iotc ctoi



Introduction to Management Strategy Evaluation with TunaMSE: Stock assessment vs MPs

Dan Fu (IOTC)

Busan, Republic of Korea, 19-20 February 2020



Fishery management

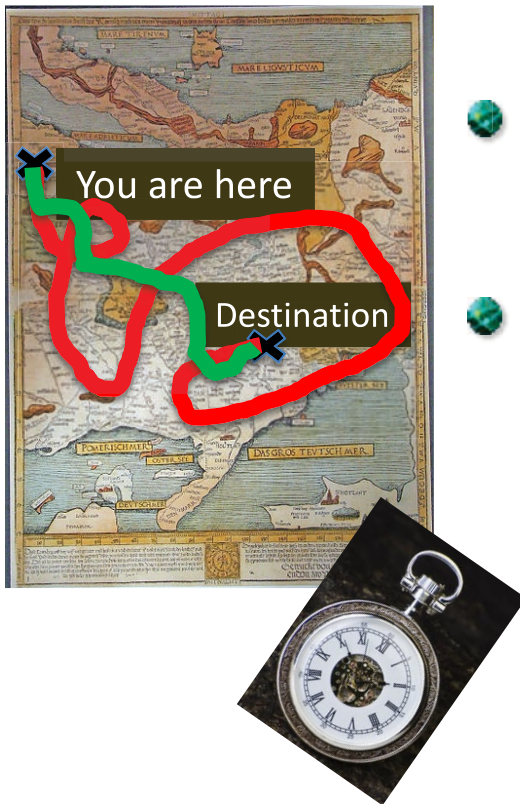
Goals

- Generate sustainable economic and social benefit
- Conserving productivity of the fish stock
- Minimizing direct and indirect impact on wider ecosystem

Requires

- Assessment of stock status and sustainable level of harvest
- Management measures to control fishing in response to changes in the resource

Fishery management challenges



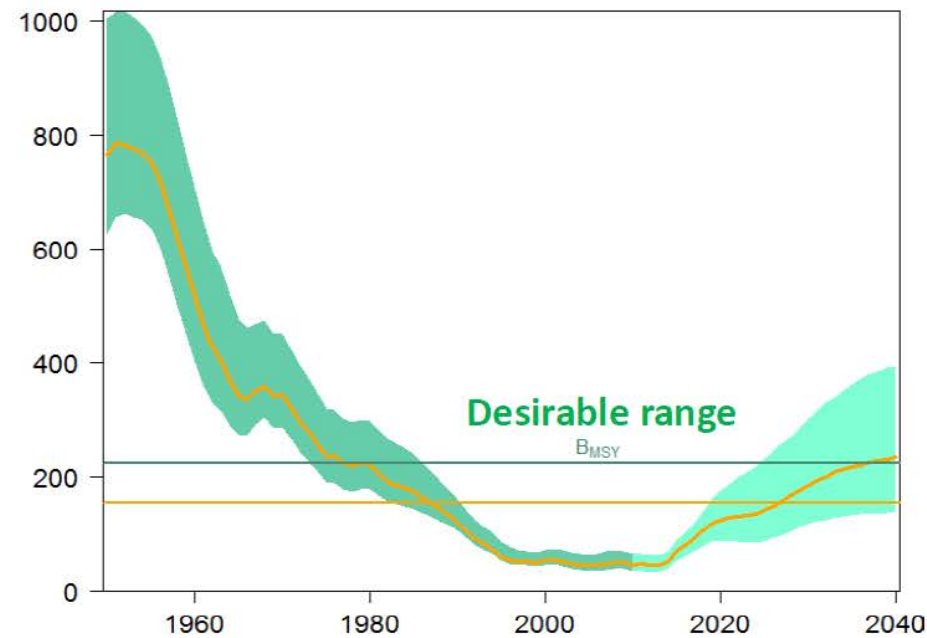
- Assessing the status of the stock and predicting future catch levels
- Monitoring and predicting impacts of the fishery on the resources
- Setting reasonable harvest levels and providing catch advice
 - Making decisions under large uncertainty
 - Making trade-offs between short and long-term objectives

Fishery management elements

- Availability of information on resource status and trends relative to desirable levels
- Capacity to adjust harvest controls in response to changes in stock abundance
- Ability to implement and enforce harvest regulations

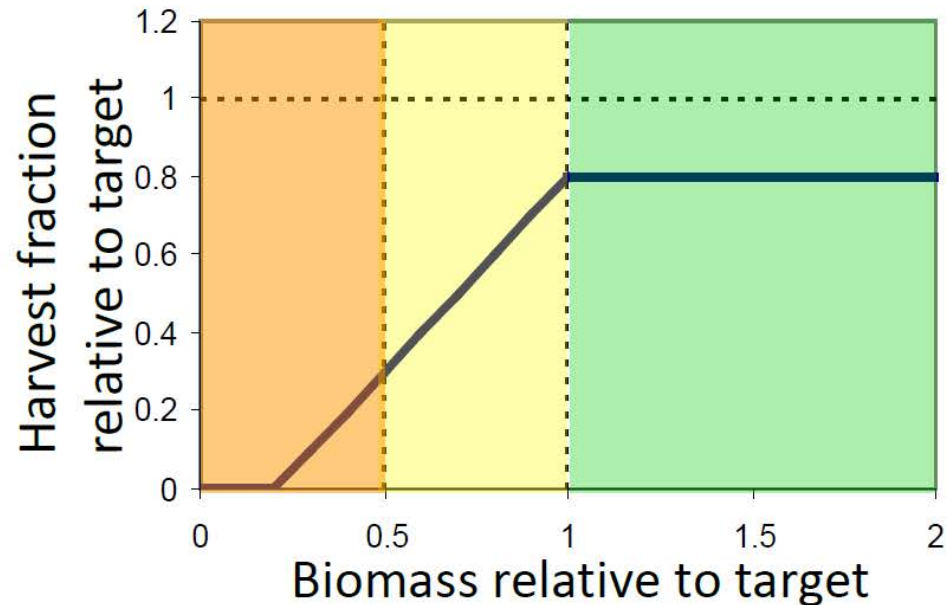
Information on resource status relative to desirable levels

- Analyze data collected using population models
- Estimate historical and current stock status
- Estimate desirable levels of stock size

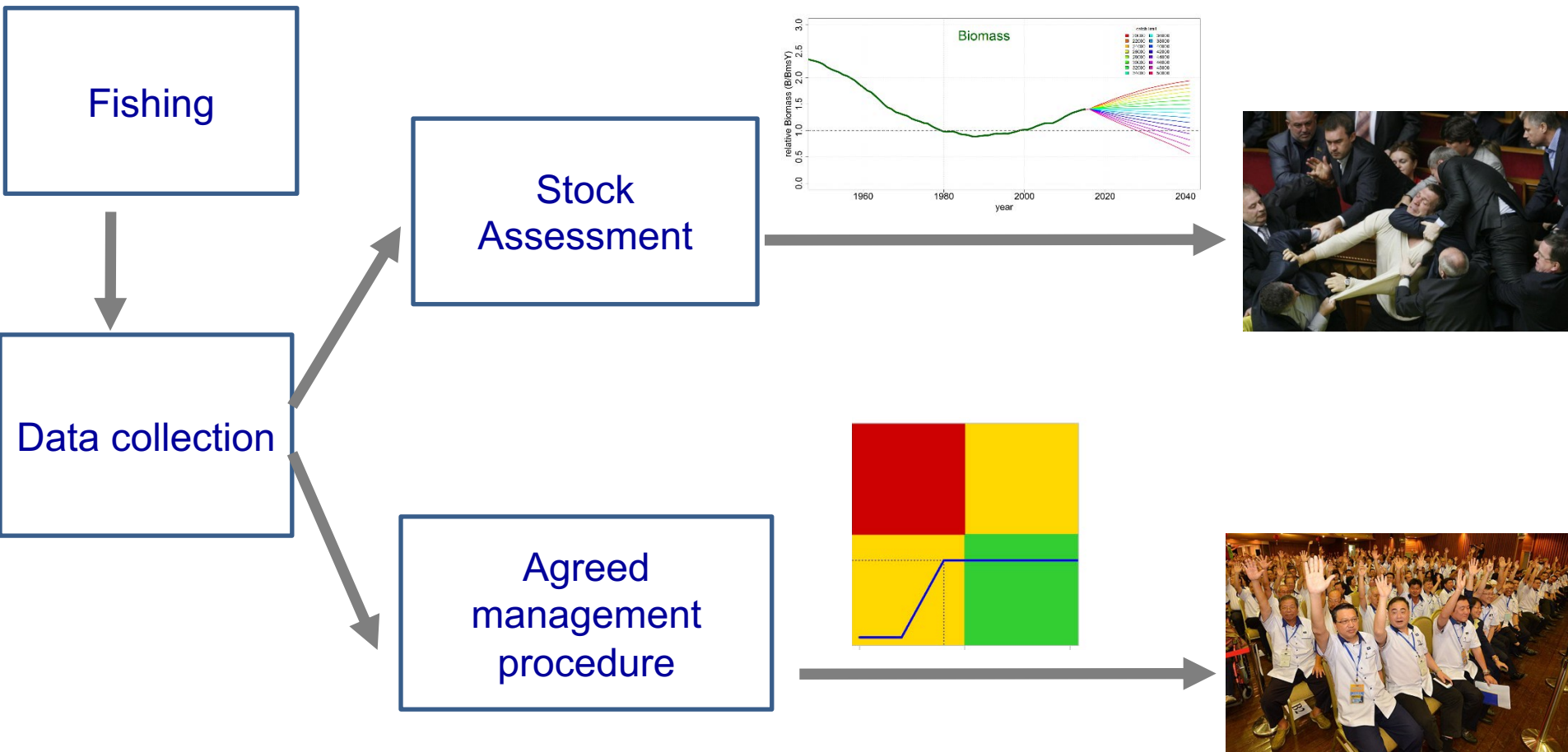


Adjust harvest controls in response to stock abundance

- Set annual catch limit using harvest control rules or management procedures



Catch advice



Stock assessment

- Mathematic representation of population processes
- Provide “best fit” to observations
- Reconstruct population history
- Estimate stock size and reference quantities

Population dynamics

A (very) simple summary:

$$B_{current} = B_0 - F - M + Y$$

Current
state

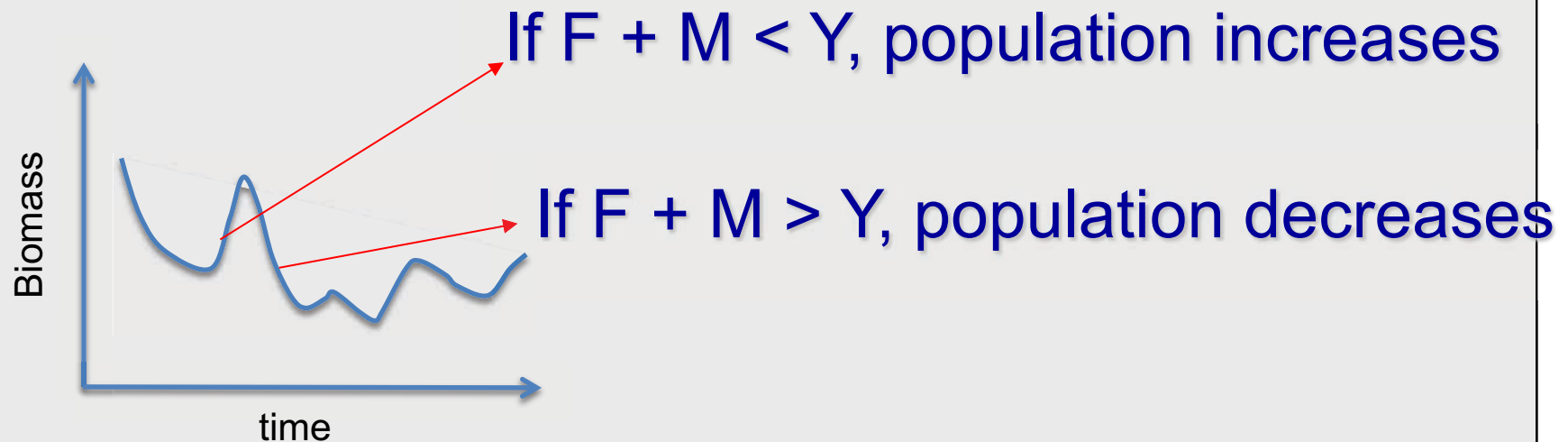
“Initial”
state

Fishing
mortality

Natural
mortality

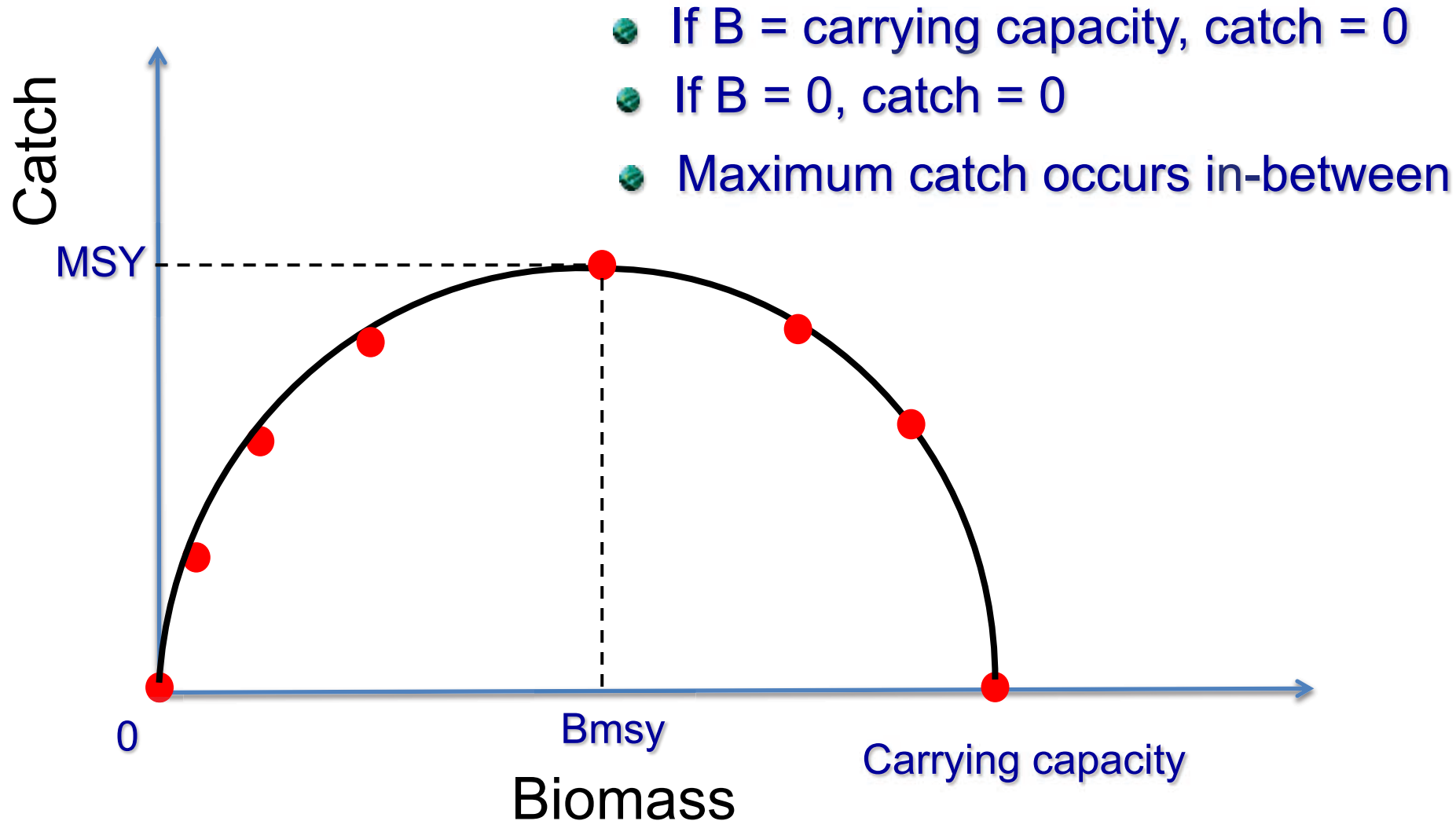
Recruitment
(Births)+Growth

Stock assessment – Reconstruct population history



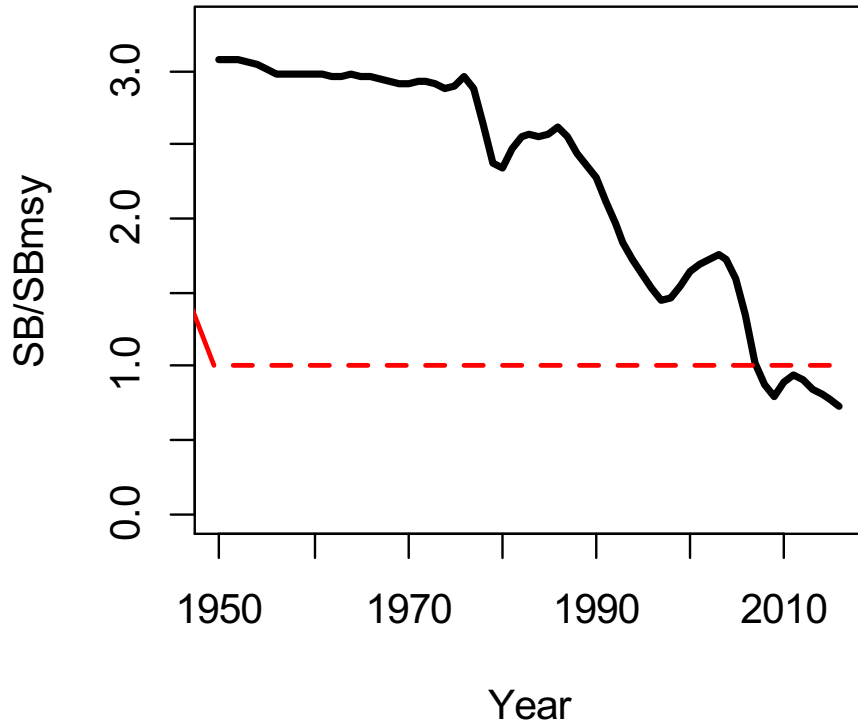
- MSY – maximum catch that can be taken sustainably
- B_{msy} – biomass level that support MSY
- $F_{msy} = MSY / B_{msy}$

Maximum sustainable yield (MSY)

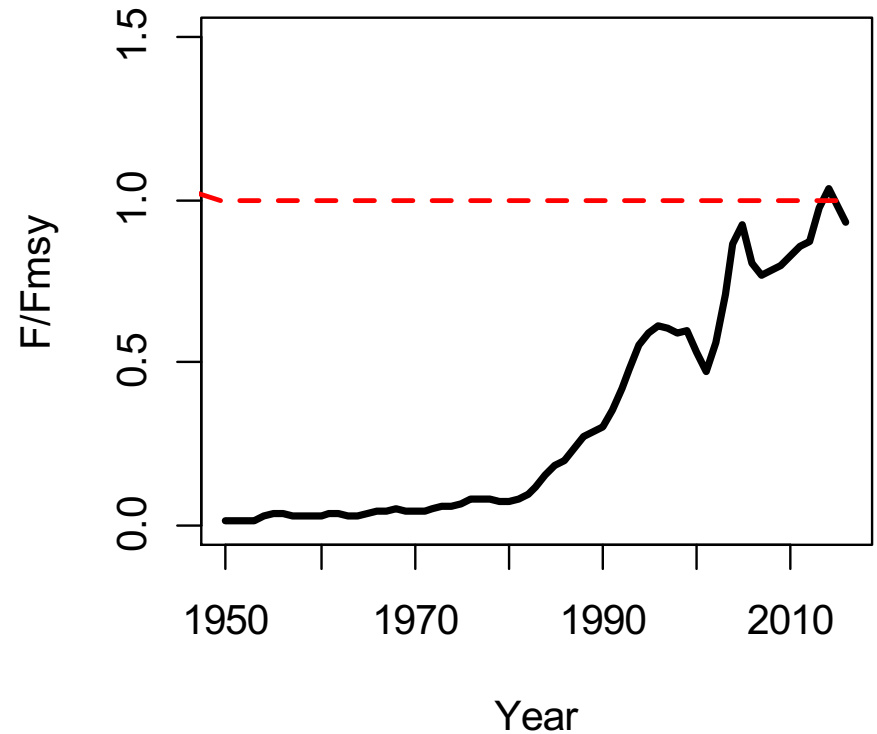


Stock assessment (Yellowfin example*)

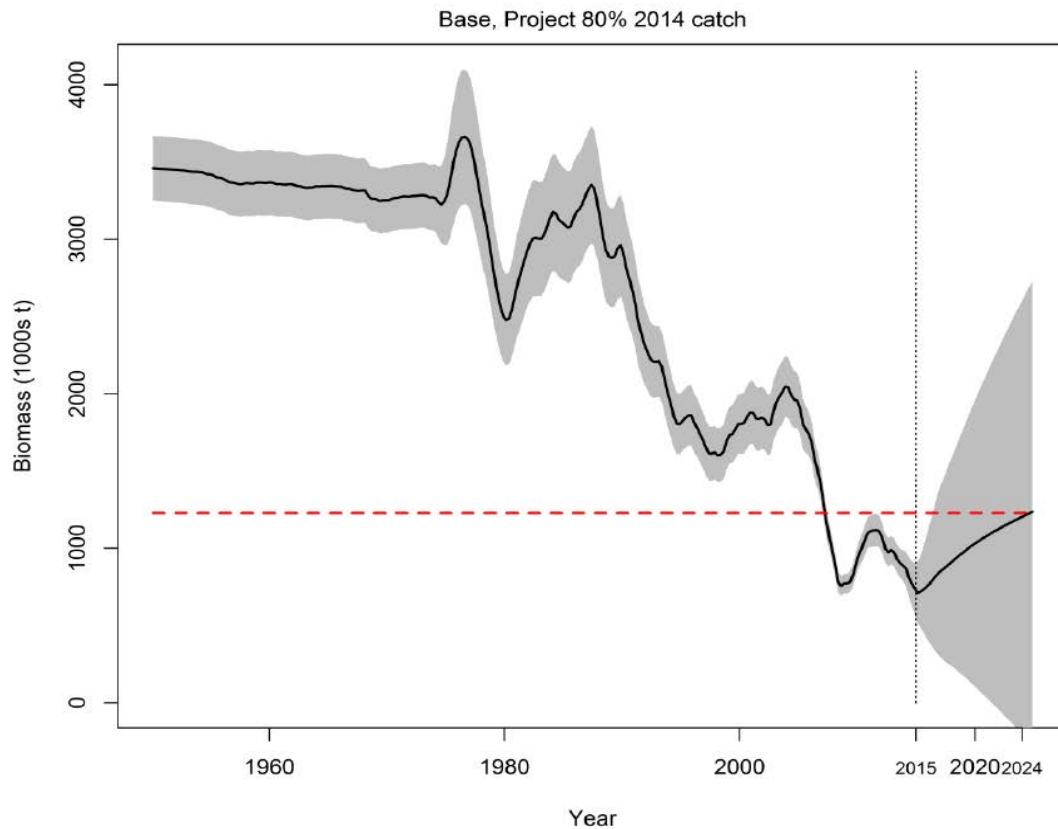
Biomass



Exploitation rates



Stock assessment – Projection



YFT assessment
At 20% catch
reduction, biomass
rebuilds to Bmsy
after 10 years (50%
probability)

Kobe II Strategy Matrix

TAC	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
0	38%	56%	74%	86%	91%	94%	96%	97%	98%	98%	99%	99%	99%	99%	100%	100%	100%	100%
20000	29%	38%	45%	54%	63%	69%	75%	79%	83%	85%	87%	89%	90%	92%	93%	93%	94%	95%
22000	28%	36%	43%	50%	58%	64%	70%	75%	78%	81%	84%	85%	87%	89%	89%	91%	92%	92%
24000	27%	35%	40%	46%	53%	59%	64%	69%	73%	76%	79%	81%	83%	84%	86%	87%	88%	89%
26000	26%	33%	38%	43%	49%	54%	59%	63%	67%	70%	73%	76%	78%	79%	81%	83%	84%	84%
28000	25%	31%	36%	39%	44%	49%	53%	57%	61%	63%	66%	69%	71%	73%	75%	76%	77%	79%
30000	24%	29%	34%	37%	39%	43%	47%	50%	54%	57%	59%	61%	63%	65%	66%	68%	69%	71%
32000	23%	27%	31%	34%	36%	39%	41%	44%	47%	49%	51%	53%	55%	57%	58%	59%	61%	62%
34000	22%	24%	27%	30%	32%	34%	36%	38%	40%	41%	43%	45%	47%	48%	49%	50%	52%	52%
36000	21%	22%	23%	25%	27%	29%	31%	32%	33%	34%	35%	36%	38%	39%	40%	40%	41%	42%

Stock assessment summary

- Reconstruct population history
- Estimates of current stock status
 - Overfished ? ($\text{Biomass} < \text{B}_{\text{msy}}$)
 - Overfishing? ($F > F_{\text{msy}}$)
- Forecast of future stock status

'Tuna MSE' – Stock assessment

Toy Tuna MSE

About

Manual Projections

HCR Projections

Multiple HCRs

Summary

Specifications

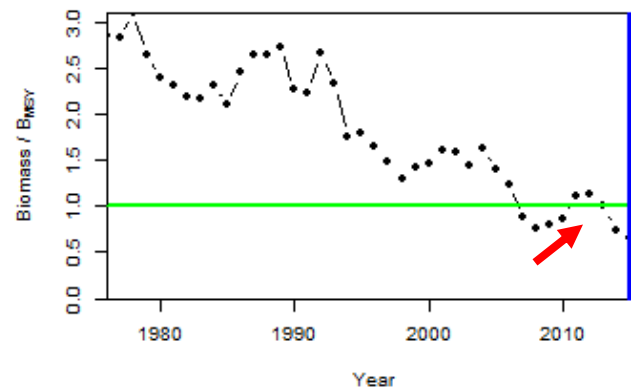
Management decisions (mouse over for description)

Catch Limit ('000); Catch(2014)=408

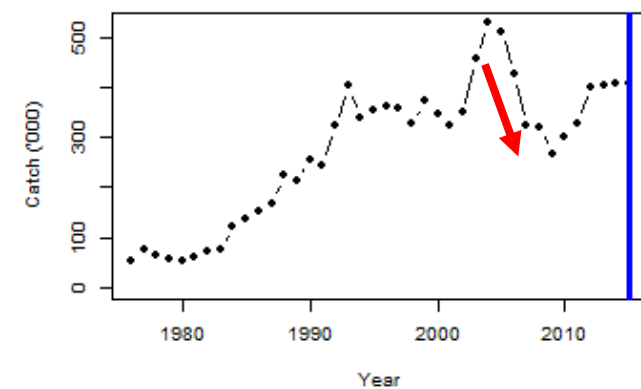
Length of quota period

Project and Update

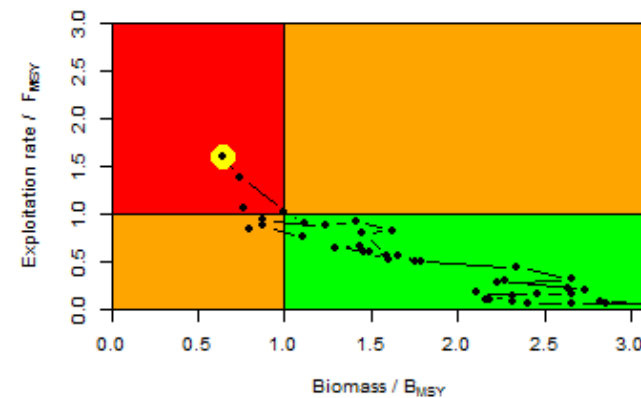
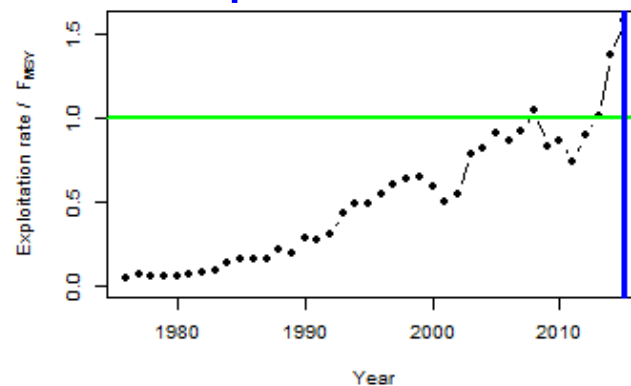
Stock status



Catch

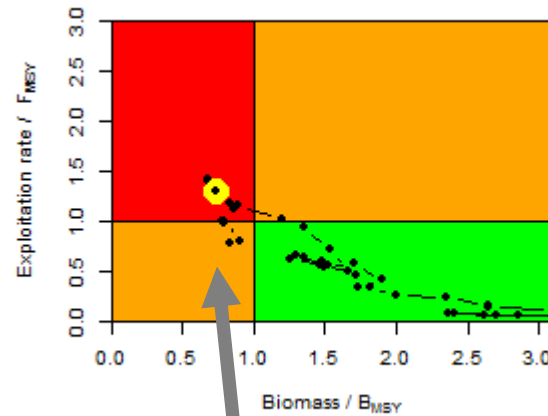


Exploitation rate

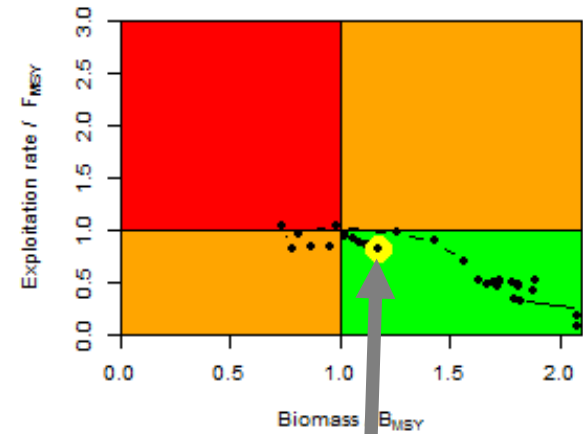


'Tuna MSE' – Underlying Truth

We are
not always
lucky !



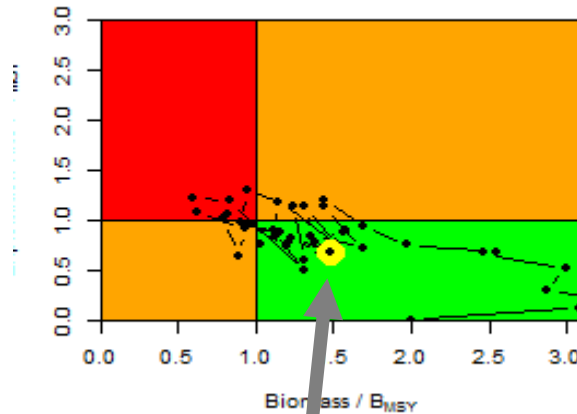
Assessment: the
stock is in red



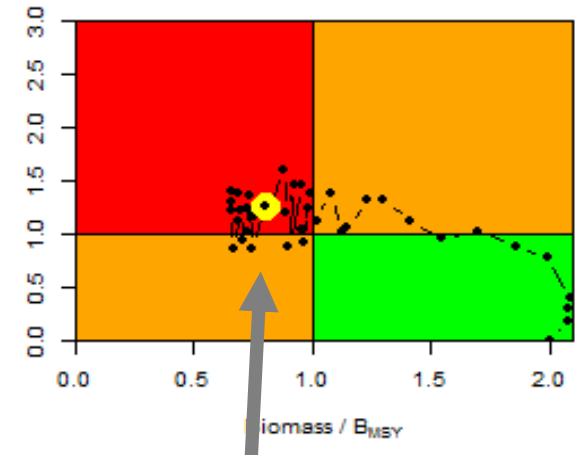
The truth: the
stock is in green

'Tuna MSE'– Underlying Reality

We are
not always
lucky !



Assessment : the
stock is in green

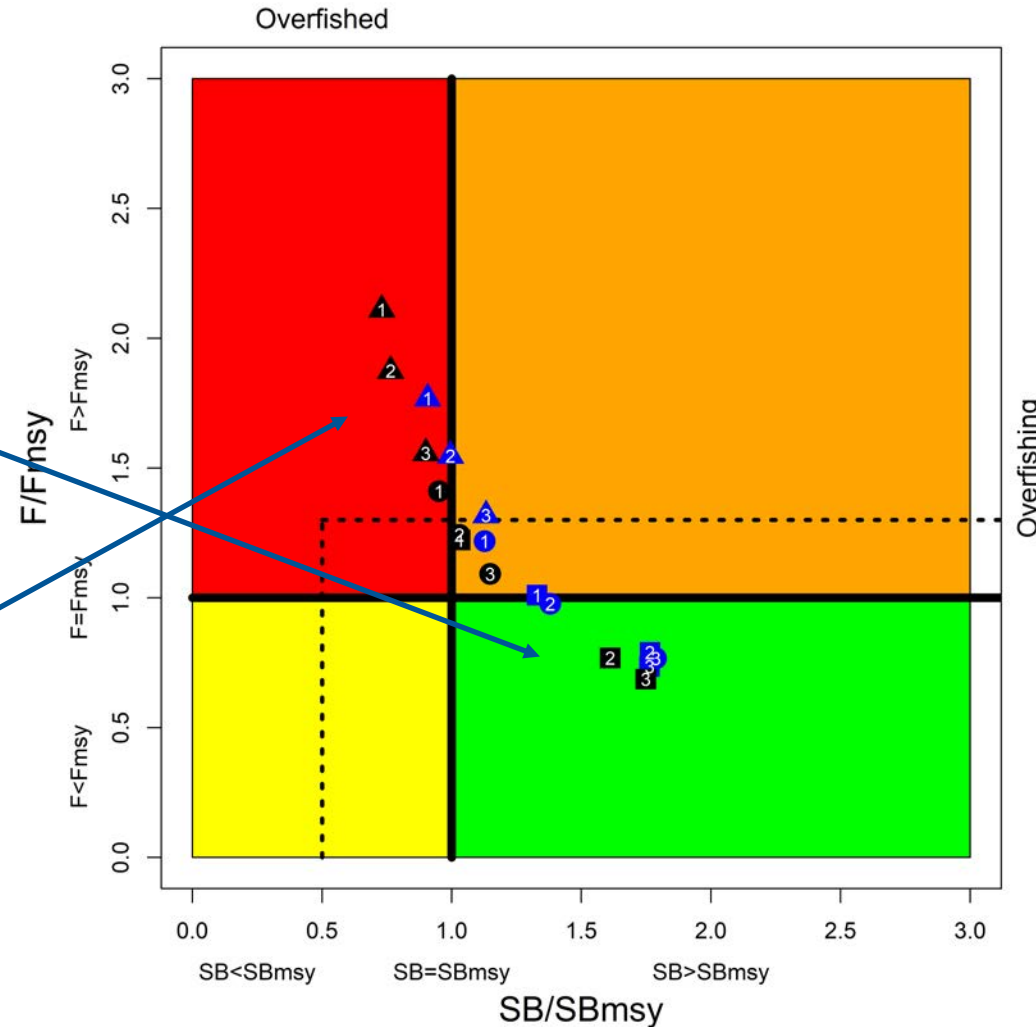
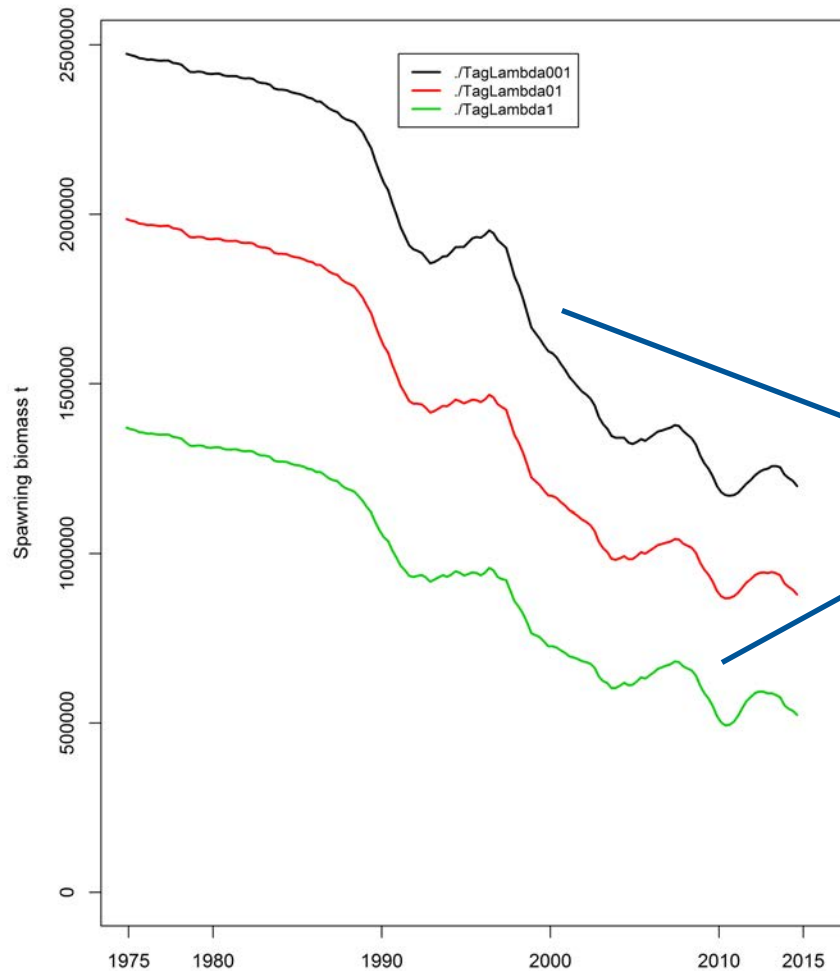


Reality: the
stock is in red

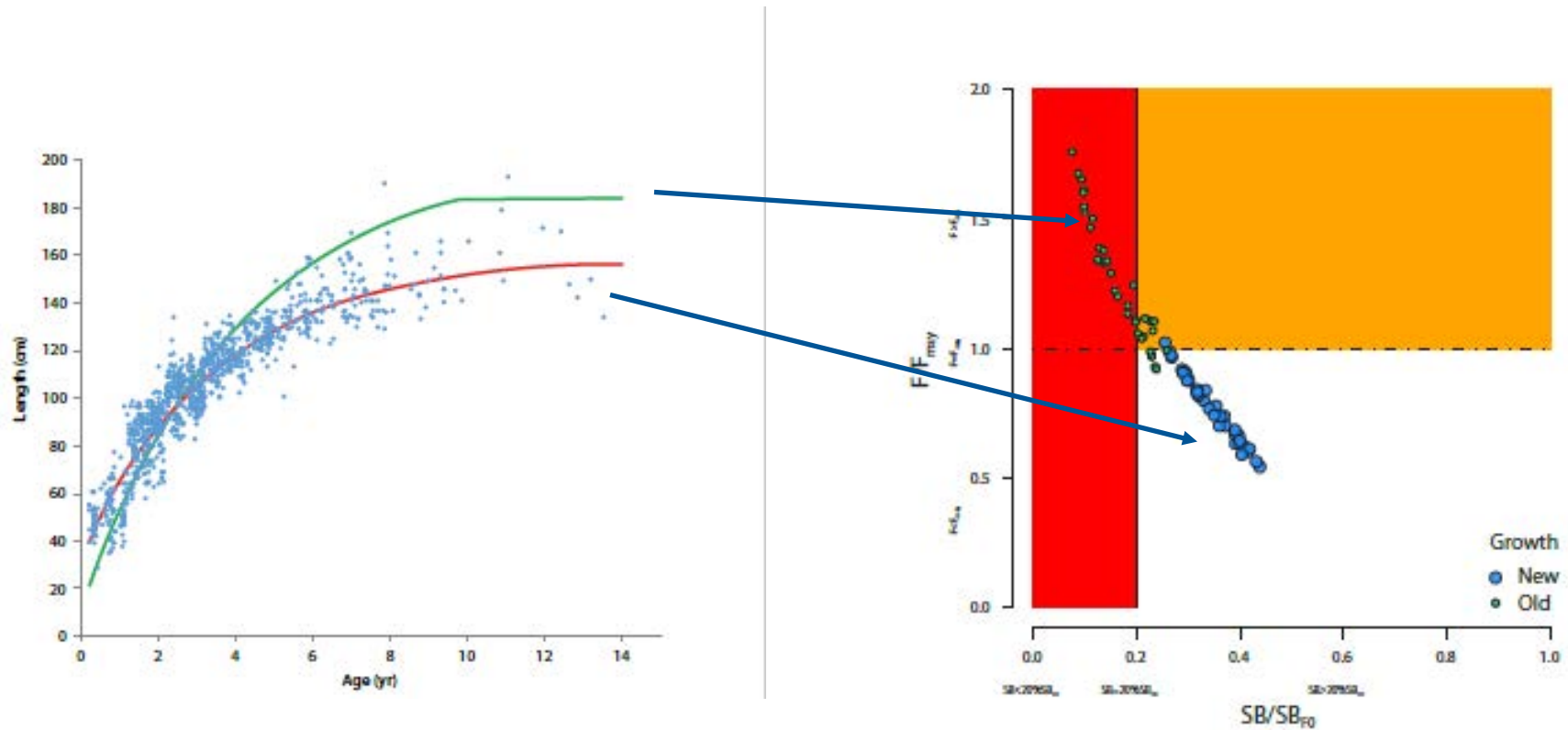
Stock assessment issues

- Uncertainty in the status of the Stock
- Uncertainty in future levels of recruitment
- Uncertainty in the impact of future catches on the Stocks
- Overall uncertainty in state of stock and impacts of future catches makes consensus decision making difficult

IOTC bigeye tuna assessment



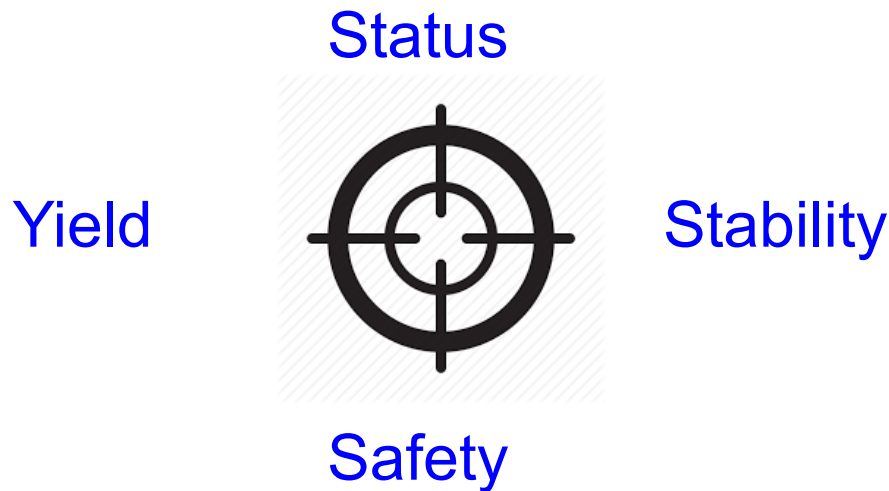
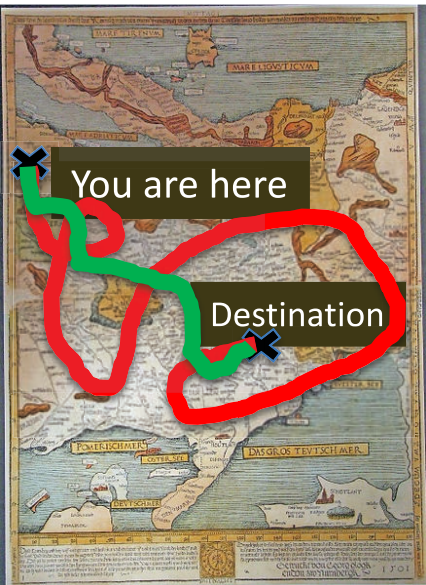
WCPFC bigeye tuna assessment



Disadvantages of stock assessment

- Results depended on quality of the data, and may be sensitive to method used
- Stock status is uncertain, and can easily change with new interpretation of data or change of models
- Often consider the most probable scenario, not covering a wide range of possibilities
- not characterize the full uncertainty in the long-term
- Not considering management response
- No rules about how quotas will be set and thus no transparency and understanding of what will happen

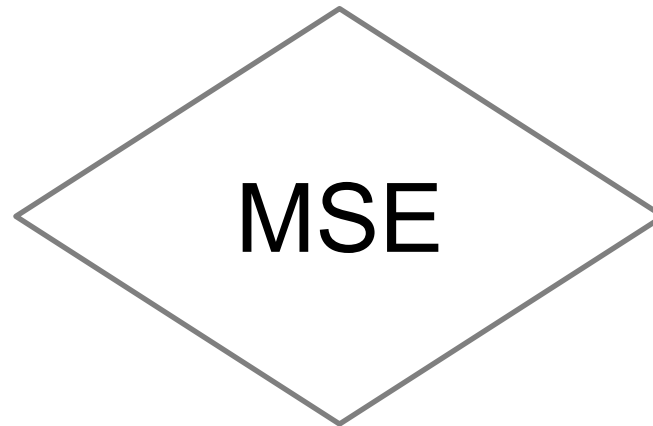
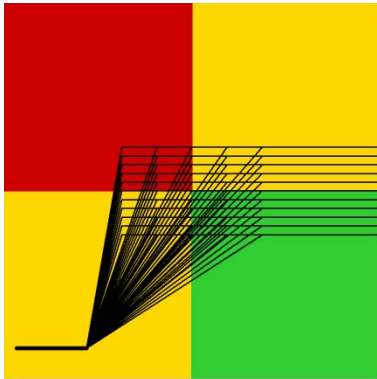
Being there is everything



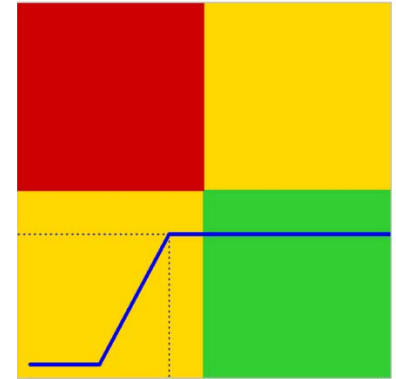
- Stock assessment – where we are now
- Management procedure – How to get there
- MSE – What's the best way

Management strategy evaluation

Candidate
management
procedures



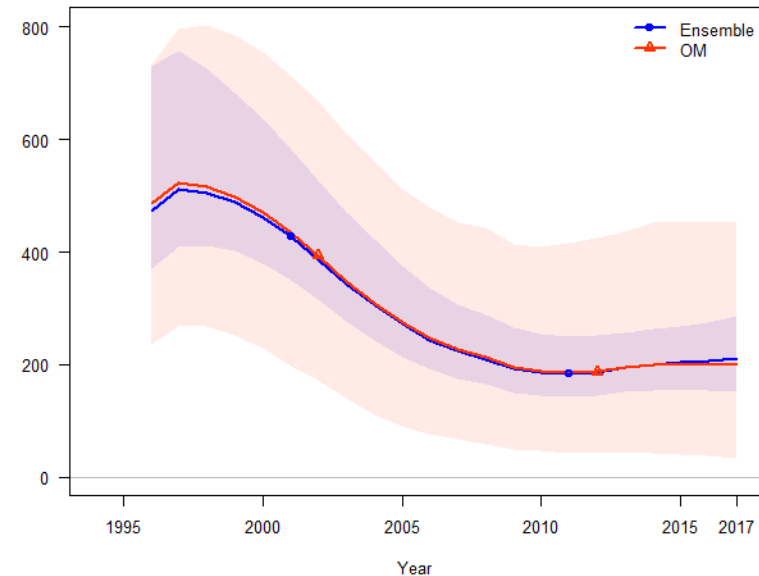
Agreed
management
procedures



- Management objectives
- Operating models
- Simulation testing
- Performance measures

Advantages of Management Procedure

- Incorporates greater uncertainty than the assessment
- The goal is to develop a management procedure robust to uncertainty and variability in the long-term



Allan Hicks, IPHC (2018)

Advantages of Management Procedure

- Provides greater certainty for all stakeholders (agreed rules for decision making).
- Designed to achieve an agreed balance between competing management objectives.
- Provides a better chance of achieving management objectives (pre-testing to identify robust strategies).
- Designed to be robust to current scientific uncertainty.
- Demonstrates to the community that you are managing responsibly.

Challenges with Implementing a Management Procedure

- Technical challenges in developing and testing an MSE.
- Scientists and Commissioners are required to make a number of decisions and choices related to:
 - The management objective.
 - Choice of Harvest control rules
- Each decision involves trade-offs between catch and risk to the stock.



Food and Agriculture
Organization of the
United Nations



Introduction to Management Procedure approach, components and concepts

**Furthering Capacity Building for Harvest Control Rules and Management Strategy
Evaluation: Indian Ocean Tuna Management Workshop**

Busan, Republic of Korea, 19-20 February

**Dr. Hilario Murua (ISSF)
Dr. Dan fu & Dr. Toshihide Kitakado
(TUMSAT)**

Outline

- Provision of Management Advice (**H. Murua**)
 - Target and Limit Reference Points,
 - Kobe Plot,
 - Decision framework.
- MP and MSE basic principles (**T. Kitakado**)
 - Objectives,
 - Timeframes & risk,
 - Trade-off between objectives,
 - MSE Process
 - Feedback from managers,
- Presentation of MSE Results (**T. Kitakado**)
 - Performance Indicators
- Roles and responsibilities and feedback mechanism

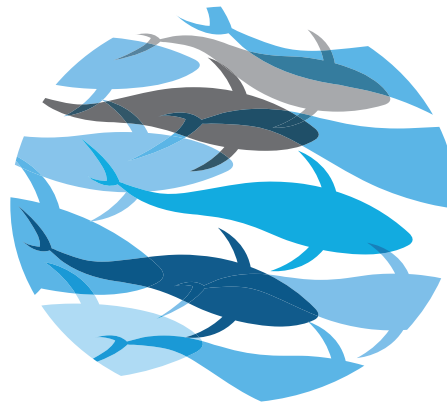
PROVISION OF MANAGEMENT ADVICE



Food and Agriculture
Organization of the
United Nations



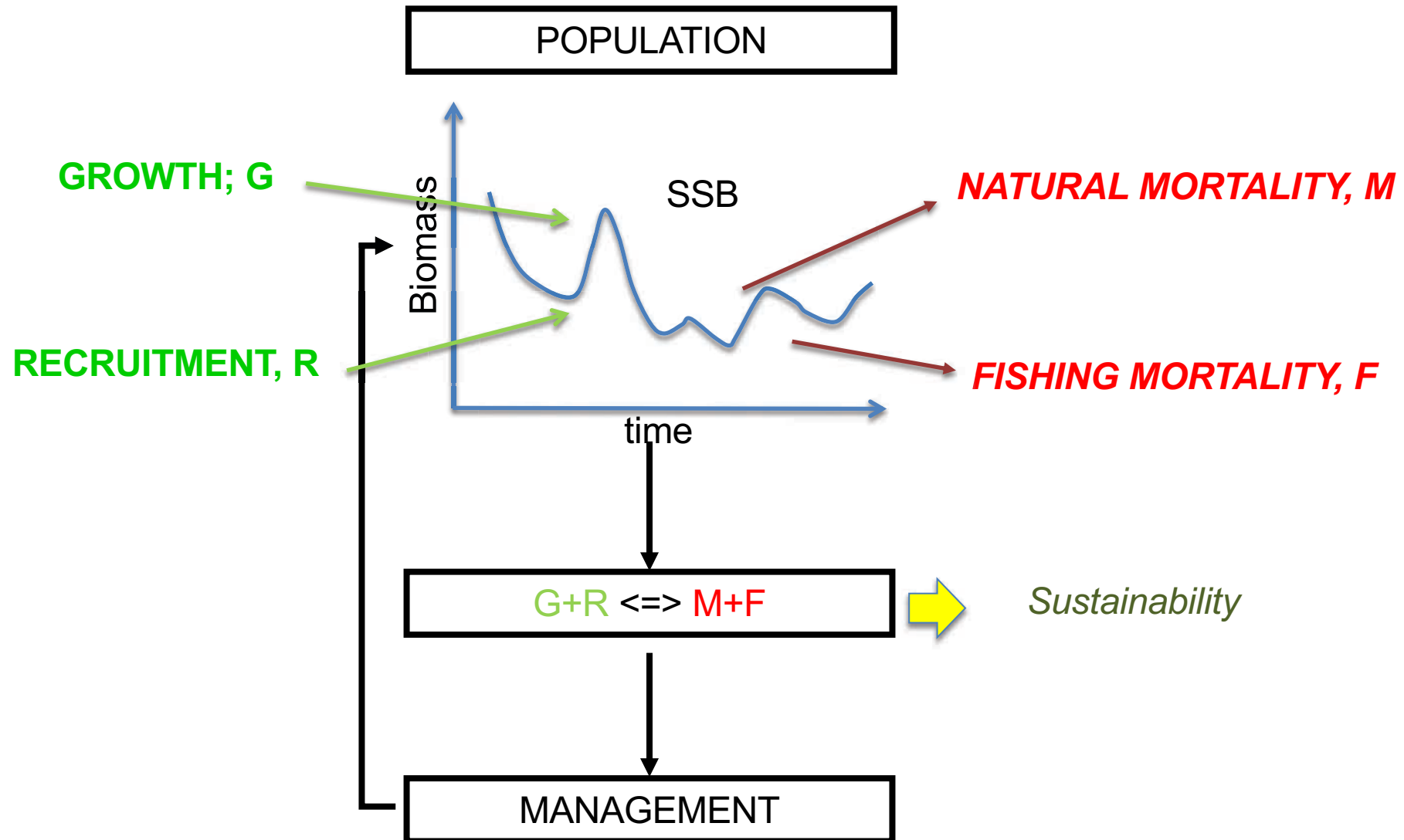
COMMON OCEANS



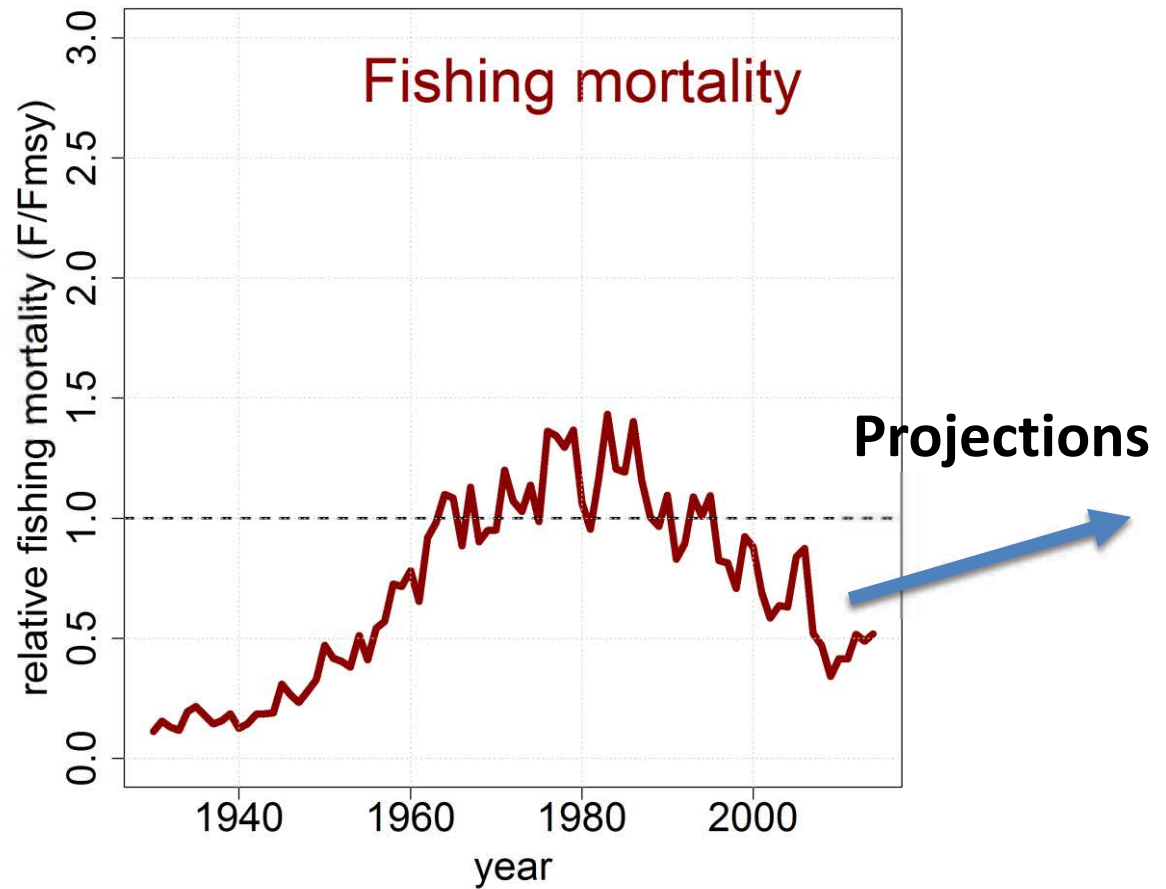
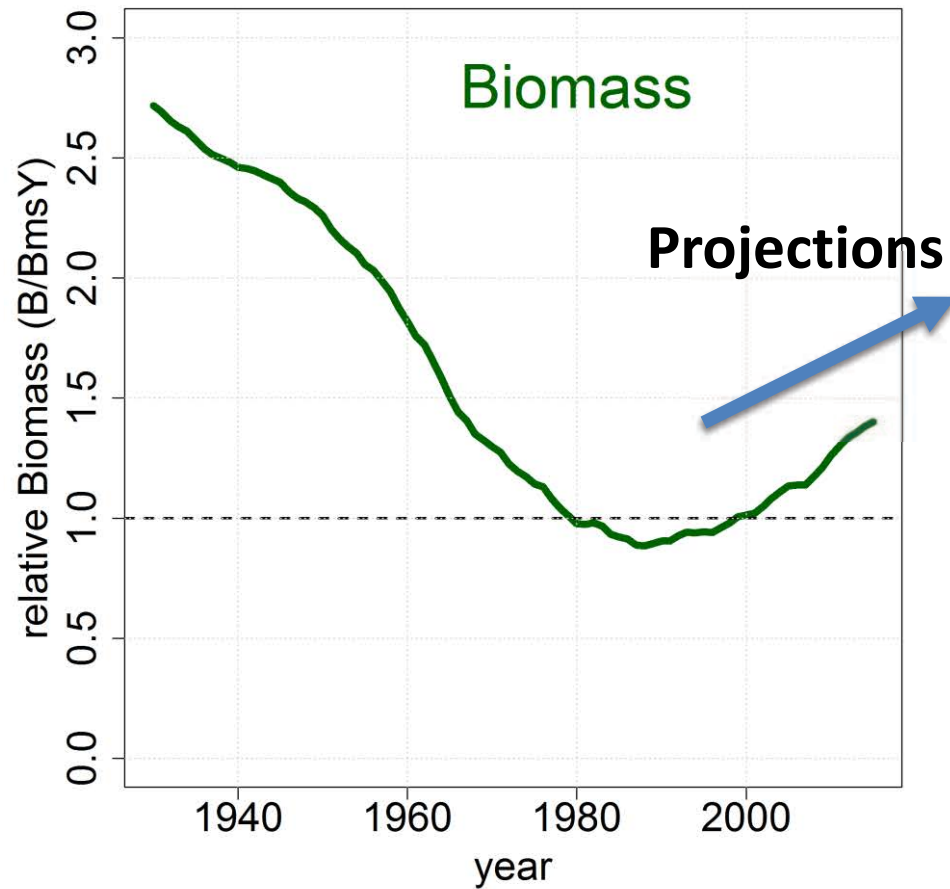
iotc ctoi



Stock Assessment: Reconstruct population history



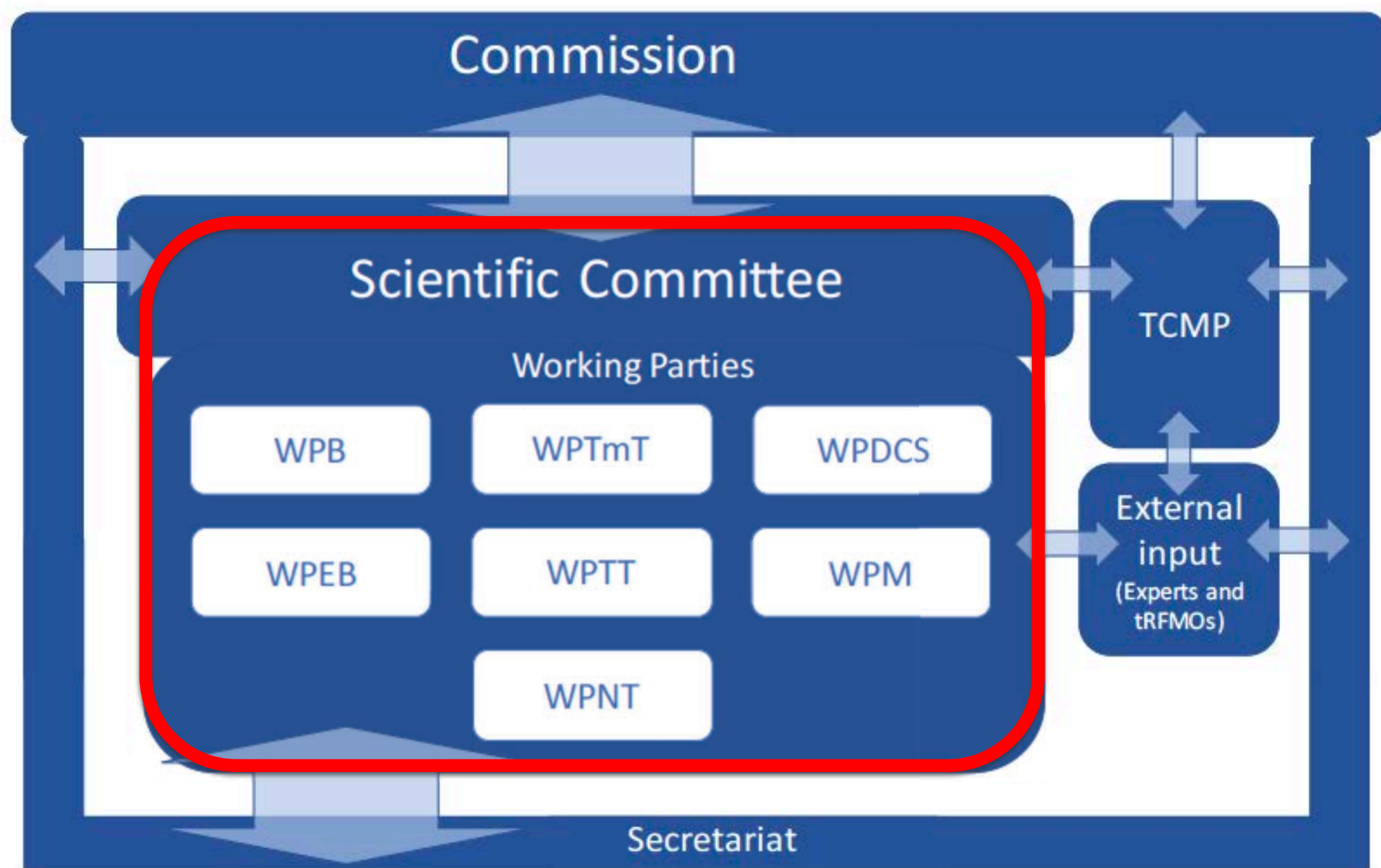
Stock Assessment: Reconstruct population history



Prediction is very difficult, especially if it's about the future - Niels Bohr, Physicist

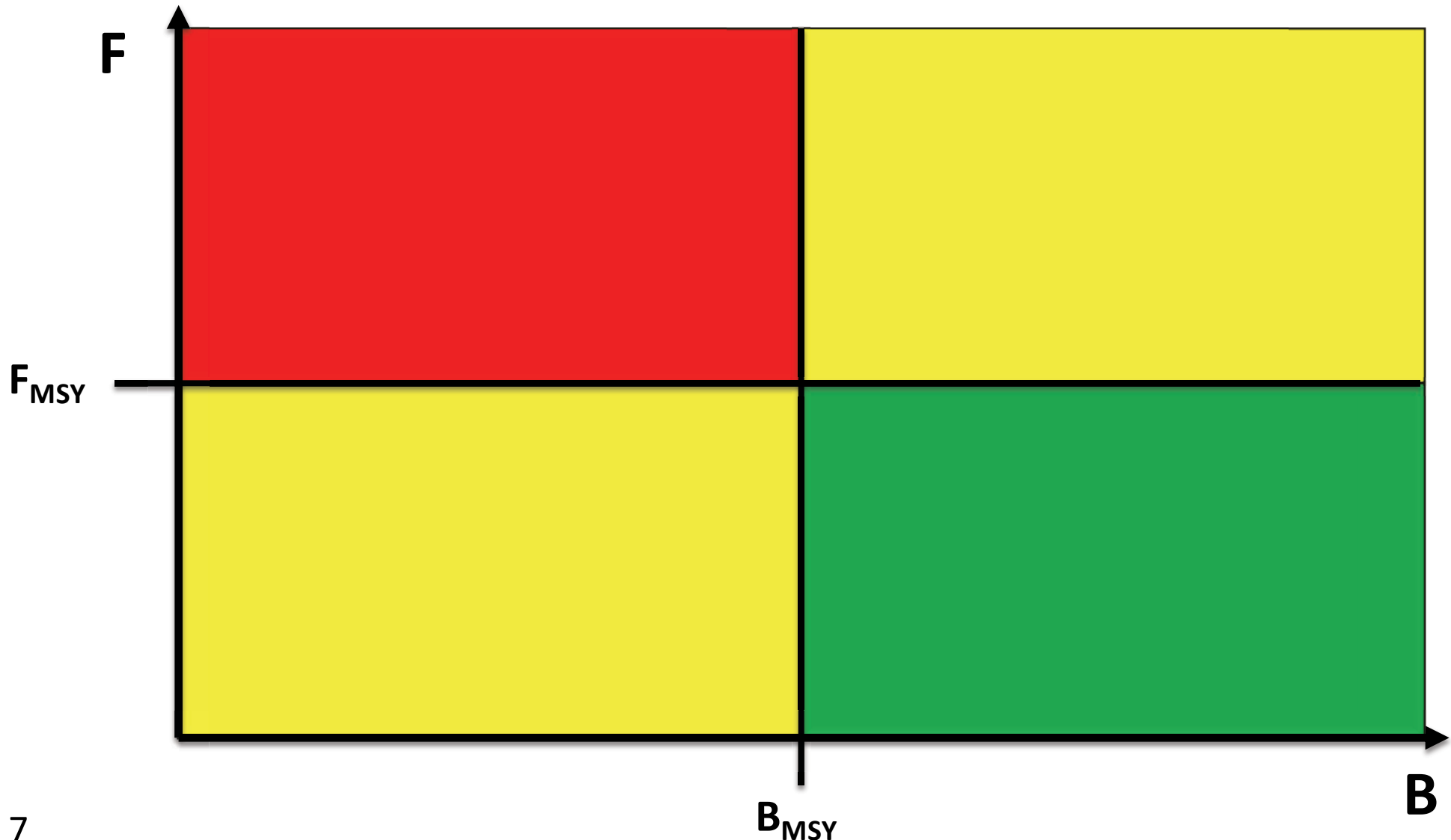


ic



IOTC Convention Objective (Strategic or Conceptual)

The Commission shall *promote cooperation among its Members* with a view to ensuring, through appropriate management, the conservation and *optimum utilization of stocks* covered by this Agreement and *encouraging sustainable development of fisheries* based on such stocks.



Provision of Management Advice

Resolution 15/10: Reference Points (Operational Objectives)

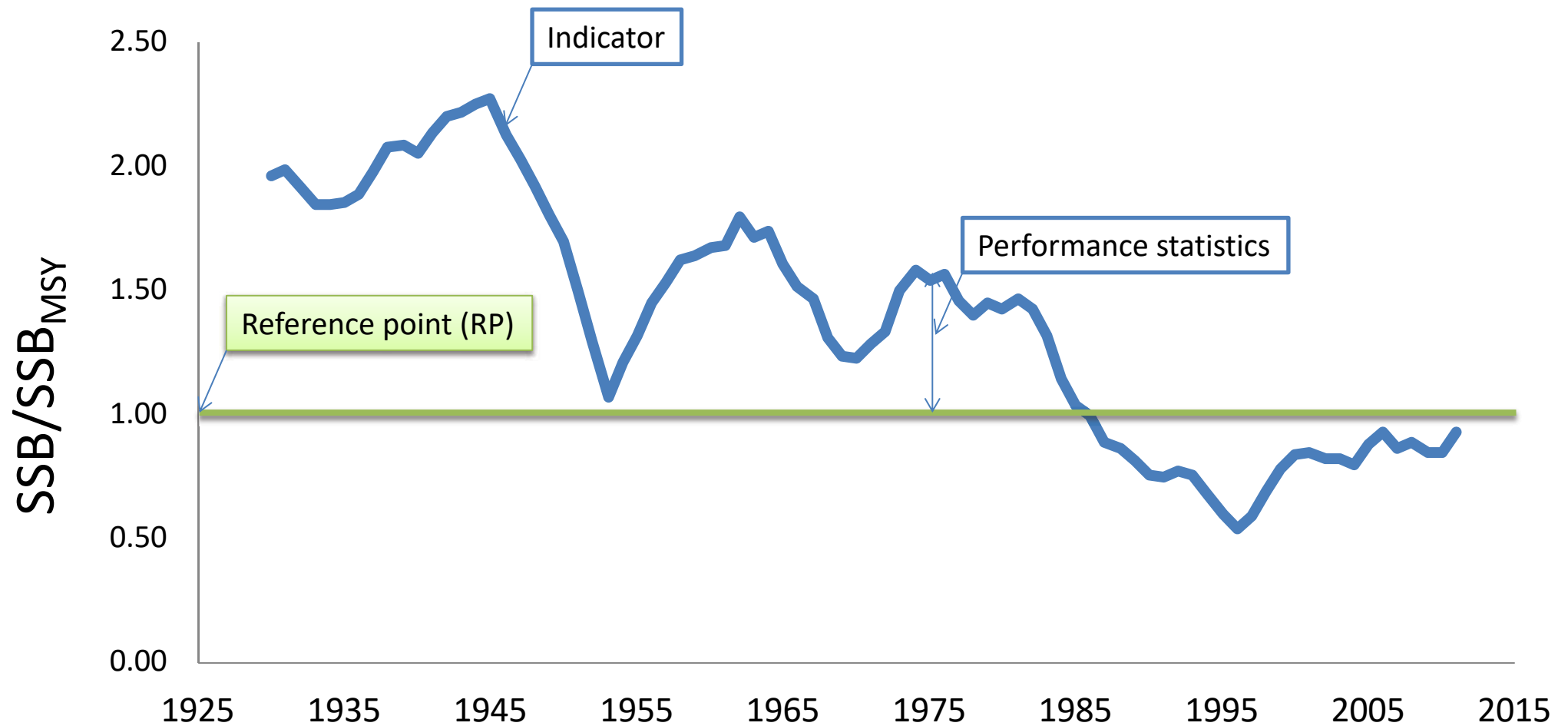
Interim Target and Limit Reference Points (TRPs and LRPs)

When assessing stock status and providing recommendations to the Commission, the **IOTC Scientific Committee should, where possible, apply MSY-based target and limit reference points for tuna and tuna-like species.**

Stock	Target Ref. Point	Limit Ref. Point
Albacore	$B_{\text{target}} = B_{\text{MSY}}$ $F_{\text{target}} = F_{\text{MSY}}$	$B_{\text{lim}} = 0.4 * B_{\text{MSY}}$ $F = 1.40 * F_{\text{MSY}}$
Yellowfin		
Swordfish		
Bigeye		$B_{\text{lim}} = 0.5 * B_{\text{MSY}}$ $F = 1.30 * F_{\text{MSY}}$
Skipjack* (based on B_0)		$B_{\text{lim}} = 0.4 * B_{\text{MSY}}$ $F = 1.50 * F_{\text{MSY}}$

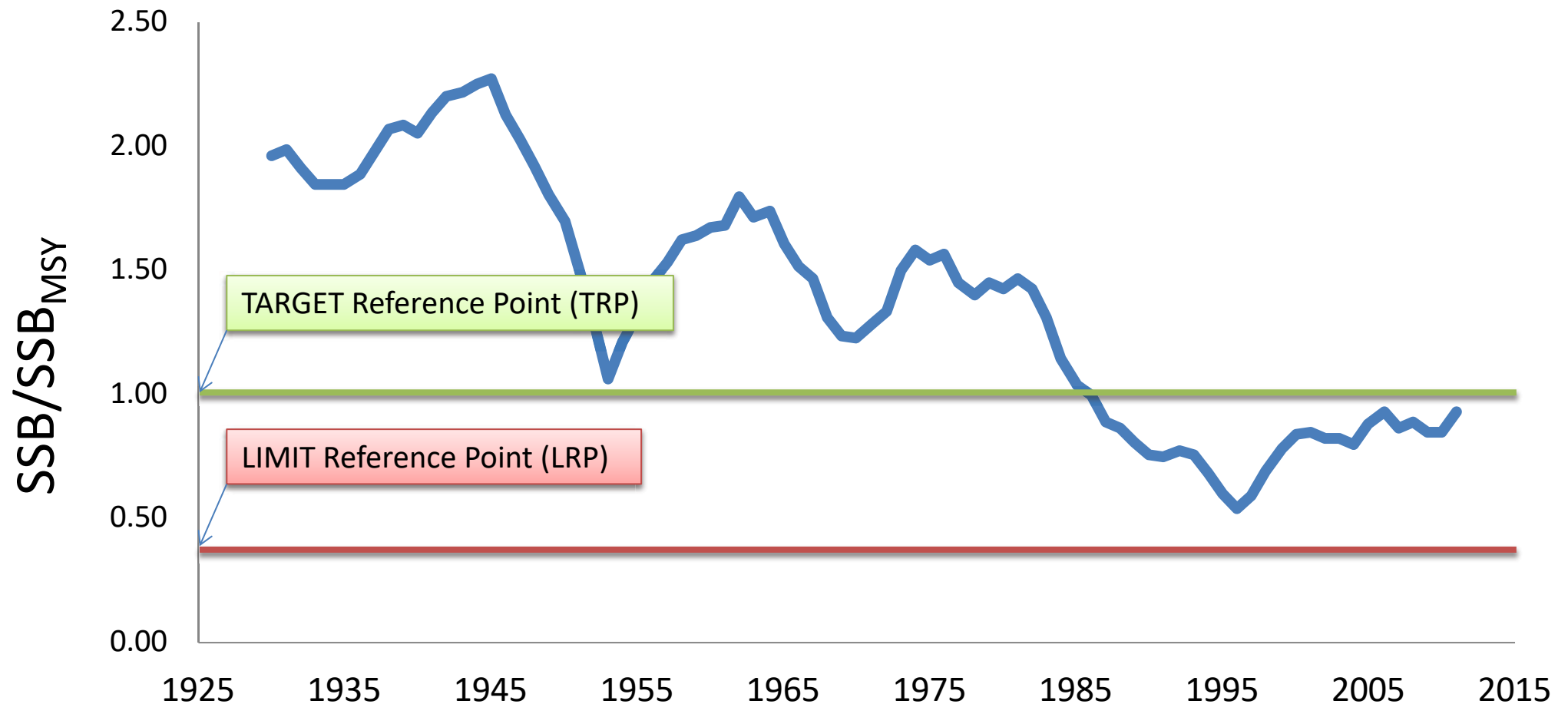
* when MSY-based reference points cannot be reliably estimated
RPs relative to B_0 .

Resolution 15/10: Reference Points



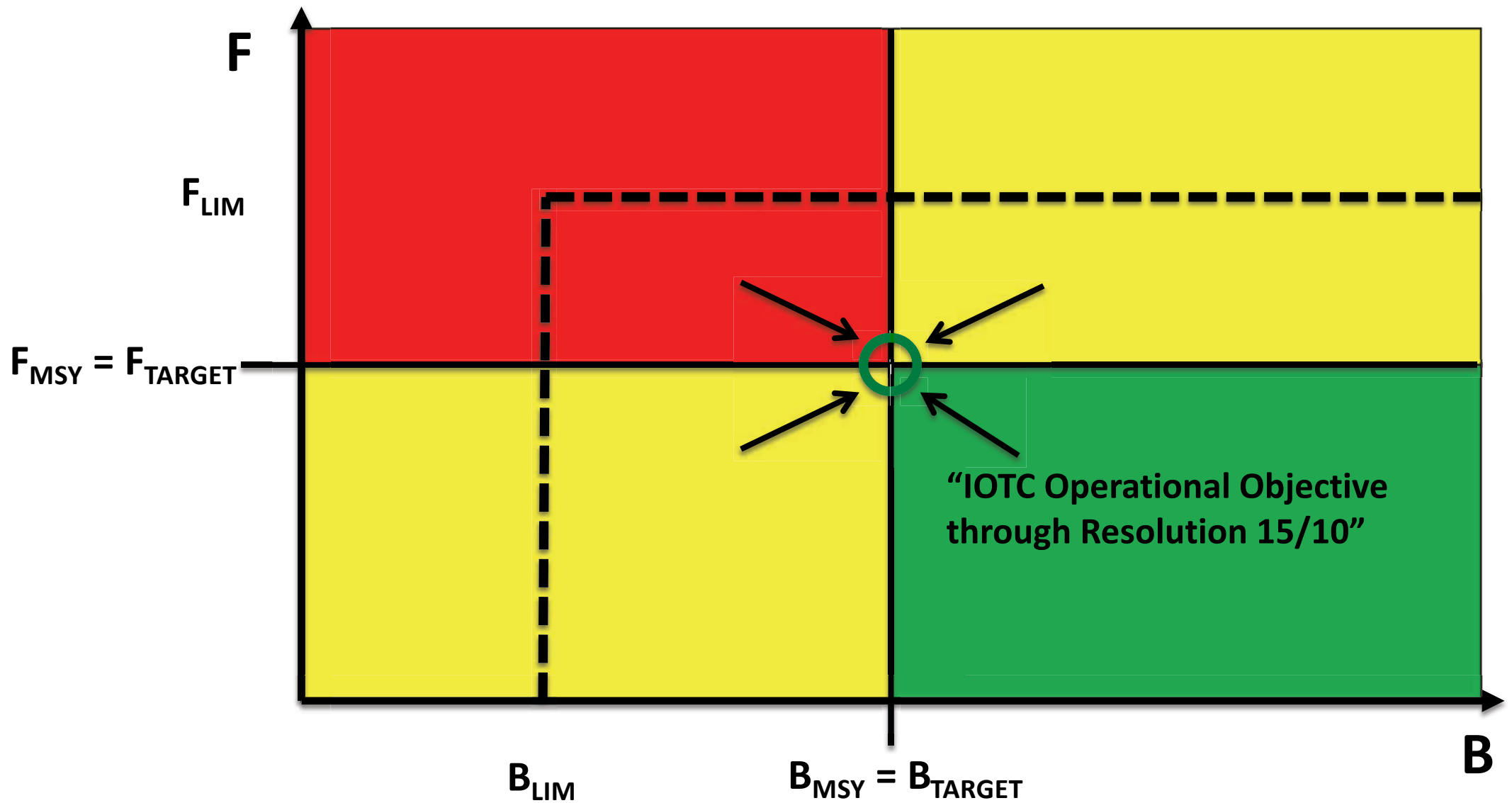
Reference Point is a **pre-determined** level of a given indicator that corresponds to a particular state of the stock

Resolution 15/10: Reference Points

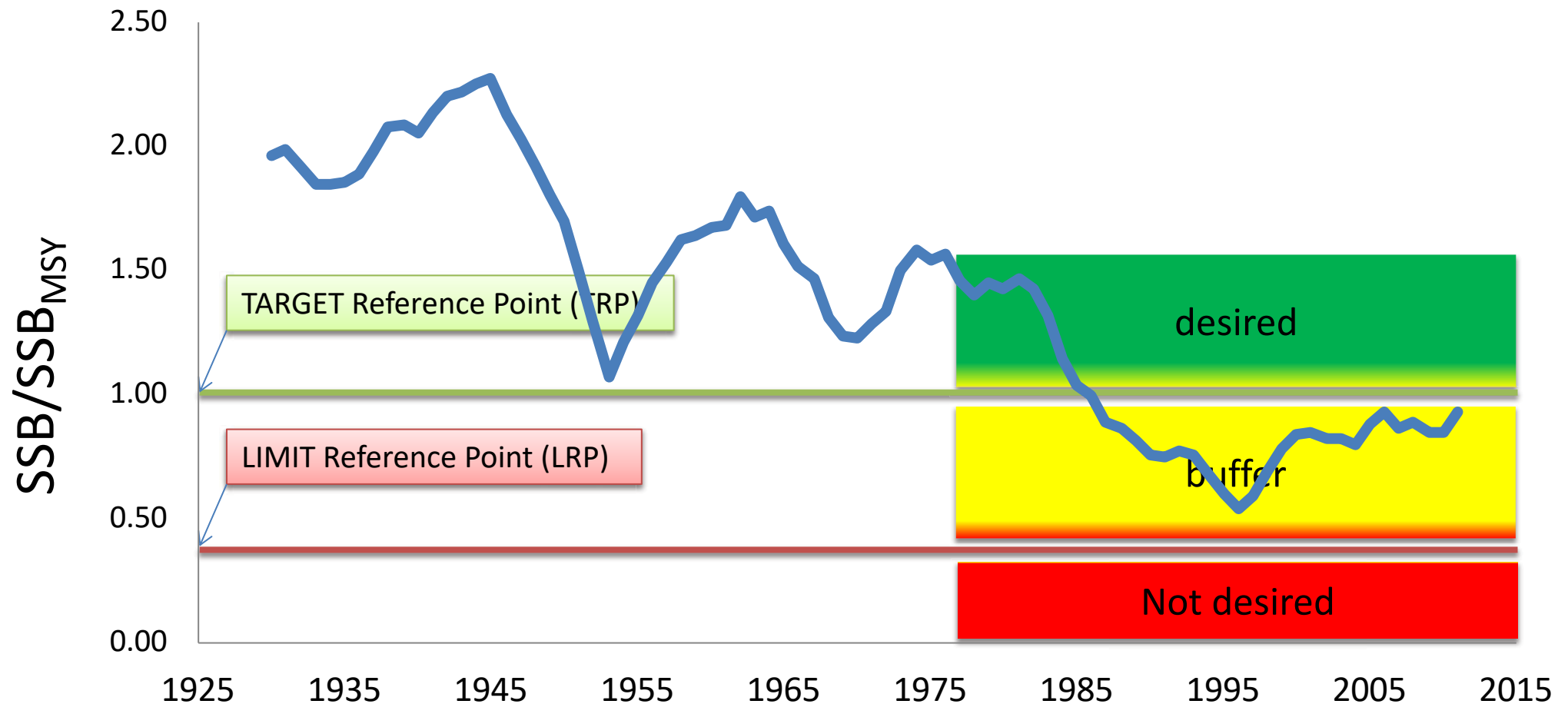


Reference Point is a **pre-determined** level of a given indicator that corresponds to a particular state of the stock that management either seeks to **achieve (TRP)** or **avoid (LRP)**.

Provision of Management Advice

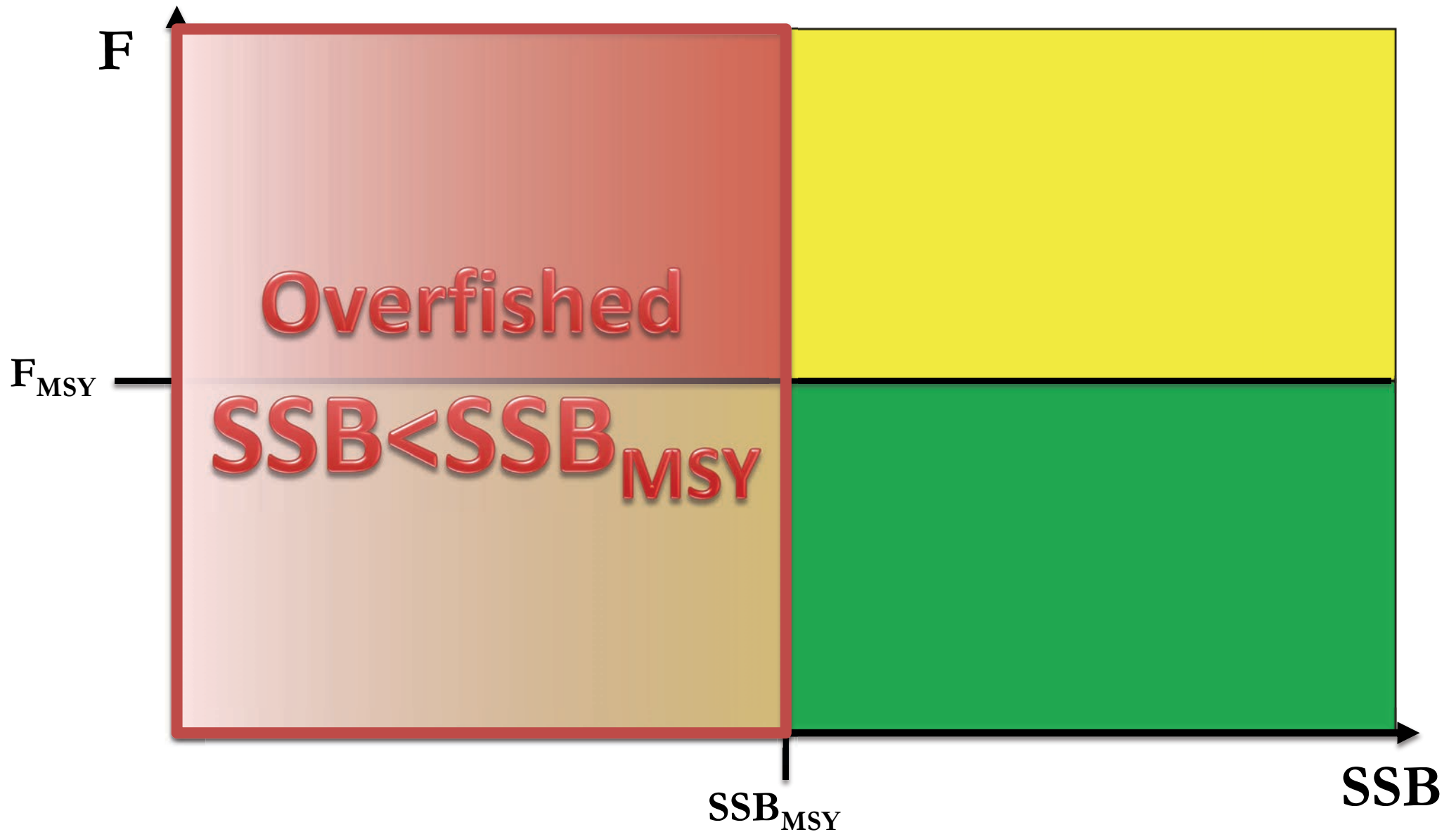


Resolution 15/10: Reference Points

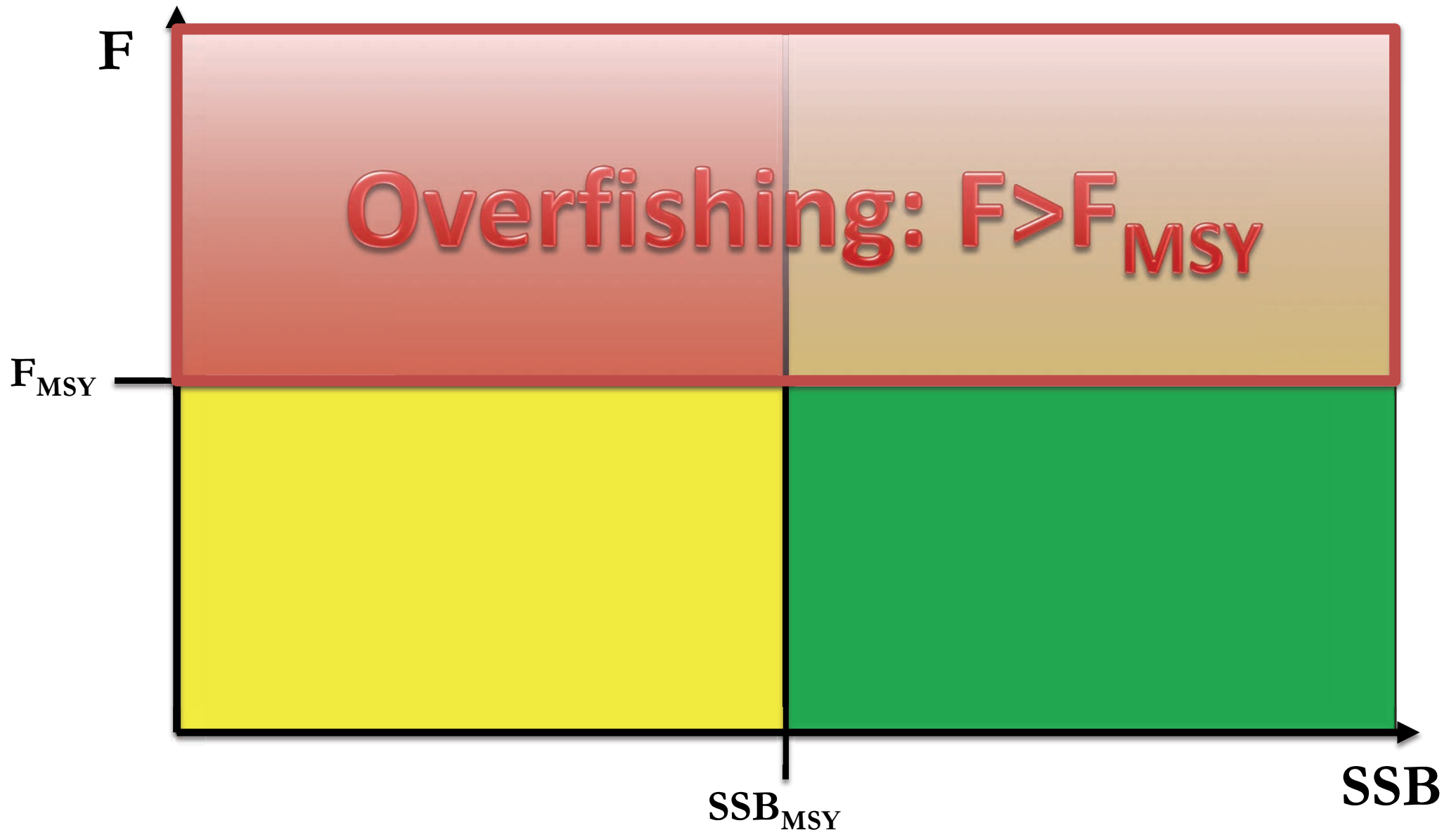


Reference Point is a **pre-determined** level of a given indicator that corresponds to a particular state of the stock that management either seeks to **achieve (TRP)** or **avoid (LRP)**.

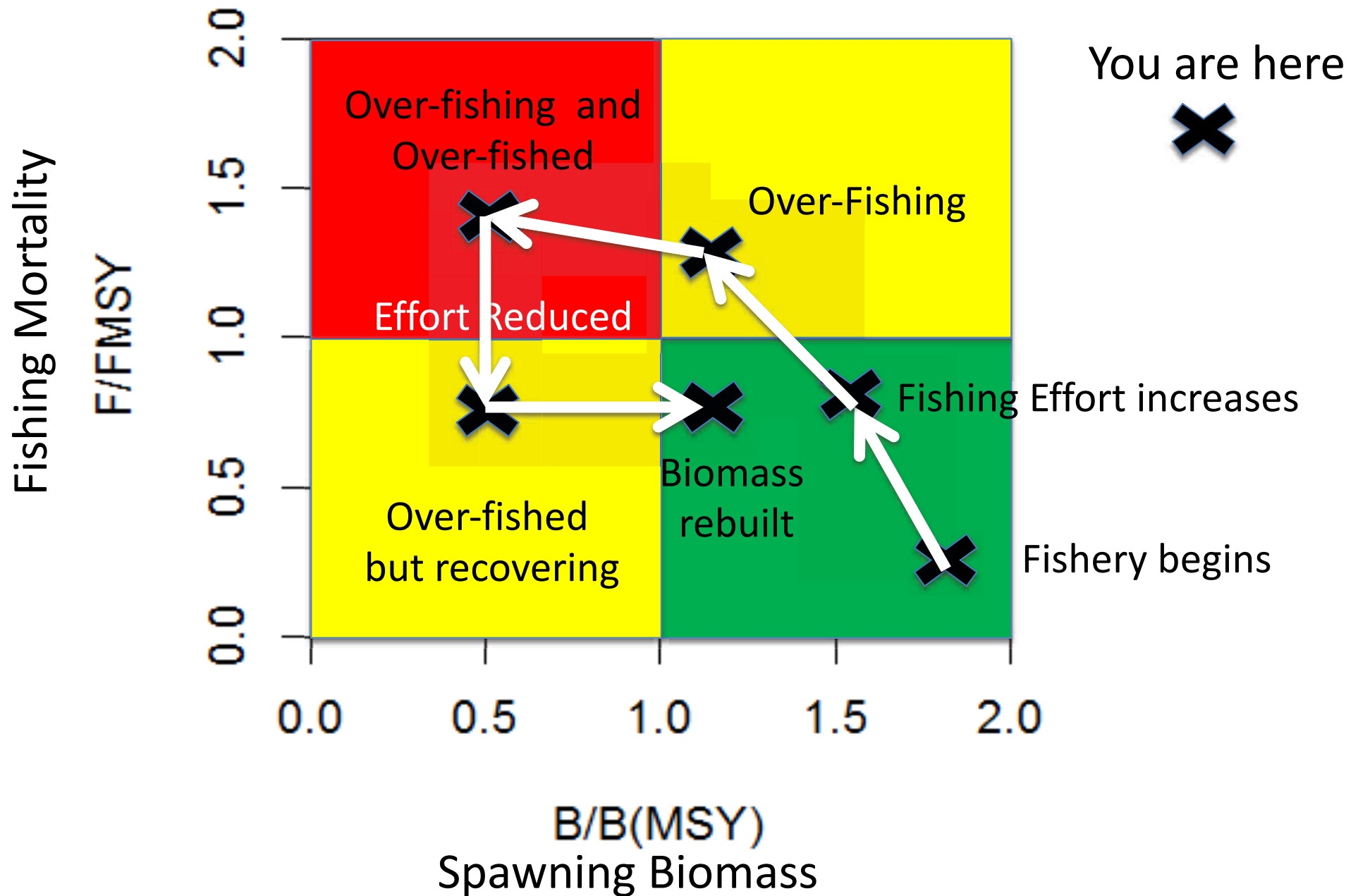
“Kobe plot”



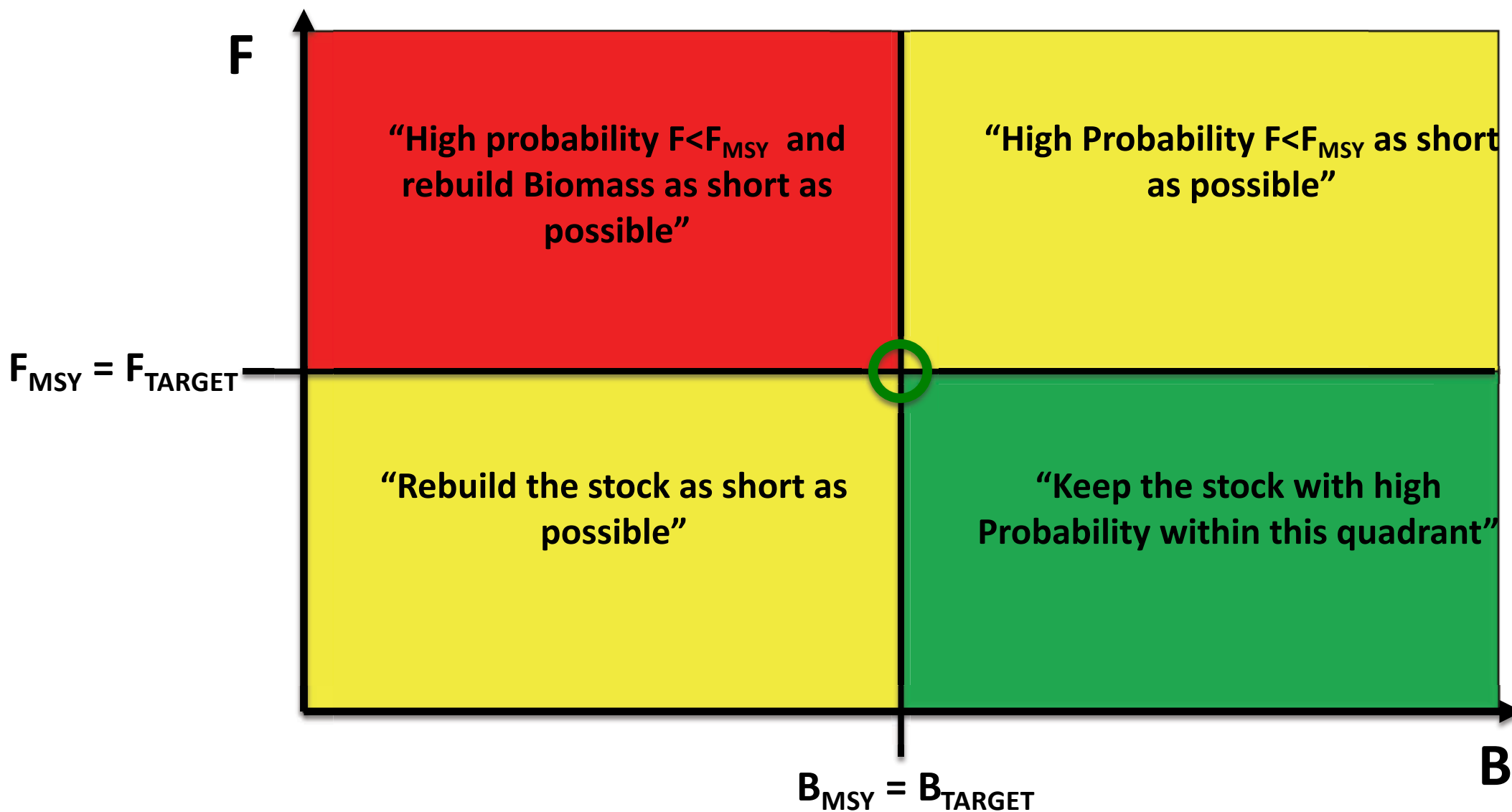
“Kobe plot”



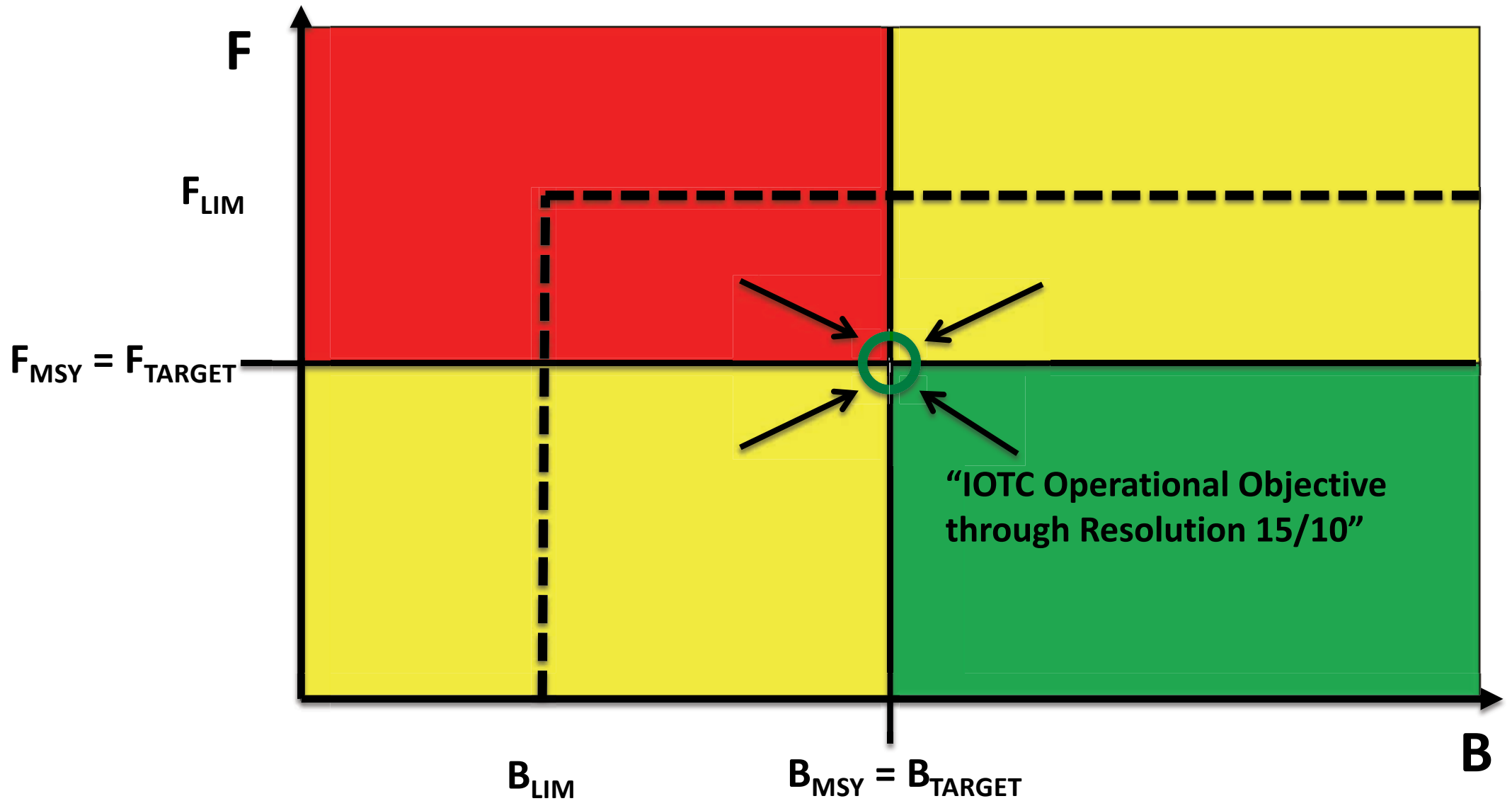
Providing scientific advice

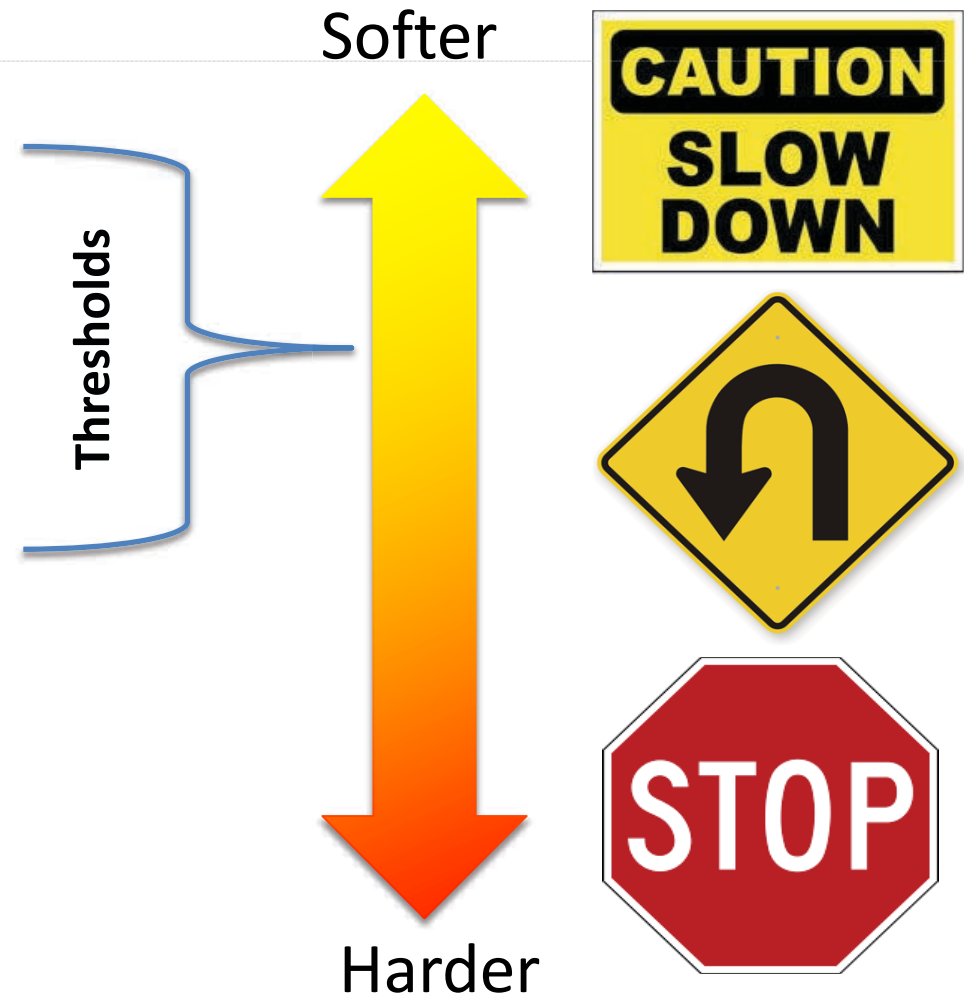
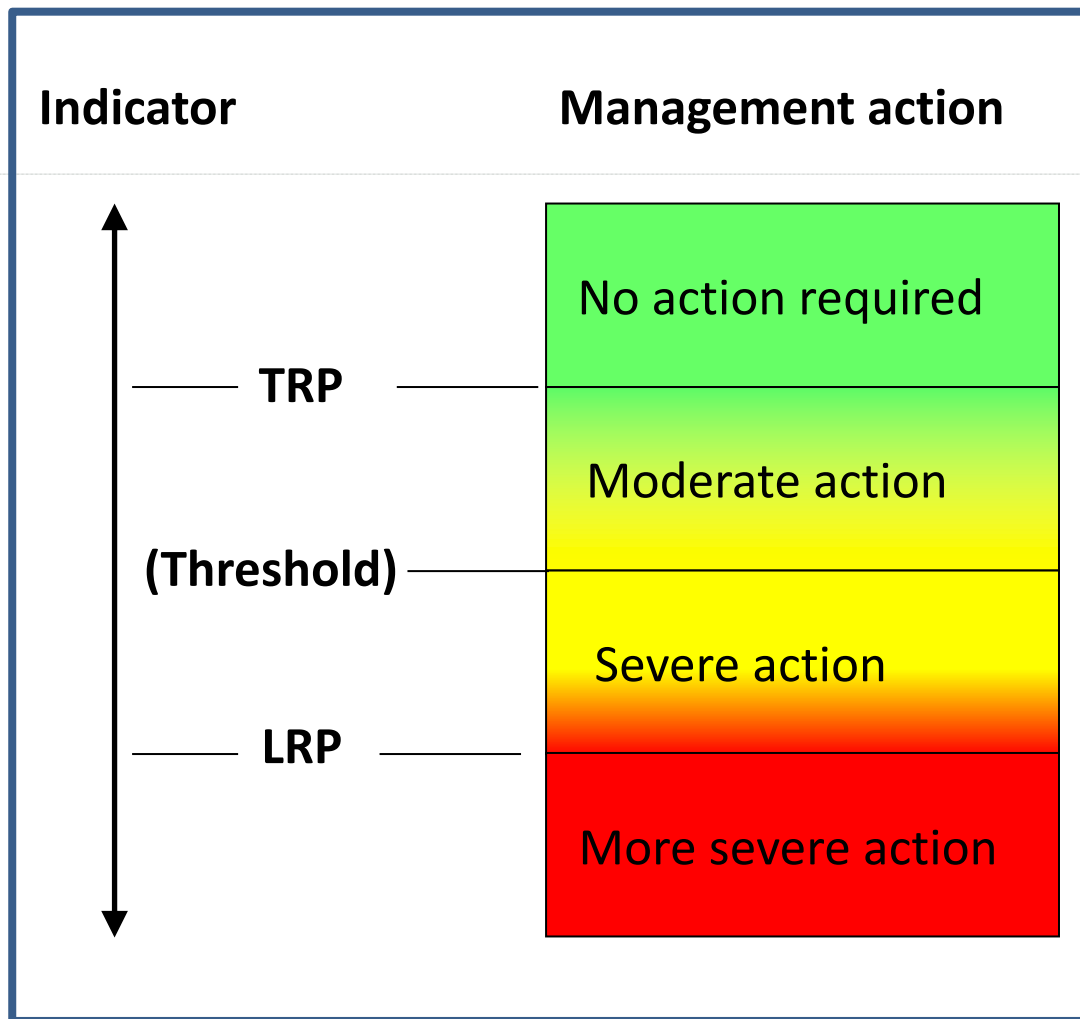


Resolution 15/10: Reference Points (Operational Objectives)



Provision of Management Advice

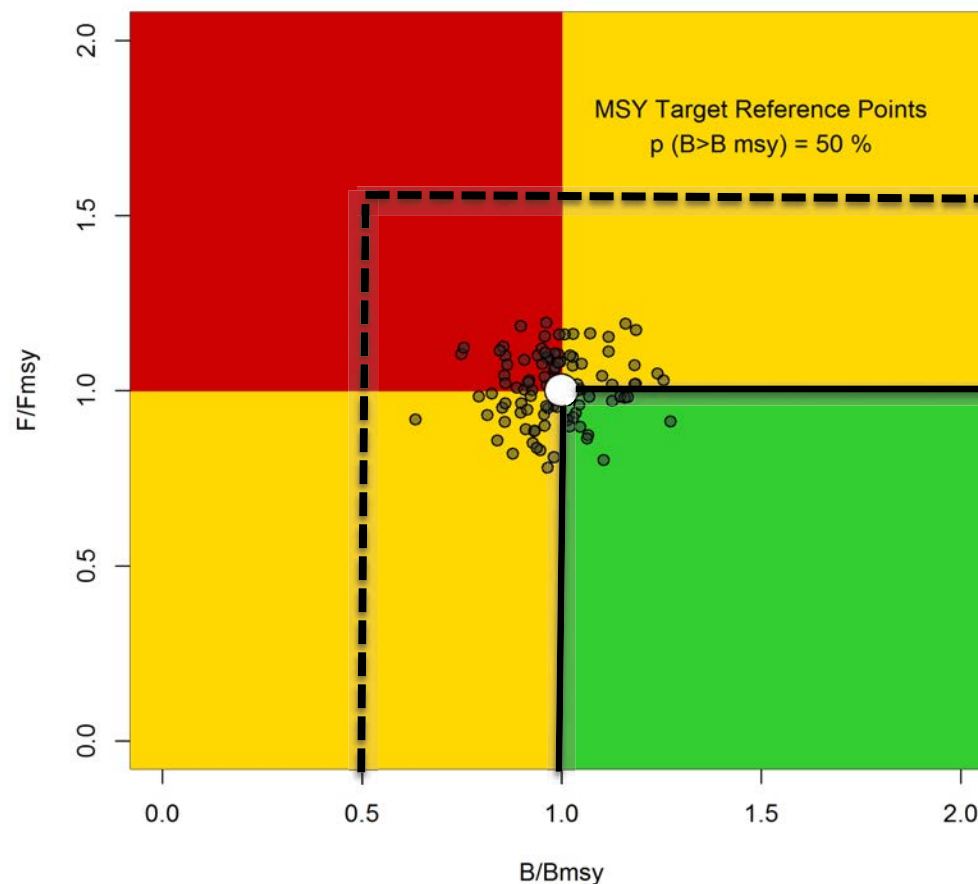




- **Target Reference Points (TRPs):** values for stock size and/or fishing mortality rate that a manager aims to **achieve and maintain**.
- **Limit Reference Points (LRPs),** which describe an undesirable state of the indicator that should be **avoided** with high probability.
- **Thresholds** defining management responses.

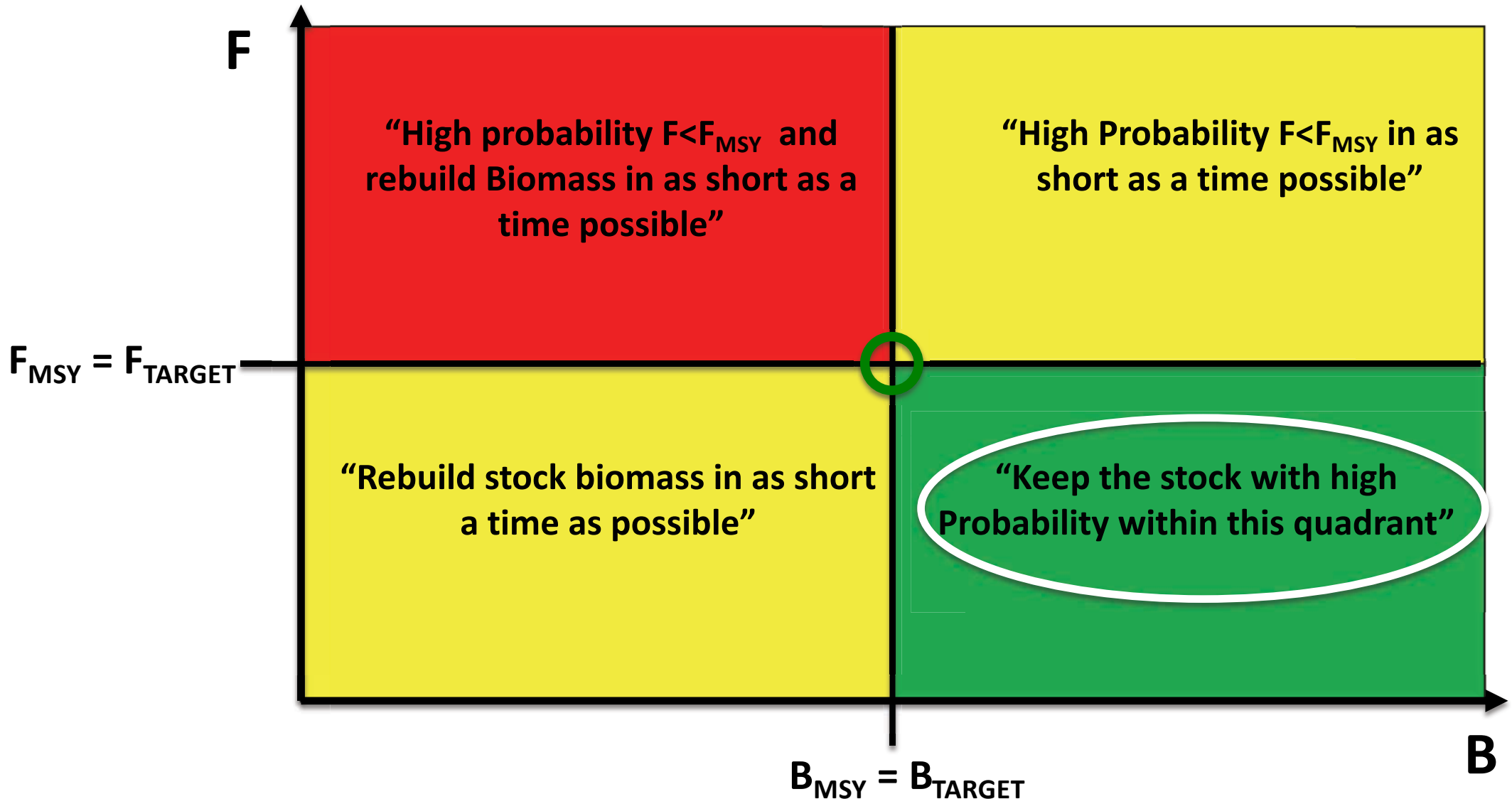
Provision of Management Advice

Where does IOTC want the fishery to be? If the objective is to be at or above BMSY and fishing at FMSY, there can be a $\approx 50\%$ chance of being overfished in the Kobe classification due to natural fluctuations.



Provision of Management Advice

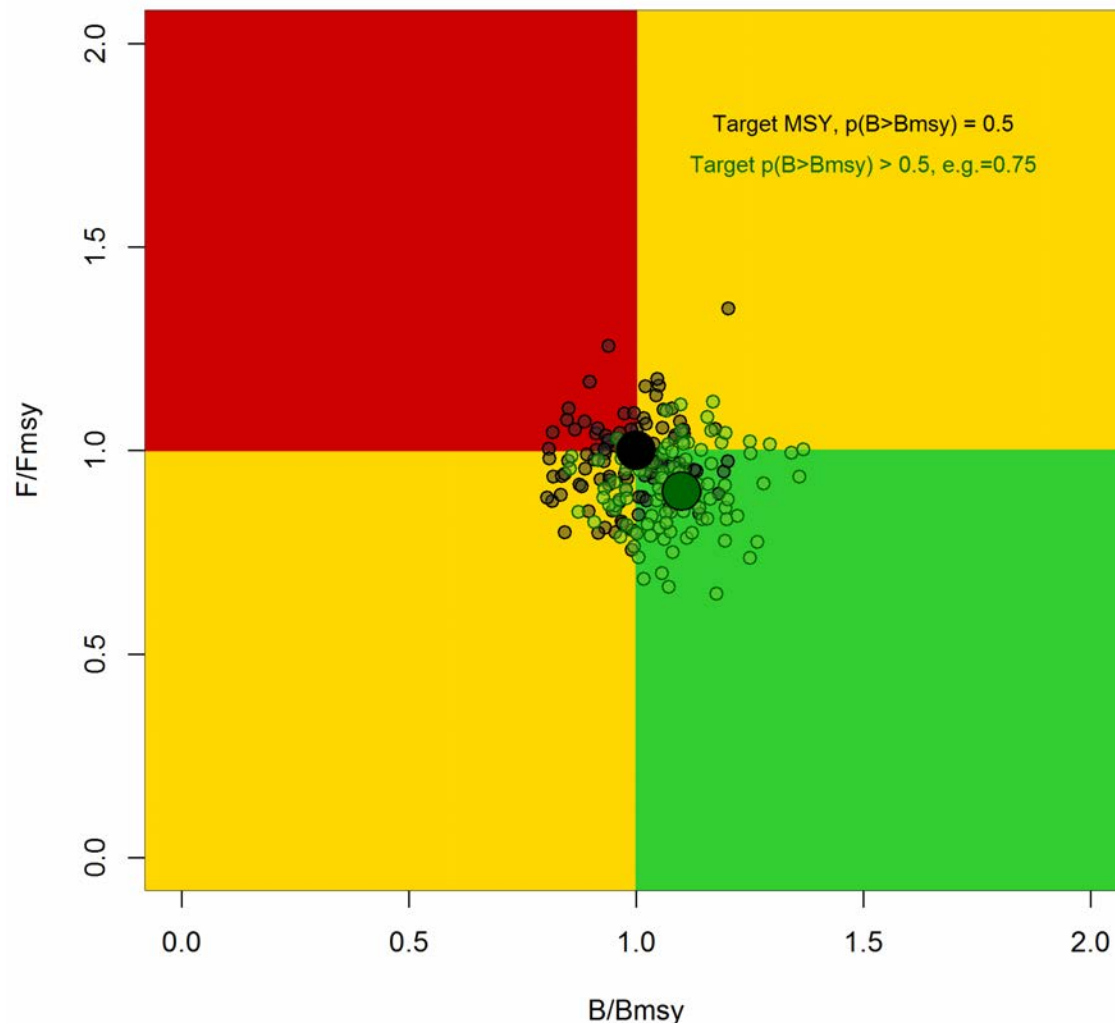
Resolution 15/10: Reference Points (Operational Objectives)



- ... but what are the timeframes and probabilities?

Objectives

Where do we want the fishery to be, considering Decision Framework in Res 15/10?



OBJECTIVES:

“Maintain the biomass at or above levels required to produce MSY or its proxy and maintain the fishing mortality rate at or below F_{MSY} or its proxy;” and

“Avoid the biomass being below B_{LIM} and the fishing mortality rate being above F_{LIM} ”

Management Procedures: Objectives

**OBJECTIVE
TO MAINTAIN IN GREEN**

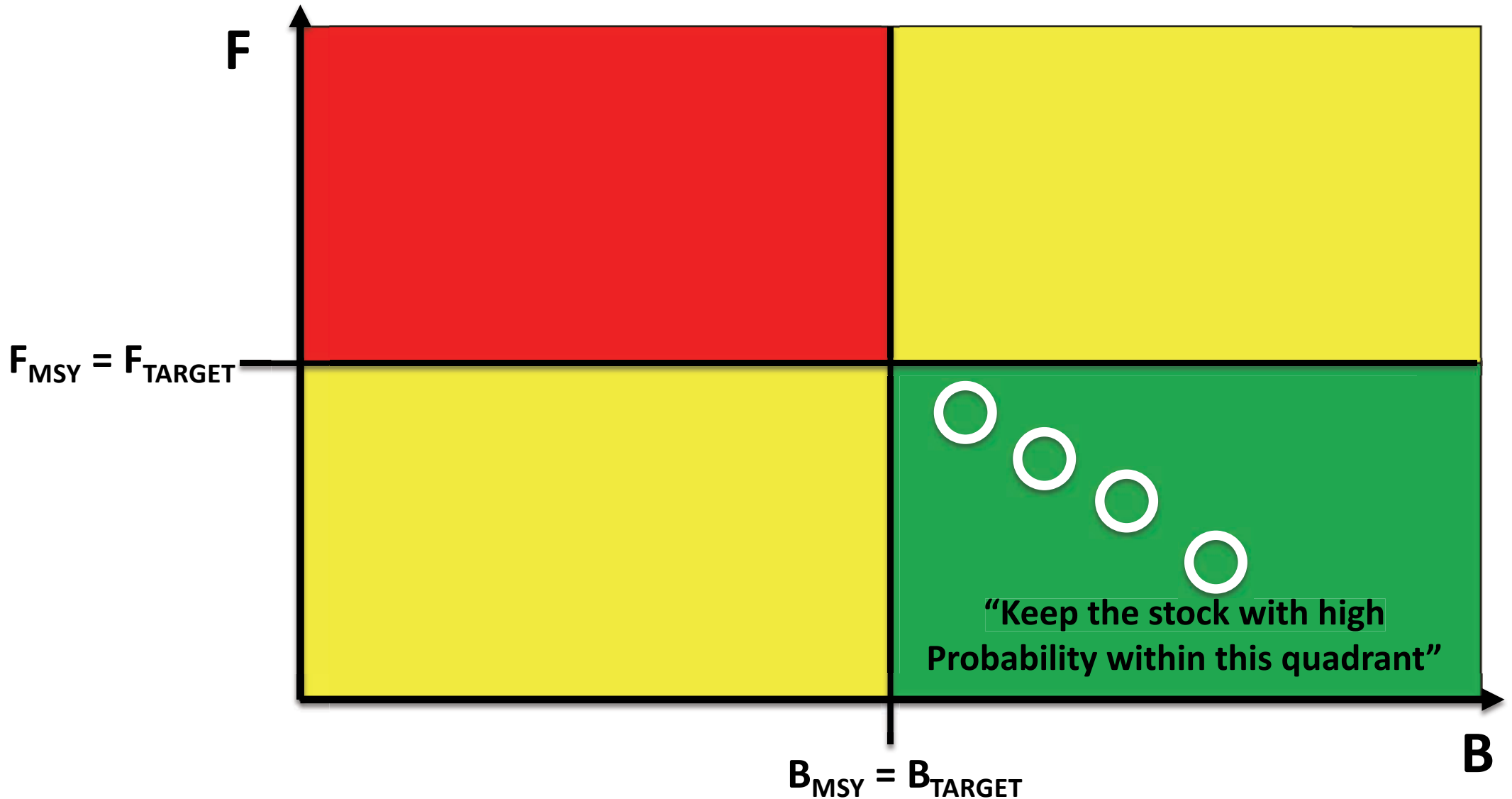
BUT, WHAT GREEN?



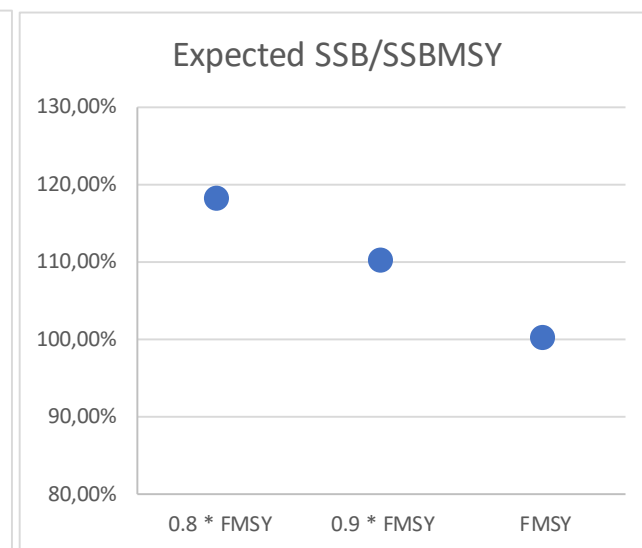
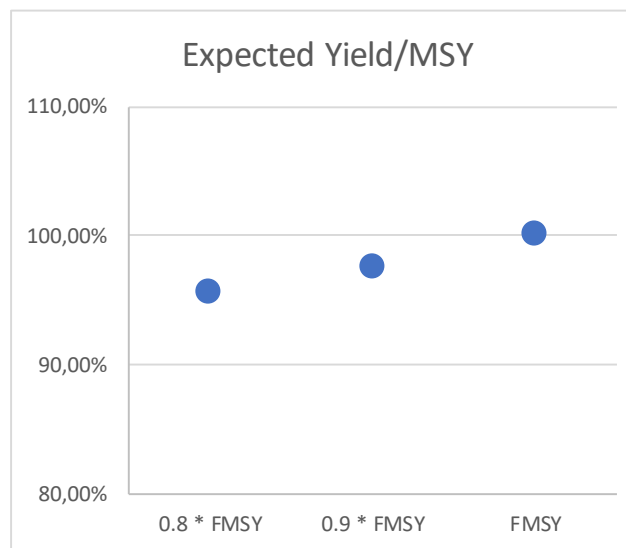
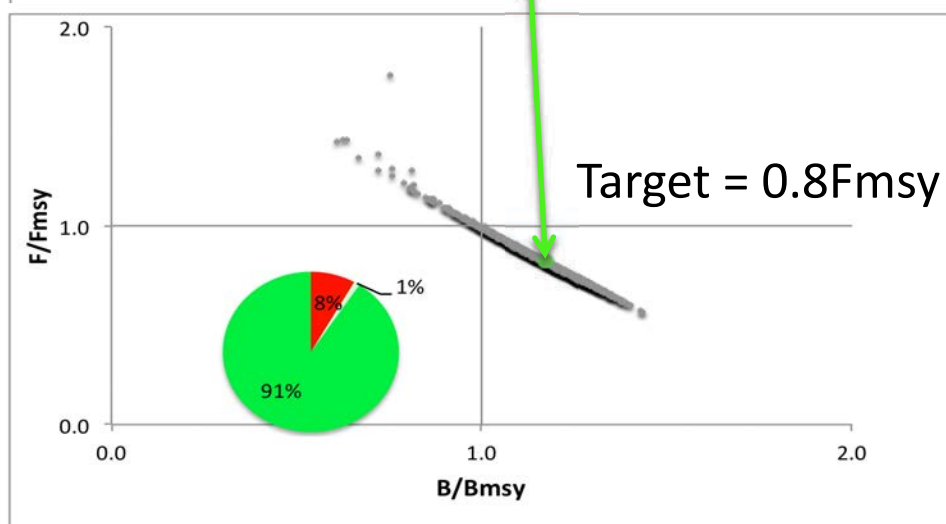
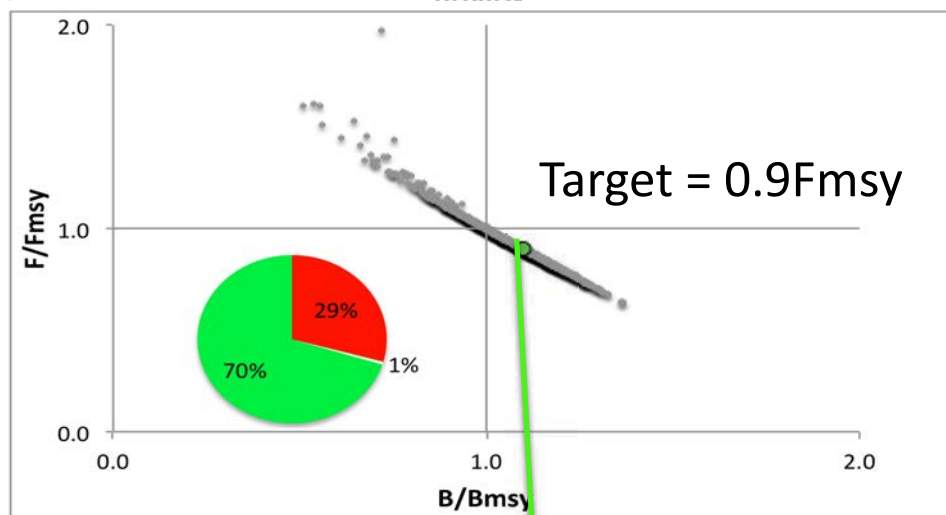
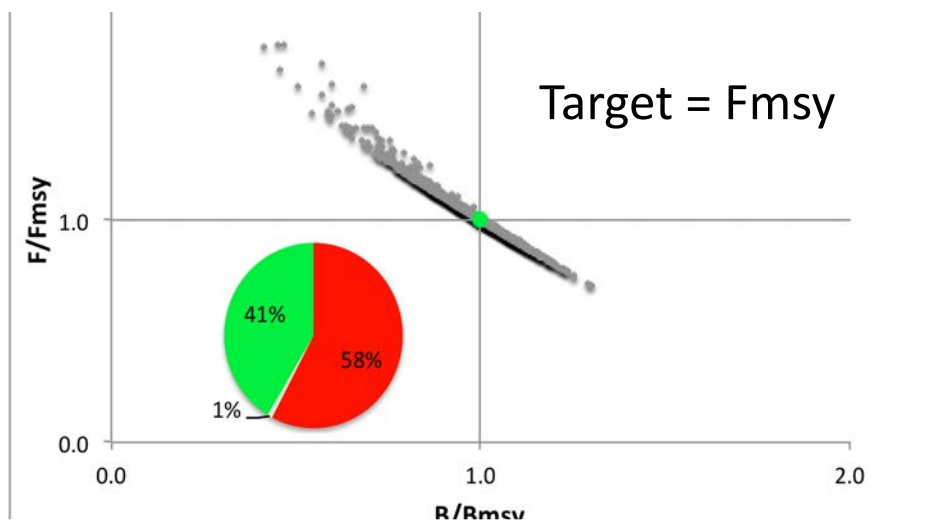
OR AT PROBABILITY?

Management Procedures: Objectives

Resolution 15/10: Reference Points (Operational Objectives)



Uncertainty impacts on targeting

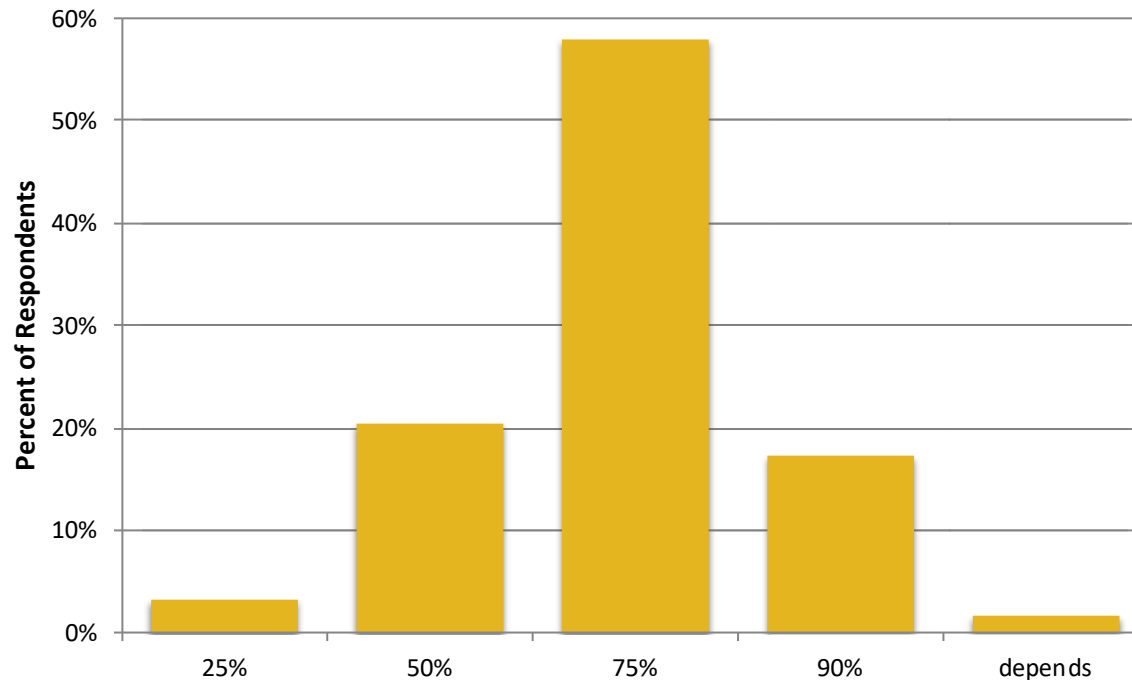


Relatively small,
<5%, loss in
Yield

Substantial gain
in SSB with gain
in P("Green")

What is High Probability of Achieving a Target?

Survey Says.....



From 2015 Surveys at IOTC's MPD02 and ICCAT's SWGSM (64 respondents). In keeping with other organizations, the majority view by participants was that ~75% (or 3 chances out of 4) is a high probability for achieving a target.

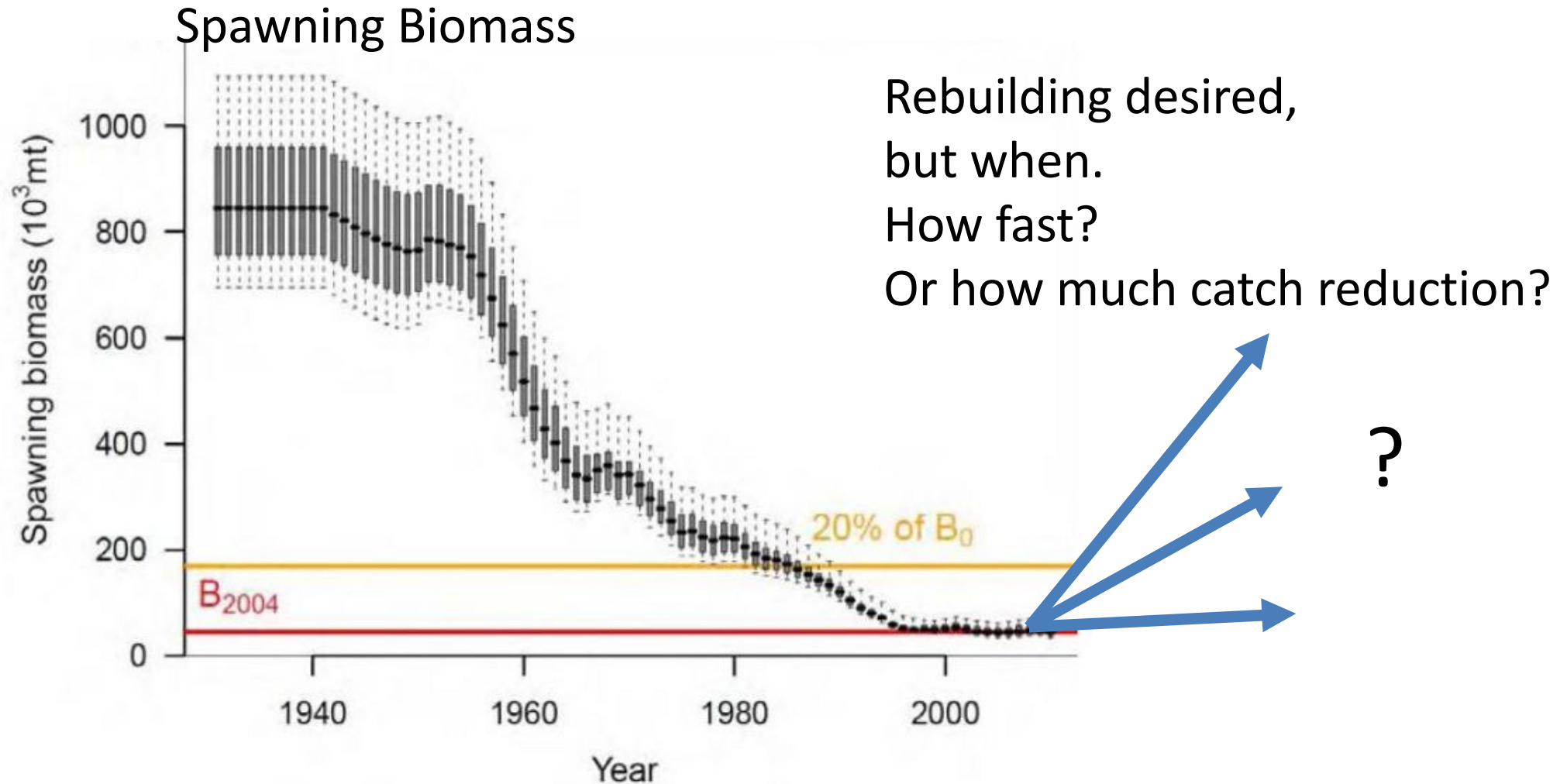
Harvest Control Rules: Timeline

Where and when do we want the fishery to be?



Harvest Control Rules (with Reference Points): Timelines

Where and when do we want the fishery to be?



Objectives

- Green Zone with **high probability**
- In case of not green zone, come back as **quick as possible** with **high probability**.

Other Priorities (Social)

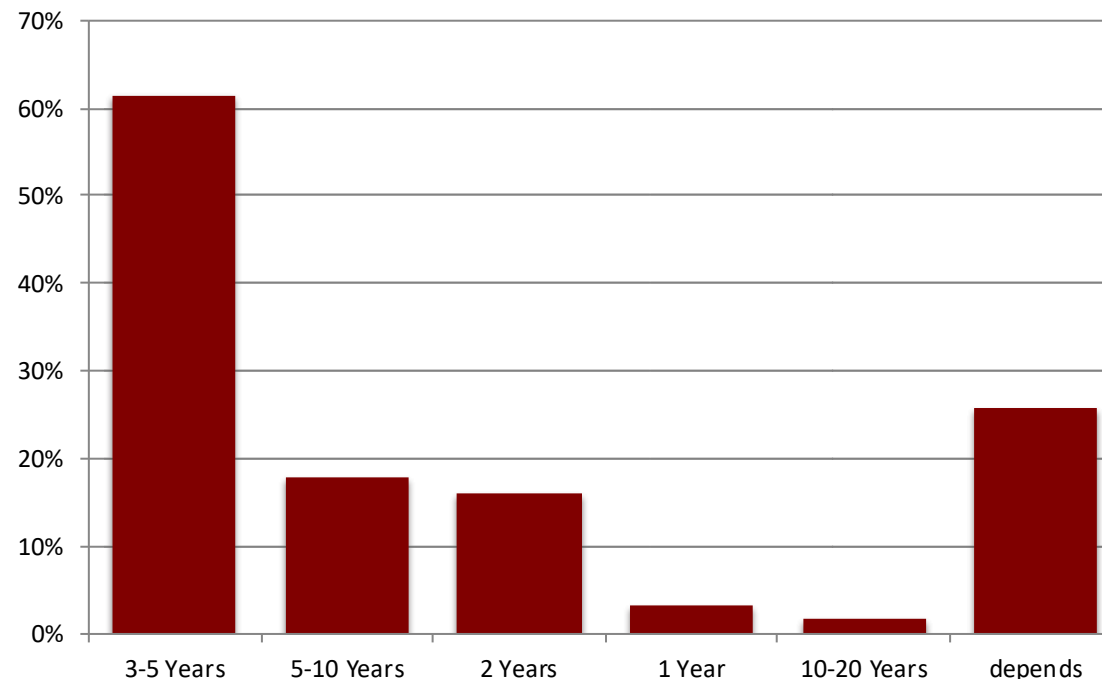
- Employment/stability of catch
- Maximum Economic Yield Vs Maximum Sustainable Yield.
- Expanding Fleet Capacity/ Opportunity (Industry)
- Conserving stocks for Intrinsic Benefits (Enviros)

Inherently what you need to decide

- Balance long-term yield to long-term stock biomass.
- In case of adverse conditions, evaluate how long it may take to recover.
- Take a lot of pain now for benefits later or less now for longer rebuilding time

What should be 'as short a time as possible' for recovery?

Survey says ...

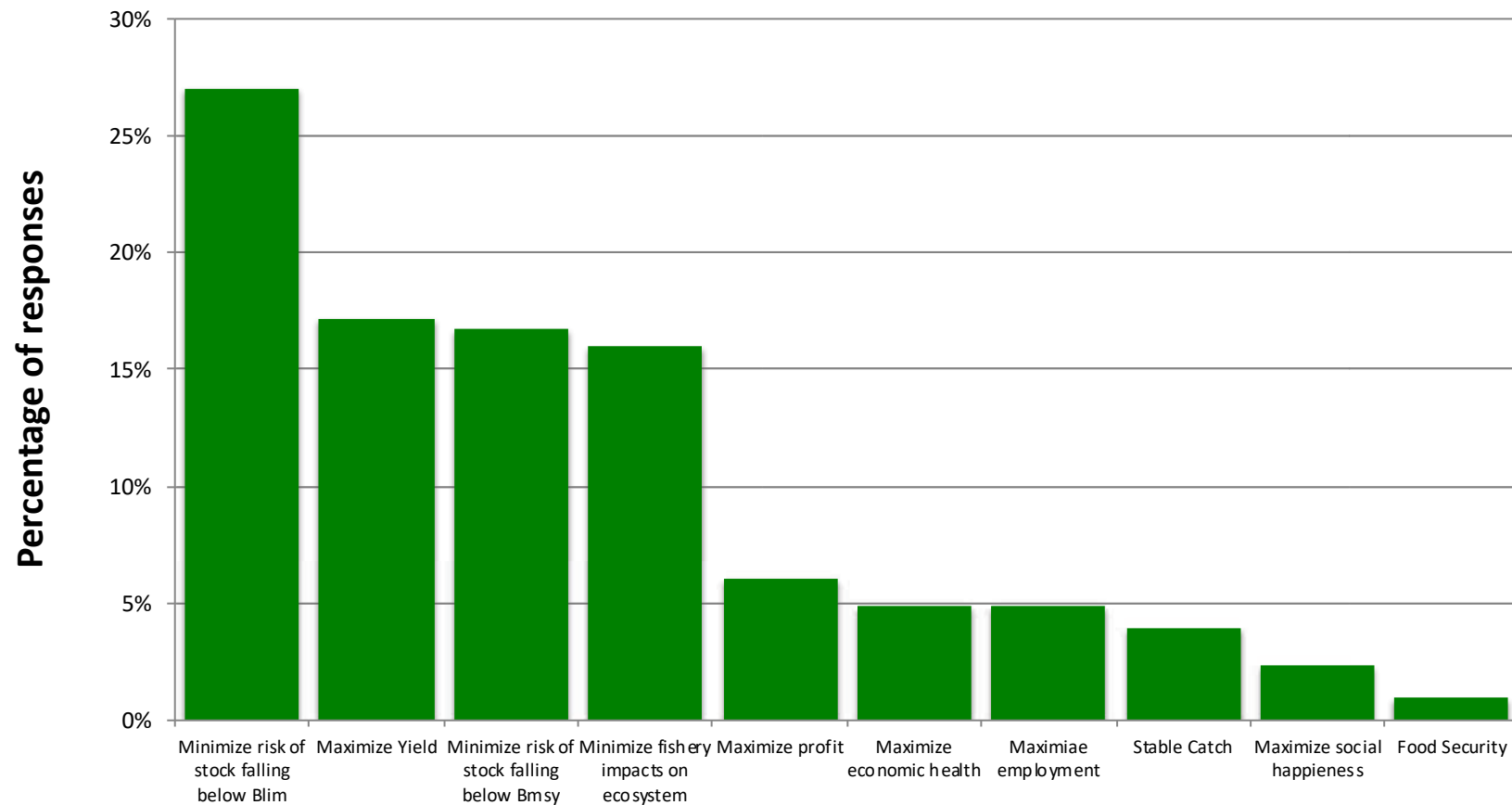


- From 2015 Surveys at IOTC's MPD02 & ICCAT's SWGSM (76 respondents). Most participants viewed a time frame of 3-5 years in this context, although a high proportion of respondents indicated it depends on the stock of concern. Others indicated that time frames for managing fishing intensity (F) should be more immediate than for rebuilding biomass to desired levels.

Harvest Control Rules: Trade-offs

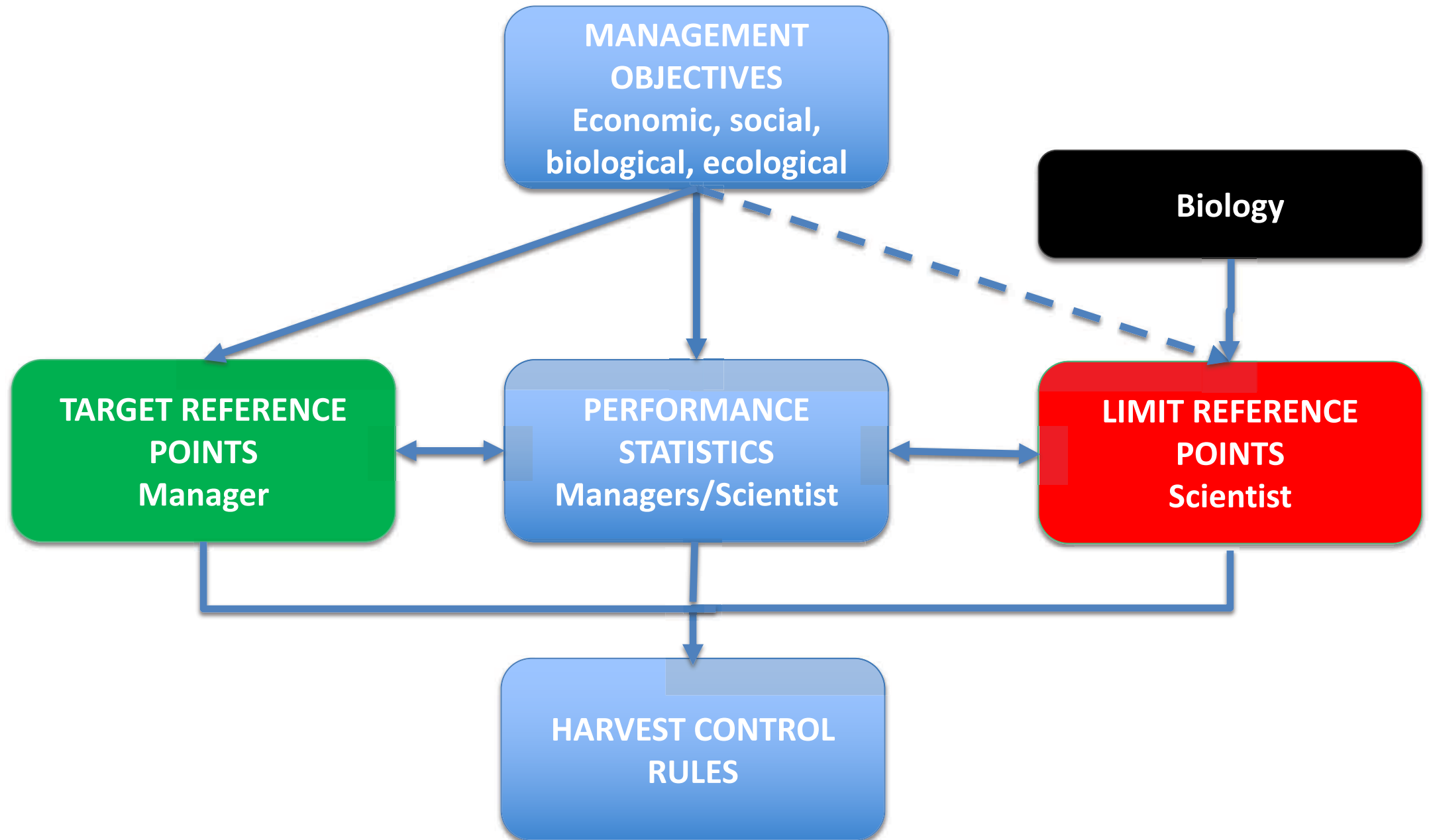


Different Management Objectives → Trade offs

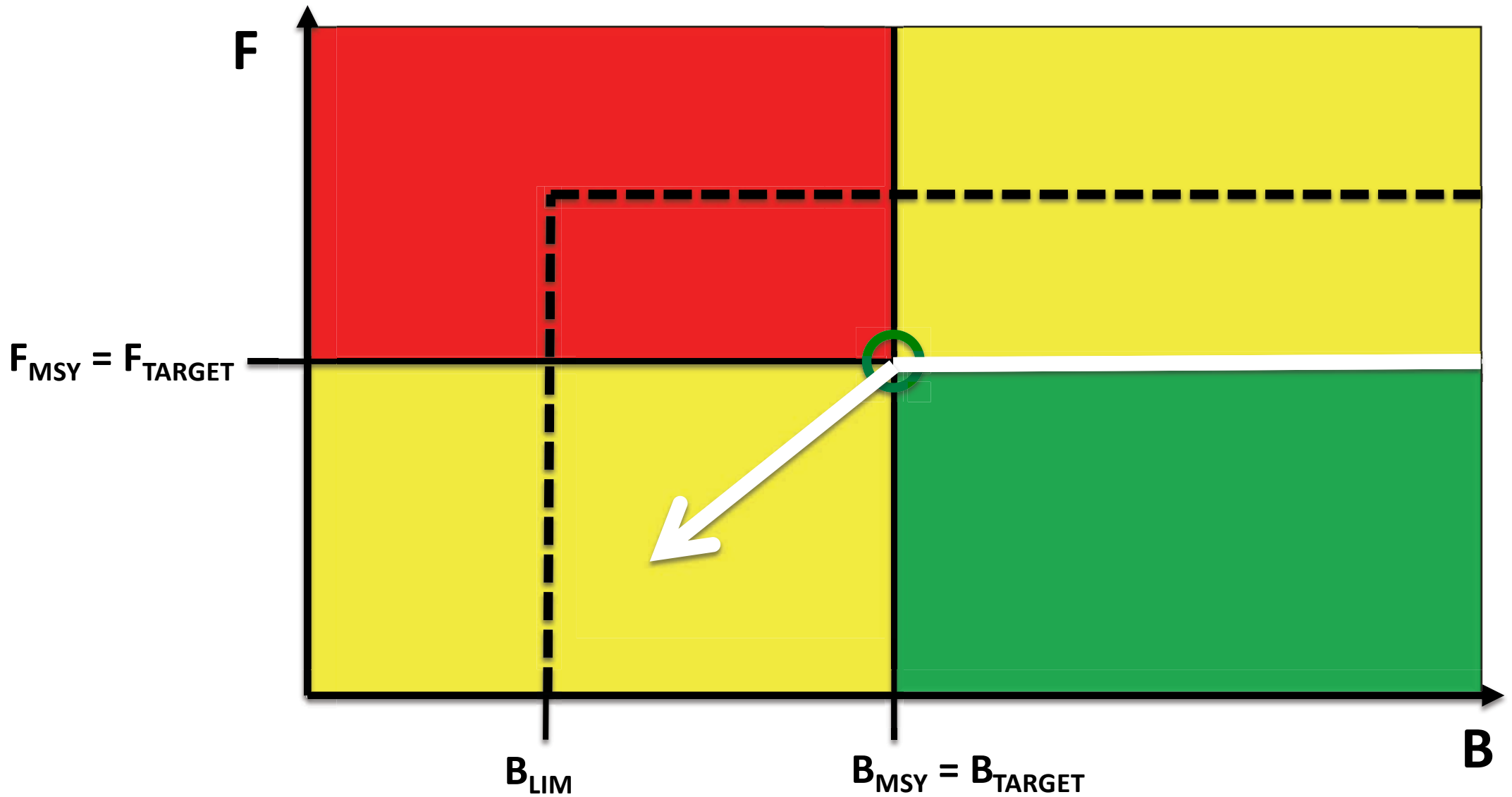


- From 2015 Survey at ICCAT's SWGSM. Considering priority given to the management objectives noted by Participants, those related to 'Safety', 'Yield', and P(green) aka 'Sustainability' ranked highest followed by minimizing ecosystem impacts.

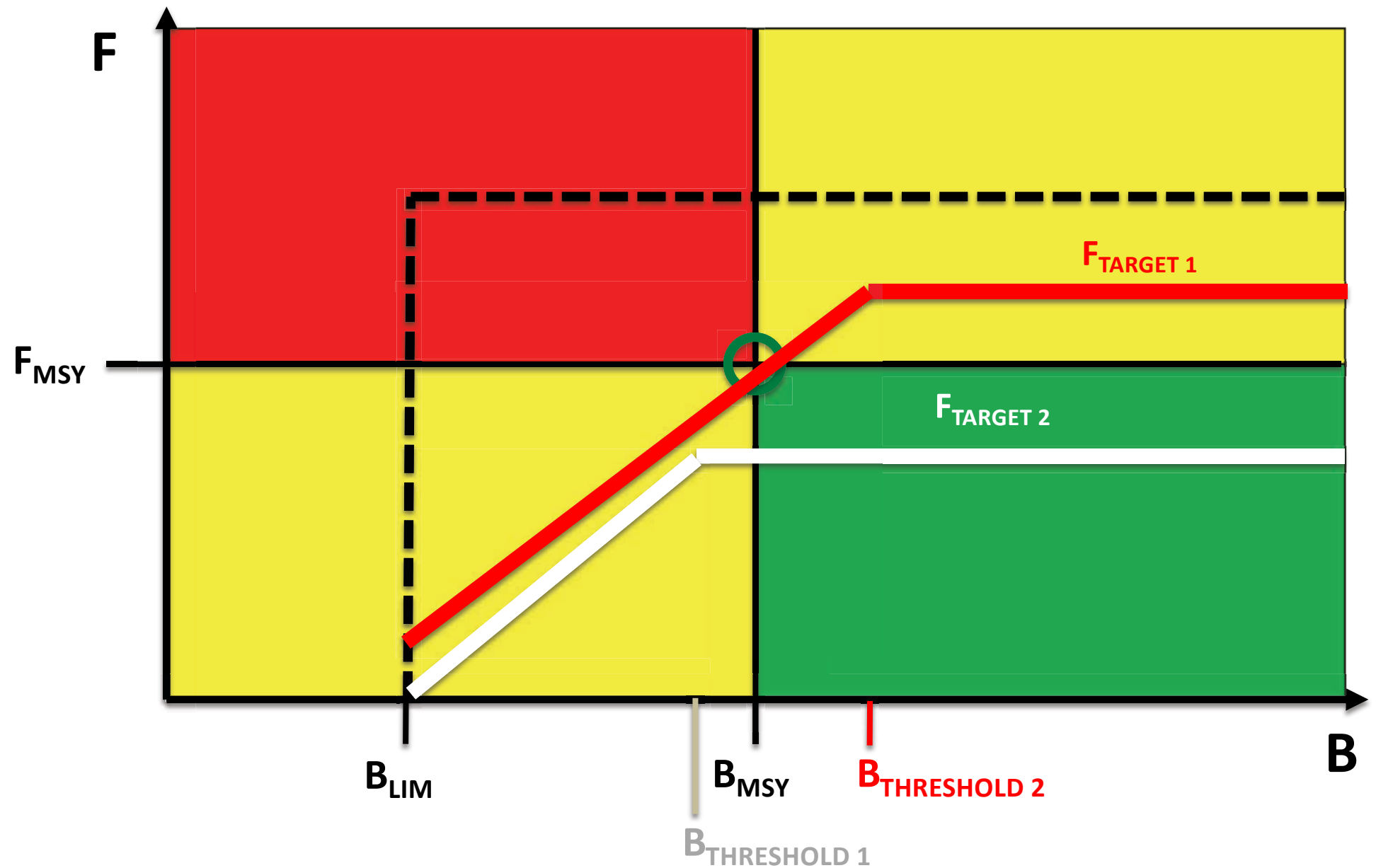
Harvest Control Rules



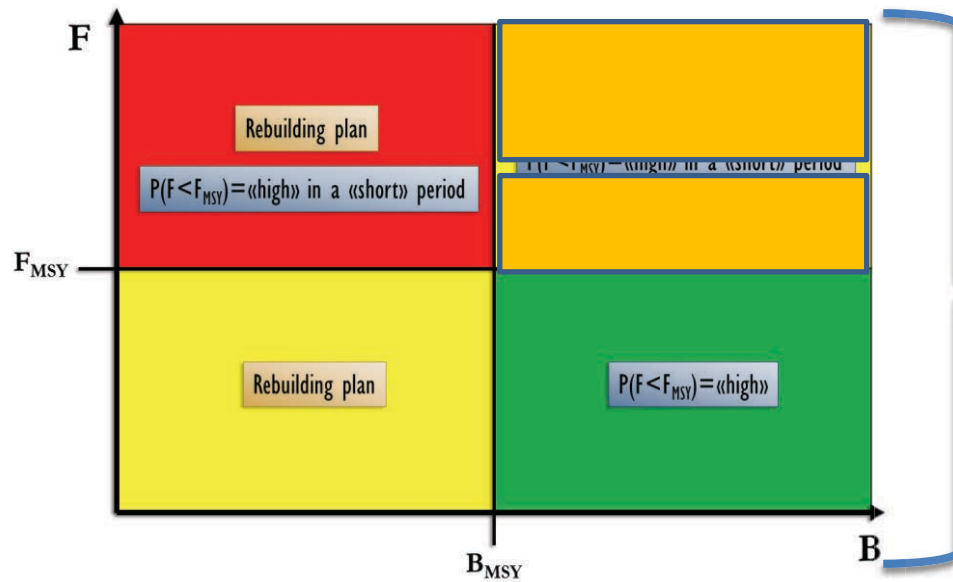
Harvest Control Rules



Harvest Control Rules



Harvest Control Rules (HCR)

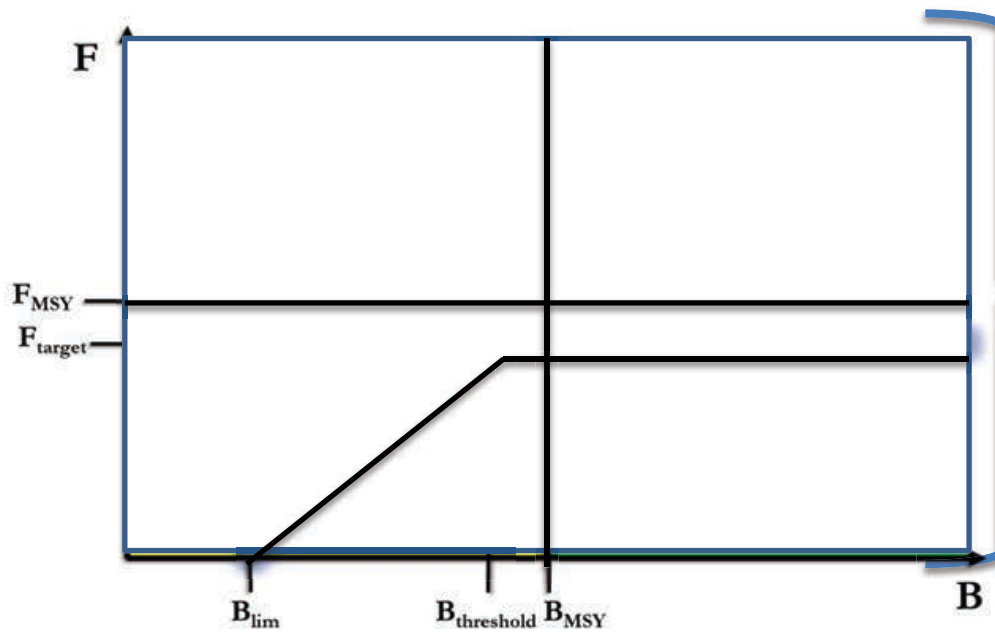


HIGH probability

IPCC: 80%
Canada: 75%
MSC: 70%-80%

SHORT period

USA: 10 years or 1.5 generations
Australia: 10 years + 1 generation
MSC: 2 generations



F target

$[0.7, 0.75, 0.8, 0.85, 0.9 \text{ and } 1] \times F_{MSY}$

B threshold

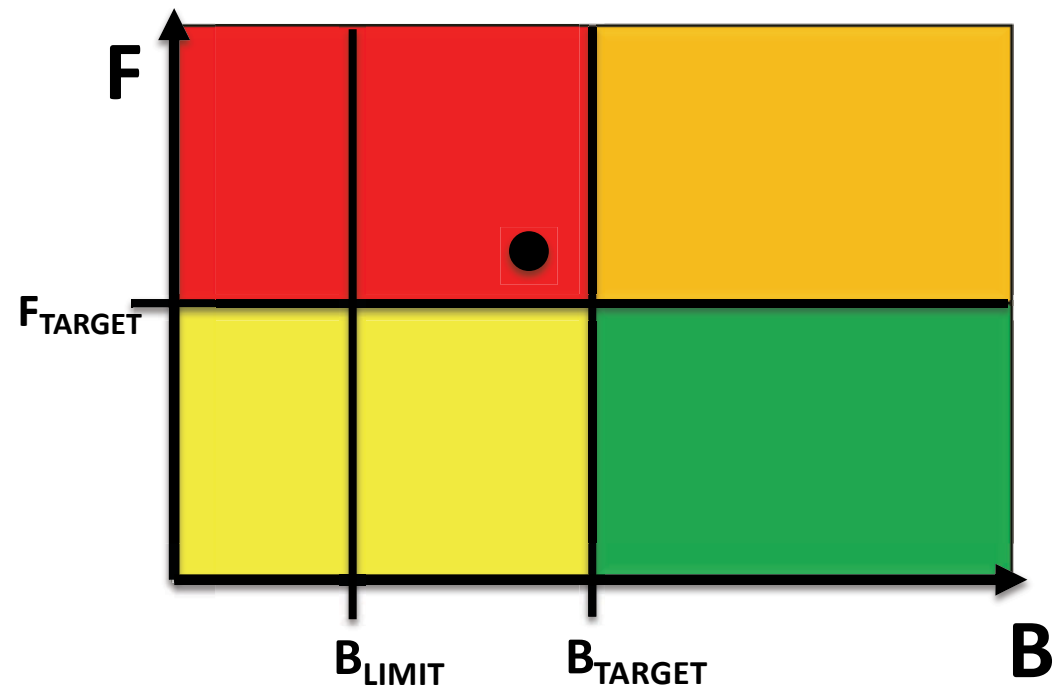
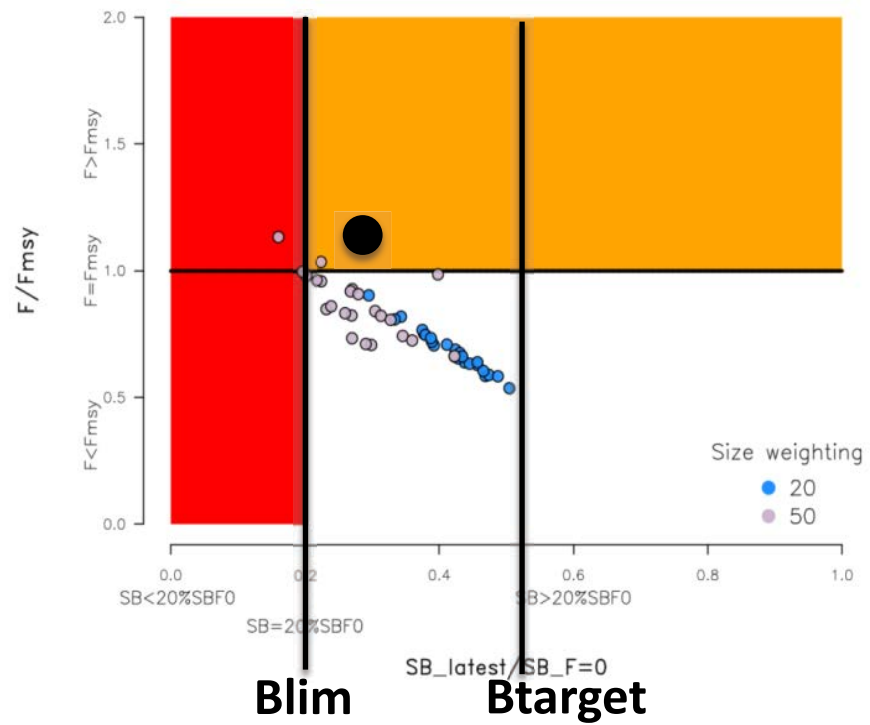
$[0.6, 0.8 \text{ and } 1] \times B_{MSY}$

B lim

$0.4B_{MSY}$

Courtesy: ICCAT

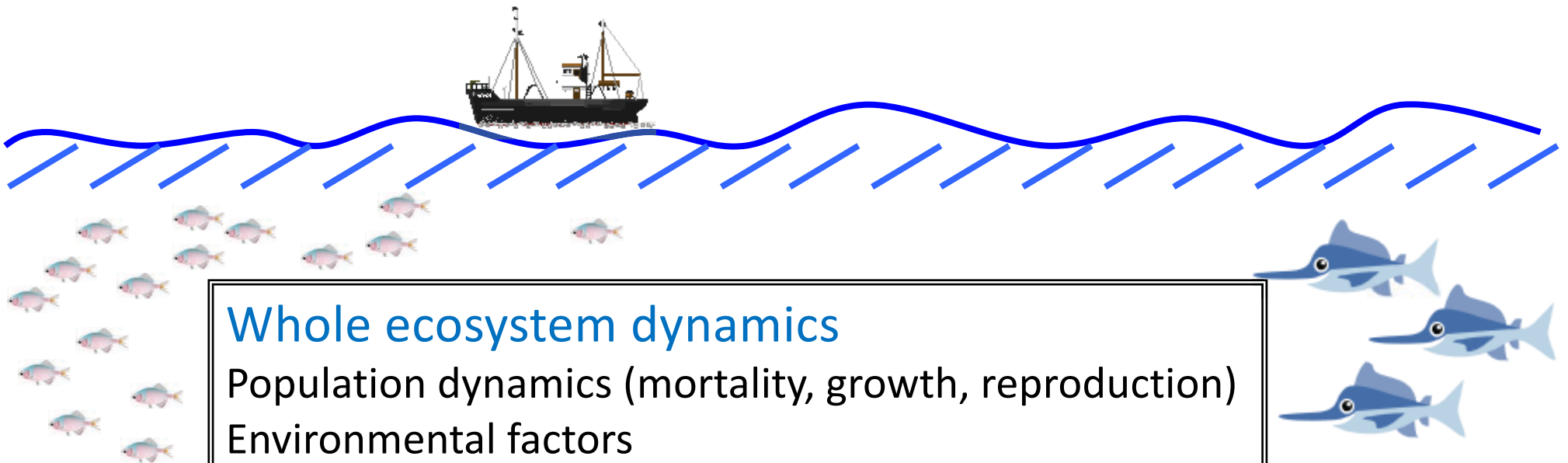
Provision of Management Advice



MSE BASIC PRINCIPLES



Fishery management



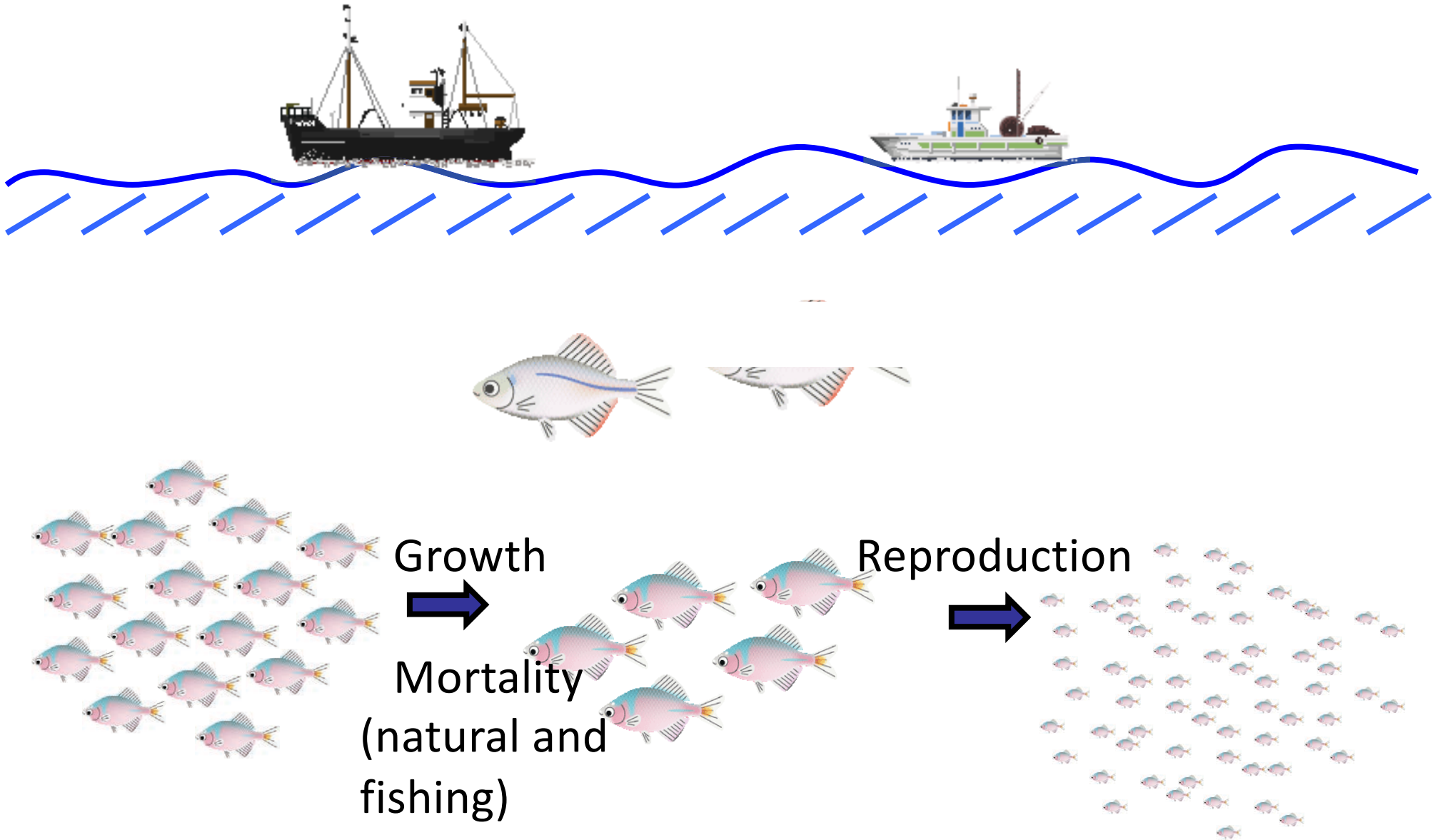
Whole ecosystem dynamics

Population dynamics (mortality, growth, reproduction)

Environmental factors

Food web, genetic stock structure

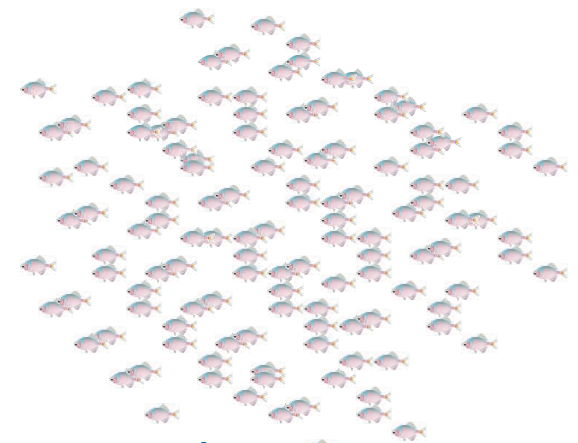
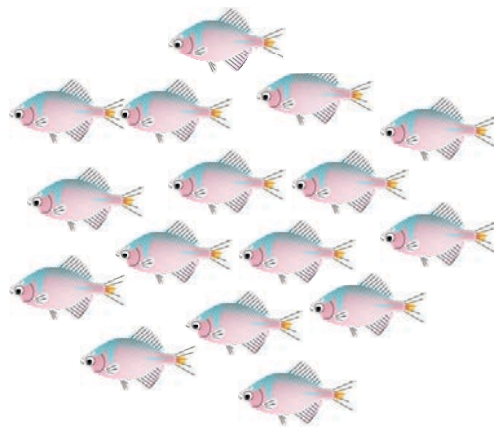
Fishery management



Fishery management

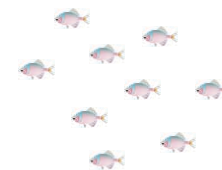


Stock A

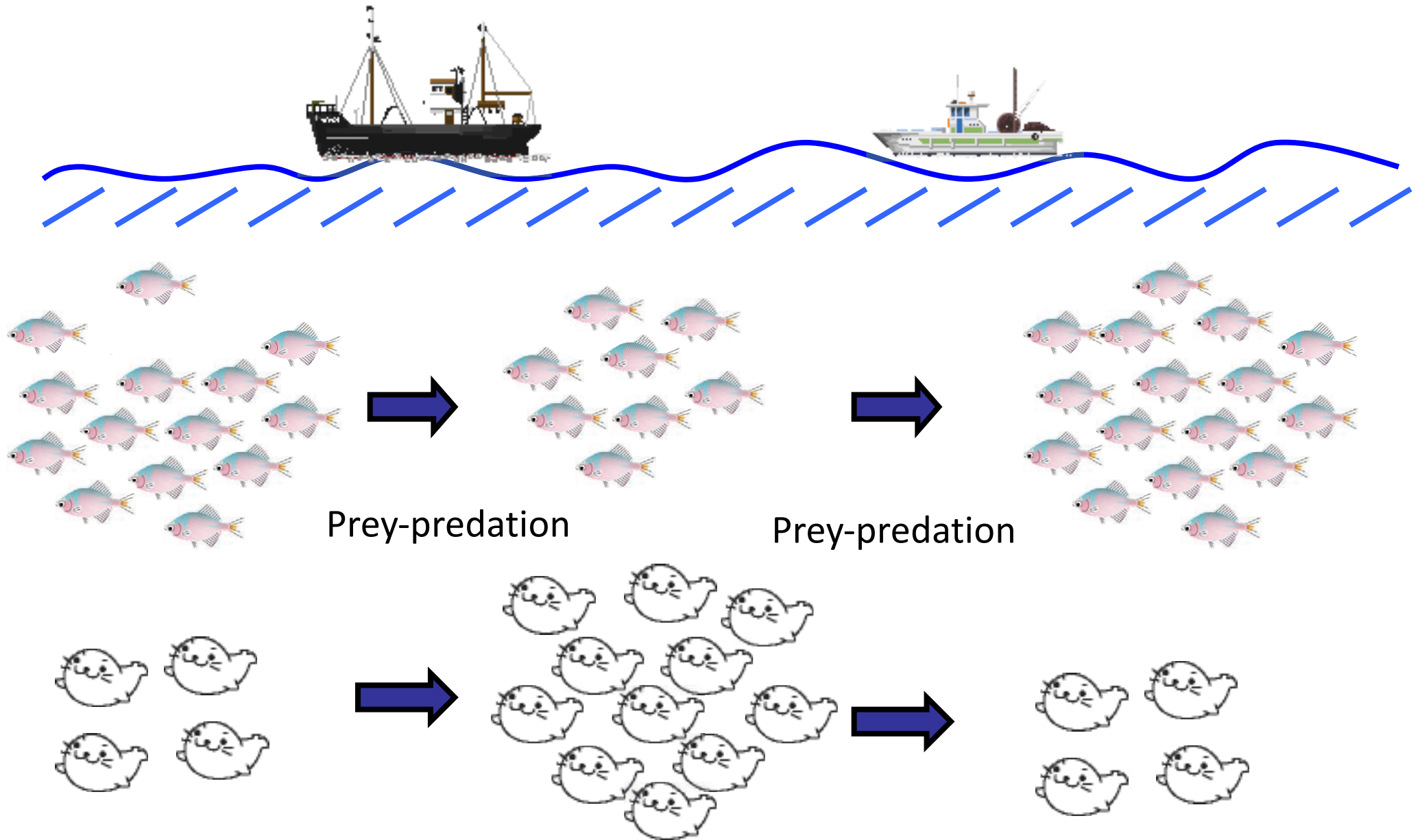


Different biological parameters
Different genetic composition

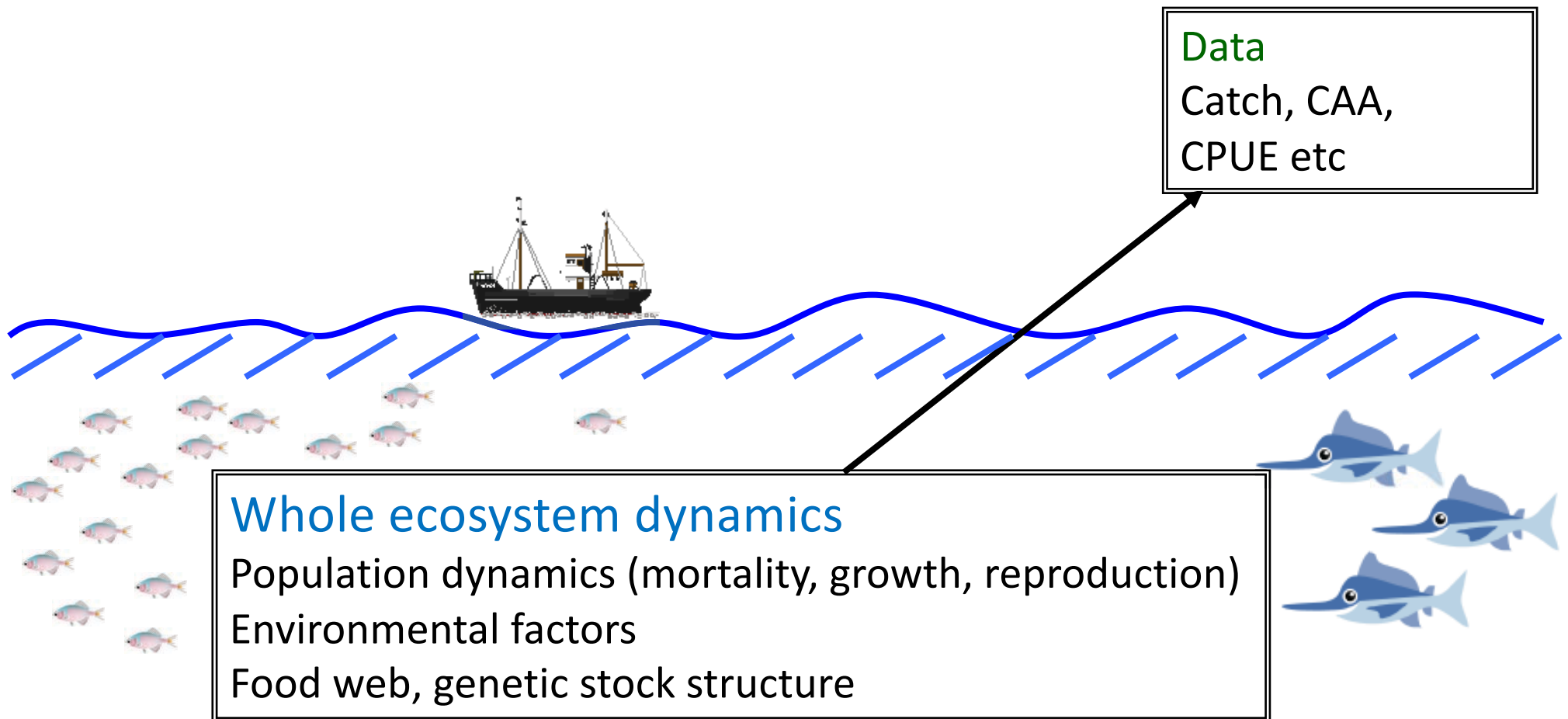
Stock B



Fishery management



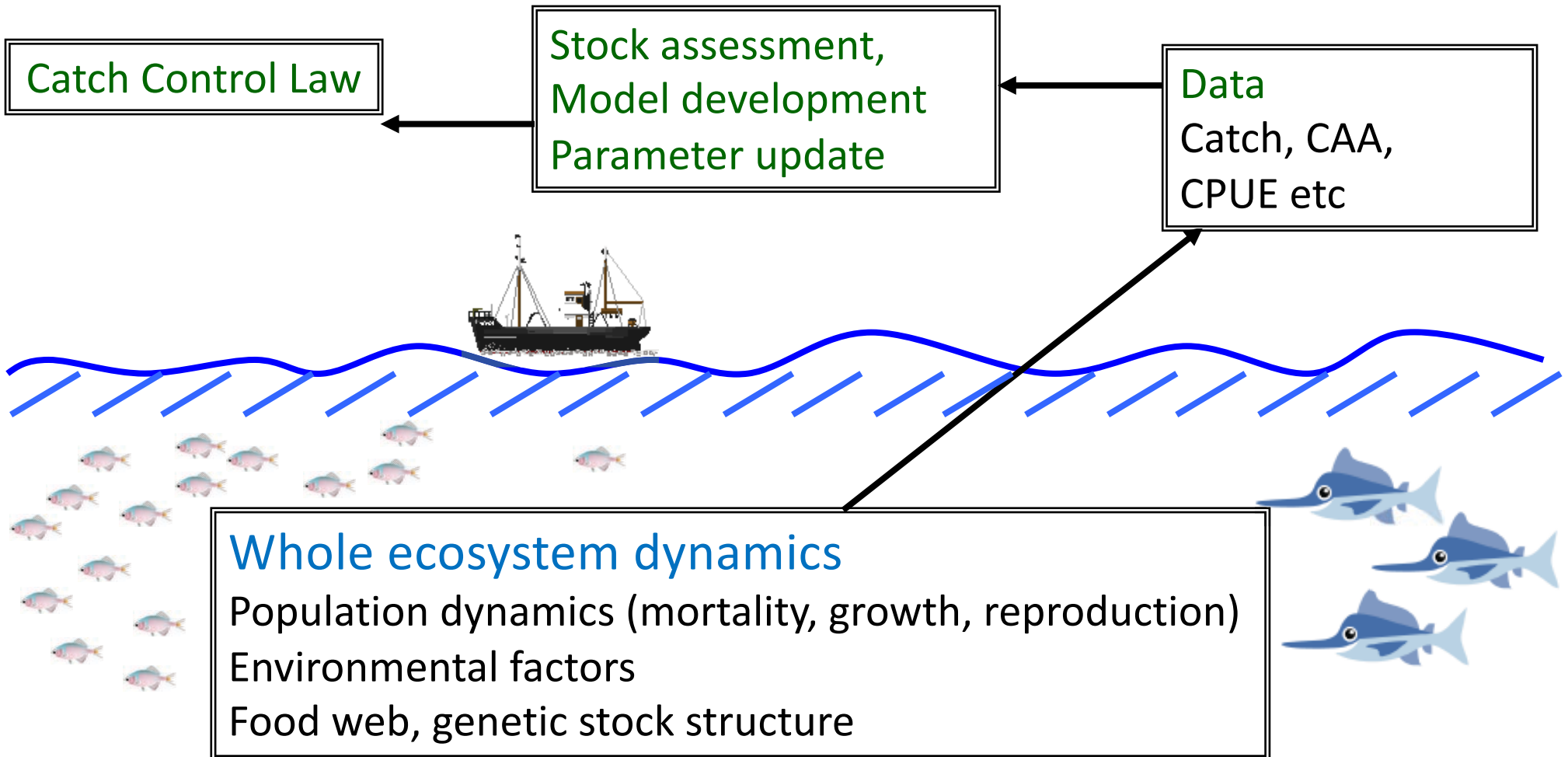
Fishery management



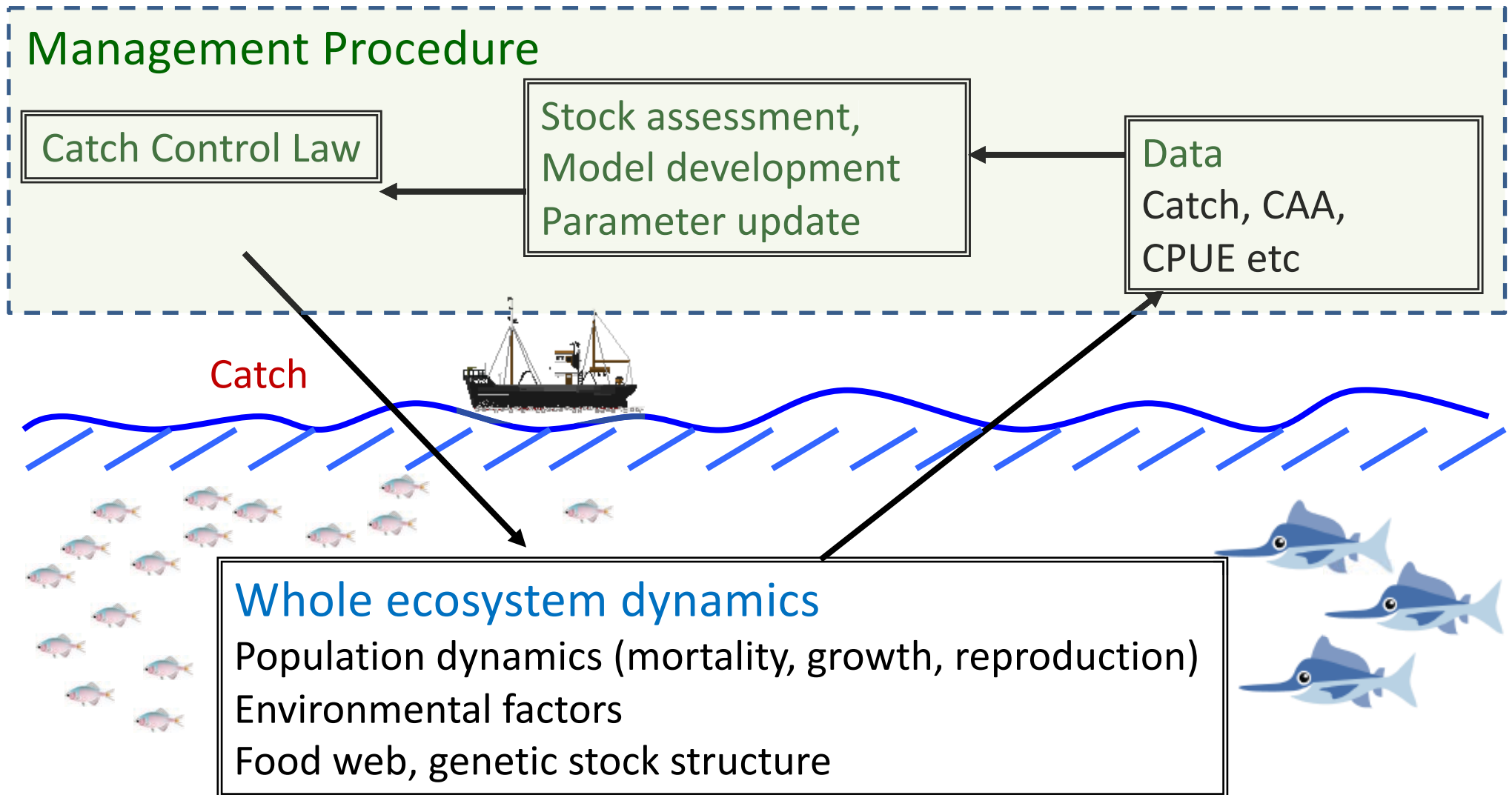
Fishery management

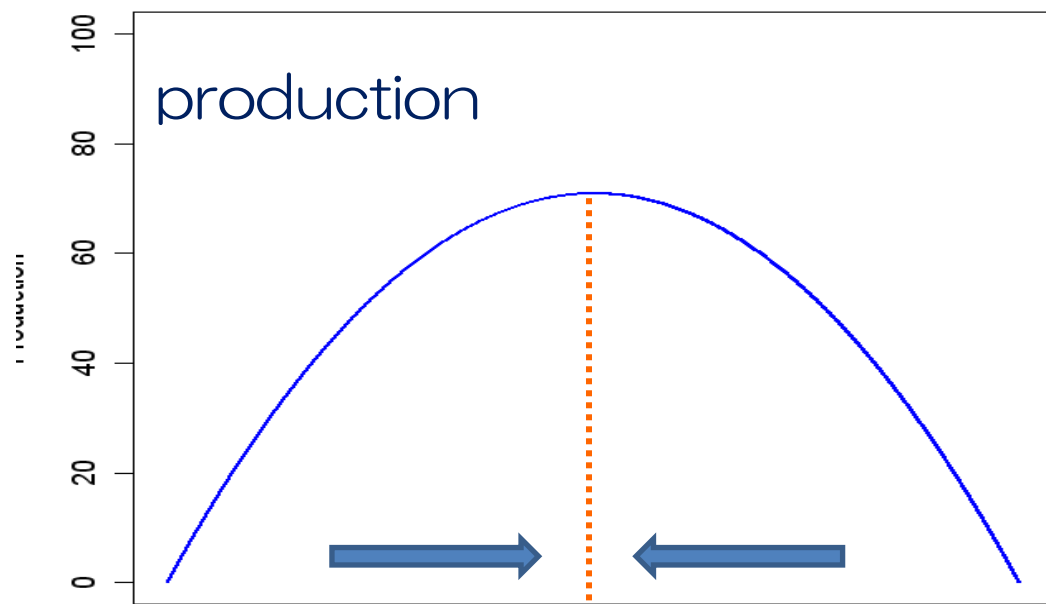
Total Allowable Catch
(TAC)

Allowable Biological Catch
(ABC)



Fishery management

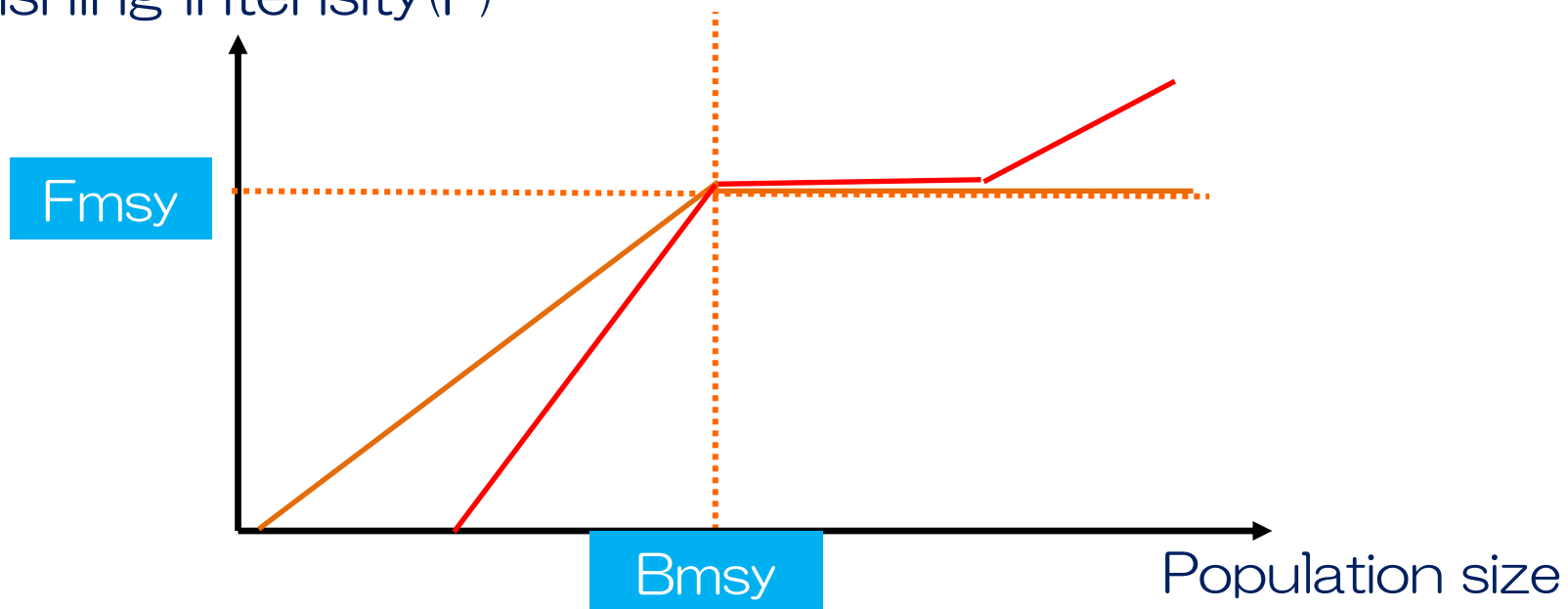




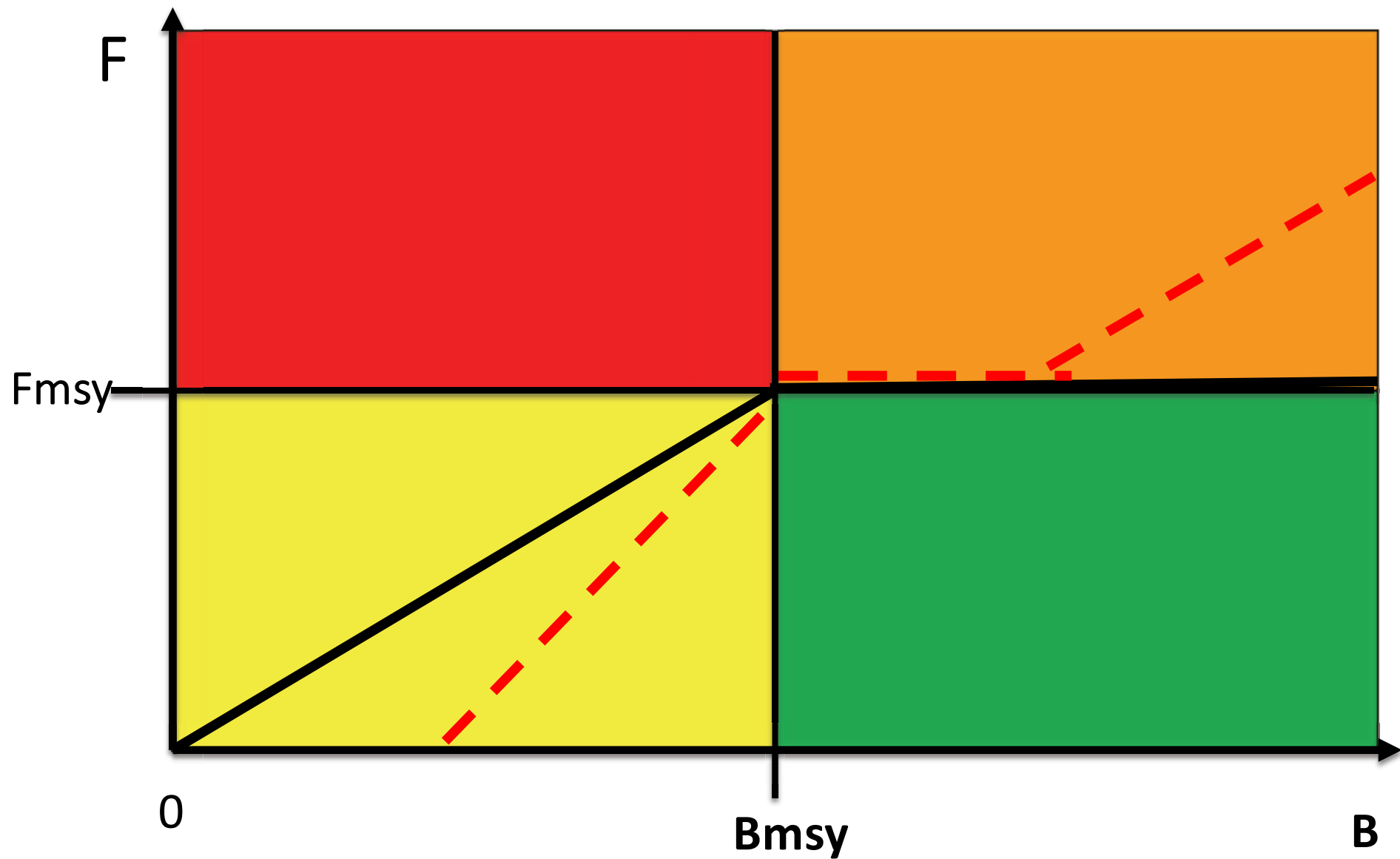
$$B_{msy} = \frac{K}{2}$$

$$F_{msy} = \frac{r}{2}$$

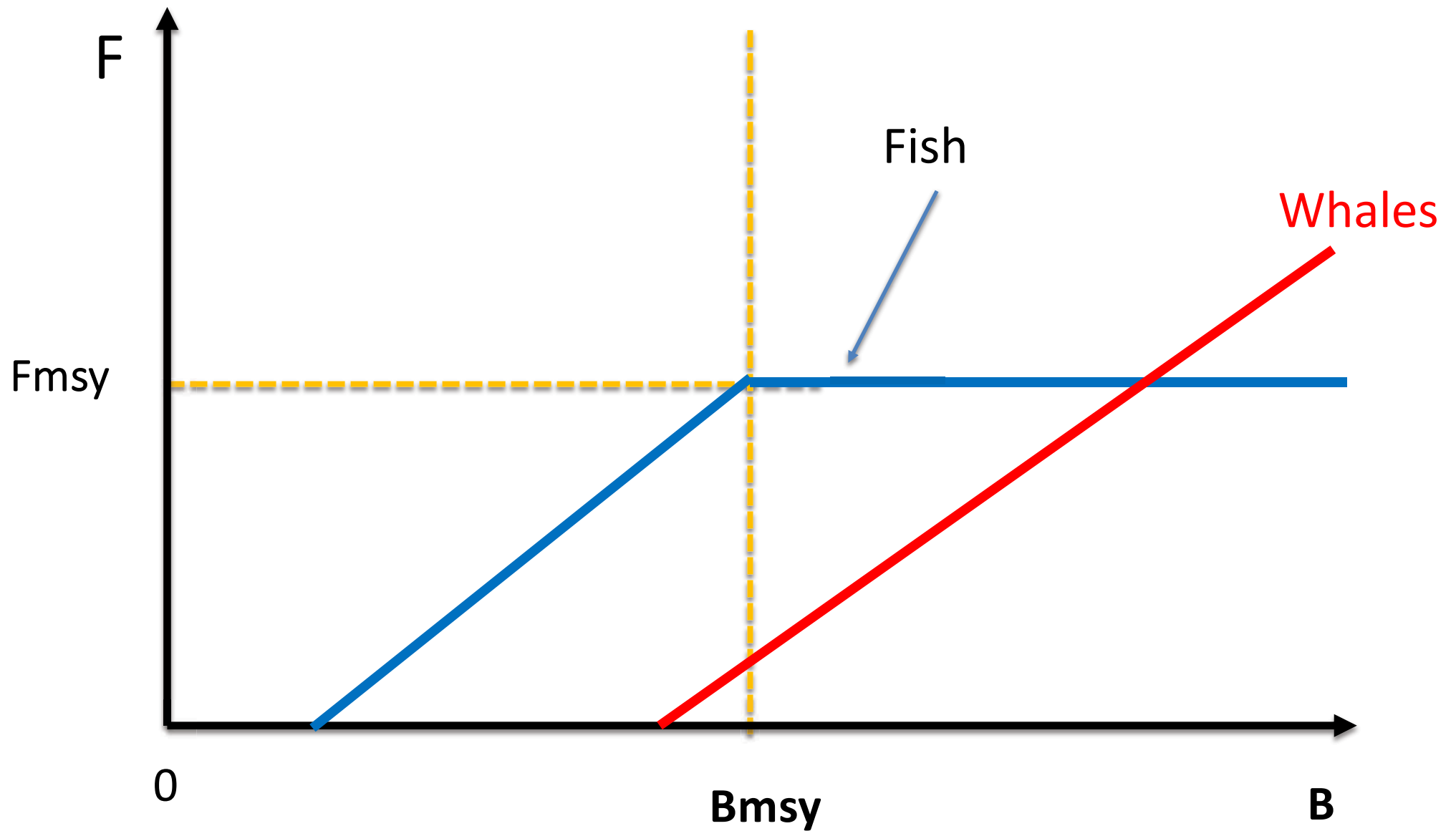
Fishing intensity (F)



Kobe plot上に管理方式を上書きすると



Catch Limit Algorithm (CLA) for management of whales



Why MSE?

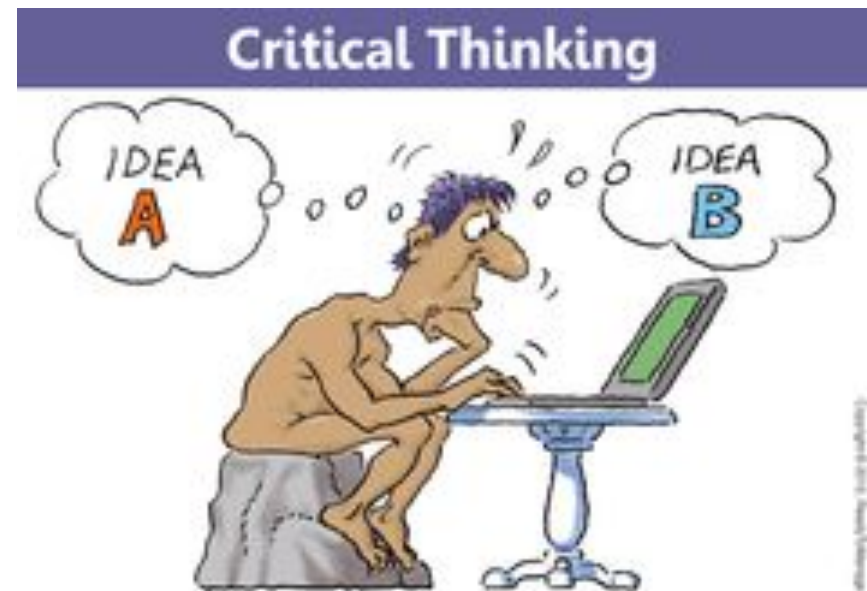
- Imagine that you are a responsible person to set a fishery quota for next XX years
- You might want to check if a quota set by "you" works or not



ToonClips.com

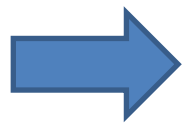
#55366

service@toonclips.com



Why MSE ?

- But, how do you set a quota?
- How do you evaluate it?

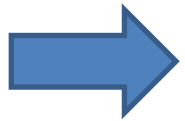


you need predetermined goals/objectives



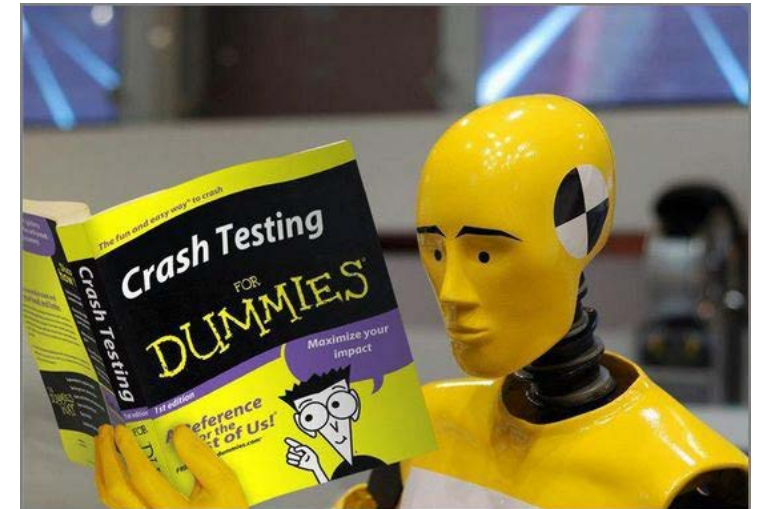
Why MSE?

- How do you set?
- How do you evaluate?



You need predetermined goals/objectives

You need computation
for simulation



If the quota set by you does not perform adequately under simulation, can we expect it to work in the real world?"

=> **No!**

What is MSE ?

- A simulation framework for assessing the performance of management procedures
- A pioneer work: **IWC/SC's RMP**
- Since then, the idea has been used and developed for lots of species (not only fishery resources but also terrestrial animals)
- The questions are: **if goals/objectives are achieved or not**
- Through this process, **various sources of uncertainty** are taken into account
- Also, **adaptive procedures** can be incorporated and tested
- Should be practical as much as possible
- Anytime interim, should be reviewed regularly

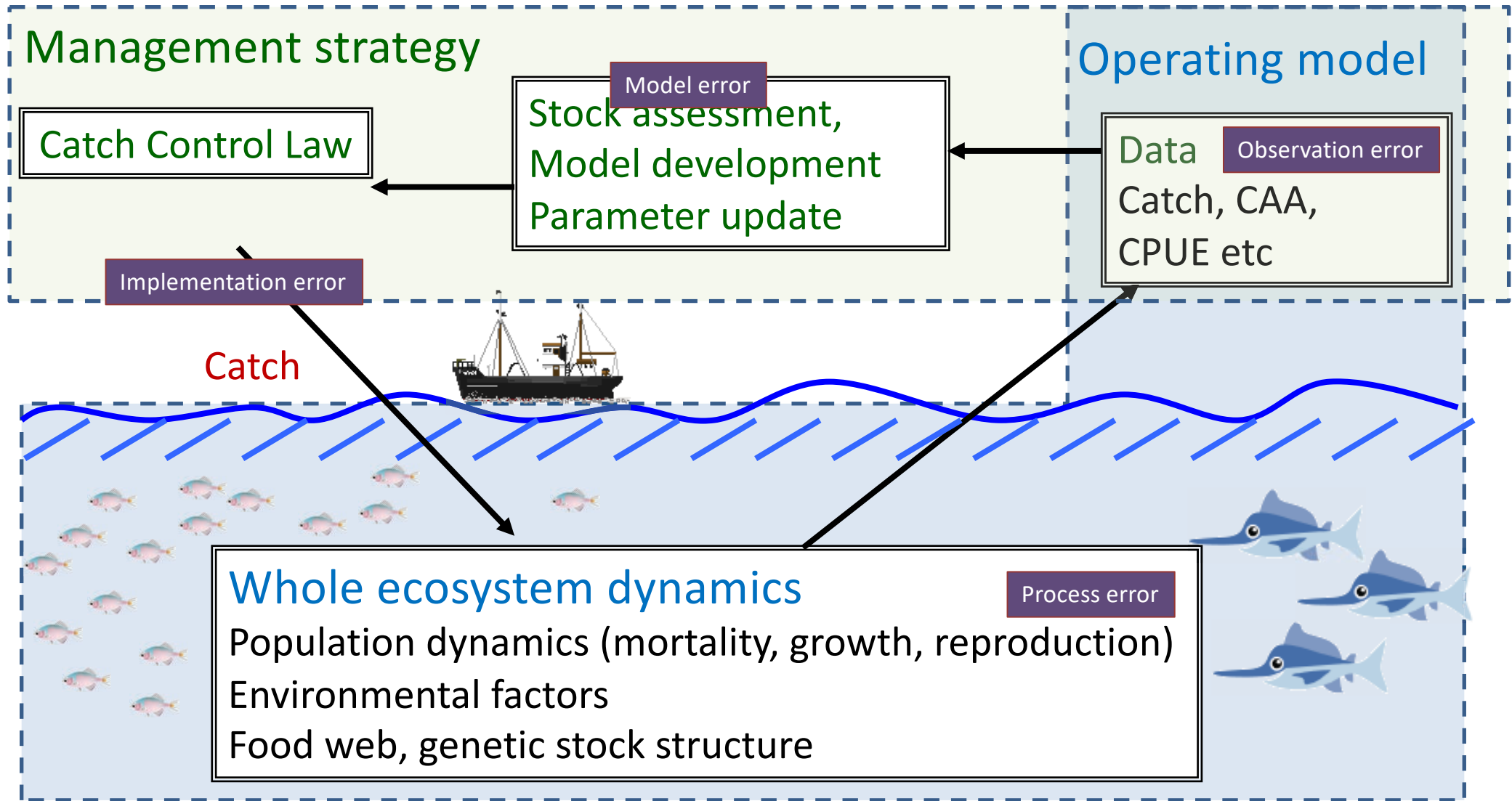
What is MSE ?

- Possible to handle various types of uncertainty
(e.g. Francis & Shotton 1997)
 - Uncertainty in data and input parameters
 - Process uncertainty (e.g. process errors, environmental)
 - Estimation uncertainty (estimation error, SE, CV)
 - Model uncertainty
 - Implementation uncertainty
- Possible to test adaptive management procedures
- Objective and comprehensive evaluation of management procedures and harvest control rules in terms of efficacy, advantage/disadvantage and risks
- Compatible with Ecosystem-based Fishery Management (EBFM)
- Bridge between scientific and social interests

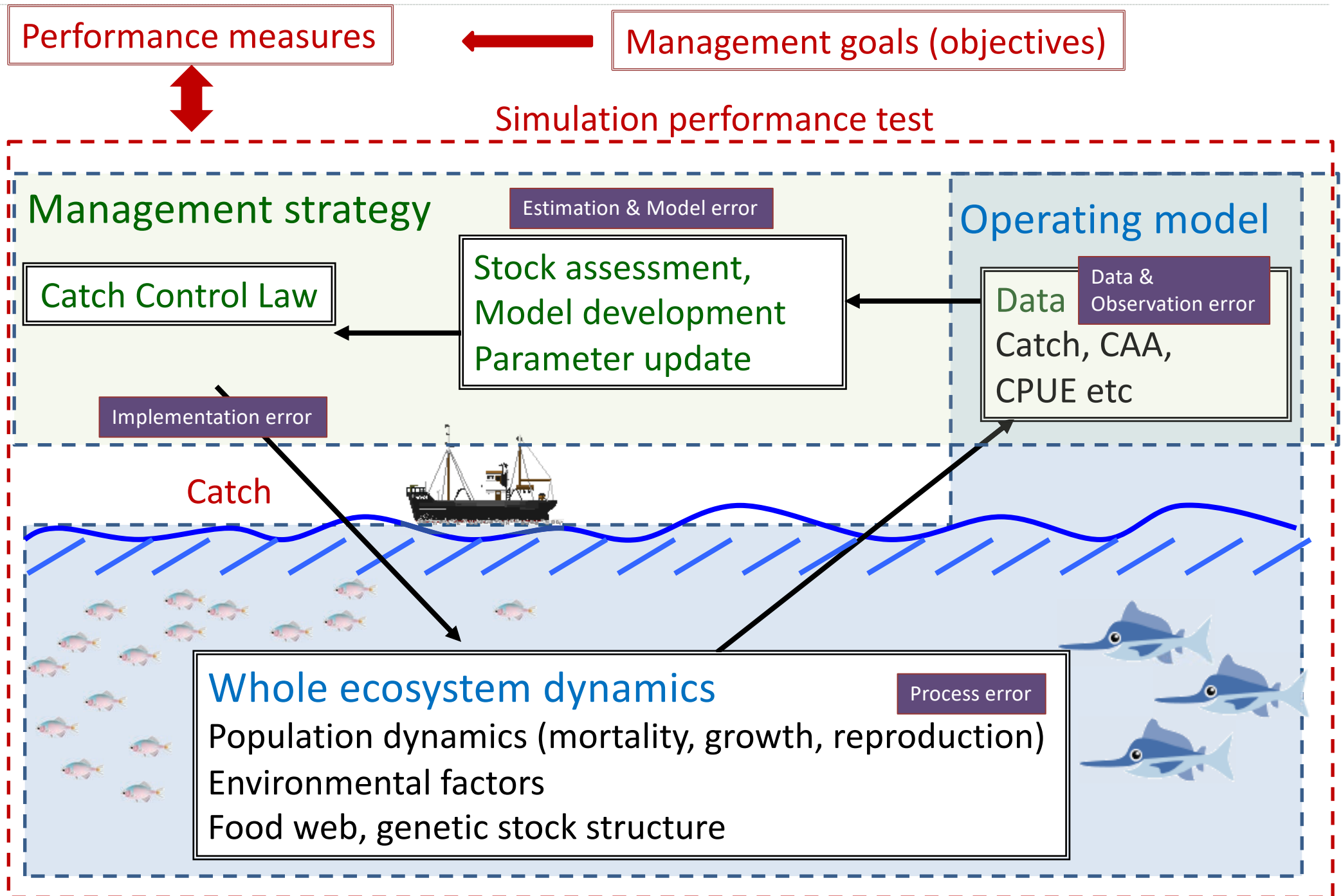
Fishery management

Assess

- Is population sustained by this fishery management strategy?
- How much catch is available in the future? Is it stable?
- Is management strategy robust to uncertainty? Etc.



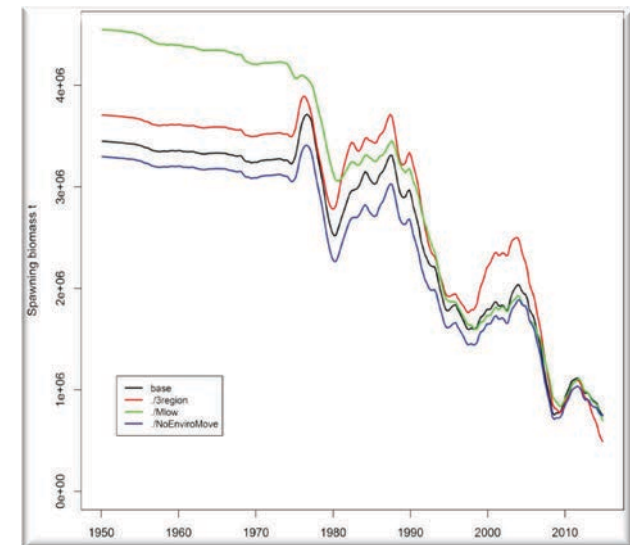
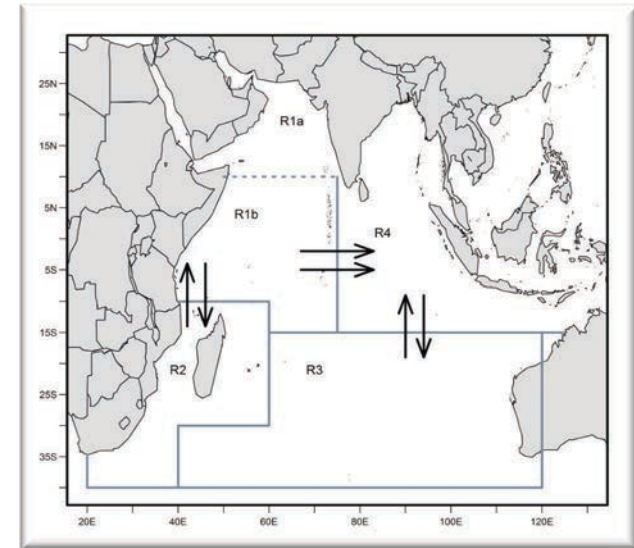
Management Strategy Evaluation (MSE)



Operating Models (OMs)

Usually based on existing stock-assessment with

- Best-available information
- Plausible range of biological ecological parameters
- As virtual reality
- Uncertainty with respect to
 - data
 - parameters
 - models
 - estimation
 - stochastic process in population
 - implementation



Possible range of stock assessment models

Age \ Year	1	2		y	y+1		Y
0							
1							
a							
a+1							
A							

Age-structured

$N_{a,y}$ → $N_{a+1,y+1}$

Age \ Year	1	2		y	y+1		Y
0							
1							
a							
a+1							
A							

Stage-based

Age \ Year	1	2		y	y+1		Y
0							
1							
a							
a+1							
A							

Delay-difference model

Age \ Year	1	2		y	y+1		Y
0							
1							
a							
a+1							
A							

Production model

Management Procedures (MPs)

MPs including HCRs

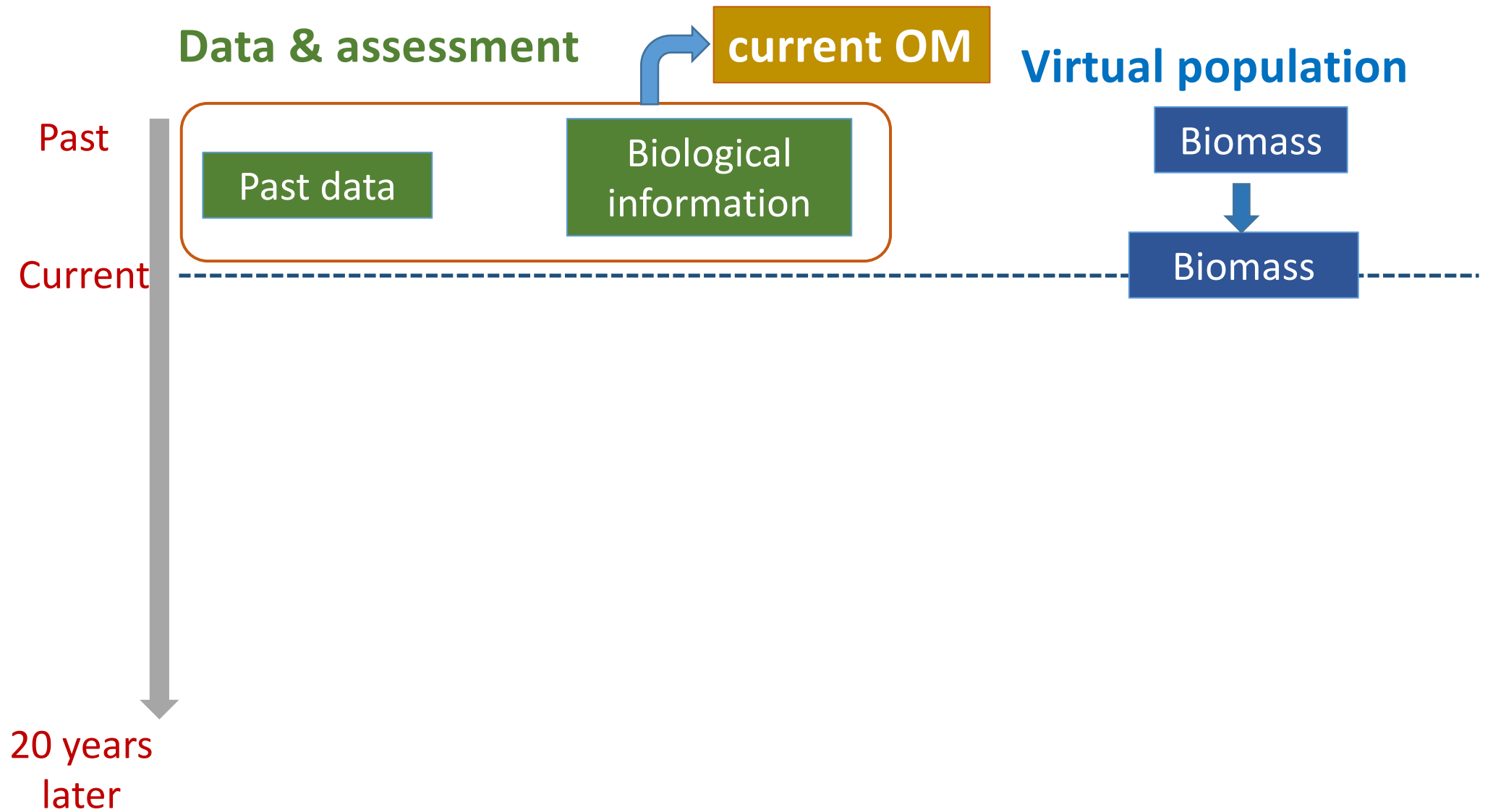
- Predetermined rules to set catch limit
- Data collection and assessment

Note: Any MPs do not know the reality of OMs !!

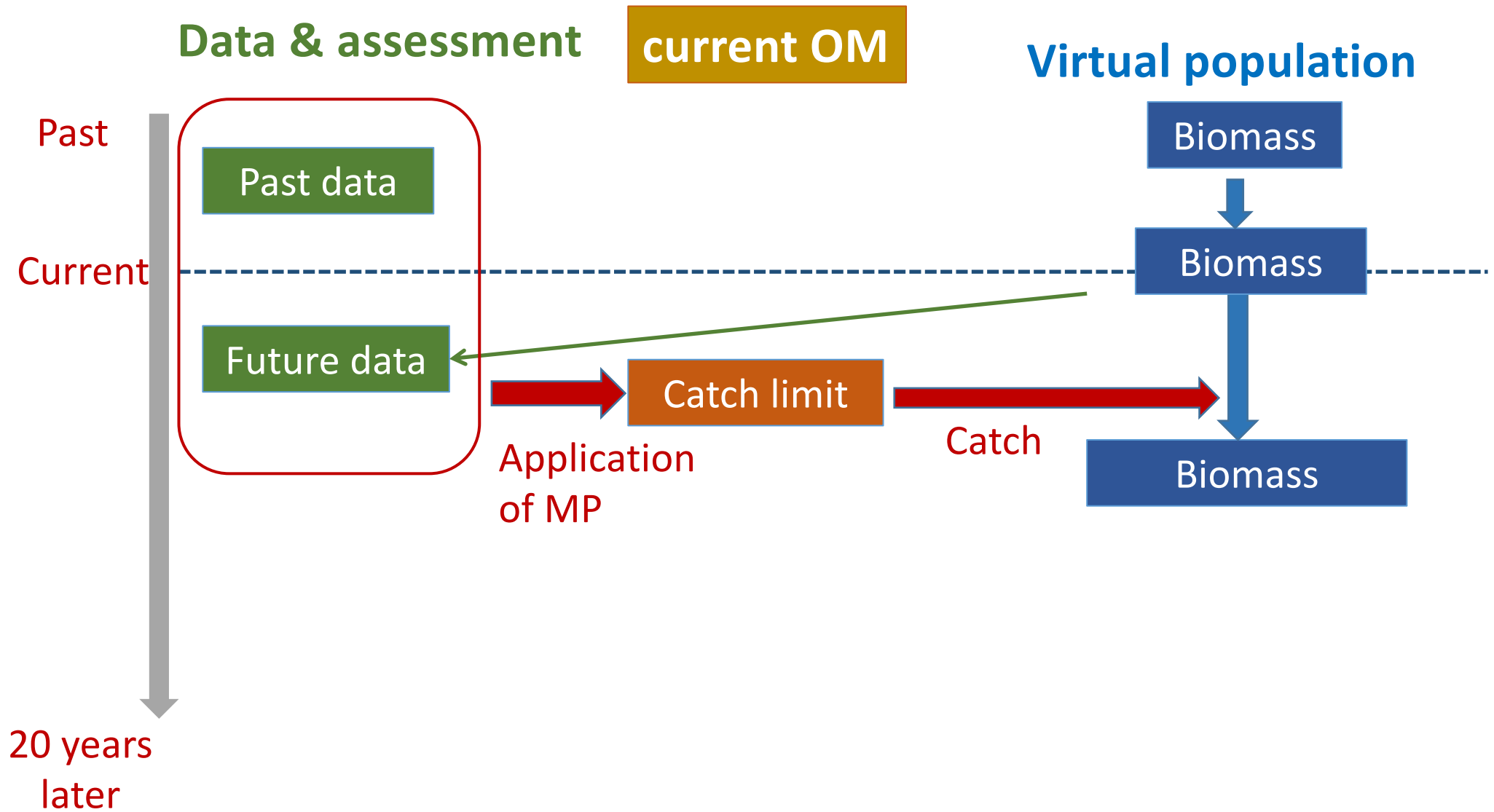
- Kinds of blind tests
- If MPs know OMs, just like "judge" and "prosecutor" is a same person



Update of MPs



Update of MPs

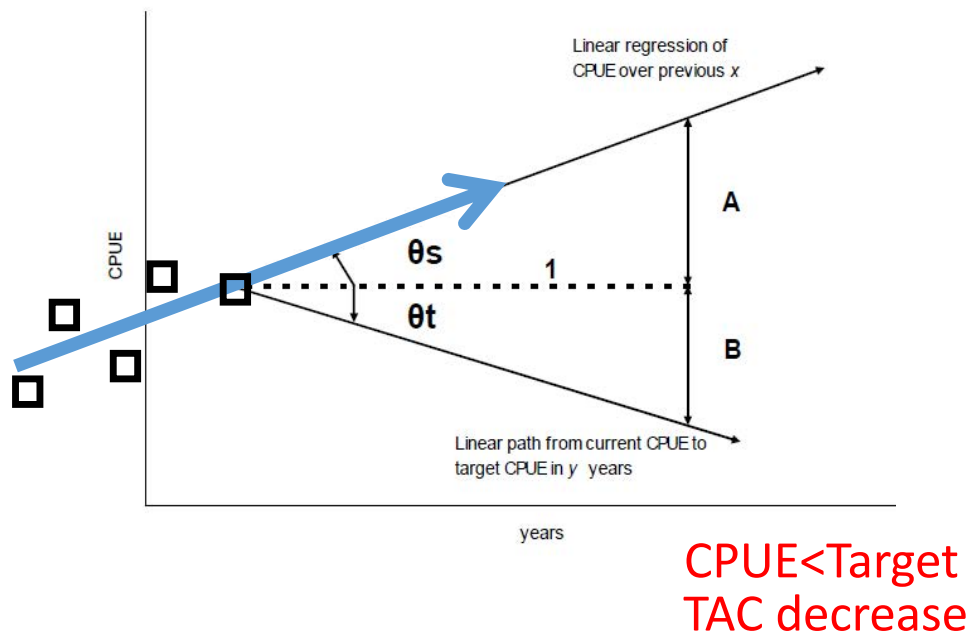


Currently two types of MPs

- 1) Empirical (model-free, CPUE-based)
- 2) Model-based (with a simple stock assessment)

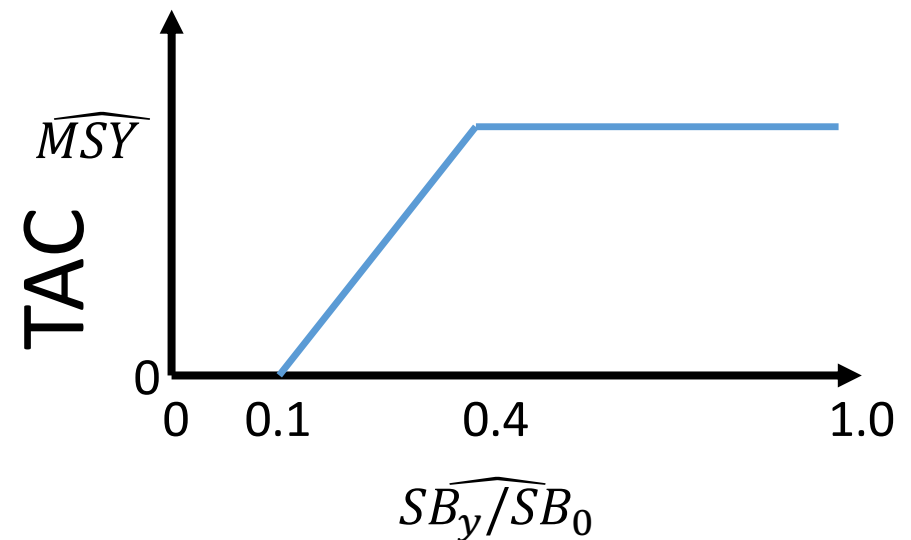
1) Empirical MP:

Aims to keep the stock near a target CPUE

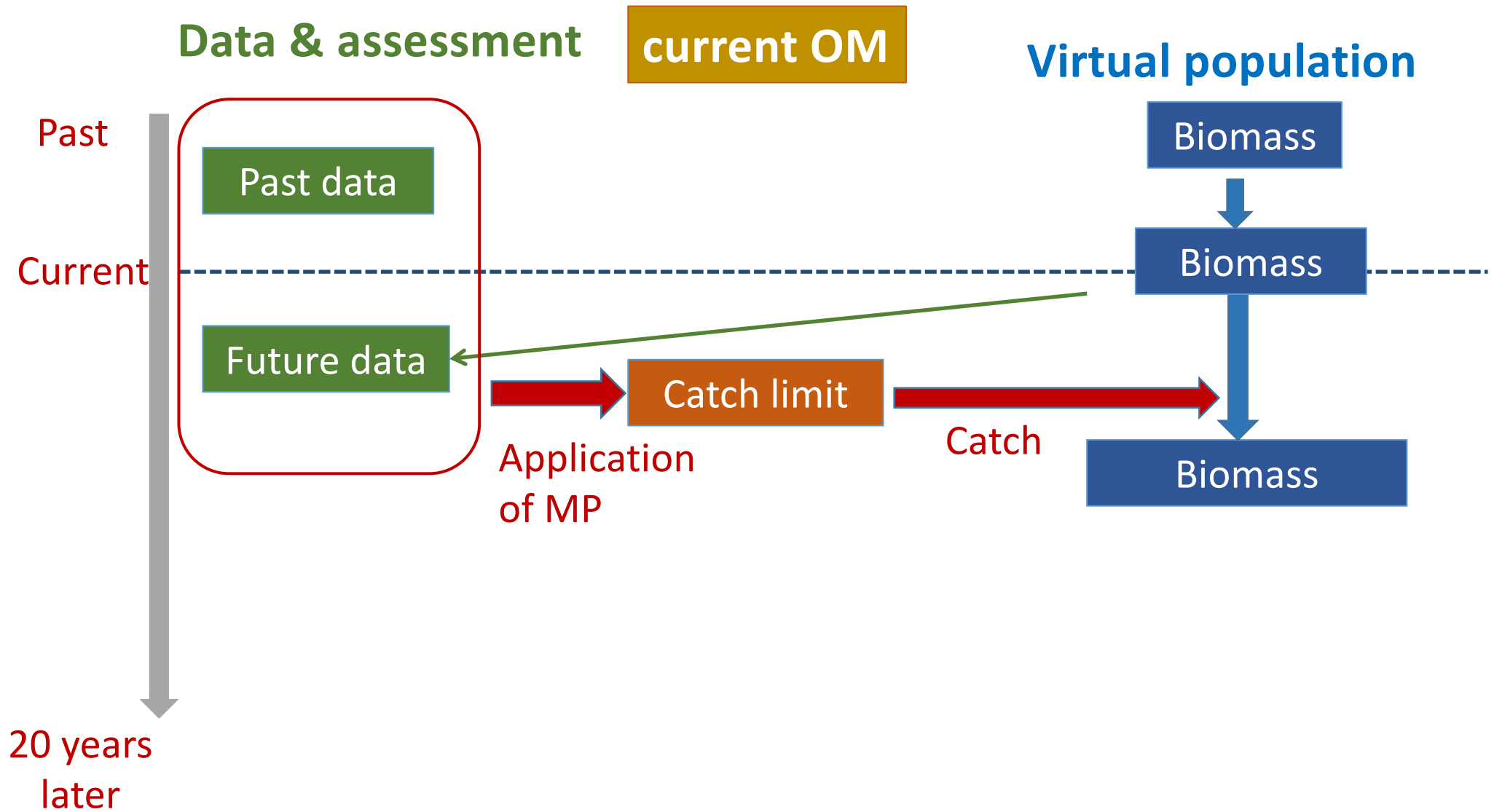


2) Model-based MP:

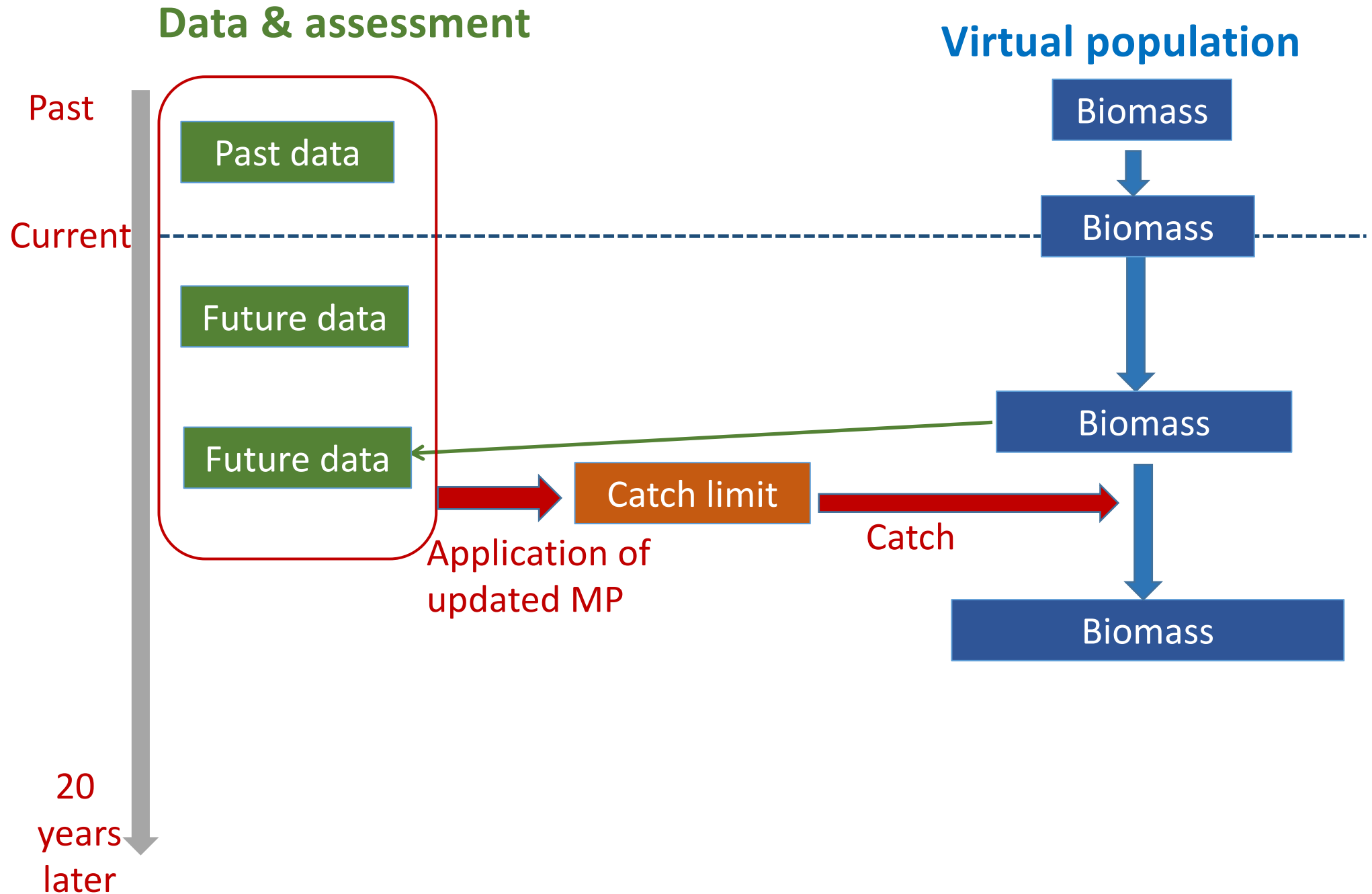
- Fits a Pella-Tomlinson surplus production model,
- Set the TAC using a 40:10-type HCR



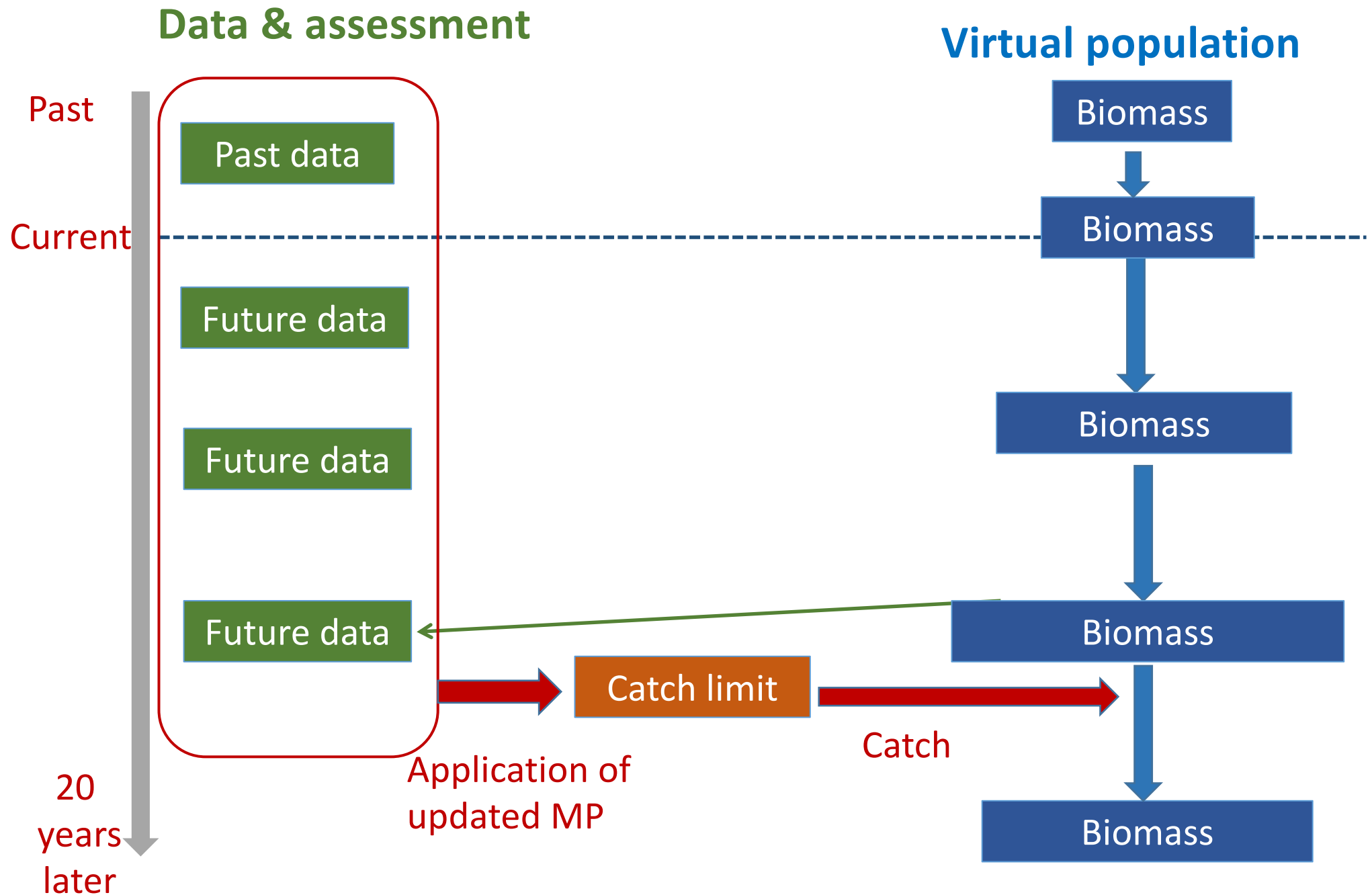
Update of MPs

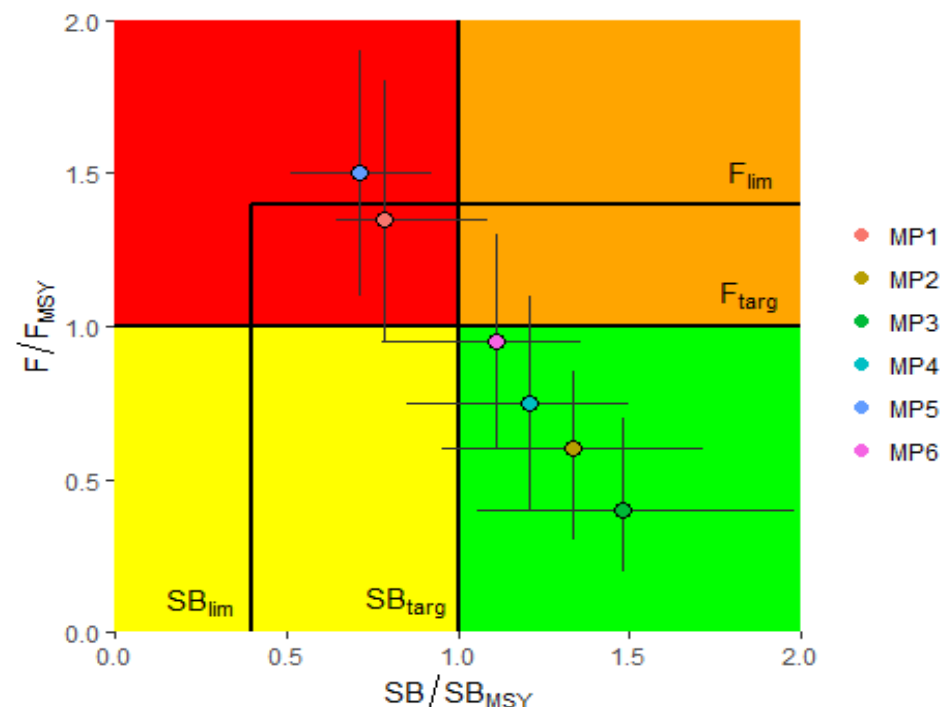
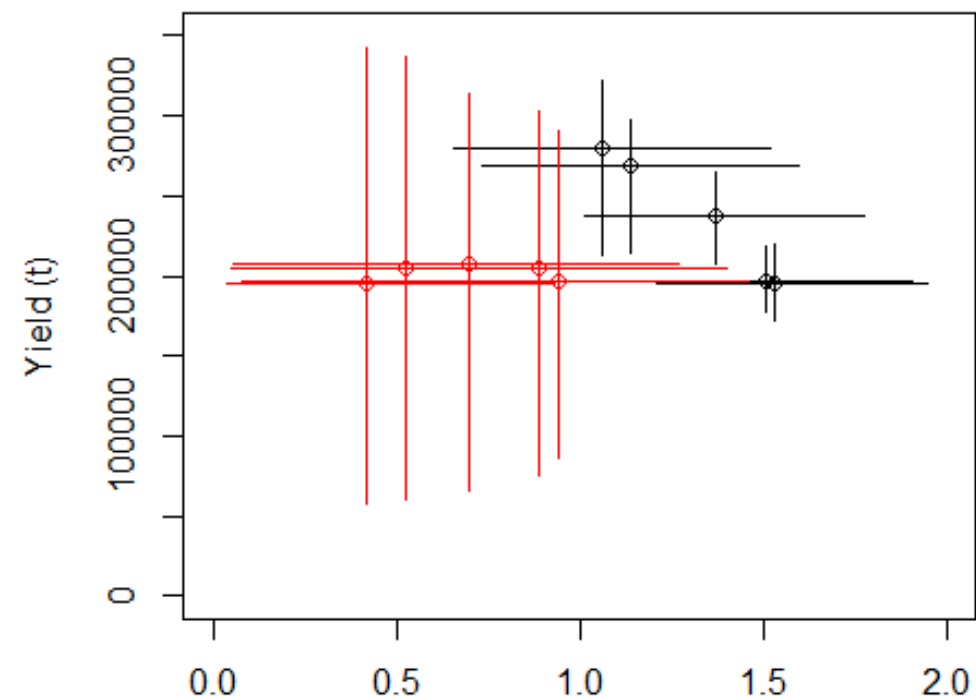
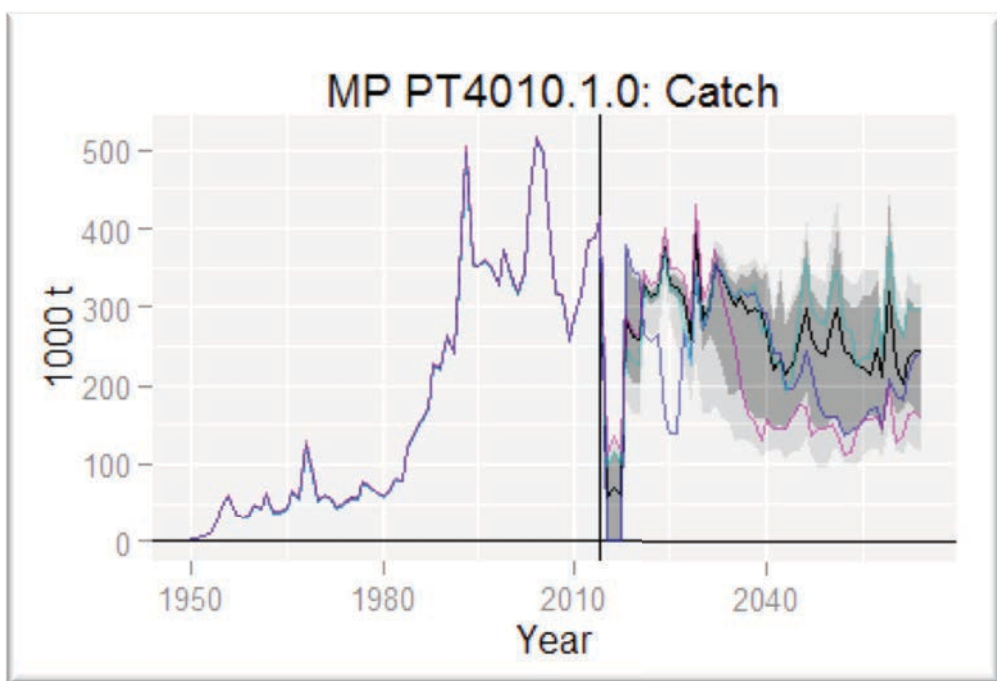
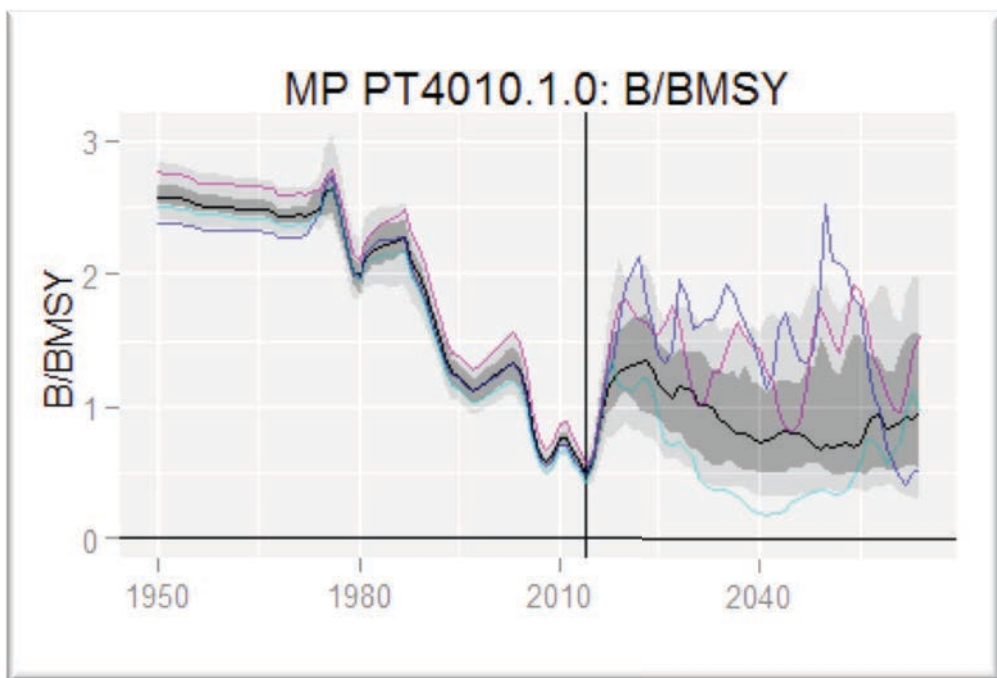


Update of MPs



Update of MPs





Management Strategy Evaluation

Simulation testing to

- *Develop management procedure strategy for a particular fishery*
- *Evaluate generic management procedure*
- *Identify management procedures that will not work and should therefore be eliminated from further consideration*
- *Evaluate benefits of additional data collection.*

Key Note: The aim is to find **management procedure** through Simulation Testing that are **robust to major uncertainty** (rather than strategies that are optimal if a particular scenario is true)

Management Procedure: the combination of pre-defined data, together with an algorithm to which such data are input to provide a value for a set of implementable management measures.

Management Strategy Evaluation

- MSE what are we evaluating?



“Simulated reality”
Operating Model

Management Strategy Evaluation

- MSE what are we *evaluating*?



“Simulated reality”
Operating Model



Management Procedure

Management Strategy Evaluation

- MSE what are we evaluating?



But WHAT IF?

“Simulated reality”
Operating Model

Management Strategy Evaluation

- MSE what are we evaluating?



But WHAT IF?



“Simulated reality”
Operating Model

- MSE what are we *evaluating*?



But WHAT IF?

“Simulated reality”
Operating Model

Management Strategy Evaluation

- MSE what are we *evaluating*?



“Simulated reality”
Operating Model



Management Procedure

The aim is to find a **Management Procedure** through Simulation Testing that is **robust to major uncertainty**

Management Strategy Evaluation

Simulation testing to

- Develop management procedure strategy for a particular fishery
- Evaluate generic management procedure
- Identify management procedures that will not work and should therefore be eliminated from further consideration
- Evaluate benefits of additional data collection.

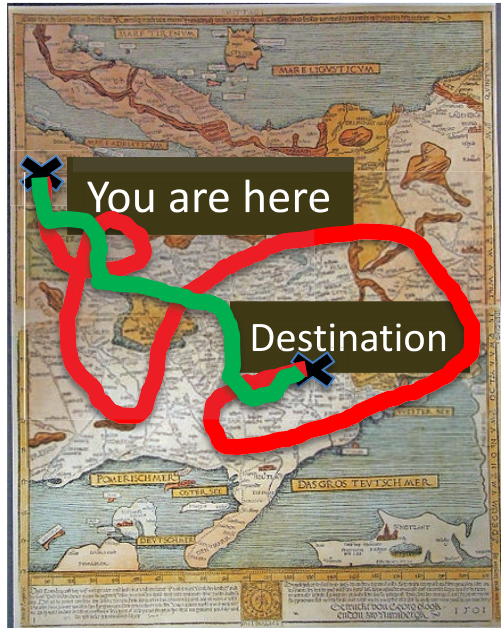
Key Note: The aim is to find management procedure through Simulation Testing that are robust to uncertainty (rather than strategies that are optimal if a particular scenario is true)

Management Procedure: the combination of pre-defined data, together with an algorithm to which such data are input to provide a value for a set of **implementable management measures**.

“Agreeing the rules of the game before it is played”

Doug Butterworth

Management Procedure



Yield

Status



Stability

Safety

- Stock assessment – where we were and are now
- Management procedure – How/When to get to the target
- MSE – What's “*the best*” way to the target (eg a MP meeting the target and provided most appropriate trade-off results between desired management objectives)

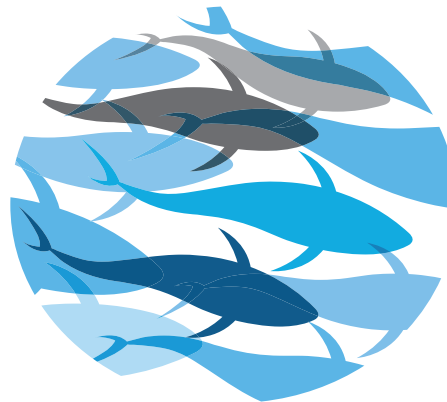
Management Strategy Evaluation PROCESS



Food and Agriculture
Organization of the
United Nations



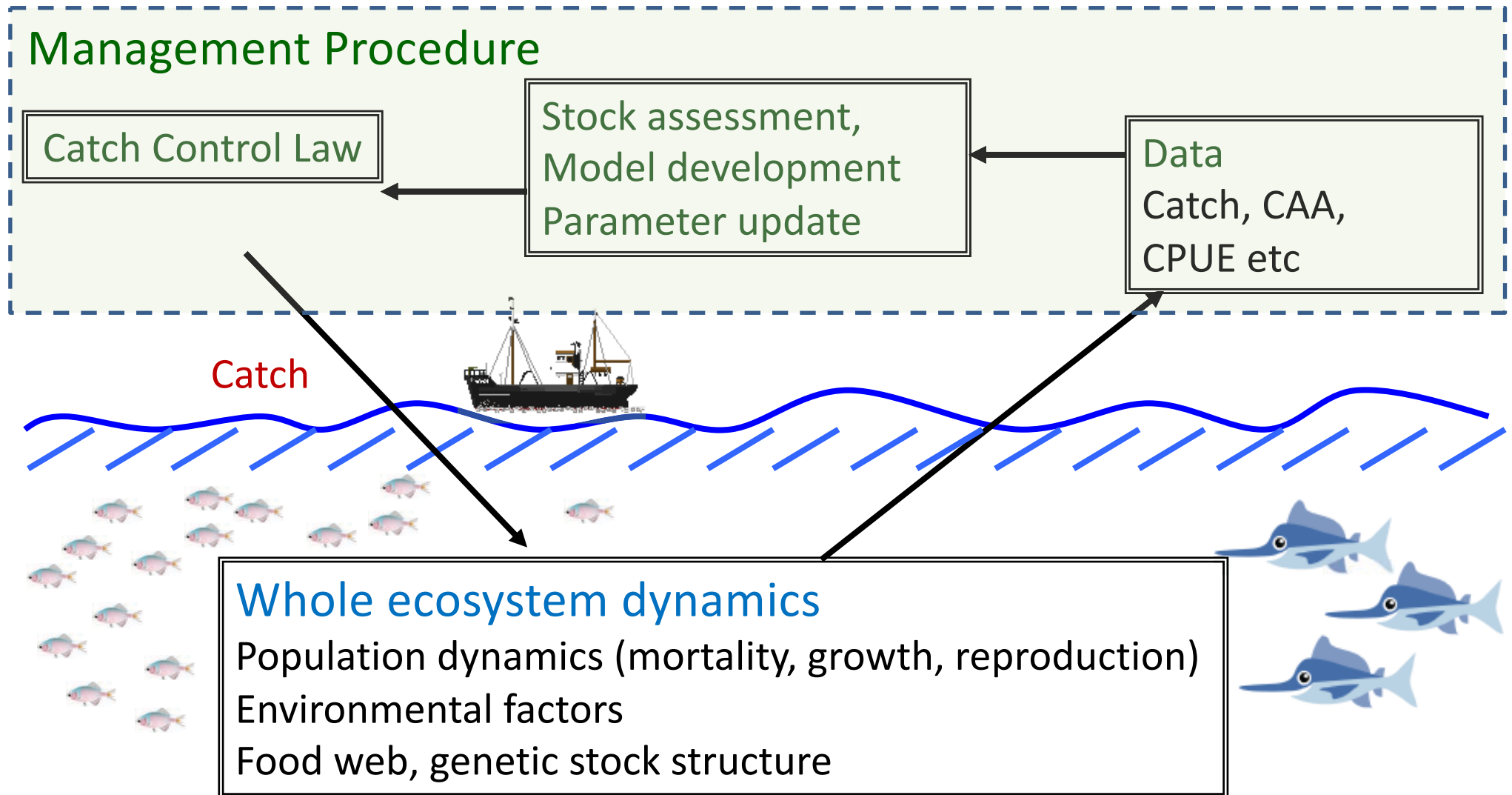
COMMON OCEANS



iotc ctoi



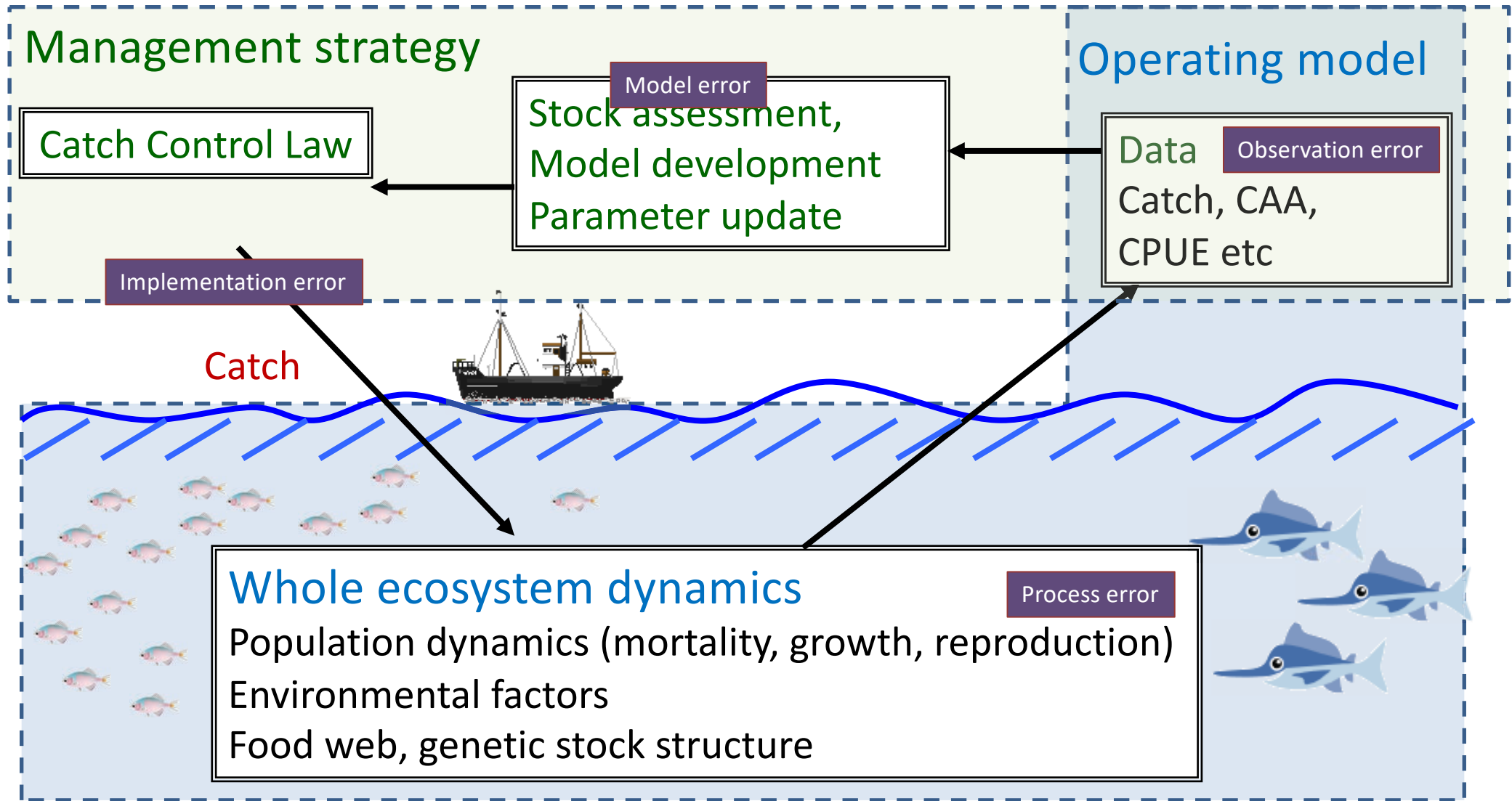
Fishery management



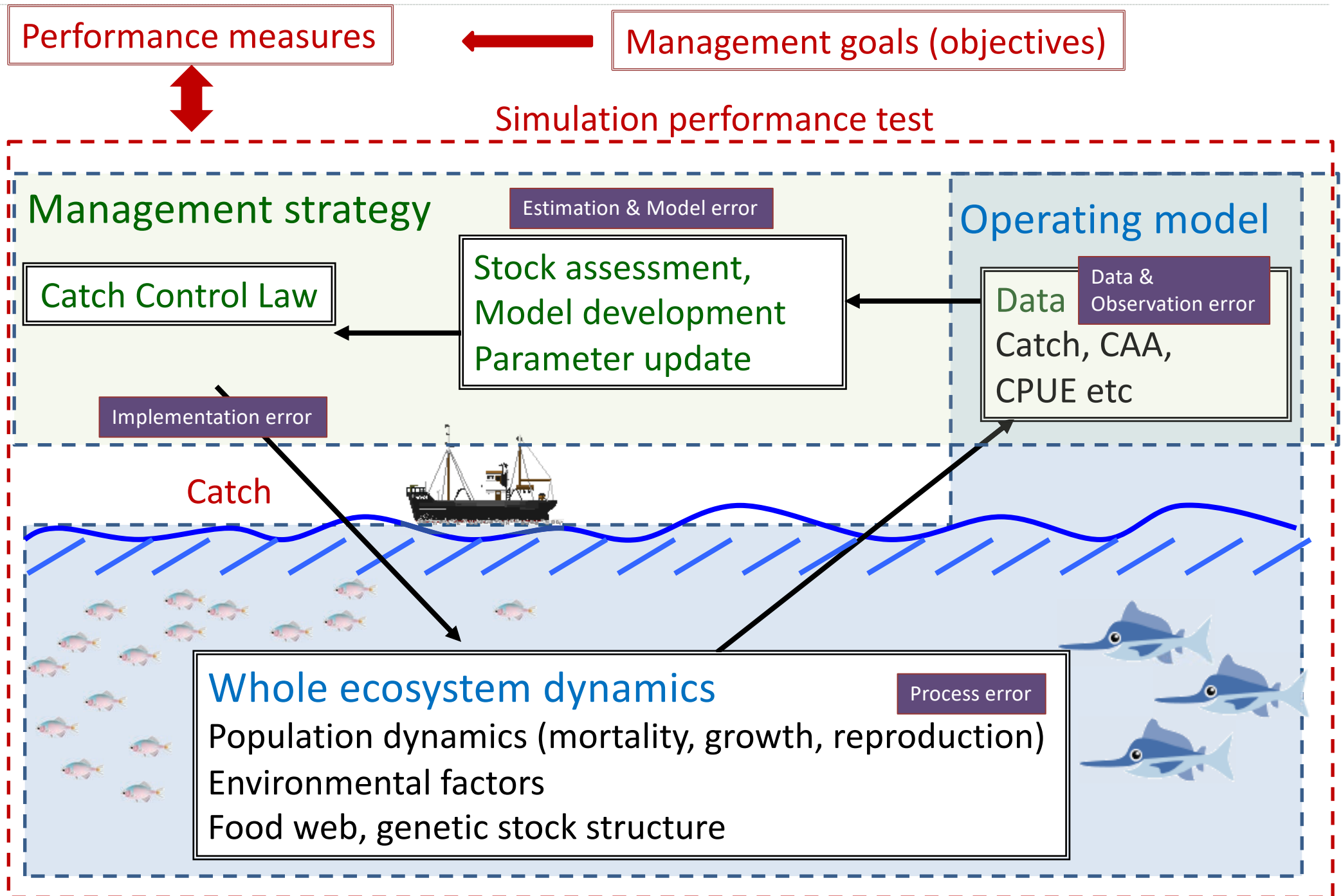
Fishery management

Assess

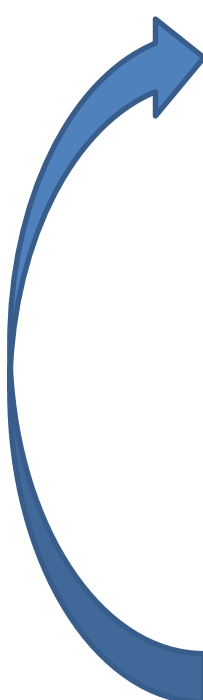
- Is population sustained by this fishery management strategy?
- How much catch is available in the future? Is it stable?
- Is management strategy robust to uncertainty? Etc.



Management Strategy Evaluation (MSE)



MSE Process

- 
1. Identification of management objectives and quantifiable performance measures
 2. Development of a range of Operating Models (OMs) to represent the uncertainty in the fishery
 3. Development of candidate Management Procedures (MPs)
 4. Simulation testing of candidate MPs with the OMs
 5. Selection of an MP on the basis of the simulated performance
 6. Implementation of the MP.

Skipjack Harvest Control Rule (HCR)

Simulation Testing:

- Assume “consensus stock assessment” will be available with known statistical properties
 - Simulate fishery
 - Simulate stock assessment result
 - Use HCR to set quota
- 

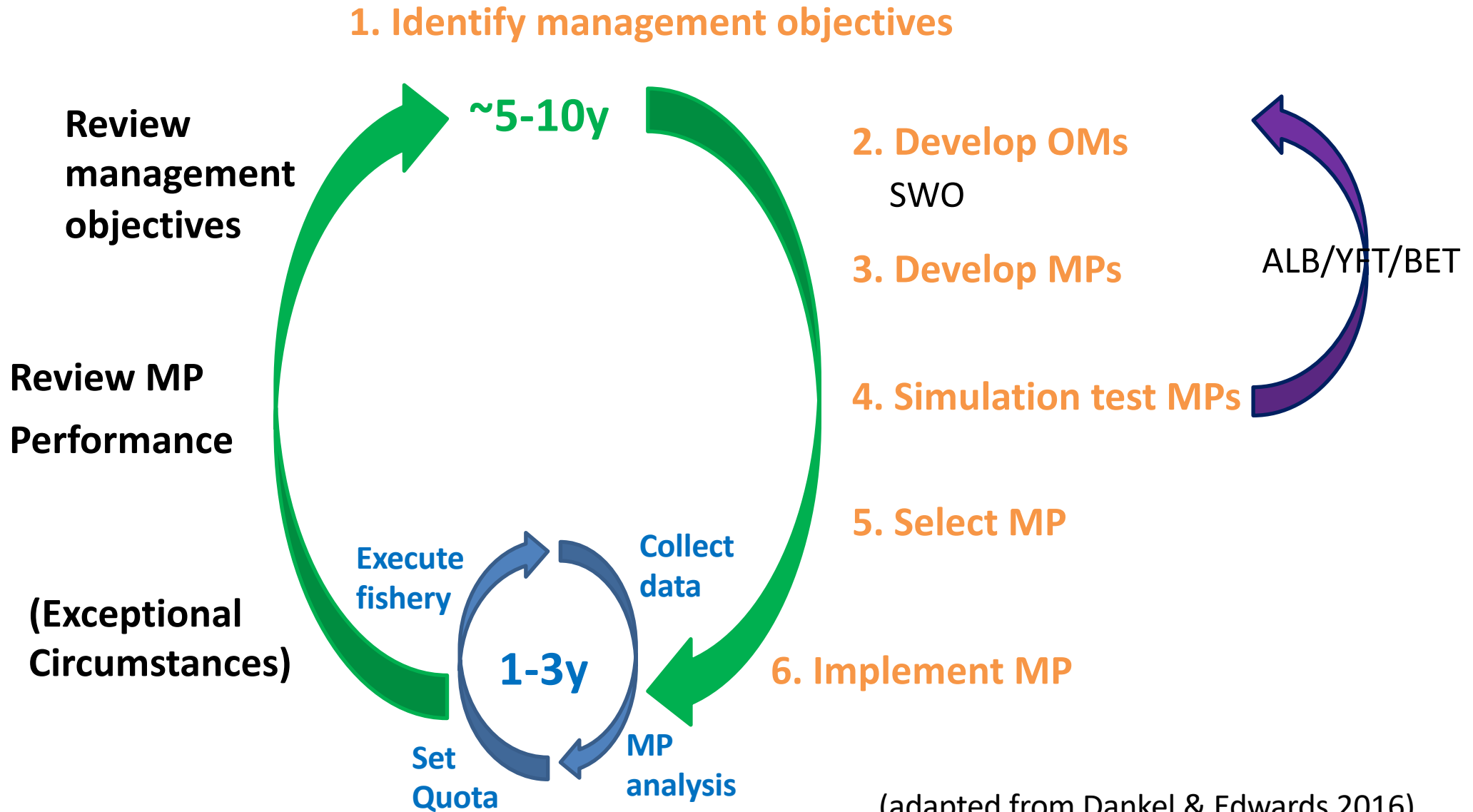
Management Procedure (BET, ALB, YFT, SWO)

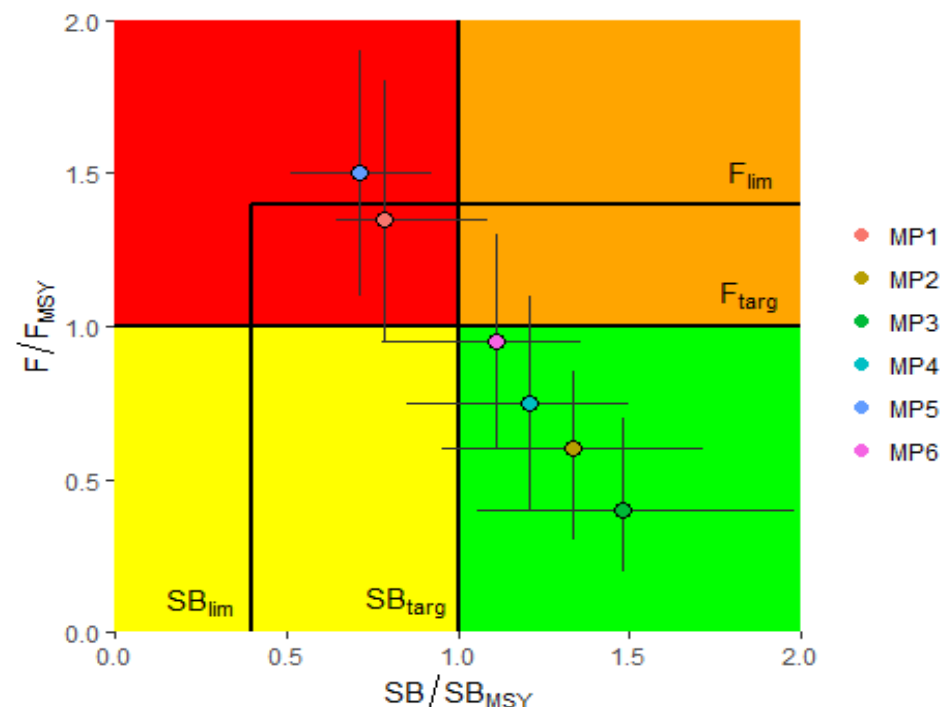
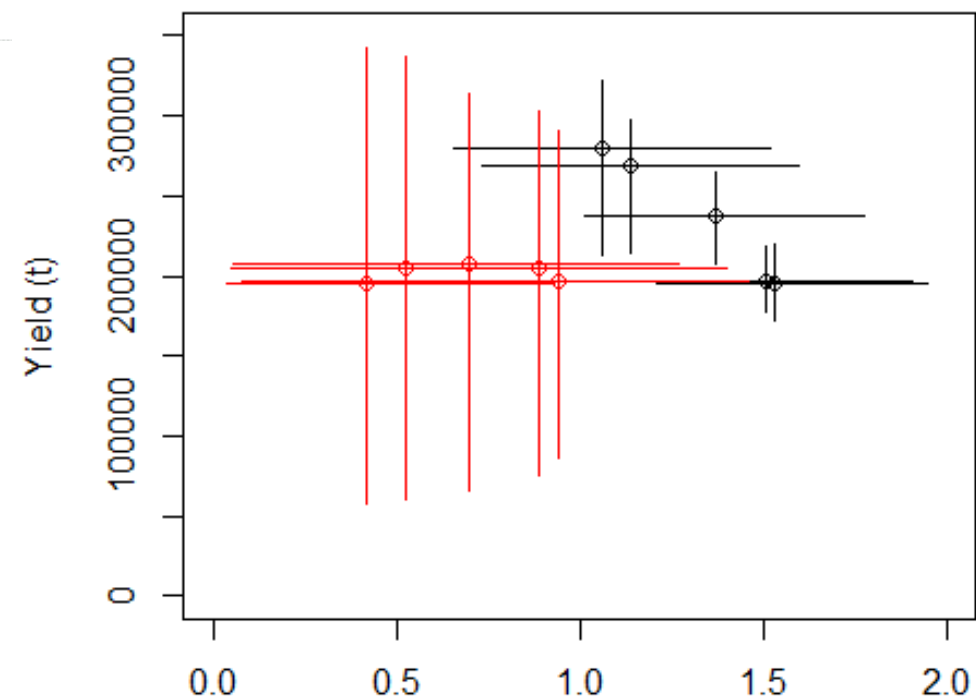
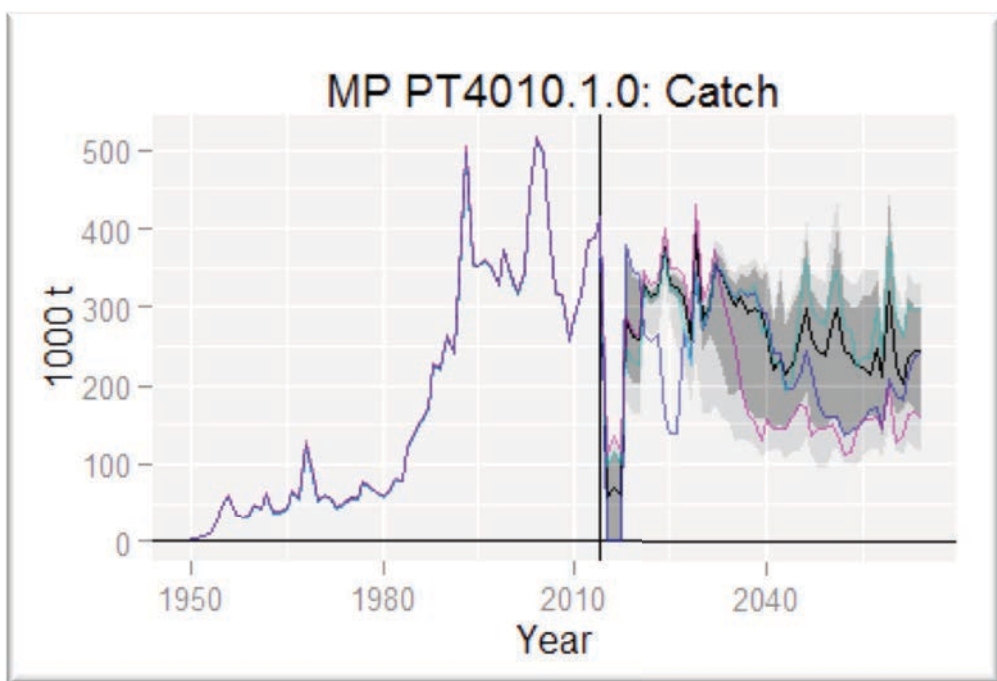
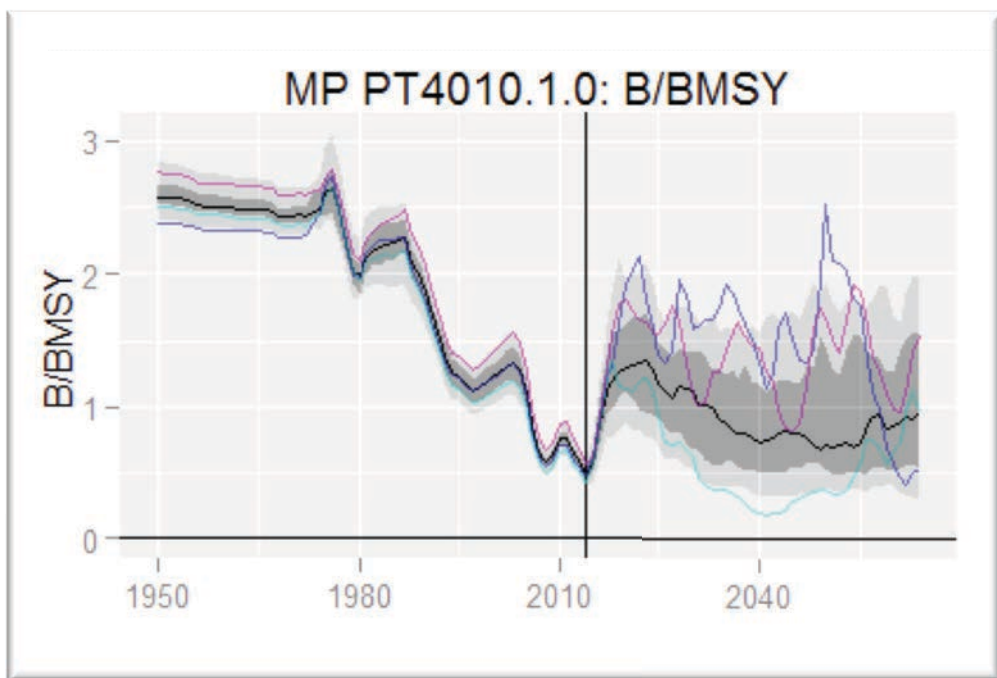
Simulation Testing:

- Predefine data collection, analysis and HCR
 - Simulate fishery
 - Simulate Data collection and estimate “indicators”
 - Use MP to set quota
- 

i.e. “consensus stock assessment” is not a problem – it is already agreed and tested as part of the MP

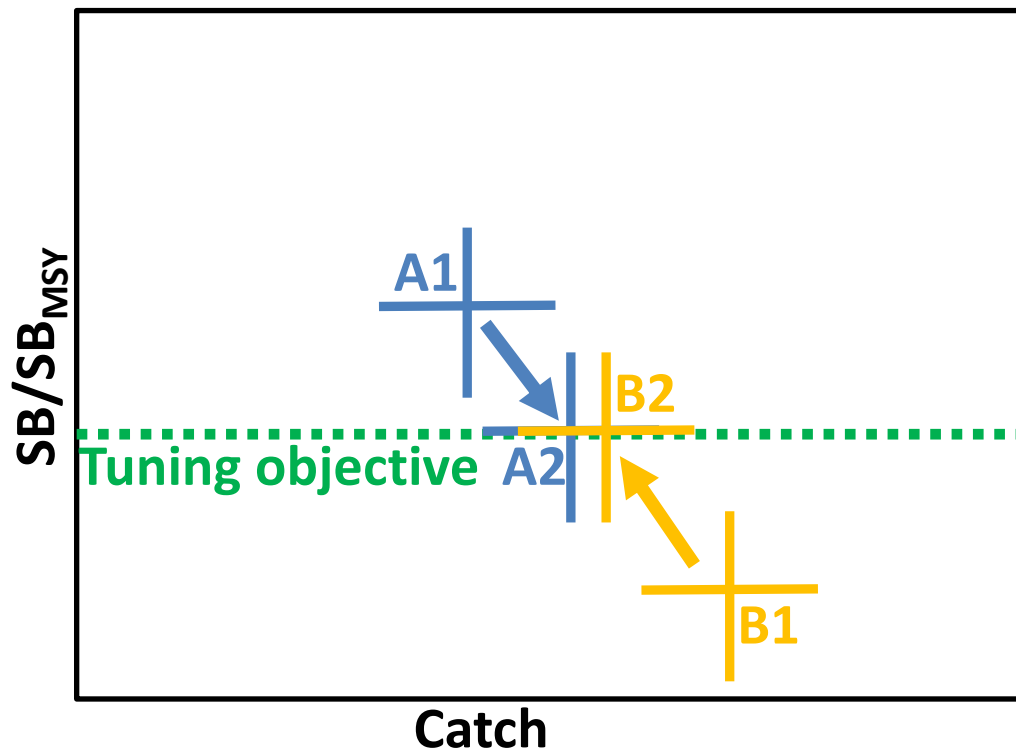
MSE: Fishery Management Cycle





Tuning the Management Procedures allows an objective to be achieved exactly

- Tuning only works for a single (high priority) objective
- Tuning involves changing a control parameter within the harvest control rule



A1 & B1 are not tuned at the same level and, thus, not comparable

A2 & B2 are tuned to achieve the target biomass objective

B2 yields higher catch than A2

MSE: “Meta-rules” higher level oversight MP-based management

“Exceptional Circumstances”

- Rare events, when the fishery system falls outside of the scope of the simulation testing, e.g.
 - Critical CPUE data are no longer available
 - Large IUU catches identified
 - Sustained recruitment failure, etc.
- Requires regular monitoring (e.g. indicator-based rather than comprehensive stock assessment)
- What to do?
 - Suspend MP with ad hoc management until a new MP can be developed and implemented

NOT a mechanism to simply avoid an inconvenient management action

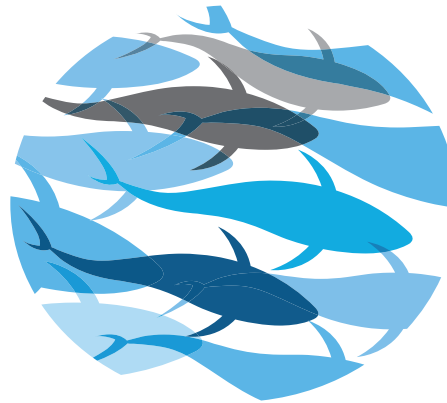
ROLES AND RESPONSABILITIES



Food and Agriculture
Organization of the
United Nations



COMMON OCEANS



iotc ctoi



Why MSE?

- Framework of "Evaluation of Management Procedures" is not only a computational tool !!
- Rather, a tool to bridge between

"Stakeholders/decision makers"

- Identify management objectives
- Make potential ideas plausible ways of management and feasibility
- Make decisions on the final set of management procedures



"Scientists"

- Translate the management objectives to performance measures and risk indicators
- Develop population dynamics with reality
- Improve better management procedures to meet the objectives

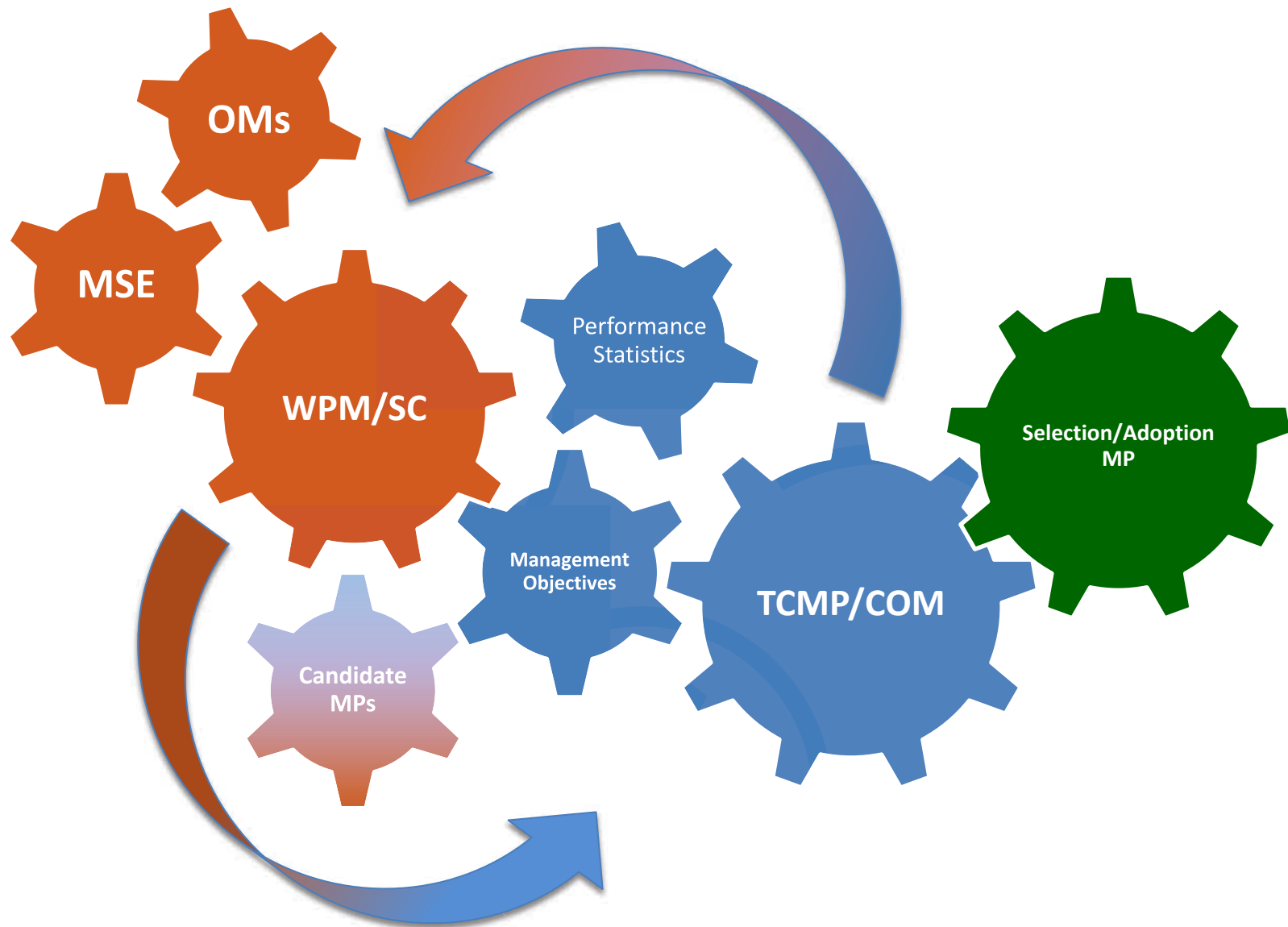
MP-MSE Process: Roles and Responsibilities

A simulation process like MSE does not consist of a series of linear steps, but rather feedback and rethinking need to be undertaken at each step in the process

Task	Responsability	Where
Specify and prioritise objectives, qualitatively/quantitatively	Managers/Stakeholders (Scientist) - Dialogue	TCMP-COM
Translate objectives into performance measures statistics	Managers/Stakeholders (Scientist) - Dialogue	TCMP-COM
Develop Operating Models and key uncertainty	Scientist	WPM-SC
Development of candidate Management Procedures	Scientist (Managers)	WPM-SC
MSE Simulation of the candidates of management procedure	Scientist	WPM-SC
Compare MP performance statistics and trade-offs	Managers/Stakeholders	TCMP
Selection and adoption of Management Procedure	Managers	COMMISSION

MP-MSE Process: Roles and Responsibilities

A simulation process like MSE does not consist of a series of linear steps, but rather feedback and rethinking need to be undertaken at each step in the process



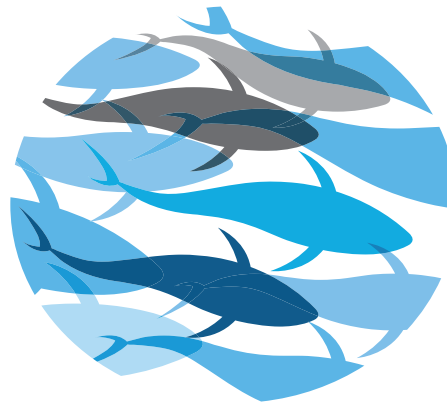
SELECTION of OBJECTIVES, TIMEFRAMES & PROBABILITIES = TUNING (i.e. FACILITATING THE PROCESS)



Food and Agriculture
Organization of the
United Nations



COMMON OCEANS

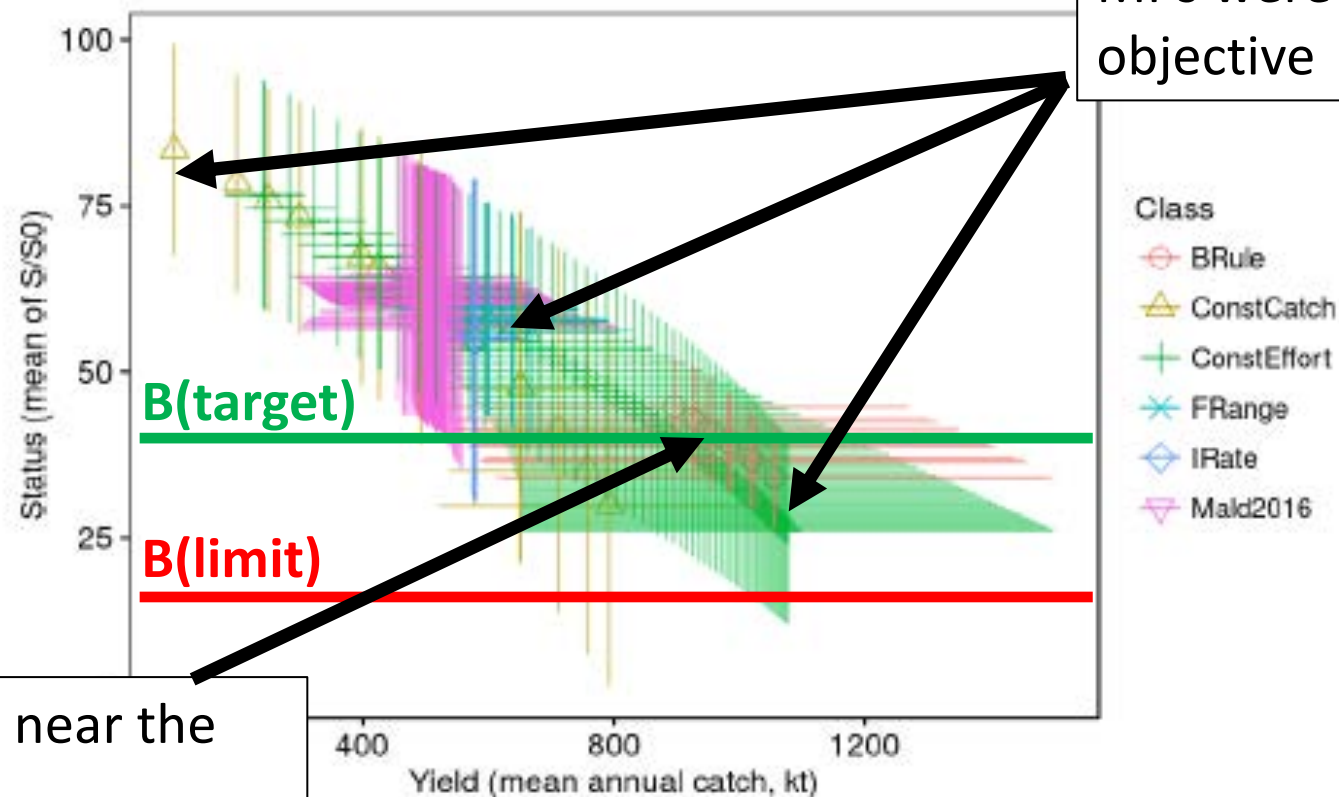


iotc ctoi



There are some management objectives expressed in the Commission documents

- e.g. Maintain the biomass at the $B(\text{target})$ reference point on average



Performance of most
MPs were far from this
objective

2-3 MPs were near the
target

Tunning Criteria from TCMP02

TCMP02 AGREED in the following TUNING CRITERIA to be tested for TCMP03:

BIGEYE

- $\Pr(\text{Kobe green zone } 2030:2034) = 0.5.$
- $\Pr(\text{Kobe green zone } 2030:2034) = 0.6.$
- $\Pr(\text{Kobe green zone } 2030:2034) = 0.7.$

The stock status is in the Kobe green quadrant over the period 2030-2034 exactly 50, 60 or 70% % of the time (averaged over all simulations).

YELLOFIN

- $\Pr(\text{SB}(2024) \geq \text{SB}(\text{MSY})) = 0.5.$
- $\Pr(\text{SB}(2029) \geq \text{SB}(\text{MSY})) = 0.5.$
- $\Pr(\text{SB}(2034) \geq \text{SB}(\text{MSY})) = 0.5.$

Average SB in 2024, 2029 and 2034 exceeds SB_{MSY} in exactly 50% of the simulations.

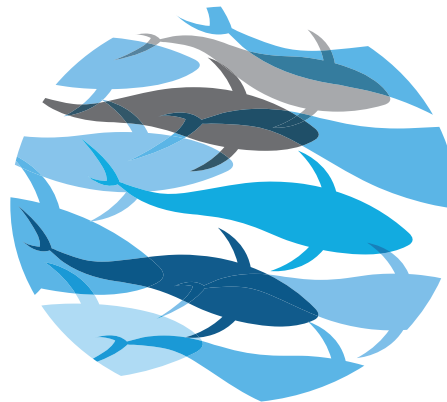
KEY ISSUES TO CONSIDER FOR FEEDBACK



Food and Agriculture
Organization of the
United Nations



COMMON OCEANS



iotc ctoi



MSE

- Advice on key management objectives to aid tuning process
- Secondary objectives and improvement of performance indicators,
- Other considerations:
 - 3 year TAC setting,
 - TAC changes constrains,
 - Maximum TAC
- Time lag between MP-TAC implementation
- Time of MP revision

STOCK STATUS

- Advice on definition of overfished/overfishing

MSE

- Advice on key management objectives to aid tuning process
- Secondary objectives and improvement of performance indicators,

Status : maximize stock status

1. Mean spawner biomass relative to pristine	SB/SB_0
2. Minimum spawner biomass relative to pristine	SB/SB_0
3. Mean spawner biomass relative to SB_{MSY}	SB/SB_{MSY}
4. Mean fishing mortality relative to target	F/F_{tar}
5. Mean fishing mortality relative to F_{MSY}	F/F_{MSY}
6. Probability of being in Kobe green quadrant	SB, F
7. Probability of being in Kobe red quadrant	SB, F

MSE

- Advice on key management objectives to aid tuning process
- Secondary objectives and improvement of performance indicators,

Safety : maximize the probability of remaining above low stock status (i.e. minimize risk)

8. Probability of spawner biomass being above 20% of SB_0 SB

9. Probability of spawner biomass being above B_{Lim} SB

Yield : maximize catches across regions and gears

10. Mean catch (1'000 t) C

11. Mean catch by region and/or gear (1'000 t) C

12. Mean catch relative to MSY C/MSY

MSE

- Advice on key management objectives to aid tuning process
- Secondary objectives and improvement of performance indicators,

Abundance: maximize catch rates to enhance fishery profitability

13. Mean catch rates (by region and gear) I
(for fisheries with meaningful catch-effort relationship)

Stability: maximize stability in catches to reduce commercial uncertainty

14. Mean absolute proportional change in catch C

15. % Catch co-efficient of variation C

16. Probability of shutdown C

BUT ALSO TO CONSIDER THE

- Different behavior of the MP simulations depending on the Population Starting point: healthy stock vs. overfished stock.
 - Not only the objective is important but also how it is reached.
- 1 phase MP including Recovery + maintaining the stock in good condition or 2 phase MP with recovery phase + after recovery phase,
- Timeframe of averaging performance statistics when in recovery vs maintaining healthy stock

Advantages of Management Procedure Tuning

- Helps clarify the Commission objectives
 - Can achieve highest priority objective exactly
 - Much easier to select among MPs on the basis of secondary and tertiary performance measures
- Simplifies communication of results
 - i.e. from many (100s) of MPs to a small number (5-10)
- Allows MP developers to focus on the appropriate trade-off space
 - Better MP performance is achievable with a narrower focus
- The guiding principle for MP selection is the management performance, not the HCR
- MP control parameters may or may not correspond to TRPs and LRPs

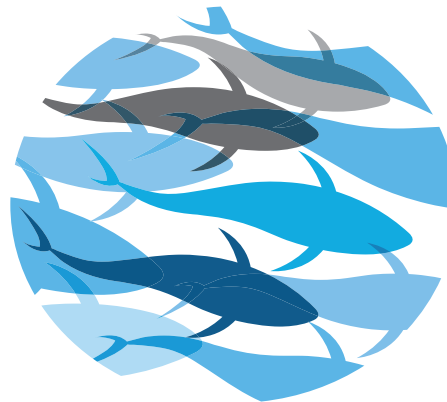
PRESENTATION OF MSE RESULTS AGREED BY SC



Food and Agriculture
Organization of the
United Nations



COMMON OCEANS



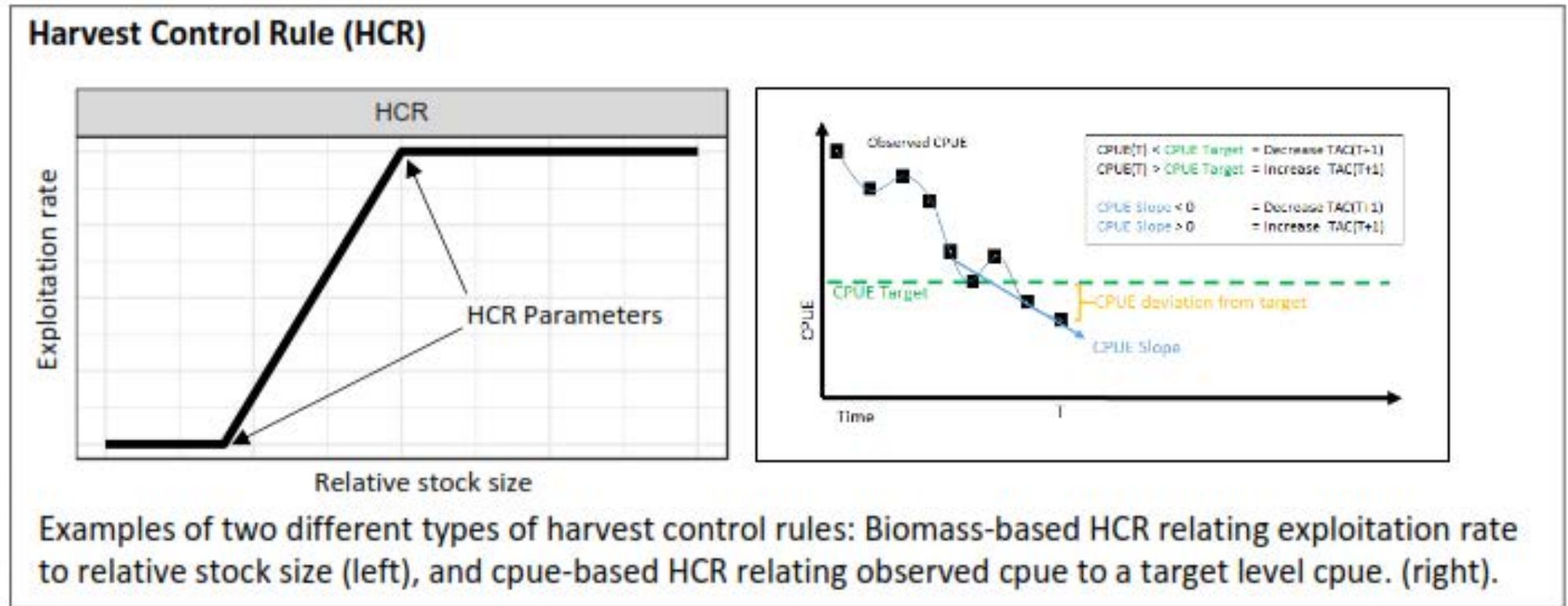
iotc ctoi



Proposal for presenting MSE results

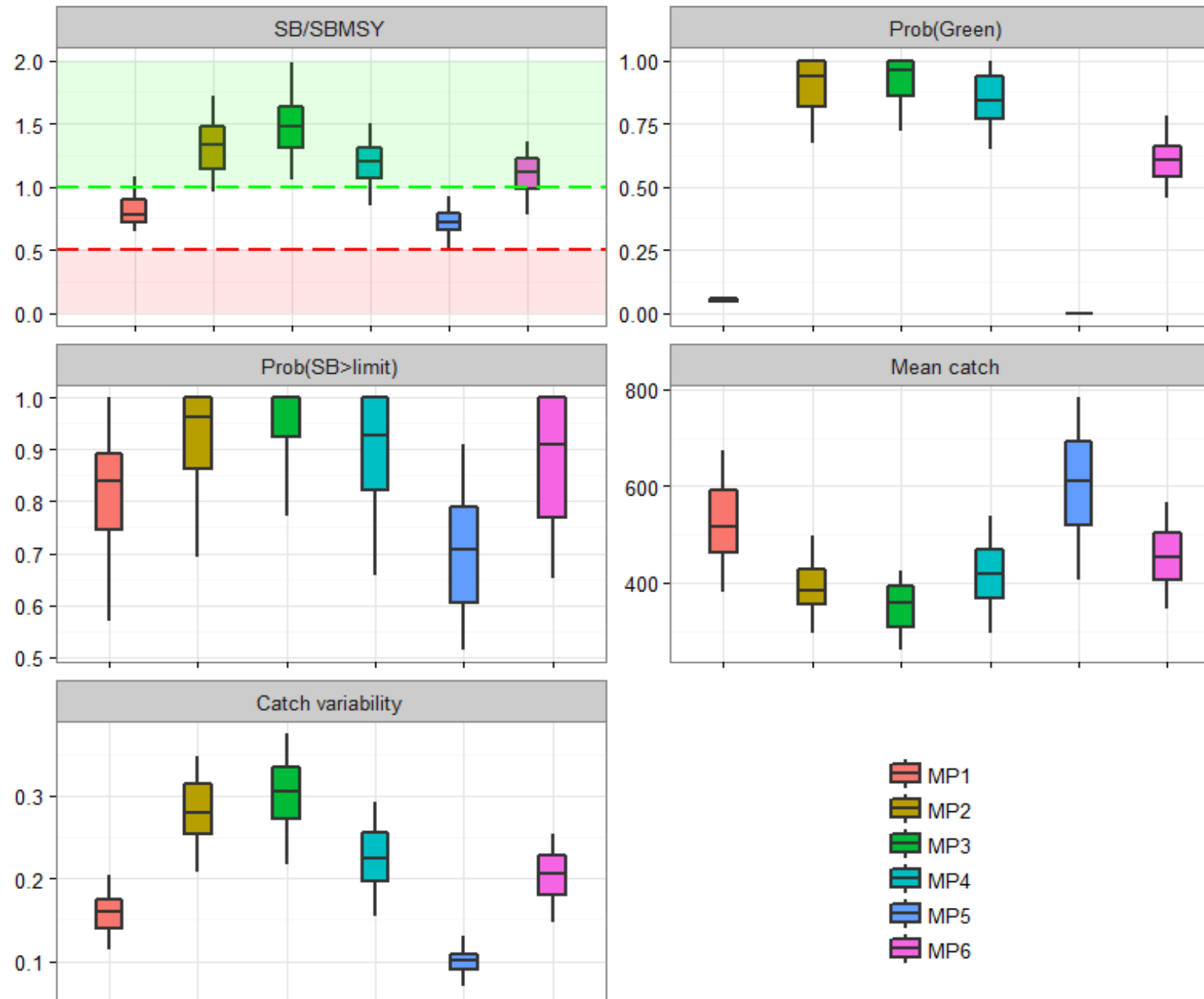
1. **Illustrate the MPs** that have been evaluated in a figure and/or briefly define them in text.
2. Present the results for the performance of each MP in:
 - a. **Boxplots** for a representative subset of performance measures
 - b. **Trade-off plots** for a representative subset of performance measures
 - c. **A summary table** that ranks the performance of each MP against a subset of performance measures
 - d. **A Kobe plot** for the B/B_{MSY} and F/F_{MSY} performance measures
 - e. **Time series plots** for stock size and fishing intensity performance measures.
3. Provide a clear and **succinct summary** of the performance of each MP.
4. Provide the numerical results for each MP across all 16 performance measures endorsed by the SC in a table in an appendix.

1. Illustrate candidate MPs or HCRs



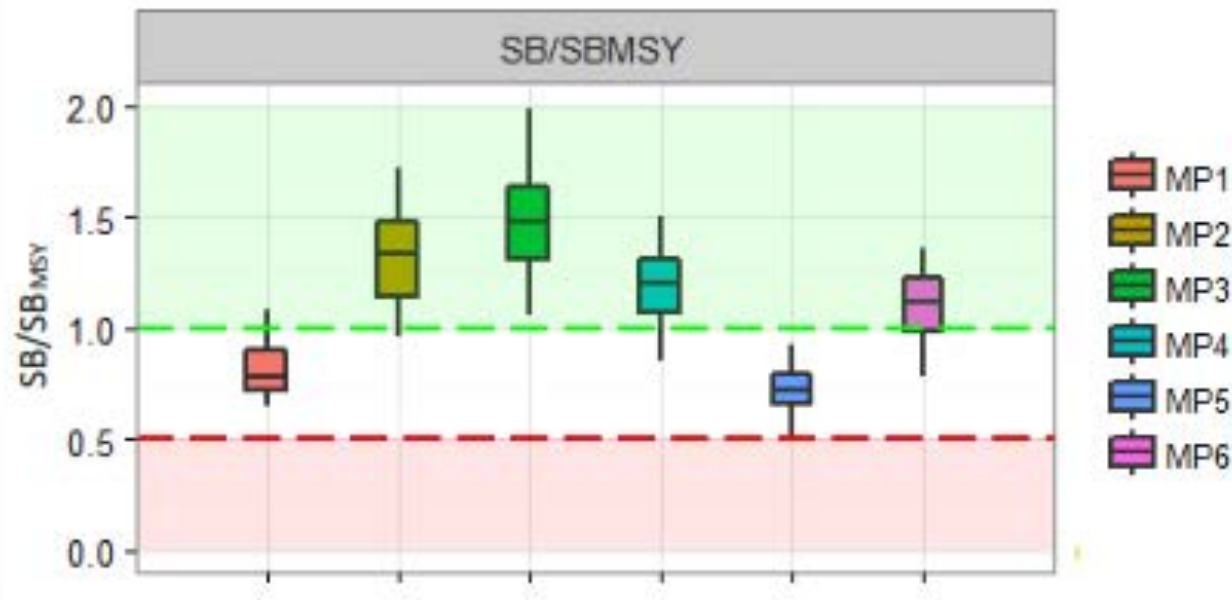
It will be important that decision makers have a clear understanding of the MPs (or HCRs) that have been evaluated. **To achieve this, a clear description of each MP (or HCR) should be presented prior to the MSE results**, along with an explanation of the relevant decision steps involved.

2. Performance of MPs – (a) Box plots



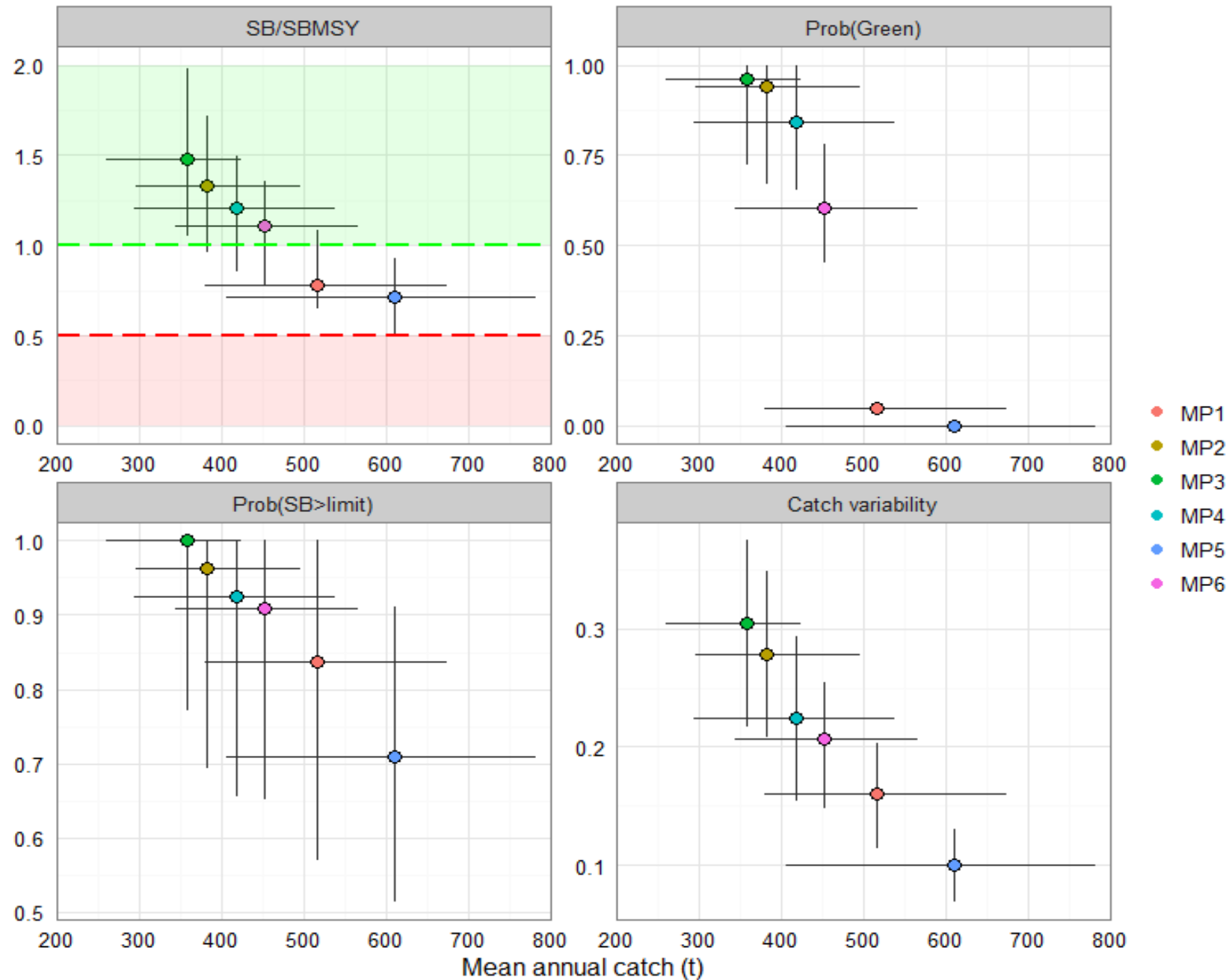
2. Performance of MPs – Box plots

Boxplot comparing performance of Management Procedures (MPs)



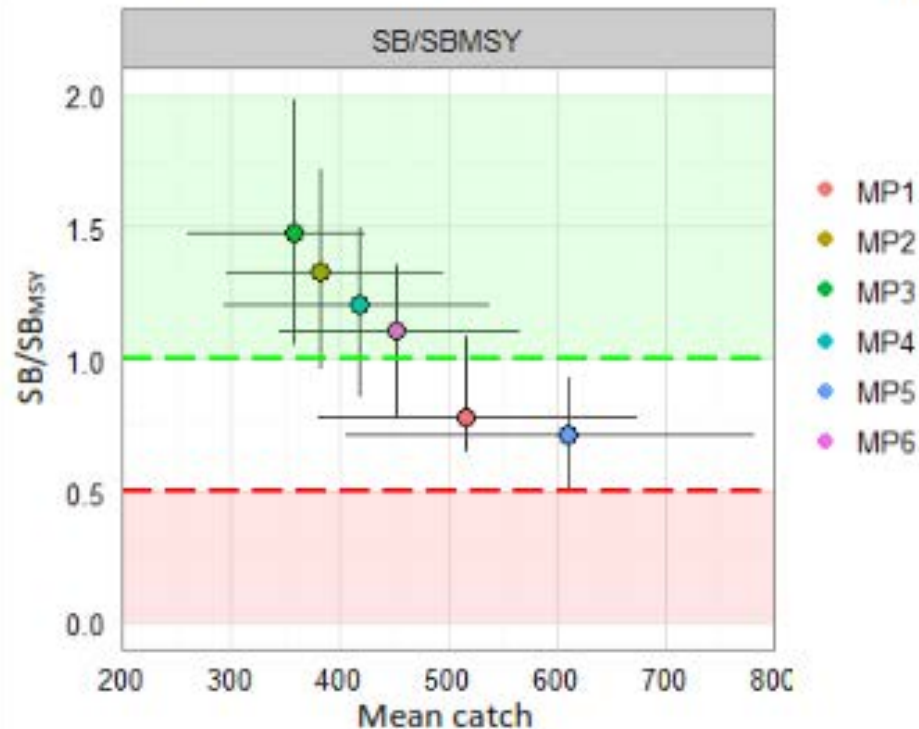
This example boxplot compares the performance of 6 MPs against SB/SB_{MSY} . Each data point represents the median over 20 years of simulation in the projection period as the horizontal line, 25th - 75th percentiles as coloured bars, and 10th - 90th percentiles as thin lines. Limit and target reference points are indicated by red and green dashed lines respectively.

2. Performance of MPs – (b) Trade-off plots



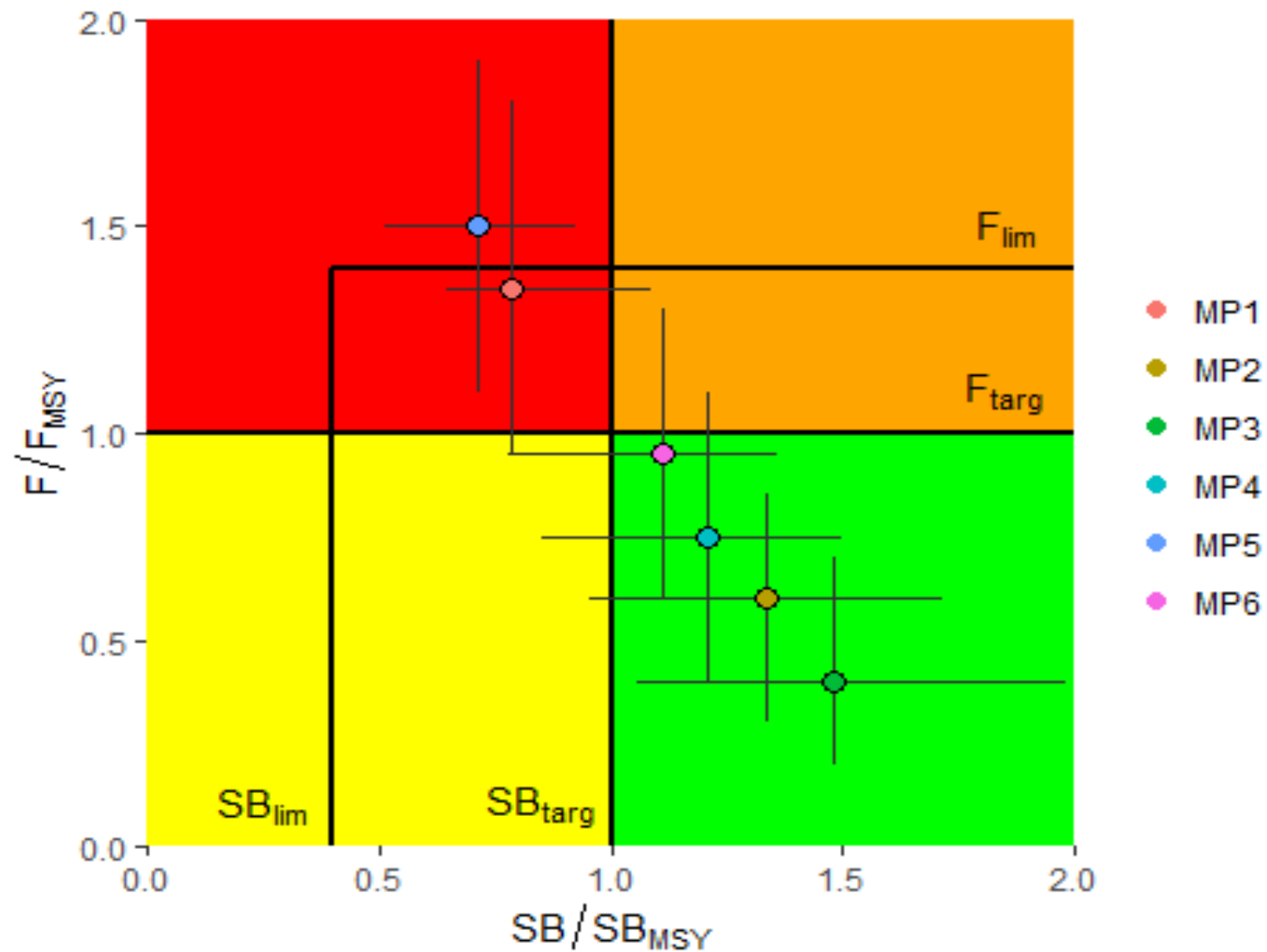
2. Performance of MPs – (b) Trade-off plots

Trade-off plot comparing performance of Management Procedures (MPs)



This example trade-off plot indicates the trade-offs in performance of 6 management procedures (MPs) between catch and SB/SB_{MSY} . Each data point represents the median over 20 years of simulation in the projection period and the errors bars represent 10th and 90th percentiles. Limit and target reference points are indicated by red and green dashed lines respectively.

2. Performance of MPs – (d) Kobe plot

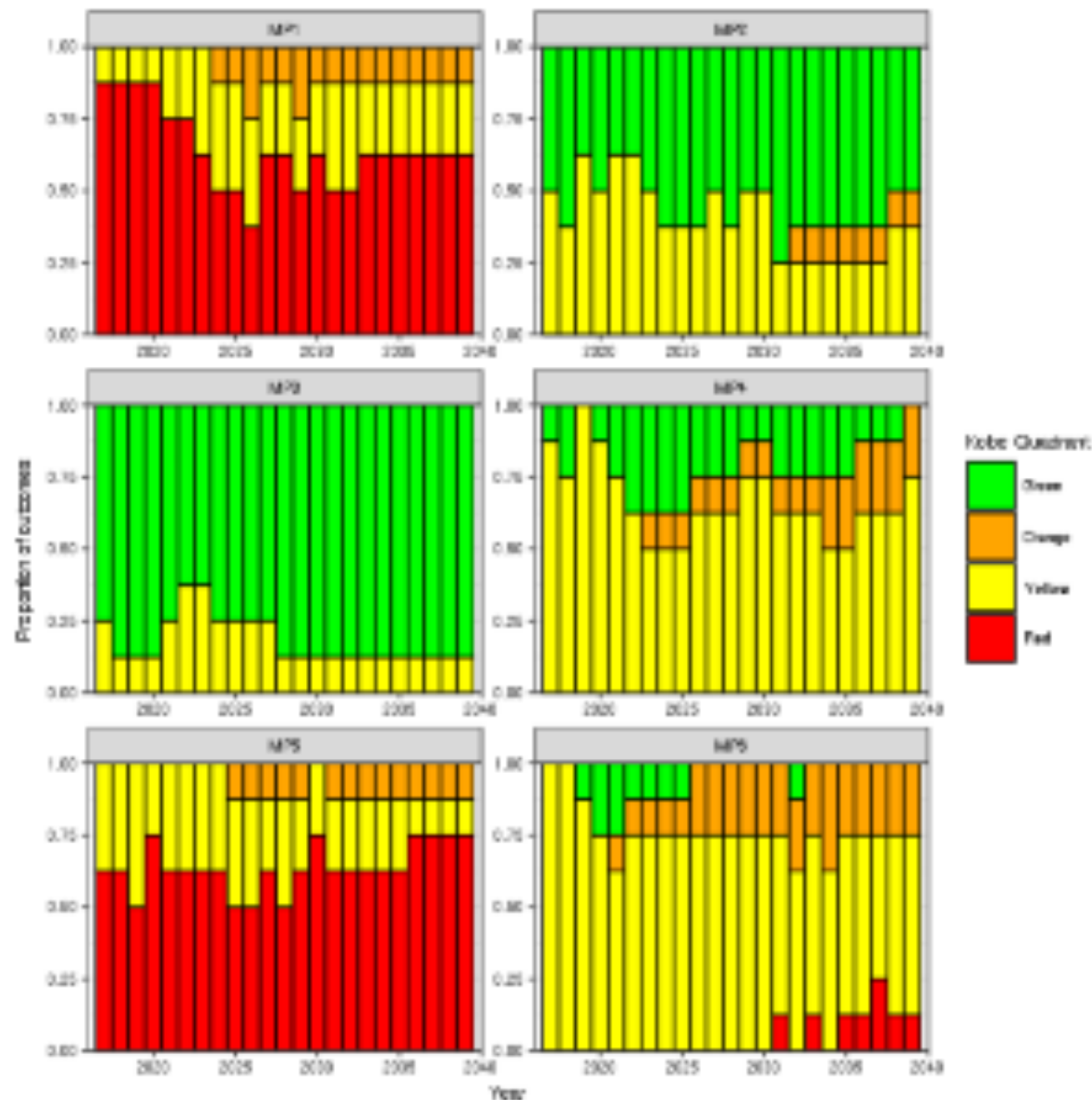


2. Performance of MPs – (c) summary table

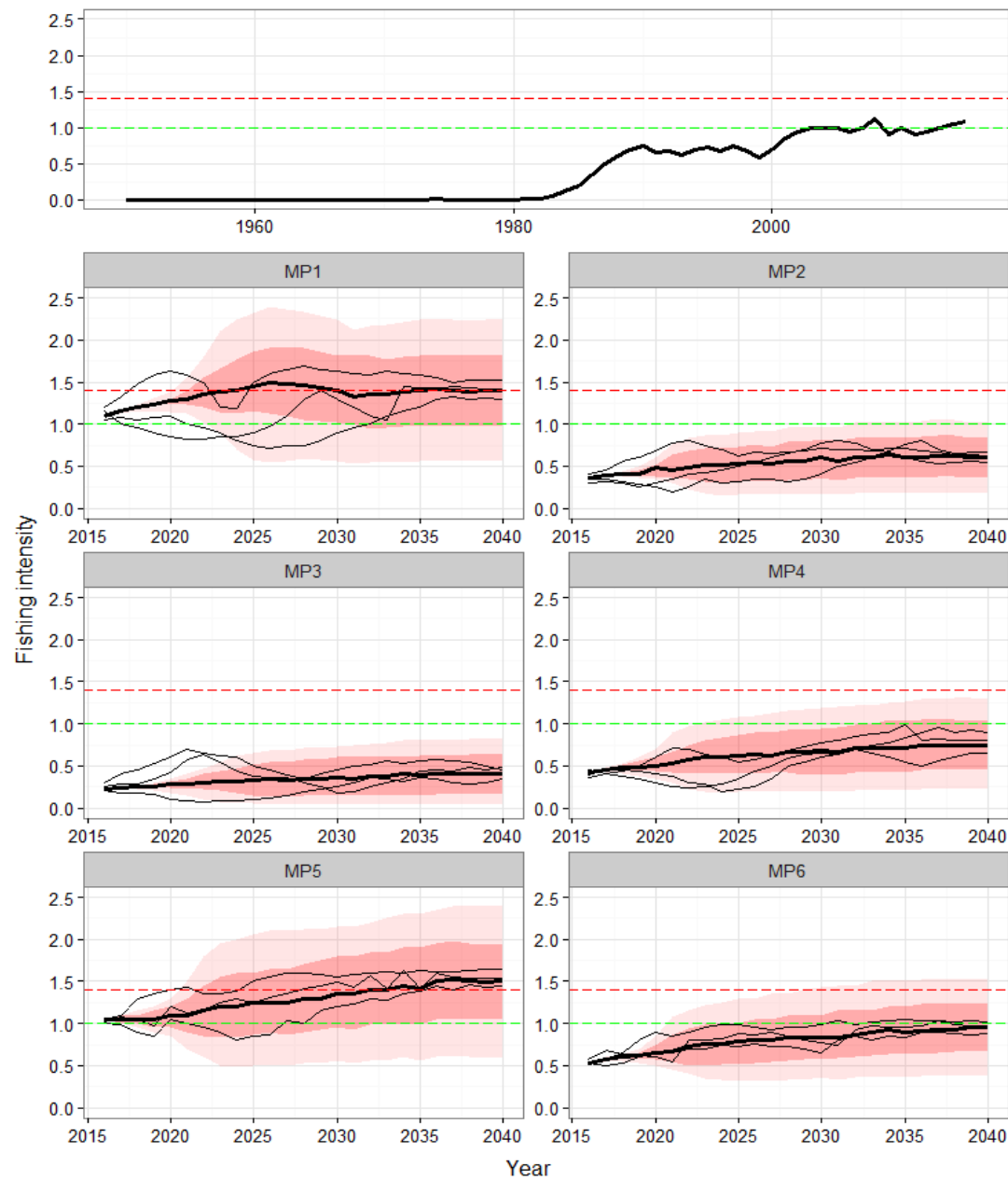
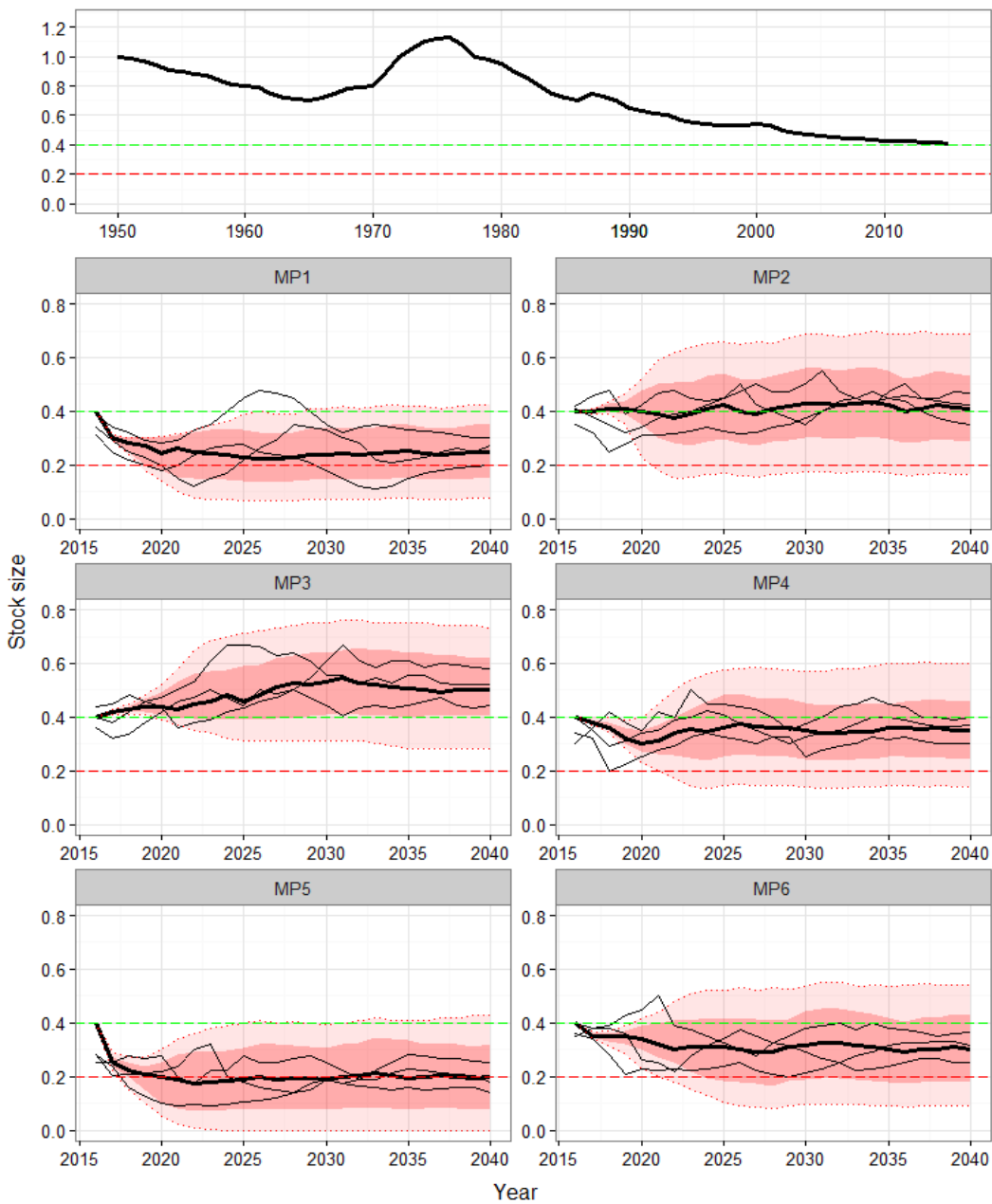
Management Procedure	Performance Measure				
	SB/SB _{MSY}	Prob(Green)	Prob(SB>limit)	Mean Catch	Catch variability
MP1	0.78	0.05	0.84	516	0.16
MP2	1.33	0.94	0.96	383	0.28
MP3	1.48	0.96	1	358	0.3
MP4	1.21	0.84	0.93	419	0.22
MP5	0.72	0	0.71	611	0.1
MP6	1.11	0.61	0.91	452	0.21

Summary table of performance of Management Procedures (MPs). Performance of 6 MPs against 5 performance measures averaged over 20 years of simulation in the projection period. Shading indicates the relative performance for each MP (dark = better, light = worse).

2. Performance of MPs – (e) Time series plots for Kobe quadrant

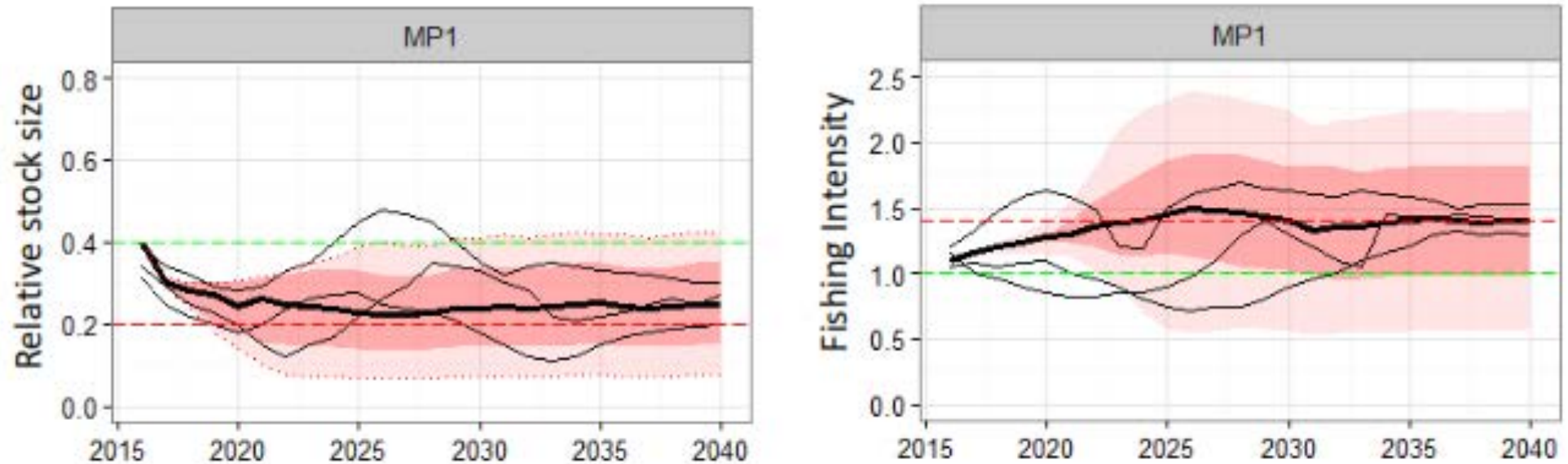


2. Performance of MPs – (e) Time series plots



2. Performance of MPs – (e) Time series plots

Time series projections for the performance of Management Procedures (MPs)



These example time series plots indicate the performance of 1 MP against the stock size (left) and fishing intensity (right) performance measures projected over the years 2016-2040. The median is represented by the bold black lines, a dark ribbon shades the 25th - 75th percentile region and a light ribbon shades the 10th - 90th percentile region. Three additional thin black lines show individual realizations. Horizontal lines indicate target (green) and limit (red) reference points.

3. Summary performance of MPs

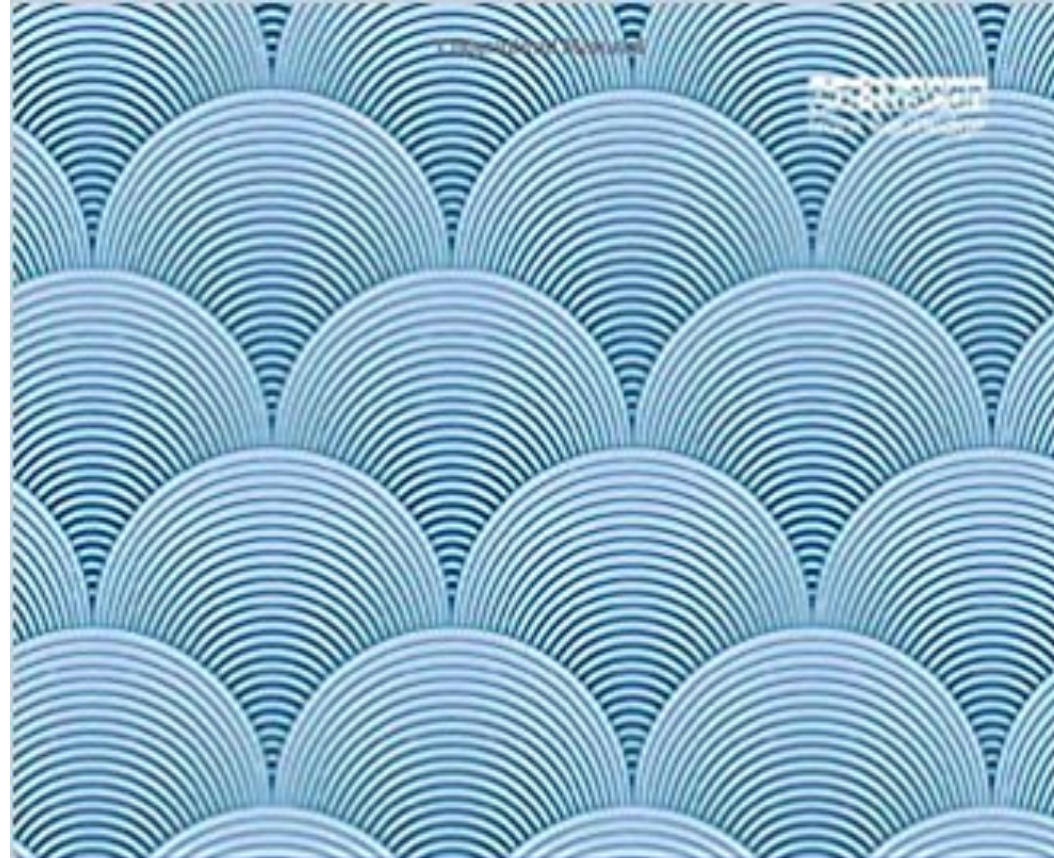
- **MP1** MP1 achieved the second highest catches, and second lowest level of catch variability. There was a 5% chance that MP1 would be at or above the biomass target reference point and 2% chance it would be at or below the fishing mortality target reference point. There is a 25% risk that MP1 will cause the spawning biomass to fall below the limit reference point and a 50% risk that MP1 will cause the fishing mortality to exceed the limit reference point over the next 20 years.
- **MP2** performed ...
- **MP3** performed ...
- **MP4** performed ...
- **MP5** performed ...
- **MP6** performed ...

4. Details of performance of MPs across all indicators

[illegible]

4. Details of performance of MPs across all indicators

[illegible]



MANAGEMENT SCIENCE IN FISHERIES

An introduction to simulation-based methods

Edited by **CHARLES T. T. EDWARDS**
and **DOROTHY J. DANKEL**

Copyrighted Material



MANAGEMENT SCIENCE IN FISHERIES

An introduction to simulation-based methods

Edited by CHARLES T. T. EDWARDS and DOROTHY J. DANKEL

Chapter 13: Empirical and model-based control

Maeda Hiroaki



Food and Agriculture
Organization of the
United Nations



iotc ctoi



Introduction to Management Strategy Evaluation with TunaMSE: Stock assessment vs MPs

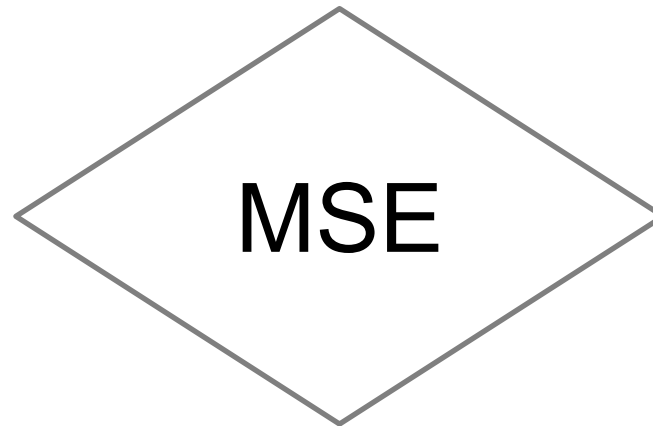
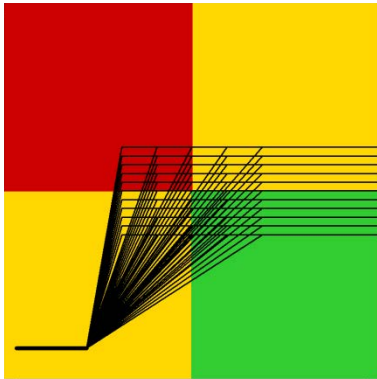
Dan Fu (IOTC)

Busan, Republic of Korea, 19-20 February 2020

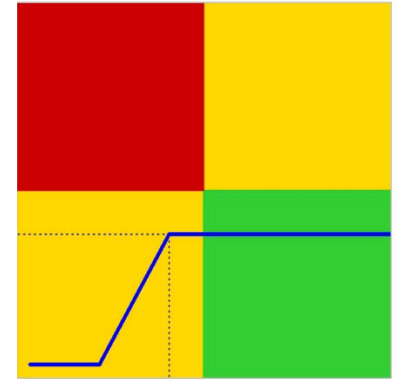


Management strategy evaluation

Candidate
management
procedures



Agreed
management
procedures



- Management objectives
- Operating models
- Simulation testing
- Performance measures

Management Strategy Evaluation

- Assess the performance of a potential MP
 - Meet management objectives ?
- Compare amongst MPs
 - Considering many possibilities – we don't know what future/reality is
 - Considering trade-off among objectives – we cannot get everything,

A hypothetical MSE example (Smith A.D.M.)

- Select amongst 4 MP
 - Constant catch (high and/or low)
 - Constant harvest rate
 - Constant biomass strategy
- Against three objectives
 - Maximise the catch
 - Minimise year-to-year catch variability
 - Minimise the risks of stock falling below a threshold

A hypothetical MSE example

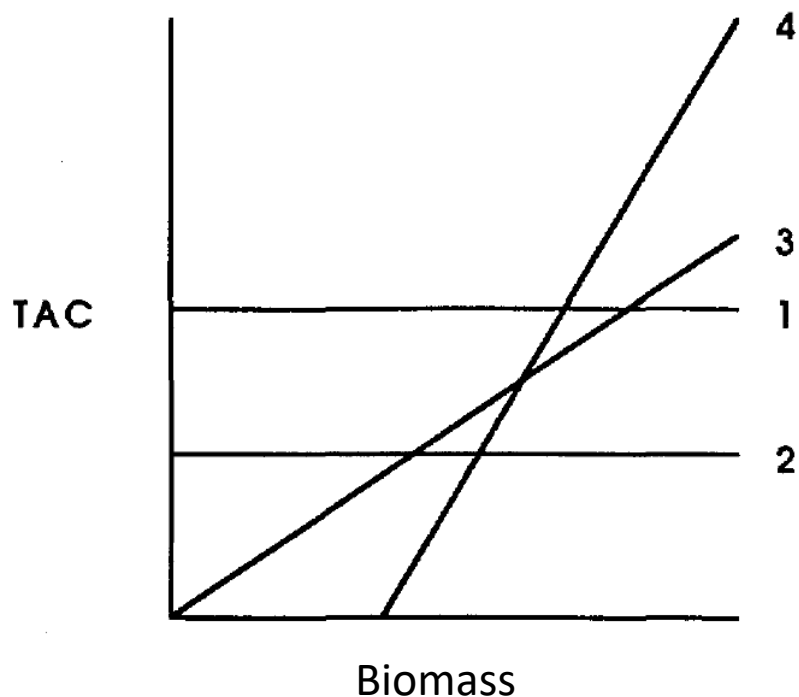
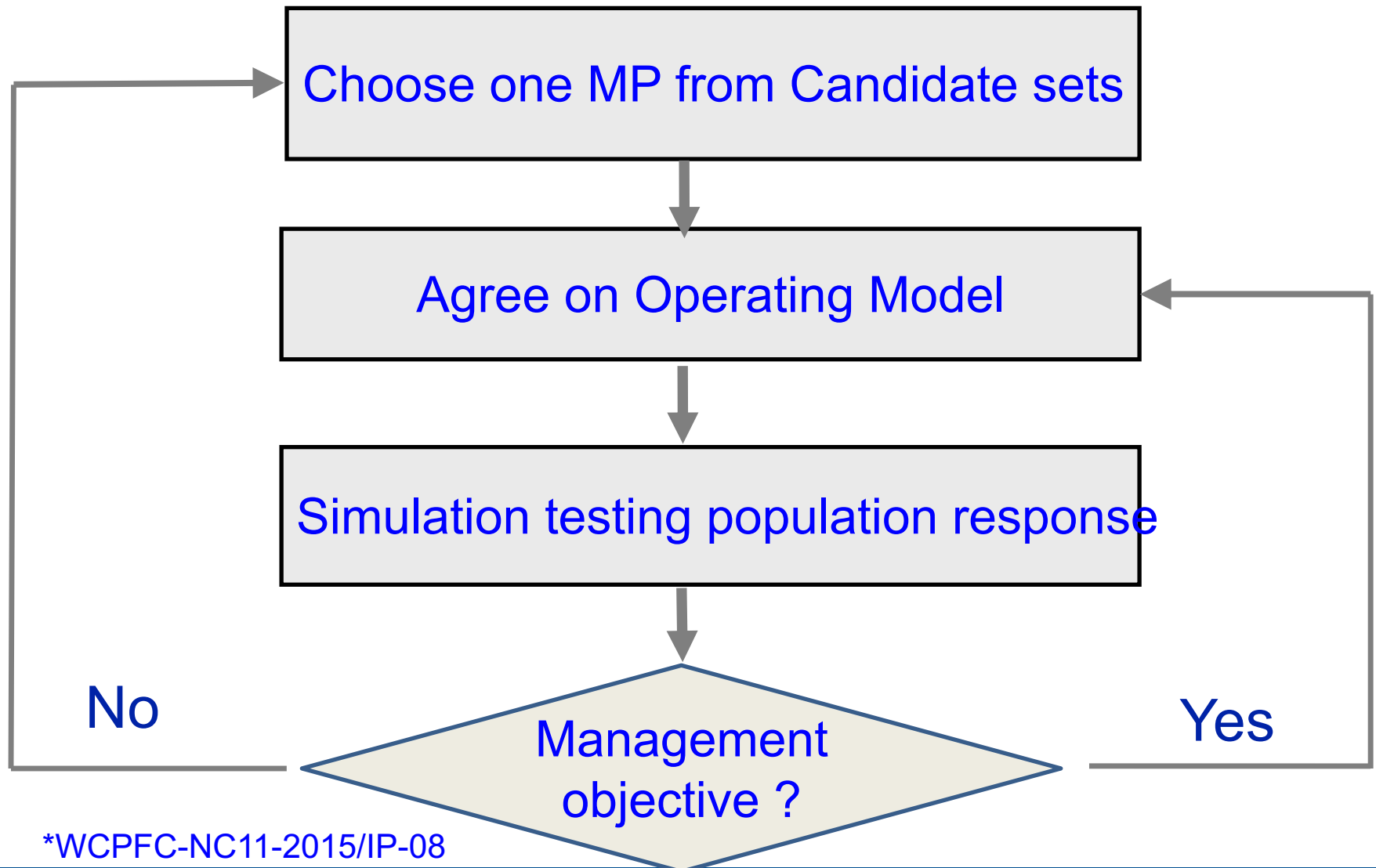


Table 1. Performance of strategies against objectives.

	OBJECTIVE		
	Maximize catch	Minimize variability	Minimize risk
STRATEGY			
Constant high catch	Moderate	Moderate	Poor
Constant low catch	Poor	Good	Moderate
Constant harvest rate	Moderate	Moderate	Moderate
Constant biomass	Good	Poor	Good

Management Strategy evaluation*



What are we evaluating?

- MSE evaluates management procedure
 - a set of rules that determine TAC from the data

Data + analysis + Harvest control rule

Harvest control rules

- Constant catch or exploitation rate
- CPUE-based rules
- Thresh-hold rules
 - Triggered when stock status approach reference points

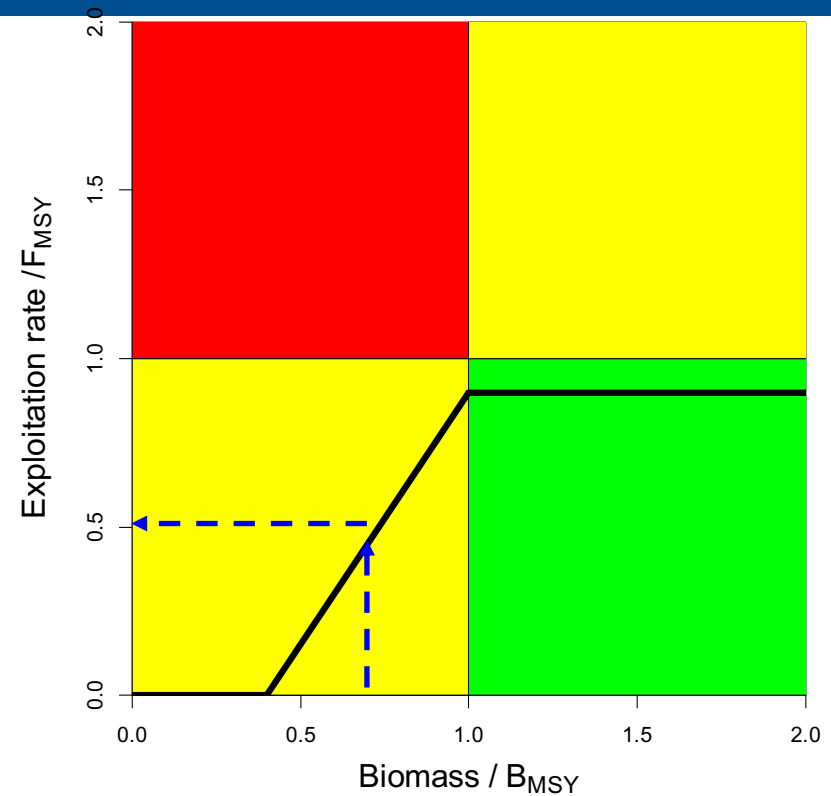
Threshold rule example

Output –
exploitation rate
or catch



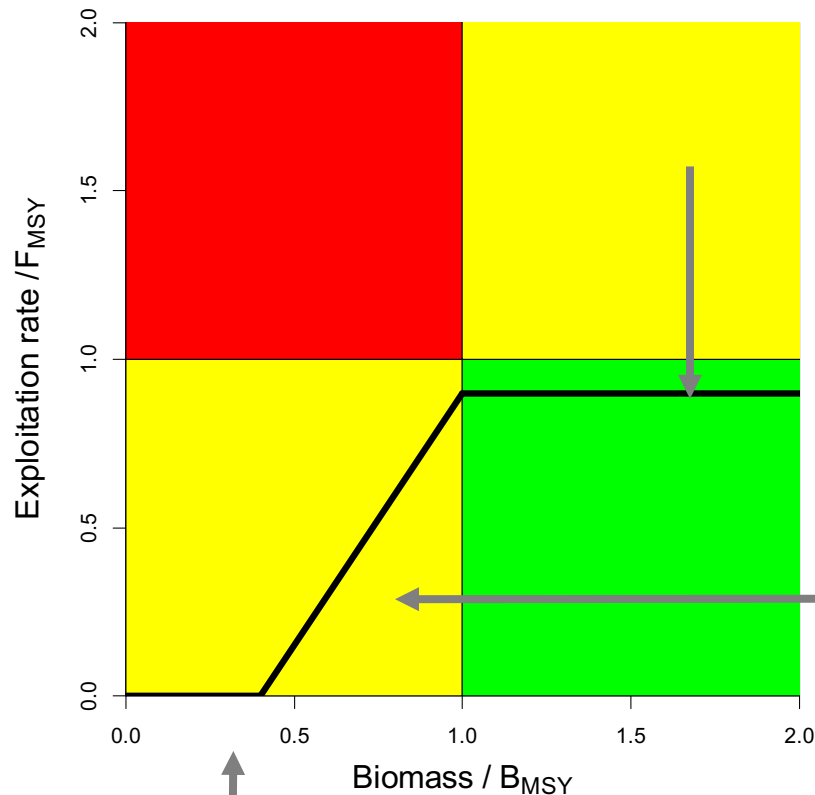
If stock status is 70% B_{msy}

Then set $F = 50\% F_{msy}$



Input – stock status

Threshold rule example

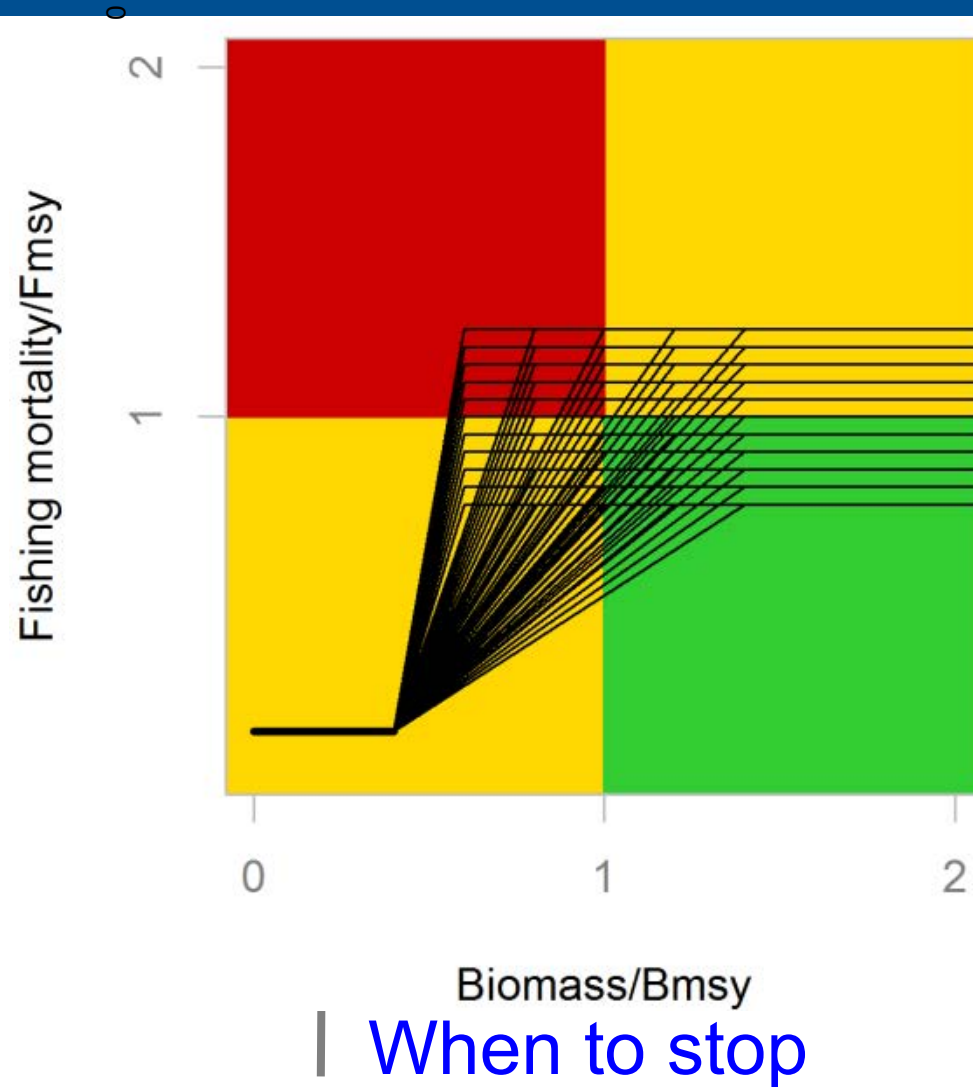


Fishing at maximum F if biomass is above B_{msy}

Reduce fishing if biomass is below B_{msy}

Stop fishing if biomass is below 40% B_{msy}

Threshold rule – control parameters



at's the maximum F

When to reduce

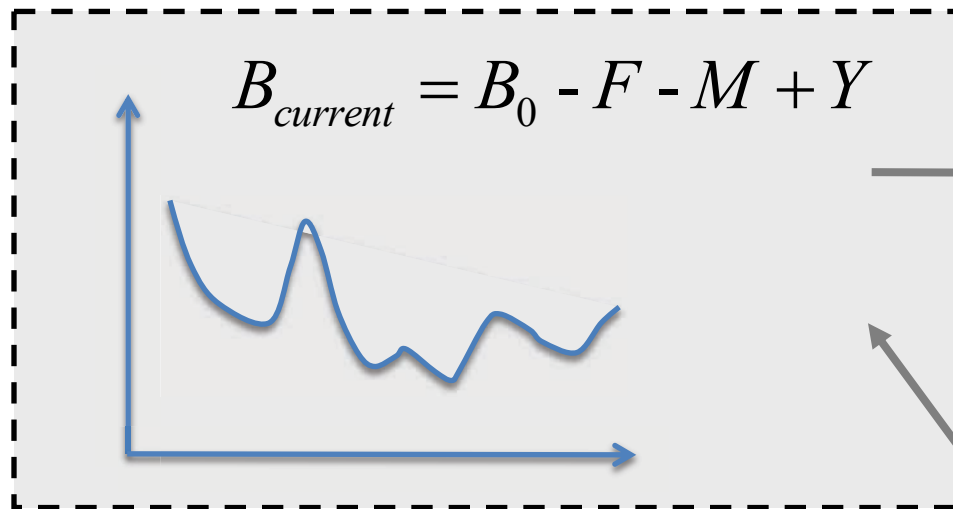
How quickly to reduce?

Why HCR needs to be tested

- Performance of a HCR may depend on
 - fishery dynamics
 - Stock productivity
 - Random (recruitment) variability
- Trade-offs in management objectives

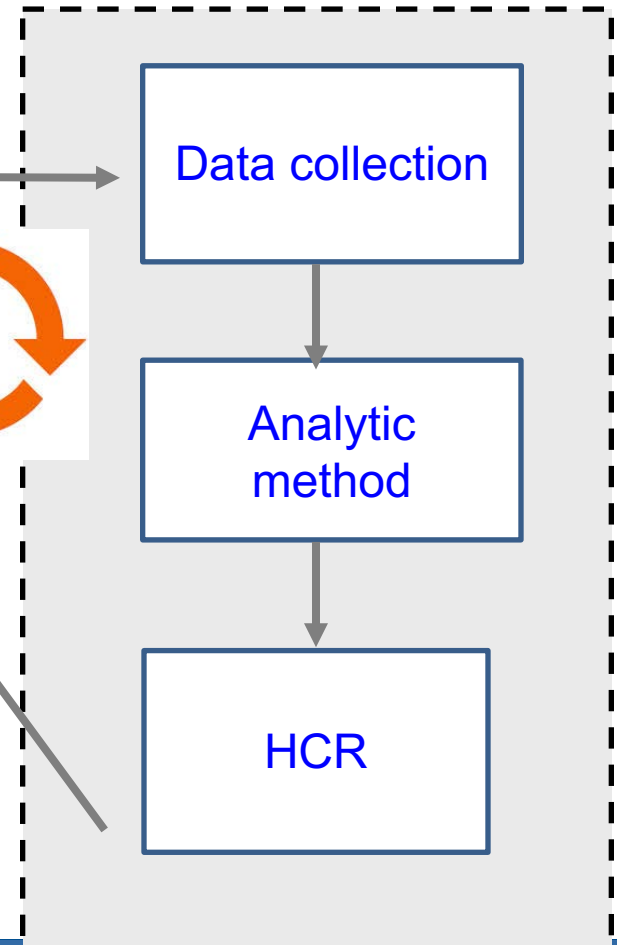
Management Strategy evaluation

Operating model



Performance measures

Management procedure



HCR Control parameter

Harvest control rule (mouse over for description)

Type of harvest control rule:

- ☒ Threshold
- ☐ Constant Exploitation Rate
- ☐ Constant catch

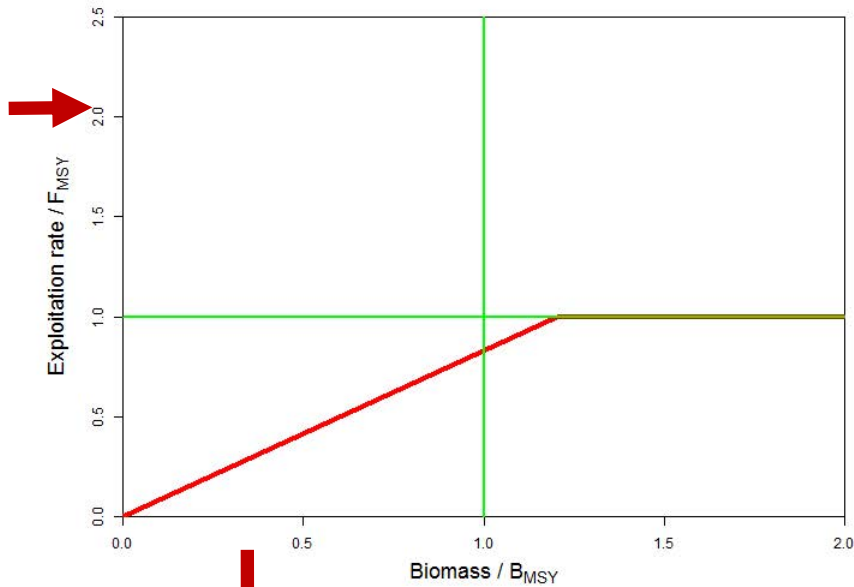
Catch ('000): Catch[2014]=408

Exploitation Rate

Maximum exploitation rate (F_{targ})

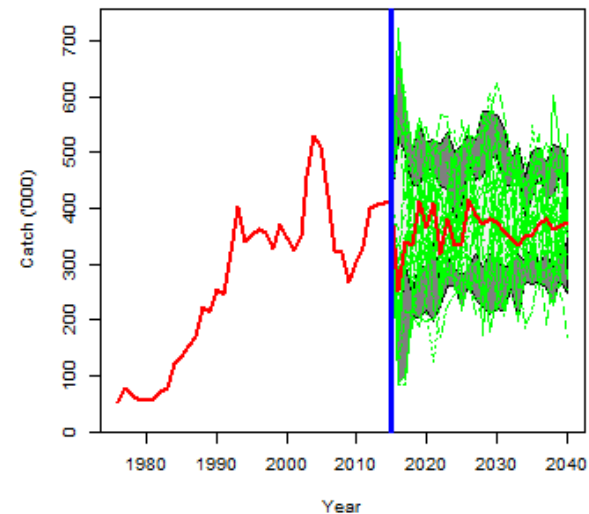
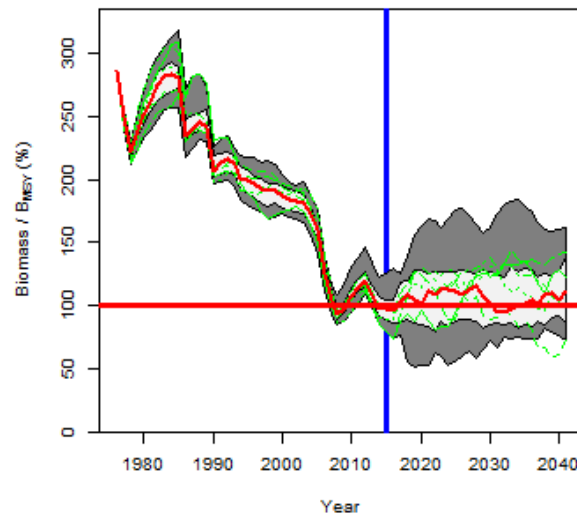
Range (BLIM & BTHRESH):

Do projections



Stock status

Catch



MP output

'Tuna MSE' – Process

Toy Tuna MSE

About

Manual Projections

HCR Projections

Multiple HCRs

Summary

Specifications

1. OM runs from 1950 to 2016
2. Year 2017:
 - i. CPUE (1950-2016) collected
 - ii. stock status estimated
 - iii. Catch for 2017 calculated
 - iv. Catch removed from the population
3. Year 2018,... repeat!

Harvest control rule (mouse over for description)

Type of harvest control rule:

☒ Threshold

☐ Constant Exploitation Rate

☐ Constant catch

Catch ('000); Catch(2014)=408

Exploitation Rate

Maximum exploitation rate (F_{targ})

0 1 2

0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2

Range (BLIM & BTHRESH):

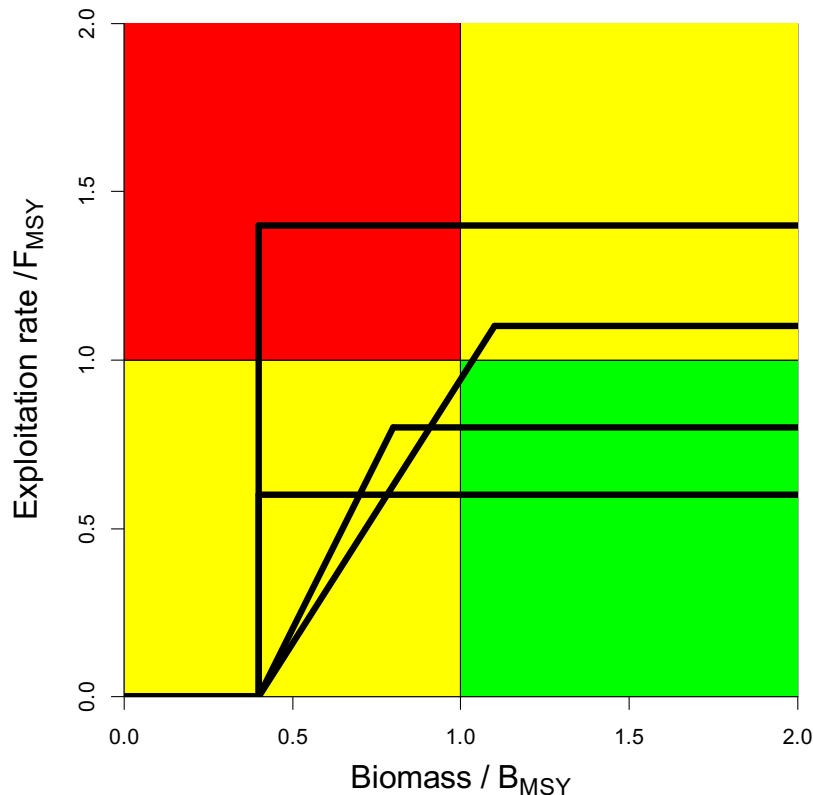
0 1.2 2

0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2

Do projections



HCR examples



Very Aggressive –
 $F = 1.4 F_{MSY}$

Aggressive –
High F at healthy stocks
but quick reaction when
stocks start to decline

Conservative –
low F , with less action
when stocks start to
decline

Very conservative –
 $F = 0.6 F_{MSY}$

Harvest control rule (mouse over for description)

Type of harvest control rule:

- ☒ Threshold
- ☐ Constant Exploitation Rate
- ☐ Constant catch

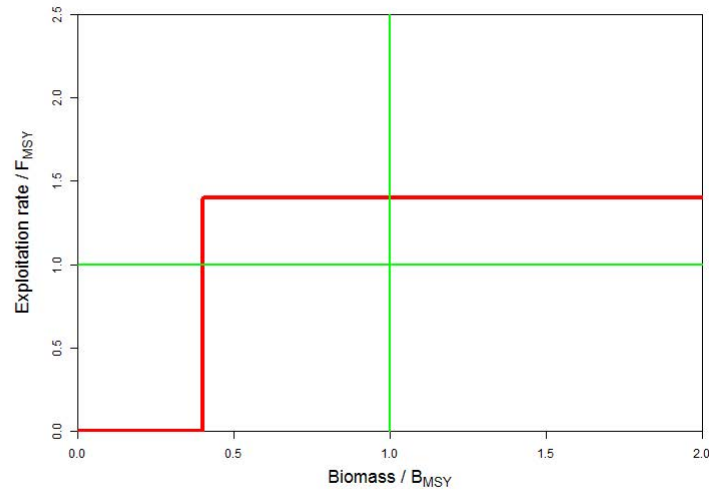
Catch (000); Catch(2014)=408

Exploitation Rate

Maximum exploitation rate (F_{target})

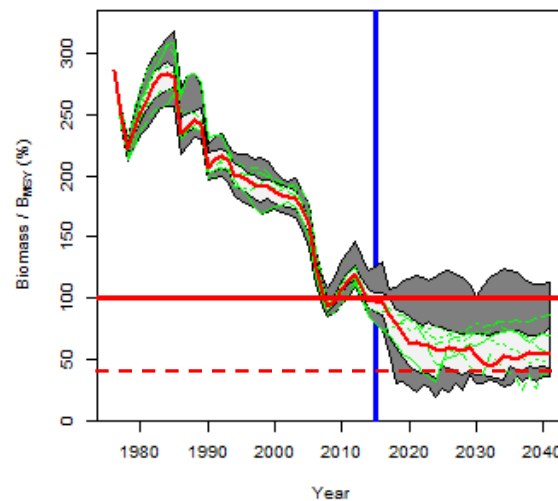
Range (BLIM & BTHRESH):

Do projections



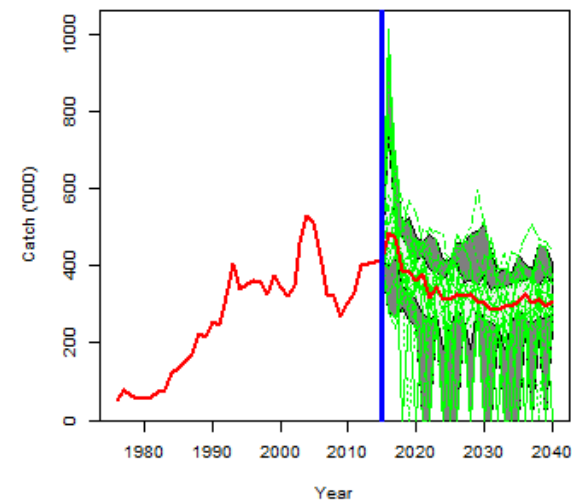
Very Aggressive

Stock status



Biomass well below the target

Catch



Catch also decline

Harvest control rule (mouse over for description)

Type of harvest control rule:

- ☒ Threshold
- ☐ Constant Exploitation Rate
- ☐ Constant catch

Catch ('900); Catch(2014)=408

408

Exploitation Rate

0.2

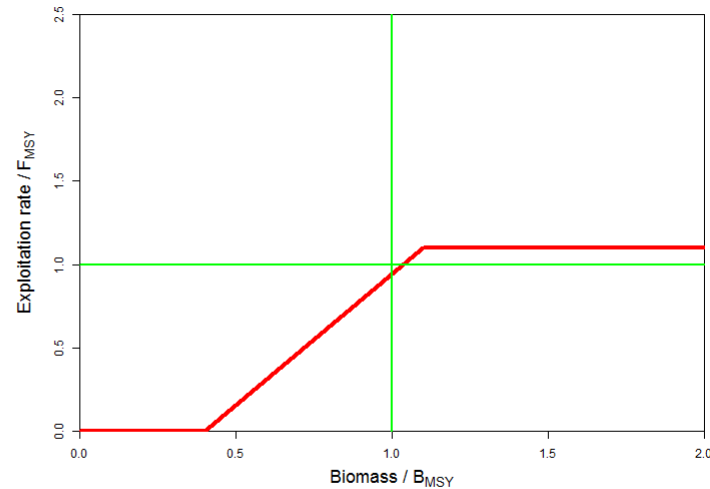
Maximum exploitation rate (F_{target})

0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2

Range (B_{lim} & B_{thresh}):

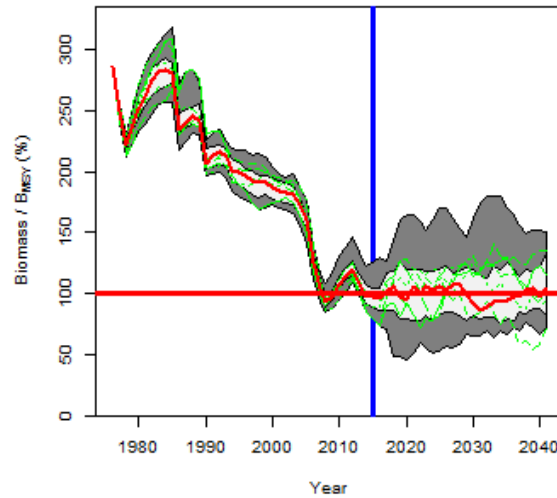
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2

Do projections

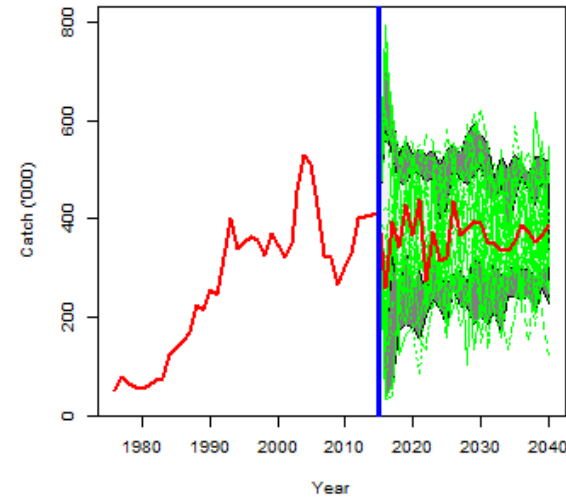


Aggressive

Stock status



Catch



Biomass below target
for some years

Catch very variable

Harvest control rule (mouse over for description)

Type of harvest control rule:

- ☒ Threshold
- ☐ Constant Exploitation Rate
- ☐ Constant catch

Catch (1980): Catch(2014)=408

408

Exploitation Rate

0.2

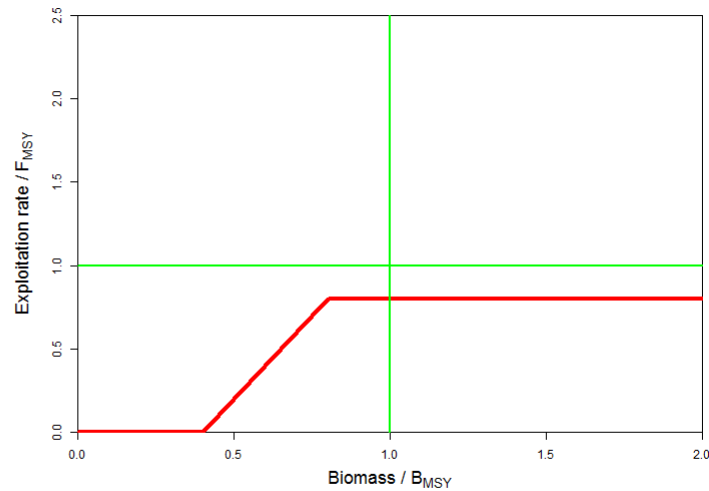
Maximum exploitation rate (F_{target})

0 0.8 2

Range (B_{lim} & B_{thresh}):

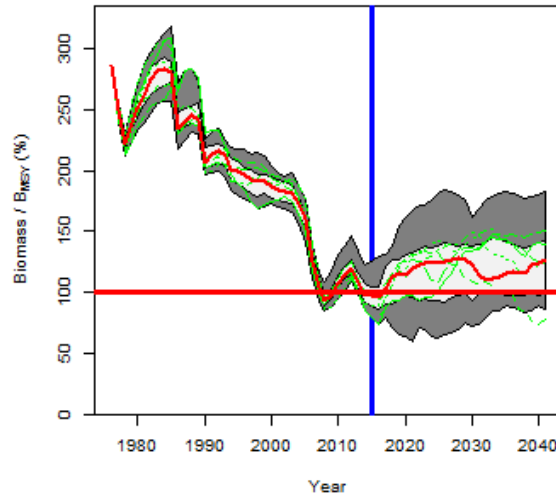
0 0.4 0.8 2

Do projections



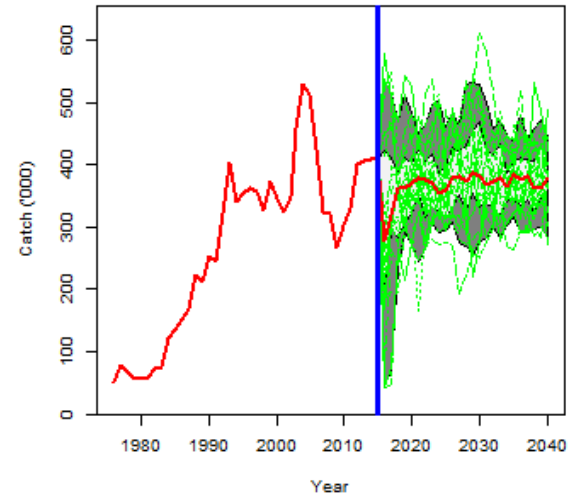
Conservative

Stock status



Biomass above the target on average

Catch



catch less variable

Harvest control rule (mouse over for description)

Type of harvest control rule:

- ☒ Threshold
- ☐ Constant Exploitation Rate
- ☐ Constant catch

Catch ('999): Catch(2014)=408

408

Exploitation Rate

0.2

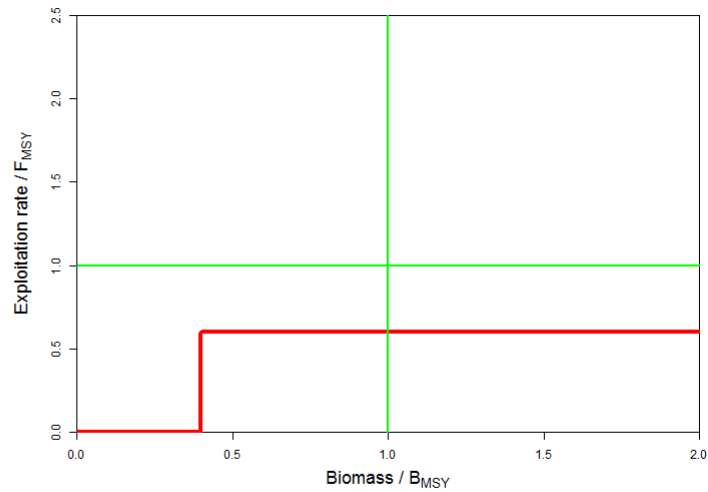
Maximum exploitation rate (F_{lim})

0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2

Range (B_{lim} & B_{thres}):

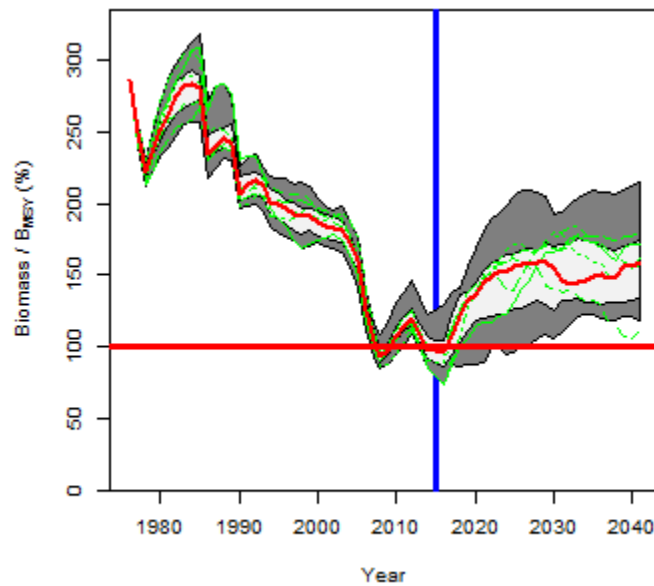
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2

Do projections



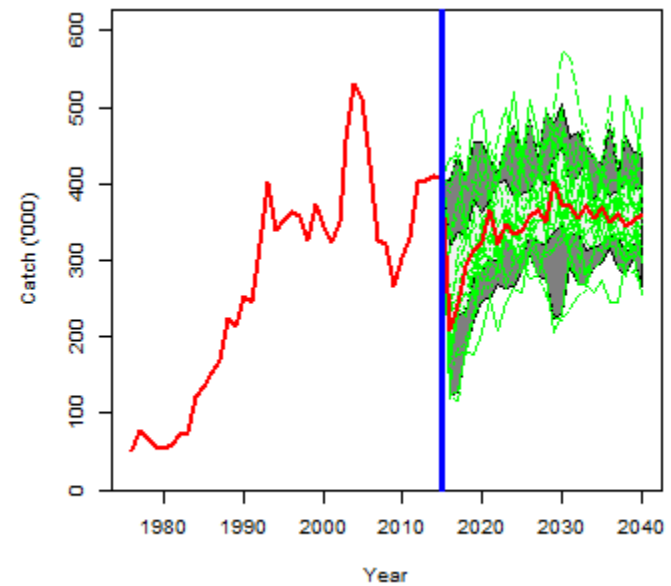
Very conservative

Stock status



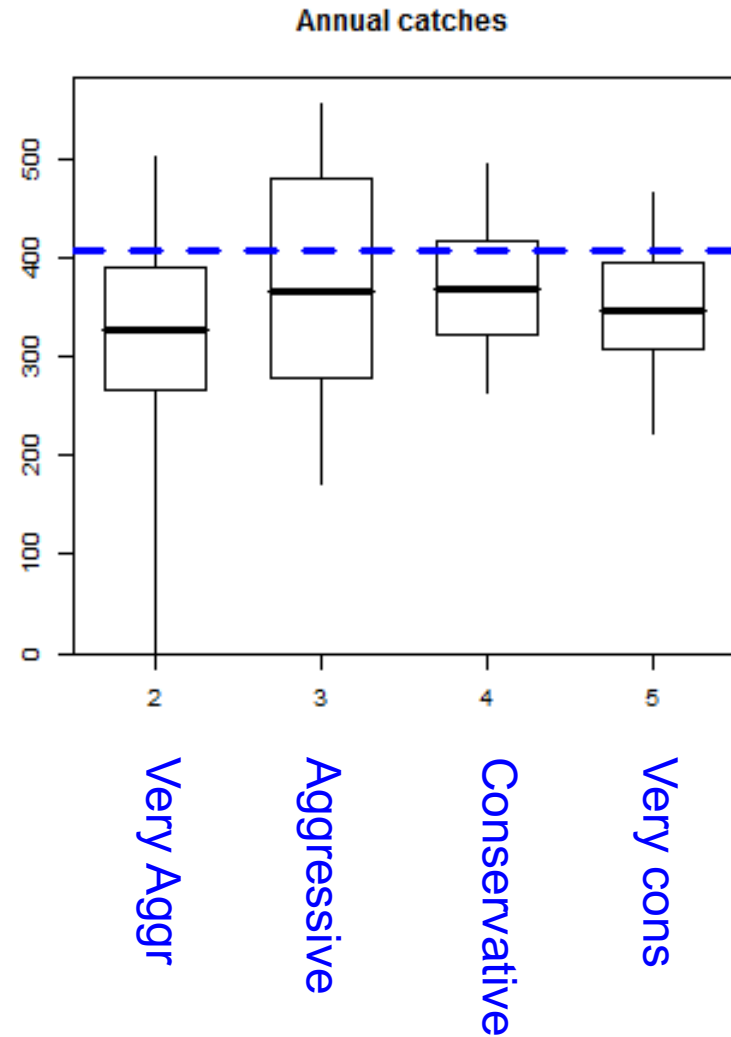
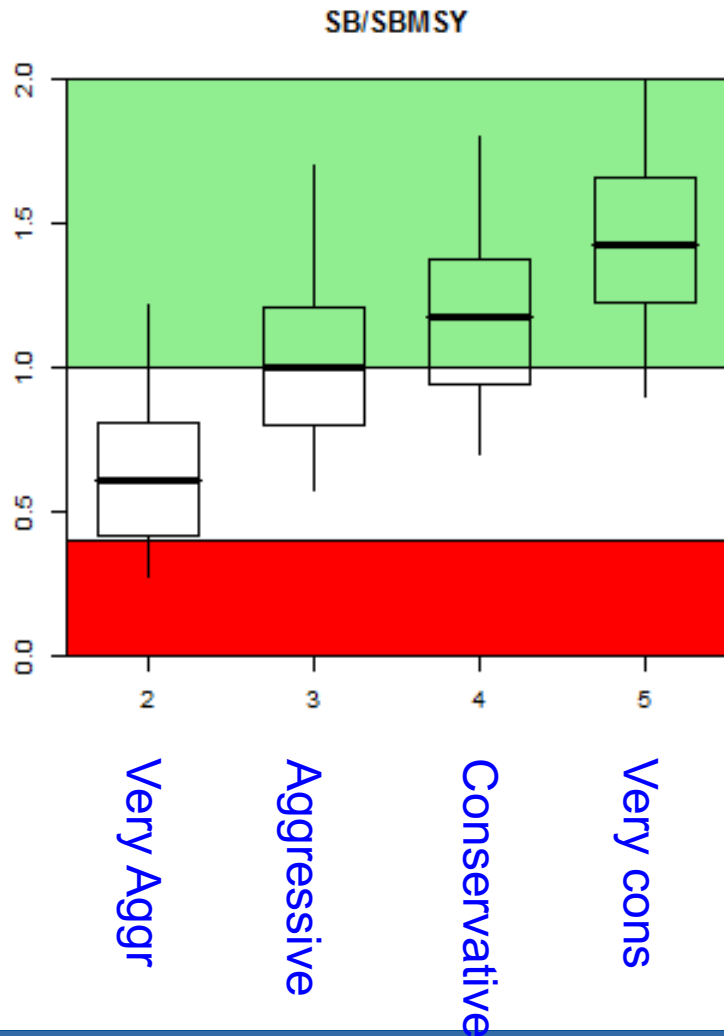
Biomass above target

Catch

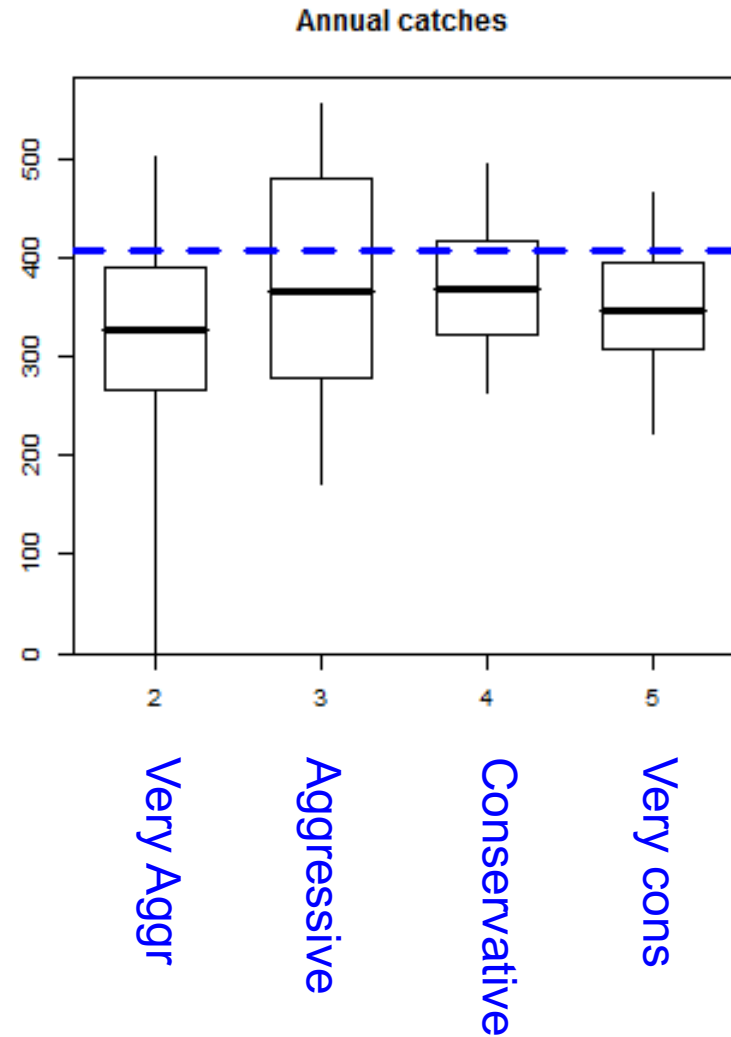
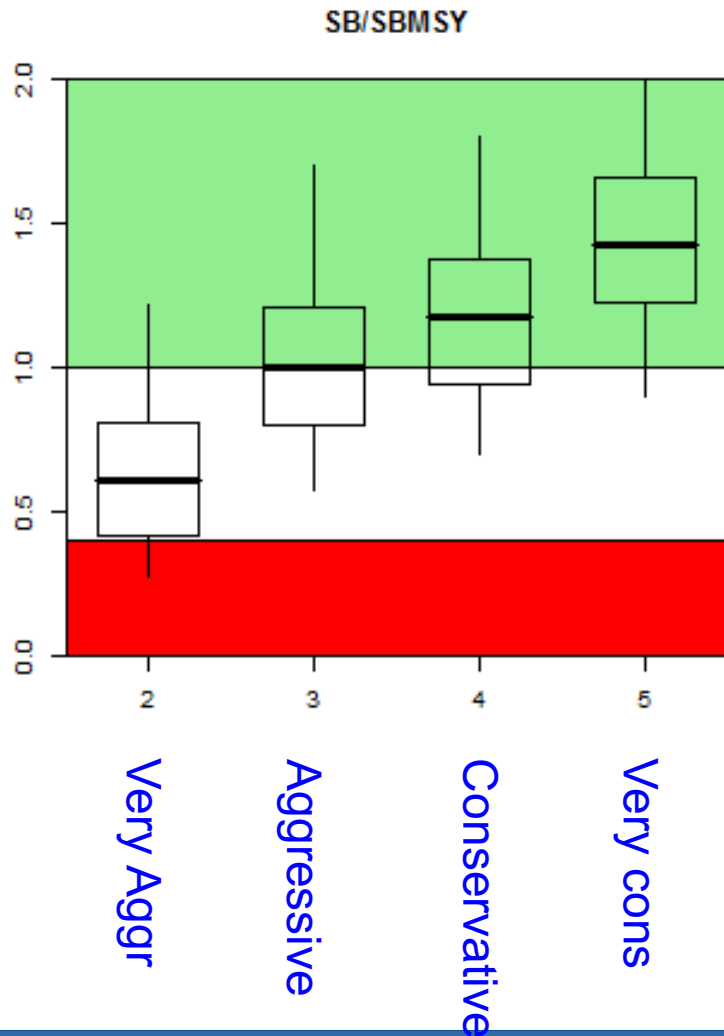


Catch low and variable

Performance measures



Performance measures





Food and Agriculture
Organization of the
United Nations



iotc ctoi



Introduction to Management Strategy Evaluation with TunaMSE: Tuna Shiny App

Dan Fu (IOTC)

Busan, Republic of Korea, 19-20 February 2020



Start the tool

- <https://puntapps.shinyapps.io/tunamse/>
- Go to the location of the HSDTool folder on your computer and double-click on run

Stock projection

Toy Tuna MSE

Ex 1. Manual Management

Ex 2. HCR Management

Ex 3. HCR selection

Settings

Manage the fishery 'manually' by changing the catch limit each year.

Each time you change the catch limit, discuss amongst the group why you are making the change. Your aim is to get the highest overall catch while maintaining stock status, avoiding overfishing and keeping catch variation low.

Catch limit ('000t)

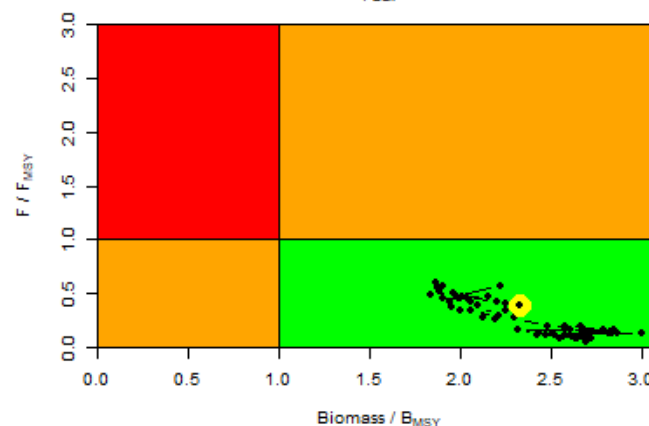
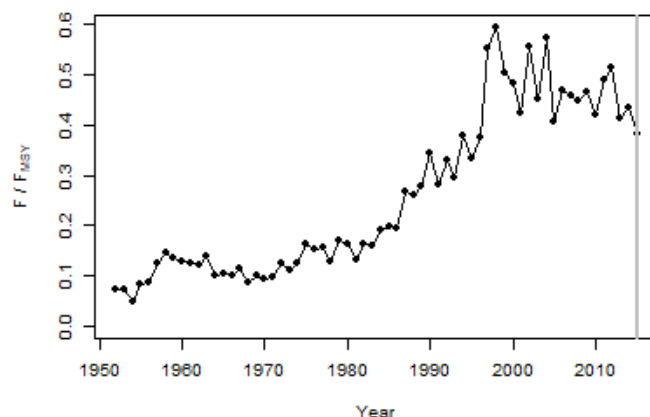
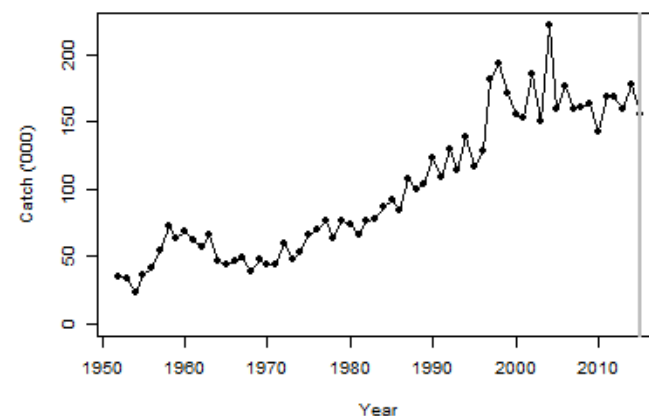
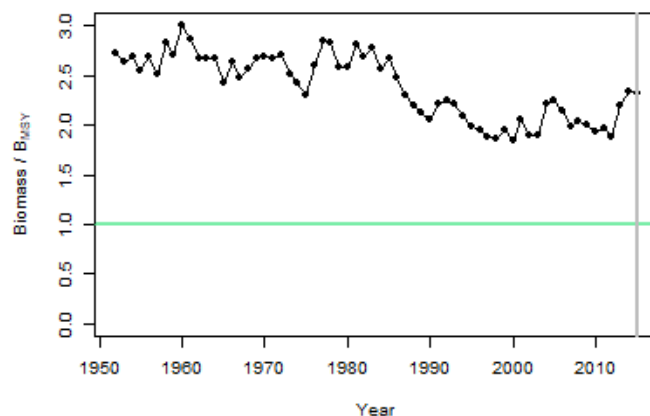
Catch limit duration (yrs)

Apply management

Restart

This tool was originally developed by André Punt and funded via WWF under the GEF/FAO ABNJ project and subsequently developed by several others.

Performance indicators: plots



Exercise 1

Find the maximum catch that can allow the stock be in the Kobe green in 10 years (**Prob. Green =1**)

A test harvest control rule

- $Blim = 0.5$
- $Bthresh = 1.2$
- $Ctarg = 180$

HCR 1.1 Set the Blim slider to 0.5

Toy Tuna MSE Ex 1. Manual Management **Ex 2. HCR Management** Ex 3. HCR selection Settings

Use a harvest control rule (HCR) to manage the fishery.

Try different types of HCR. The 'Constant Catch' and 'Constant Exp. Rate' HCRs are 'static' - they fix catch or exploitation rate at a constant level. The 'Threshold Exp. Rate' HCR is 'adaptive' or 'dynamic', it adjusts the exploitation rate depending upon the status of the stock.

Each HCR has one or more control parameters. These are like tuning knobs on an autopilot - they allow you to alter how the HCR operates. Try changing each control parameter and see how it affects the biomass and catch trajectories. Your aim is to get a high average catch, without too much variability, while maintaining the stock status around the green line and away from the red line.

Note: The <simulation outcomes> graph is ONLY updated when the <Run Simulations> button is pressed.

Type of HCR:

Threshold Catch

Maximum catch (C_{targ})



The maximum catch

Range (B_{lim} & B_{thresh}):



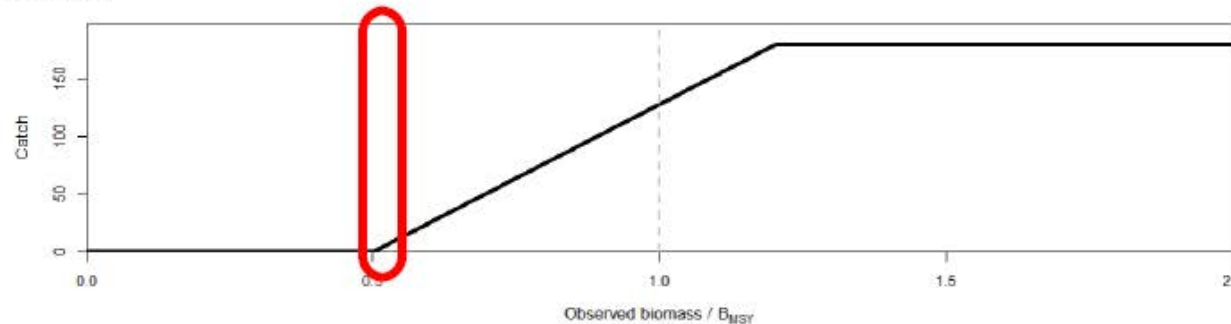
The proportion of B_{msy} over which exploitation rate changes

Number of years to compute outputs over

30

Run simulations

Harvest control rule



Simulation outcomes

HCR 1.2 Press the Run Simulations button

Toy Tuna MSE Ex 1. Manual Management Ex 2. HCR Management Ex 3. HCR selection Settings

Use a harvest control rule (HCR) to manage the fishery.

Try different types of HCR. The 'Constant Catch' and 'Constant Exp. Rate' HCRs are 'static' - they fix catch or exploitation rate at a constant level. The 'Threshold Exp. Rate' HCR is 'adaptive' or 'dynamic', it adjusts the exploitation rate depending upon the status of the stock.

Each HCR has one or more control parameters. These are like tuning knobs on an autopilot - they allow you to alter how the HCR operates. Try changing each control parameter and see how it affects the biomass and catch trajectories. Your aim is to get a high average catch, without too much variability, while maintaining the stock status around the green line and away from the red line

Note: The <simulation outcomes> graph is ONLY updated when the <Run Simulations> button is pressed.

Type of HCR:

Threshold Catch

Maximum catch (C_{targ})



The maximum catch

Range (B_{lim} & B_{thresh}):



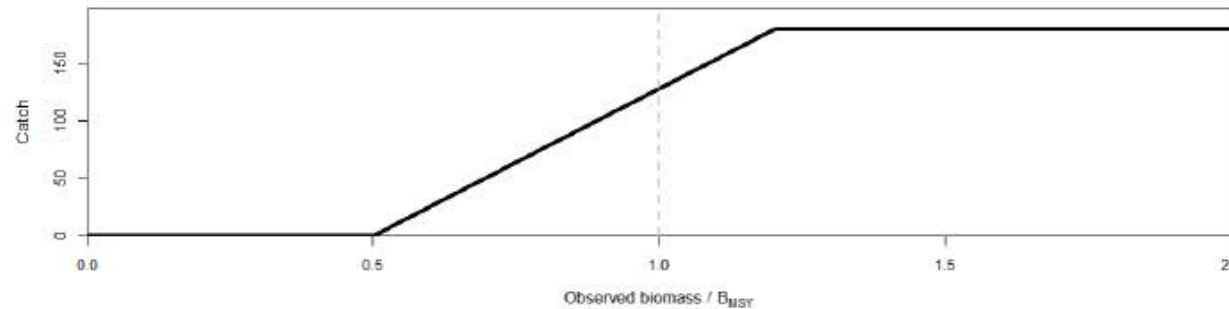
The proportion of B_{msy} over which exploitation rate changes

Number of years to compute outputs over

30

Run simulations

Harvest control rule



Simulation outcomes

HCR 1.3 What happened?

Toy Tuna MSE

Ex 1. Manual Management

Ex 2. HCR Management

Ex 3. HCR selection

Settings

Use a harvest control rule (HCR) to manage the fishery.

Try different types of HCR. The 'Constant Catch' and 'Constant Exp. Rate' HCRs are 'static' - they fix catch or exploitation rate at a constant level. The 'Threshold Exp. Rate' HCR is 'adaptive' or 'dynamic', it adjusts the exploitation rate depending upon the status of the stock.

Each HCR has one or more control parameters. These are like tuning knobs on an autopilot - they allow you to alter how the HCR operates. Try changing each control parameter and see how it affects the biomass and catch trajectories. Your aim is to get a high average catch, without too much variability, while maintaining the stock status around the green line and away from the red line.

Note: The <simulation outcomes> graph is ONLY updated when the <Run Simulations> button is pressed.

Type of HCR:

Threshold Catch

Maximum catch (C_{targ})



The maximum catch

Range (B_{lim} & B_{thresh}):



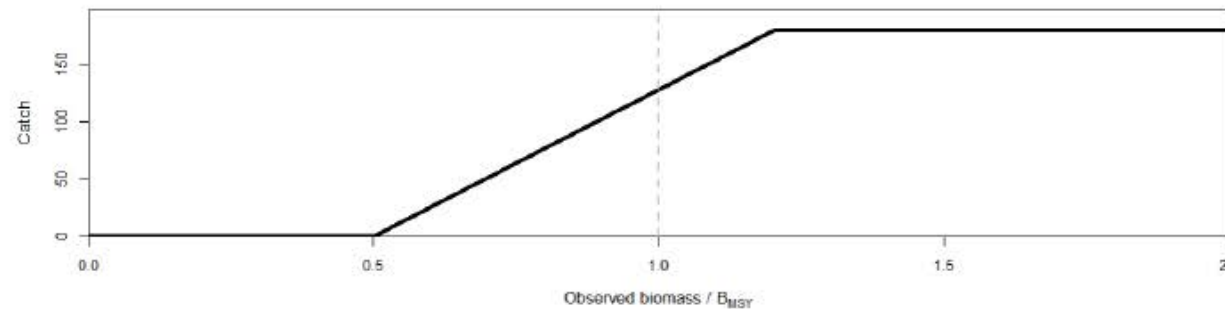
The proportion of B_{msy} over which exploitation rate changes

Number of years to compute outputs over

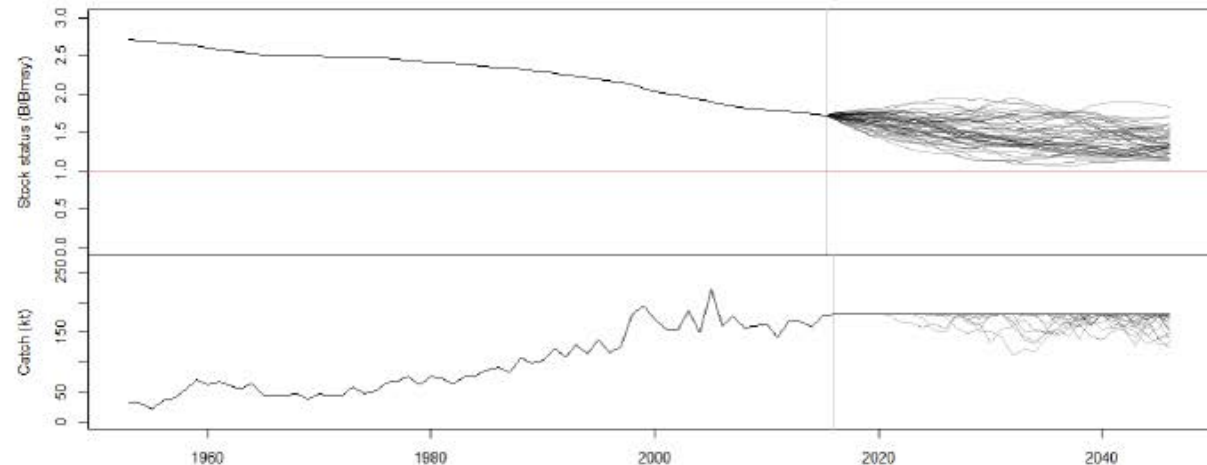
30

Run simulations

Harvest control rule



Simulation outcomes



HCR 1.3 What happened?

Toy Tuna MSE

Ex 1. Manual Management

Ex 2. HCR Management

Ex 3. HCR selection

Settings

Use a harvest control rule (HCR) to manage the fishery.

Try different types of HCR. The 'Constant Catch' and 'Constant Exp. Rate' HCRs are 'static' - they fix catch or exploitation rate at a constant level. The 'Threshold Exp. Rate' HCR is 'adaptive' or 'dynamic', it adjusts the exploitation rate depending upon the status of the stock.

Each HCR has one or more control parameters. These are like tuning knobs on an autopilot - they allow you to alter how the HCR operates. Try changing each control parameter and see how it affects the biomass and catch trajectories. Your aim is to get a high average catch, without too much variability, while maintaining the stock status around the green line and away from the red line.

Note: The <simulation outcomes> graph is ONLY updated when the <Run Simulations> button is pressed.

Type of HCR:

Threshold Catch

Maximum catch (C_{targ})



The maximum catch

Range (B_{lim} & B_{thresh}):



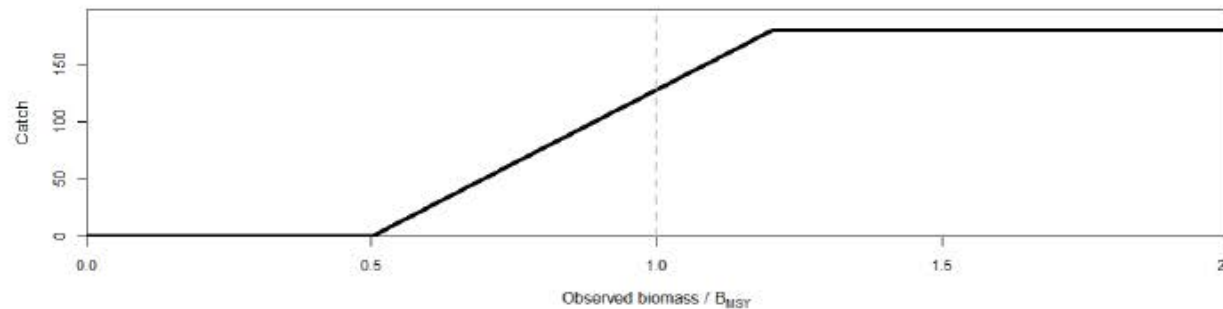
The proportion of B_{msy} over which exploitation rate changes

Number of years to compute outputs over

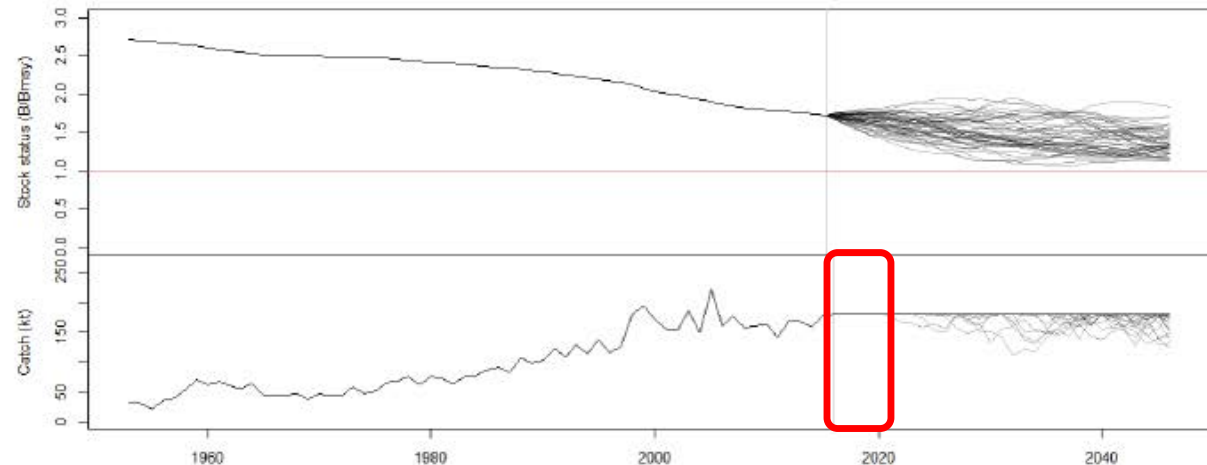
30

Run simulations

Harvest control rule



Simulation outcomes



HCR 1.6 When $B/B_{MSY} > B_{thresh}$ (1.2), catches = C_{targ}

Toy Tuna MSE Ex 1. Manual Management Ex 2. HCR Management Ex 3. HCR selection Settings

Use a harvest control rule (HCR) to manage the fishery.

Try different types of HCR. The 'Constant Catch' and 'Constant Exp. Rate' HCRs are 'static' - they fix catch or exploitation rate at a constant level. The 'Threshold Exp. Rate' HCR is 'adaptive' or 'dynamic', it adjusts the exploitation rate depending upon the status of the stock.

Each HCR has one or more control parameters. These are like tuning knobs on an autopilot - they allow you to alter how the HCR operates. Try changing each control parameter and see how it affects the biomass and catch trajectories. Your aim is to get a high average catch, without too much variability, while maintaining the stock status around the green line and away from the red line.

Note: The <simulation outcomes> graph is ONLY updated when the <Run Simulations> button is pressed.

Type of HCR:

Threshold Catch

Maximum catch (C_{targ})



The maximum catch

Range (Blim & B_{thresh}):



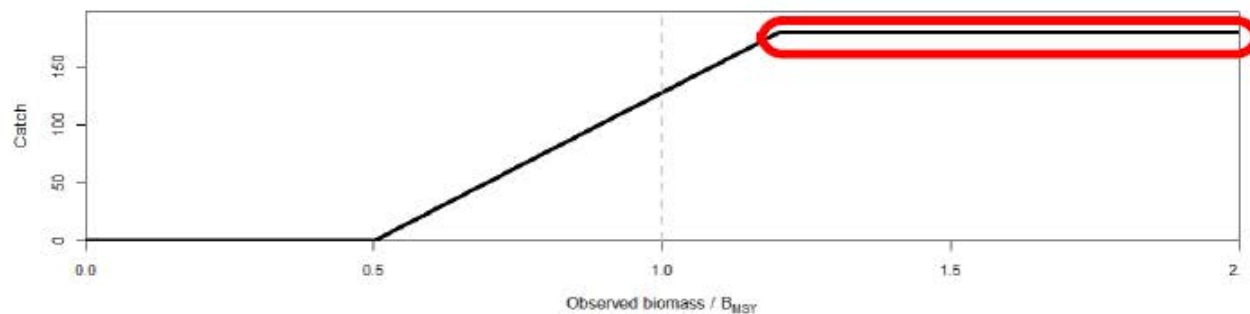
The proportion of Blim over which exploitation rate changes

Number of years to compute outputs over

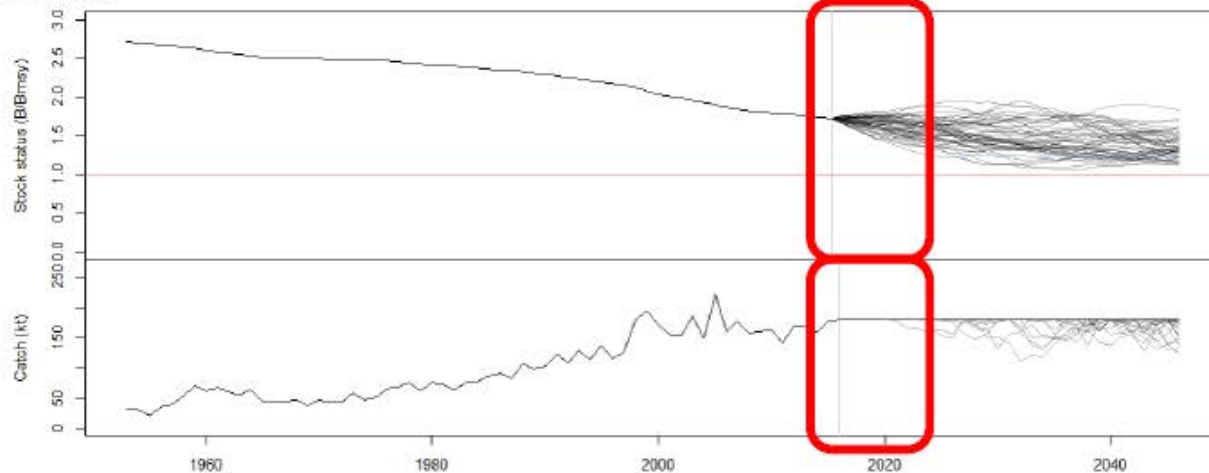
30

Run simulations

Harvest control rule



Simulation outcomes



HCR 1.3 What happened?

Toy Tuna MSE

Ex 1. Manual Management

Ex 2. HCR Management

Ex 3. HCR selection

Settings

Use a harvest control rule (HCR) to manage the fishery.

Try different types of HCR. The 'Constant Catch' and 'Constant Exp. Rate' HCRs are 'static' - they fix catch or exploitation rate at a constant level. The 'Threshold Exp. Rate' HCR is 'adaptive' or 'dynamic', it adjusts the exploitation rate depending upon the status of the stock.

Each HCR has one or more control parameters. These are like tuning knobs on an autopilot - they allow you to alter how the HCR operates. Try changing each control parameter and see how it affects the biomass and catch trajectories. Your aim is to get a high average catch, without too much variability, while maintaining the stock status around the green line and away from the red line.

Note: The <simulation outcomes> graph is ONLY updated when the <Run Simulations> button is pressed.

Type of HCR:

Threshold Catch

Maximum catch (C_{targ})



The maximum catch

Range (B_{lim} & B_{thresh}):



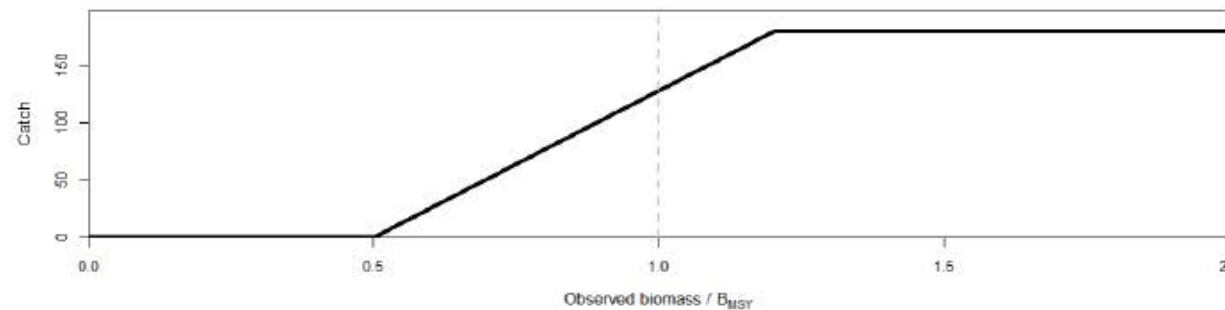
The proportion of B_{msy} over which exploitation rate changes

Number of years to compute outputs over

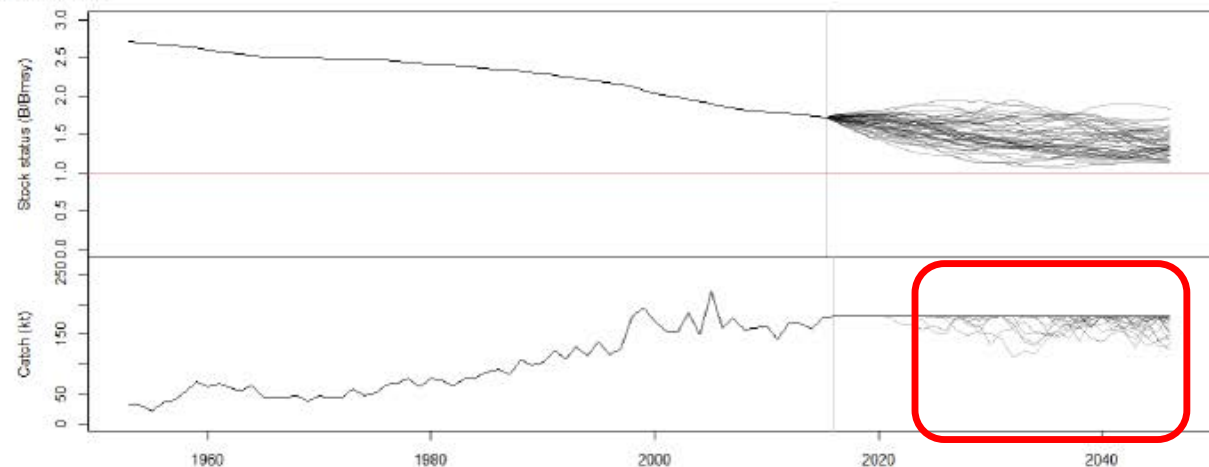
30

Run simulations

Harvest control rule



Simulation outcomes



HCR 1.7 When B/B_{MSY} drops below B_{thresh} , catches are reduced

Toy Tuna MSE Ex 1. Manual Management **Ex 2. HCR Management** Ex 3. HCR selection Settings

Use a harvest control rule (HCR) to manage the fishery.

Try different types of HCR. The 'Constant Catch' and 'Constant Exp. Rate' HCRs are 'static' - they fix catch or exploitation rate at a constant level. The 'Threshold Exp. Rate' HCR is 'adaptive' or 'dynamic', it adjusts the exploitation rate depending upon the status of the stock.

Each HCR has one or more control parameters. These are like tuning knobs on an autopilot - they allow you to alter how the HCR operates. Try changing each control parameter and see how it affects the biomass and catch trajectories. Your aim is to get a high average catch, without too much variability, while maintaining the stock status around the green line and away from the red line.

Note: The <simulation outcomes> graph is ONLY updated when the <Run Simulations> button is pressed.

Type of HCR:

Threshold Catch

Maximum catch (C_{targ})



The maximum catch

Range (B_{lim} & B_{thresh}):



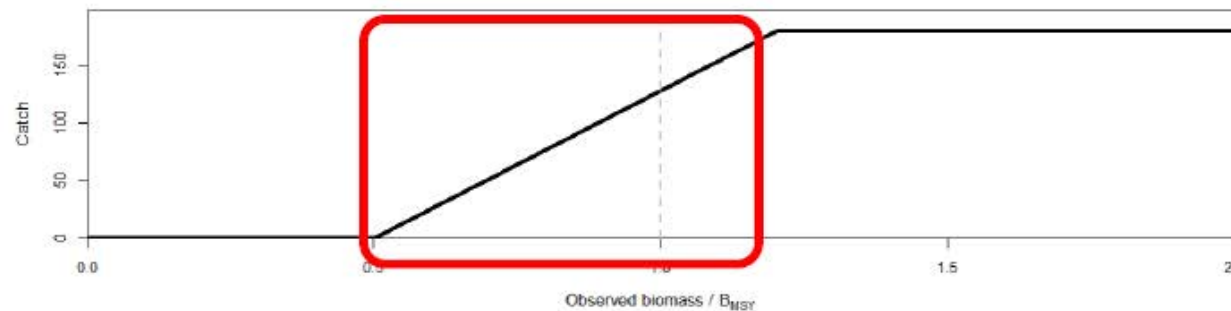
The proportion of B_{msy} over which exploitation rate changes

Number of years to compute outputs over

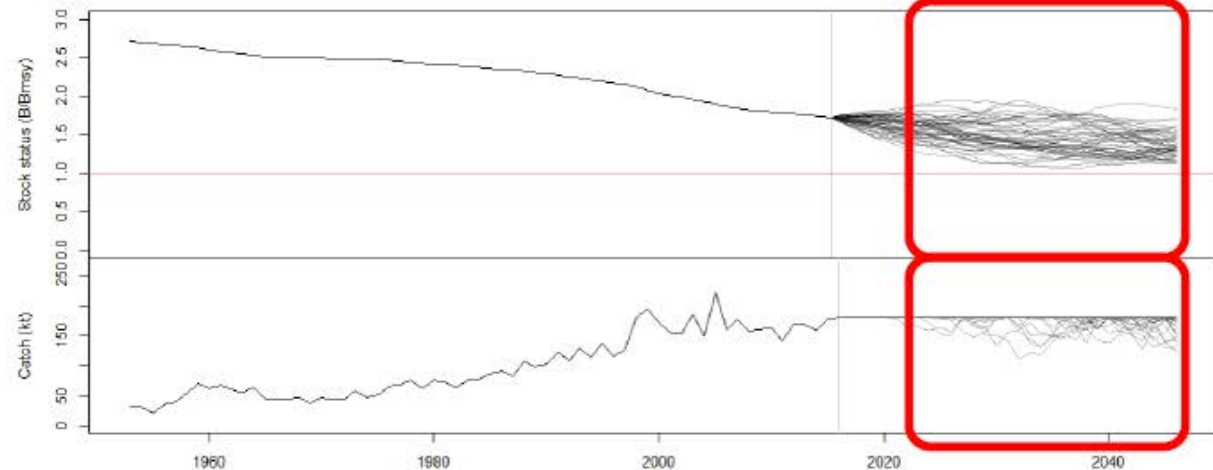
30

Run simulations

Harvest control rule



Simulation outcomes



HCR 1.9 Performance Indicators

Toy Tuna MSE Ex 1. Manual Management Ex 2. HCR Management **Ex 3. HCR selection** Settings

Select the HCR that best achieves your management objectives.

The performance indicators have been recorded for each of the HCR's that you tested during Exercise 2. Select one HCR that you think has the best tradeoffs amongst the performance indicators. You can go back to Exercise 2 and evaluate more HCRs to try and find a HCR with even better performance.

Plot trajectories for which HCR?

1

Use this to choose which HCR to plot trajectories for.

Type of plot:

Kobe

Use this to choose between a Kobe and Majuro plot. Note that these plots show the results in the final year of the projection.

Key

HCR control parameters

Catch is the constant catch

*Exp. rate is the constant exploitation rate.

F_{lim} and C_{lim} define the maximum output of the threshold HCRs.

B_{lim} and B_{thresh} are the input limits of the HCR. If an threshold exploitation rate HCR is used they are biomass relative to B_{msy}. If a threshold catch HCR is used they are biomass relative to B_{F0}

Performance indicators

Median depletion (%): Median of Summated B.

*Prob. green: probability of being above B > B_{msy} and F < F_{msy}.

*Catch: median over sims of the catch.

*Catch var.: median over sims of the catch variation

Candidate HCRs

Plots

HCR	Type	Catch	Exp. rate	F _{mult}	C _{max}	B _{lim}	B _{thresh}	Median B/B _{MSY}	*Prob. green	*Catch	*Catch var.	No. yrs average
1	Threshold Catch	NA	NA	NA	180	0.5	1.2	1.48	1	179.8	0.009	30

Plotting the HCRs 1

Toy Tuna MSE Ex 1. Manual Management Ex 2. HCR Management **Ex 3. HCR selection** Settings

Select the HCR that best achieves your management objectives.

The performance indicators have been recorded for each of the HCR's that you tested during Exercise 2. Select one HCR that you think has the best tradeoffs amongst the performance indicators. You can go back to Exercise 2 and evaluate more HCRs to try and find a HCR with even better performance.

Plot trajectories for which HCR?

Use this to choose which HCR to plot trajectories for.

Type of plot:

Kobe

Use this to choose between a Kobe and Majuro plot. Note that these plots show the results in the final year of the projection.

Key

HCR control parameters

Catch is the constant catch.

*Exp. rate is the constant exploitation rate.

F_{lim} and C_{lim} define the maximum output of the threshold HCRs.

B_{lim} and B_{thresh} are the input limits of the HCR. If an threshold exploitation rate HCR is used they are biomass relative to B_{msy}. If a threshold catch HCR is used they are biomass relative to C_{lim}.

Performance indicators

Median depletion (%) Median of B_{unfished} B.

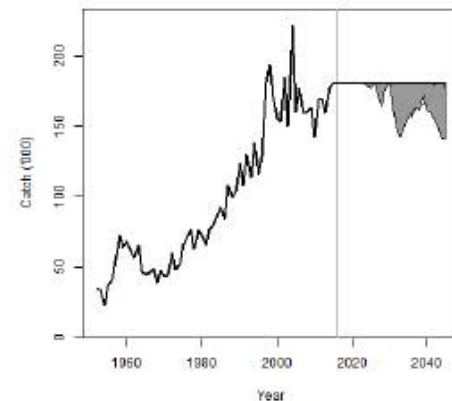
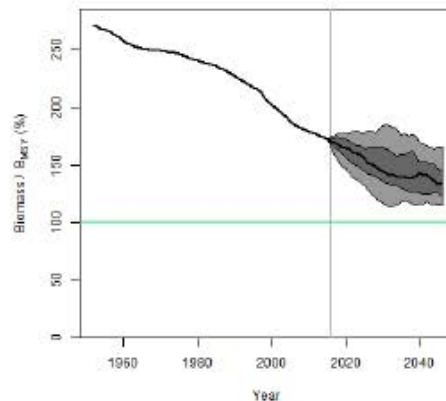
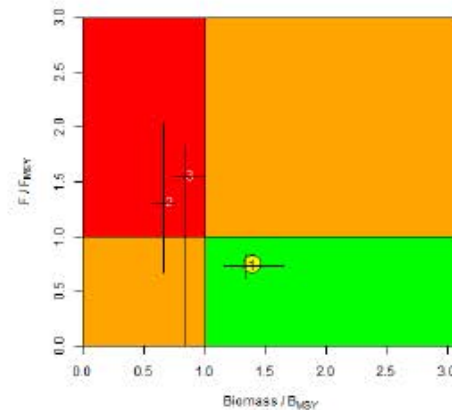
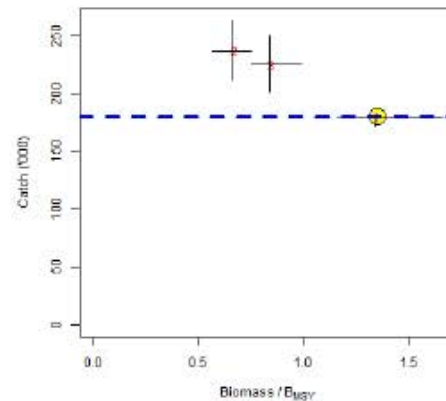
*Prob. green: probability of being above B > B_{msy} and F < F_{msy}.

*Catch: median over sims of the catch.

*Catch var.: median over sims of the catch variation.

Candidate HCRs

Plots



Another Harvest Control Rule

Let's set up another Harvest Control Rule.
Can we improve performance?

- $Blim = 0.5$
- $Bthresh = 0.8$
- $Ctarg = 250$

HCR 2.1 $B_{lim}=0.5$, $B_{thresh}=0.8$, $C_{targ}=250$

Toy Tuna MSE Ex 1. Manual Management Ex 2. HCR Management Ex 3. HCR selection Settings

Use a harvest control rule (HCR) to manage the fishery.

Try different types of HCR. The 'Constant Catch' and 'Constant Exp. Rate' HCRs are 'static' - they fix catch or exploitation rate at a constant level. The 'Threshold Exp. Rate' HCR is 'adaptive' or 'dynamic', it adjusts the exploitation rate depending upon the status of the stock.

Each HCR has one or more control parameters. These are like tuning knobs on an autopilot - they allow you to alter how the HCR operates. Try changing each control parameter and see how it affects the biomass and catch trajectories. Your aim is to get a high average catch, without too much variability, while maintaining the stock status around the green line and away from the red line.

Note: The <simulation outcomes> graph is ONLY updated when the <Run Simulations> button is pressed.

Type of HCR:

Threshold Catch

Maximum catch (C_{targ})



The maximum catch:

Range (B_{lim} & B_{thresh}):



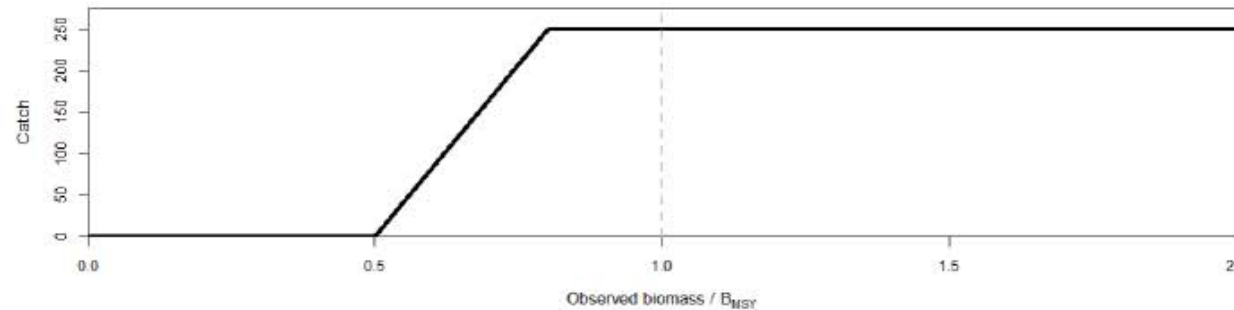
The proportion of B_{msy} over which exploitation rate changes

Number of years to compute outputs over

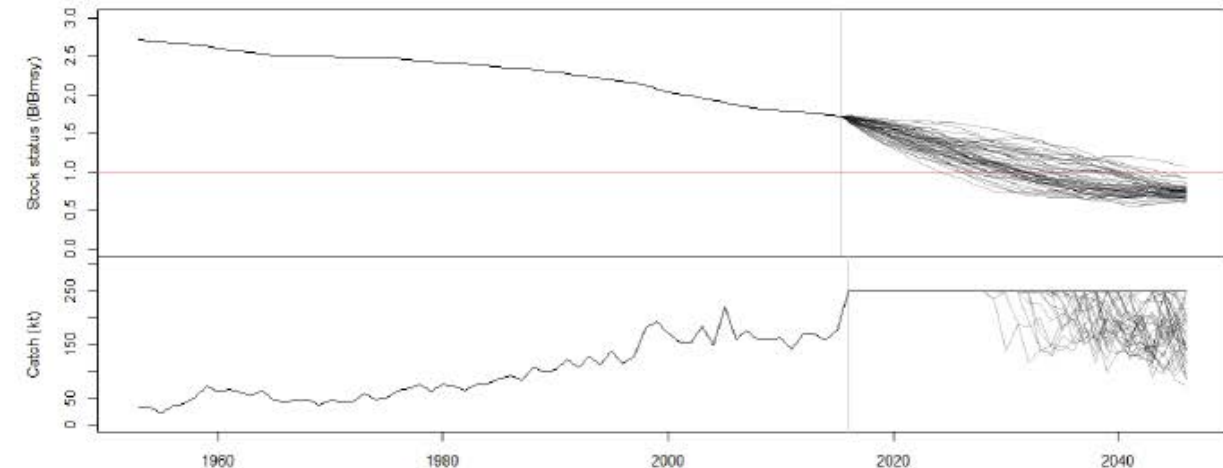
30

Run simulations

Harvest control rule



Simulation outcomes



HCR 2.2 What happened? Biomass starts to declines below BMSY...

Toy Tuna MSE Ex 1. Manual Management Ex 2. HCR Management Ex 3. HCR selection Settings

Use a harvest control rule (HCR) to manage the fishery.

Try different types of HCR. The 'Constant Catch' and 'Constant Exp. Rate' HCRs are 'static' - they fix catch or exploitation rate at a constant level. The 'Threshold Exp. Rate' HCR is 'adaptive' or 'dynamic', it adjusts the exploitation rate depending upon the status of the stock.

Each HCR has one or more control parameters. These are like tuning knobs on an autopilot - they allow you to alter how the HCR operates. Try changing each control parameter and see how it affects the biomass and catch trajectories. Your aim is to get a high average catch, without too much variability, while maintaining the stock status around the green line and away from the red line.

Note: The <simulation outcomes> graph is ONLY updated when the <Run Simulations> button is pressed.

Type of HCR:

Threshold Catch

Maximum catch (C_{targ})



The maximum catch

Range (B_{lim} & B_{thresh}):



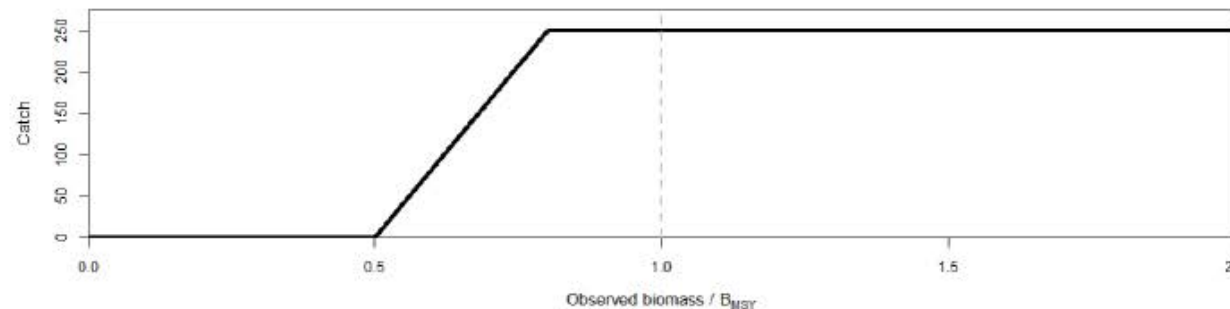
The proportion of B_{msy} over which exploitation rate changes

Number of years to compute outputs over

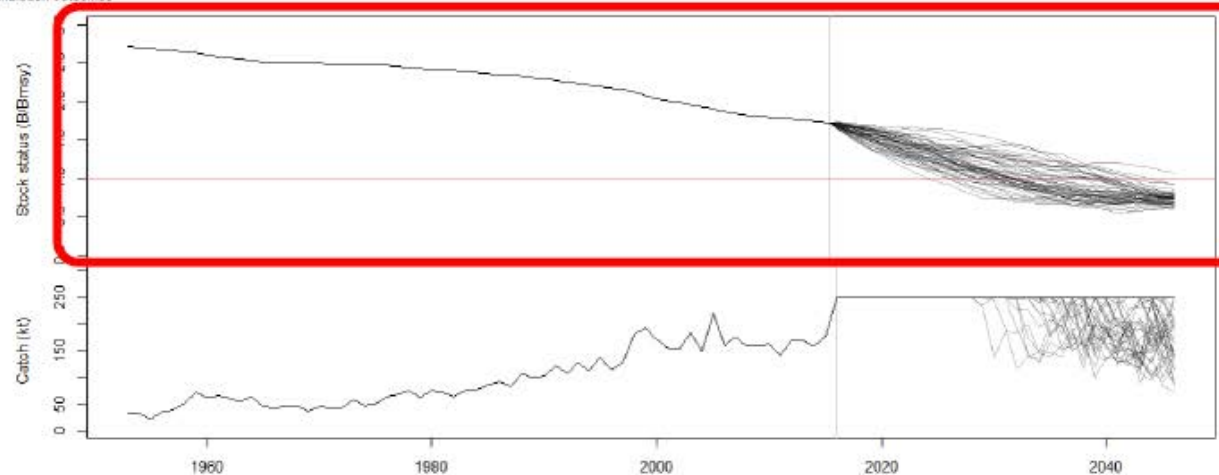
30

Run simulations

Harvest control rule



Simulation outcomes



HCR 2.3 ...but catches not cut until $B/B_{MSY} < B_{thresh}$ (0.8)

Toy Tuna MSE Ex 1. Manual Management Ex 2. HCR Management Ex 3. HCR selection Settings

Use a harvest control rule (HCR) to manage the fishery.

Try different types of HCR. The 'Constant Catch' and 'Constant Exp. Rate' HCRs are 'static' - they fix catch or exploitation rate at a constant level. The 'Threshold Exp. Rate' HCR is 'adaptive' or 'dynamic', it adjusts the exploitation rate depending upon the status of the stock.

Each HCR has one or more control parameters. These are like tuning knobs on an autopilot - they allow you to alter how the HCR operates. Try changing each control parameter and see how it affects the biomass and catch trajectories. Your aim is to get a high average catch, without too much variability, while maintaining the stock status around the green line and away from the red line.

Note: The <simulation outcomes> graph is ONLY updated when the <Run Simulations> button is pressed.

Type of HCR:

Threshold Catch

Maximum catch (C_{target})



The maximum catch:

Range (B_{lim} & B_{thresh}):



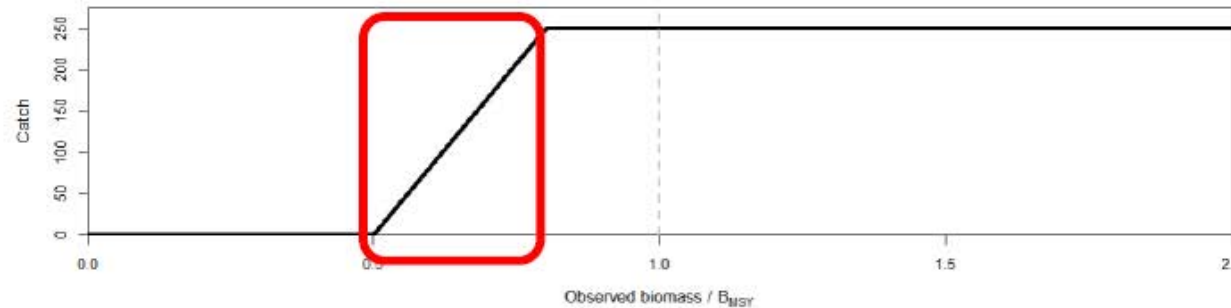
The proportion of B_{msy} over which exploitation rate changes

Number of years to compute outputs over

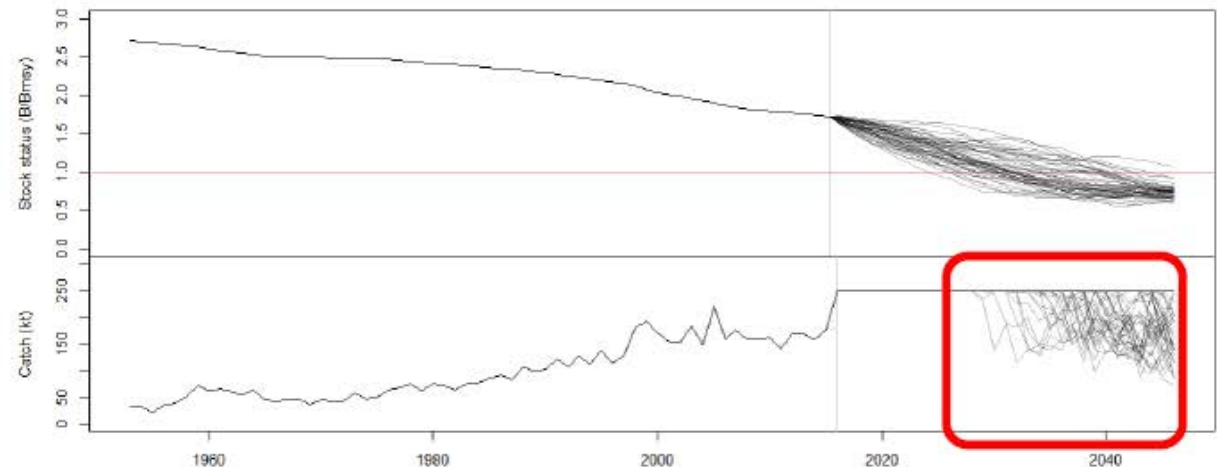
30

Run simulations

Harvest control rule



Simulation outcomes



HCR 2.5 Compare the HCRs

Toy Tuna MSE Ex 1. Manual Management Ex 2. HCR Management **Ex 3. HCR selection** Settings

Select the HCR that best achieves your management objectives.

The performance indicators have been recorded for each of the HCR's that you tested during Exercise 2. Select one HCR that you think has the best tradeoffs amongst the performance indicators. You can go back to Exercise 2 and evaluate more HCRs to try and find a HCR with even better performance.

Plot trajectories for which HCR?

Use this to choose which HCR to plot trajectories for.

Type of plot:

Use this to choose between a Kobe and Majuro plot. Note that these plots show the results in the final year of the projection

Key

HCR control parameters

Catch is the constant catch

*Exp. rate is the constant exploitation rate

F_{lim} and C_{lim} define the maximum output of the threshold HCRs.

B_{lim} and B_{thresh} are the input limits of the HCR. If an threshold exploitation rate HCR is used they are biomass relative to B_{msy}. If a threshold catch HCR is used they are biomass relative to B_{F0}

Performance indicators

Median depletion [%] : Median of Standardized B

*Prob. green : probability of being above B > B_{msy} and F < F_{msy}

*Catch : median over sims of the catch

*Catch var. : median over sims of the catch variation

Candidate HCRs

Plots

HCR	Type	Catch	Exp. rate	F _{mult}	C _{max}	B _{lim}	B _{thresh}	Median B/B _{MSY}	*Prob. green	*Catch	*Catch var.	No. yrs average
1	Threshold Catch	NA	NA	NA	180	0.5	1.2	1.48	1	179.8	0.009	30
2	Threshold Catch	NA	NA	NA	250	0.5	0.8	1.07	0.219	234.7	0.036	30

Clearing HCRs

Toy Tuna MSE Ex 1. Manual Management Ex 2. HCR Management Ex 3. HCR selection **Settings**

Specifications for the runs

Type of scenario to consider:

- ☐ Easy
☒ Moderate
☐ Hard

Type of scenario to consider:

- ☒ RUN1_USLL
☐ RUN2_JLL
☐ RUN3_CHTAI

Number of simulations

50

Last year of simulation

94

Random number seed

0

Limit Reference point (proportion of BMSY) (Not used in this version):

0.4

Catch Reference ('000)

180

Implement Updates

Now you try. Competition time!

OBJECTIVES

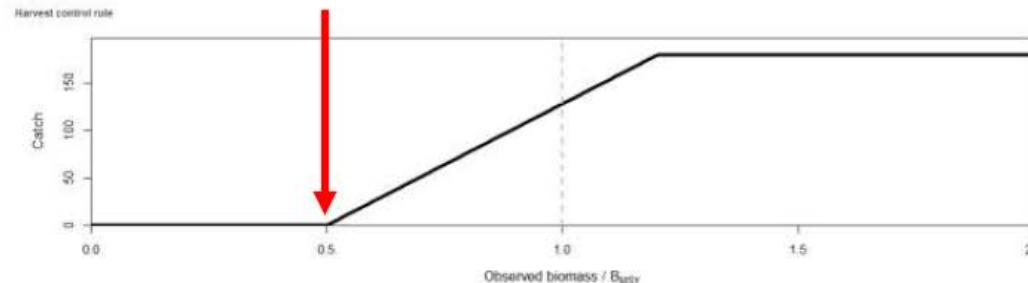
- $SB/SB_{msy} = 1$
- Maximise catch

CONSTRAINTS

- Use threshold catch HCR (the one we have been using)
- Fix B_{lim} at $0.5 SB/SB_{msy}$

MANAGEMENT

- Find combination of B_{thresh} and C_{targ} that achieves objectives



Now you try. Competition time!

OBJECTIVES

- High catches
- Biological sustainability

CONSTRAINTS

- Use threshold catch HCR (the one we have been using)
- Fix B_{lim} at $0.5 SB/SB_{msy}$

MANAGEMENT

- Find combination of B_{thresh} and C_{targ} that:
 - Gives highest catches
 - But probability of being in the green zone of the Kobe plot must be greater than or equal to 0.7

CURRENT STATUS OF IOTC MANAGEMENT STRATEGY EVALUATIONS



Bigeye Tuna



Dale Kolody & Paavo Jumppanen – CSIRO
With guidance from the IOTC MSE Task Force



TCMP-02 (2018) : 3 Tuning Objectives

B1: $\Pr(\text{Kobe green zone 2030:2034}) = 0.5$

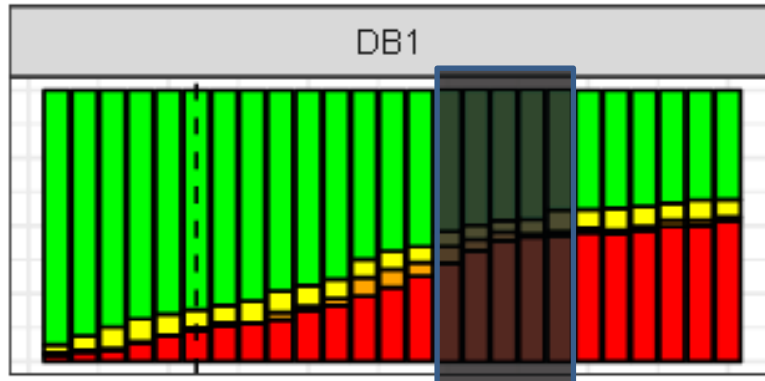
B2: $\Pr(\text{Kobe green zone 2030:2034}) = 0.6$

B3: $\Pr(\text{Kobe green zone 2030:2034}) = 0.7$

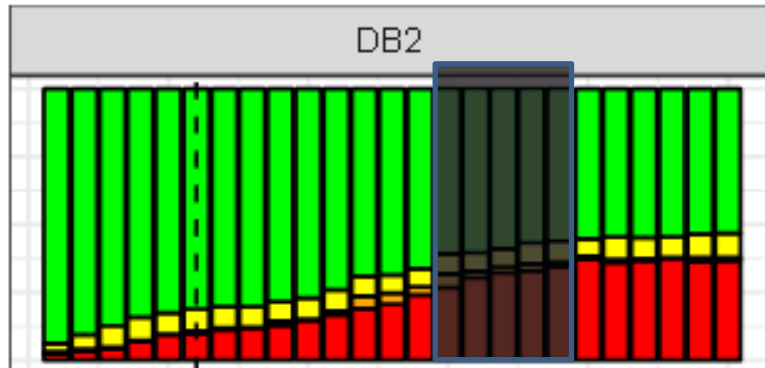
The stock status is in the Kobe green quadrant over the period 2030:2034 exactly 50, 60 or 70 % of the time (averaged over all simulations).

Visualizing the Tuning Objectives:

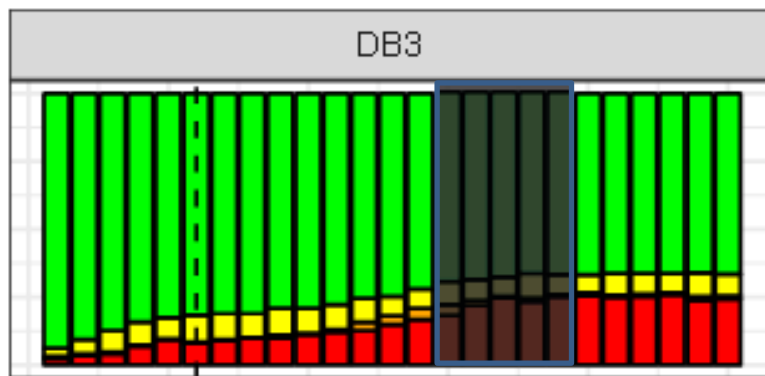
Time series of Kobe quadrant probabilities



B1: 50% Kobe green zone



B2: 60% Kobe green zone



B3: 70% Kobe green zone

2015 2020 2025 2030 2035 2040

Other MP implementation constraints:

- Frequency of quota setting
 - First MP setting: 2021
 - Then every 3 years
- TAC change constraints
 - Maximum 15% change (increase or decrease)
 - (achievable for all BET tuning objectives)
- 2 year Implementation data lag
 - E.g. 2019 CPUE available for 2021 TAC setting

Fig. 3

2021-2040

performance summary

- All tuning levels likely to result in catch equal to or exceeding current catch
- Higher catch = higher risk
- i.e. no surprises

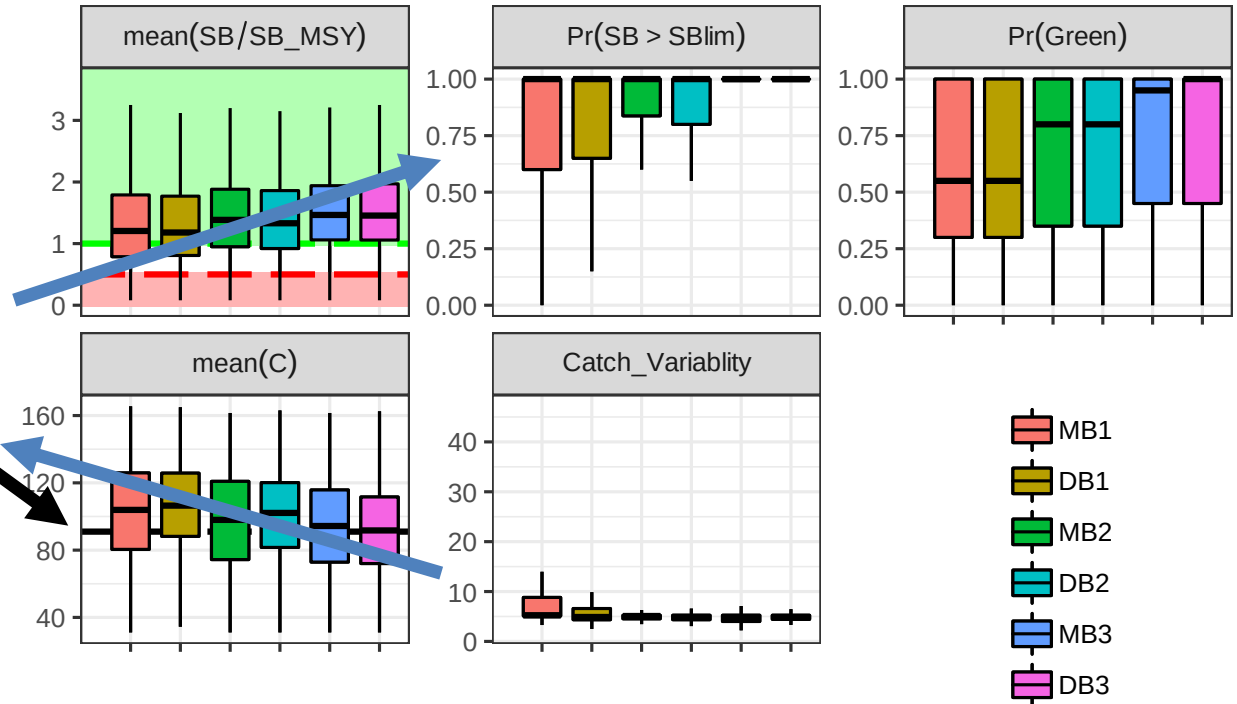


Fig. 4

2021-2040

performance summary

- All tuning levels likely to result in catch equal to or exceeding current catch
- Higher catch = higher risk

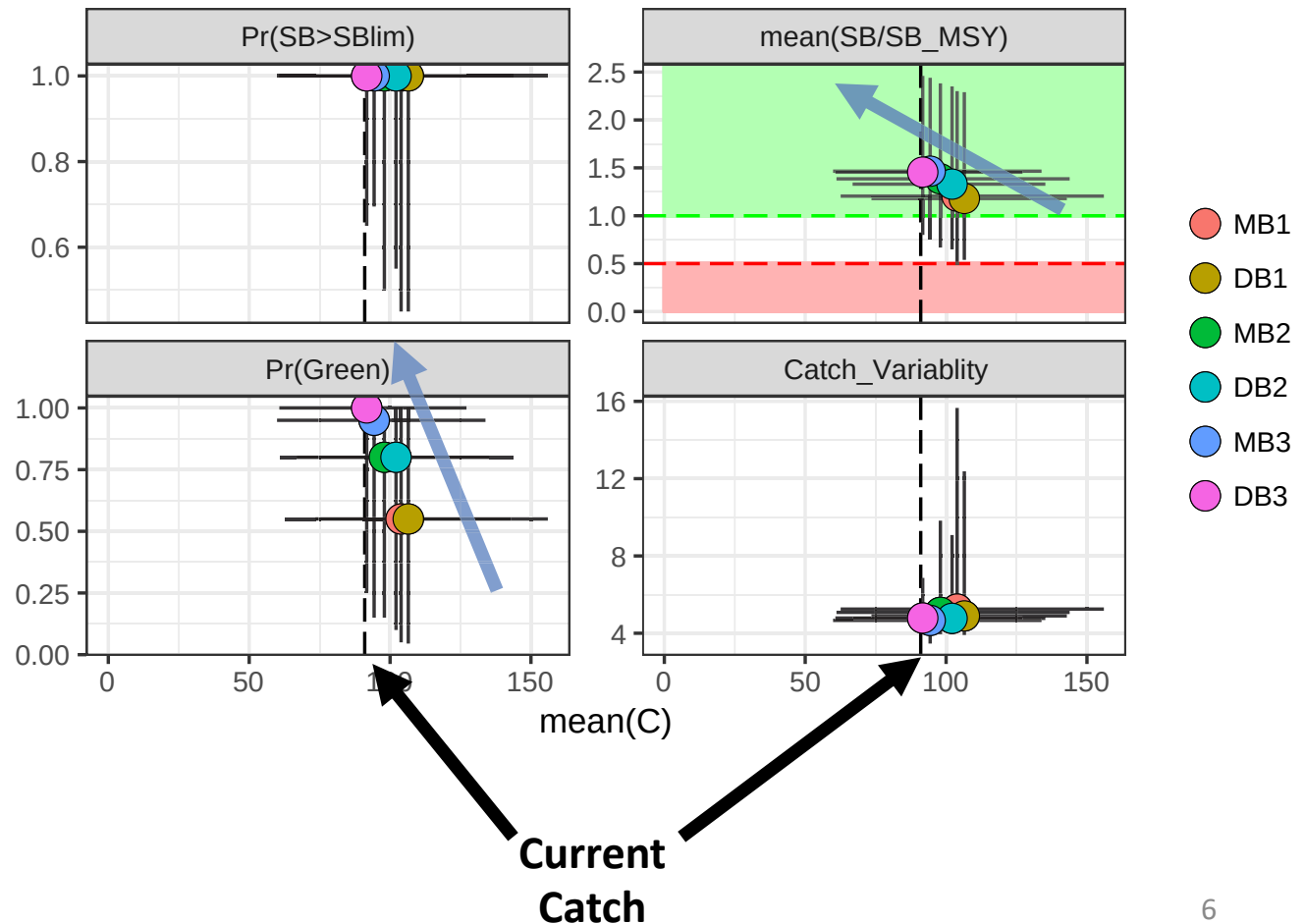


Fig.5

2021-2040

performance
summary

- Tuning level more important than MP-Class
- 3 Tuning levels cover broad range of trade-off space

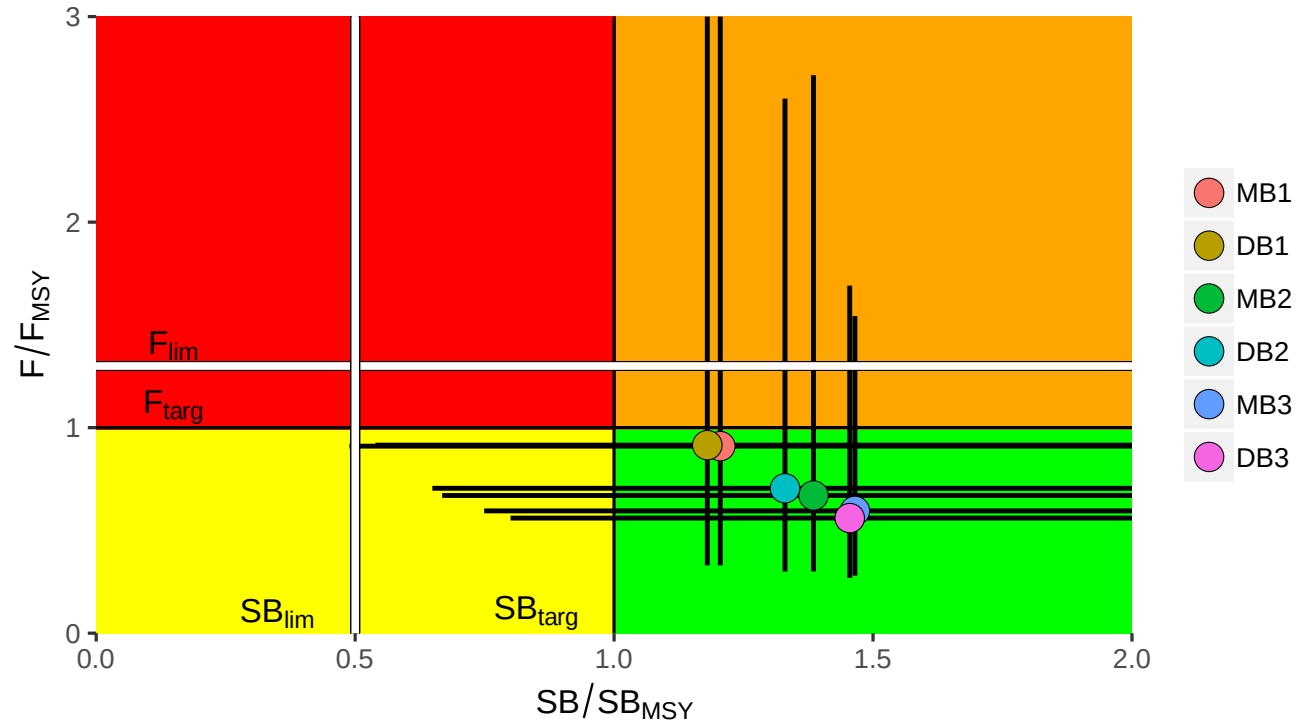
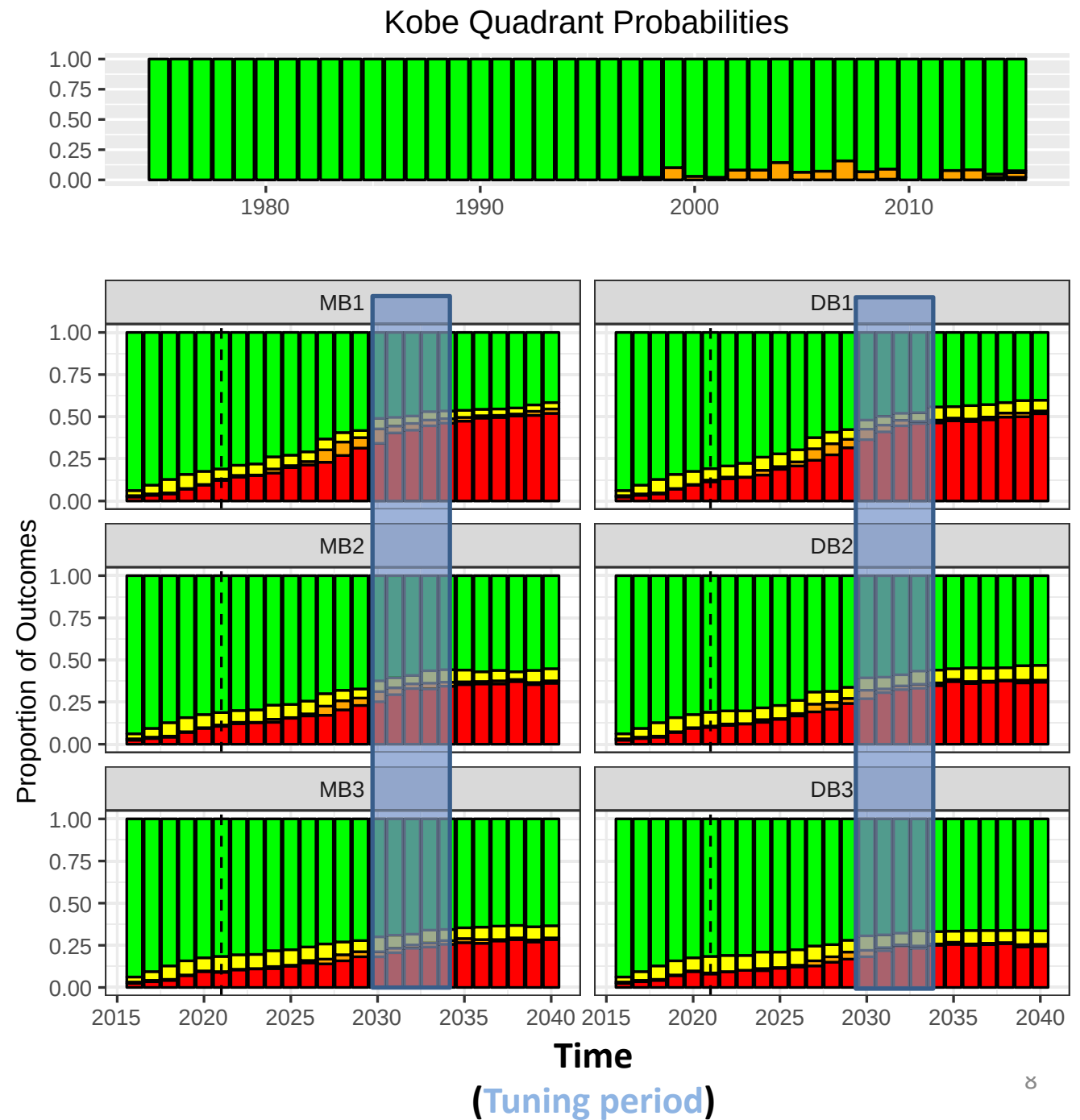


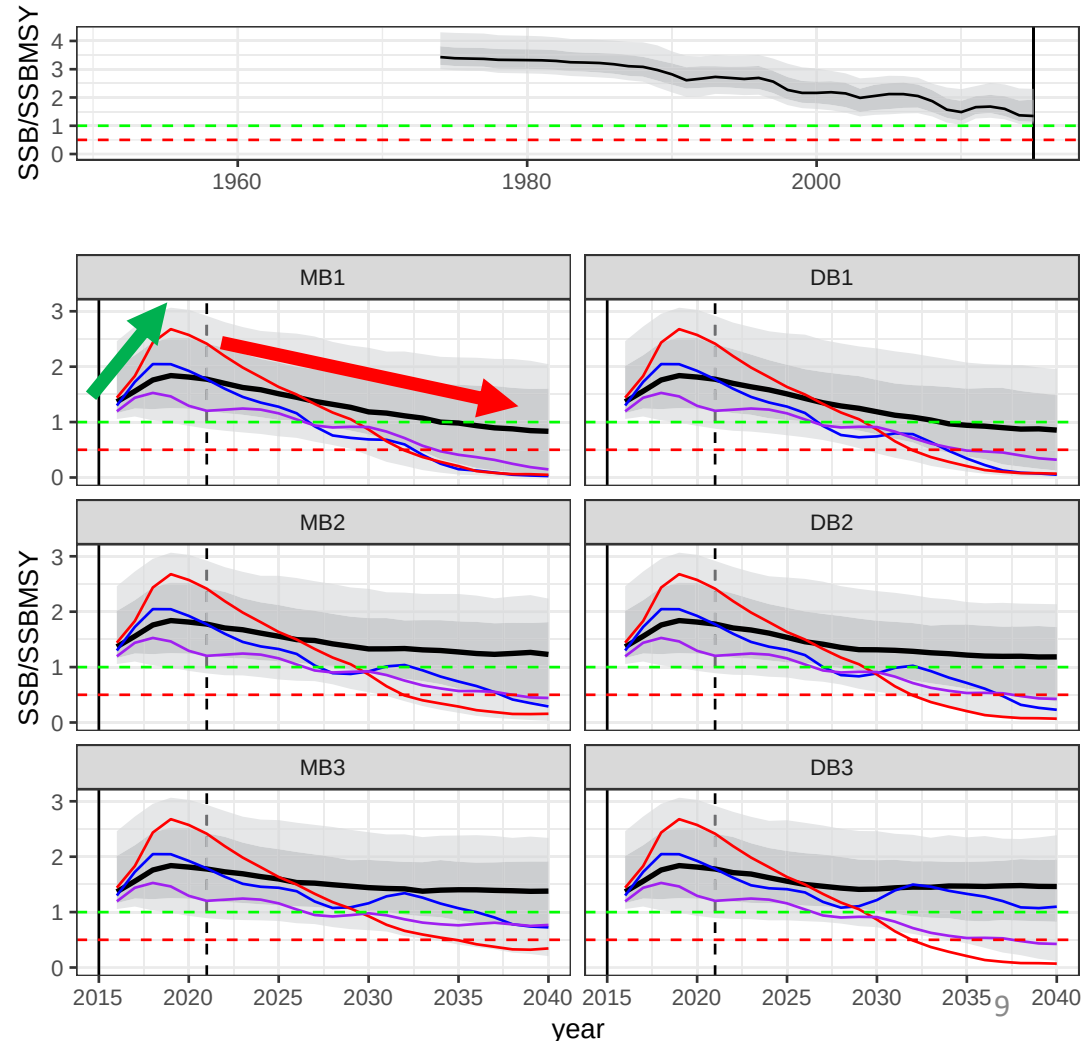
Fig. 6



Key Results of Candidate MP Evaluations

- Fig. 7
- Current low catches cause Biomass rebuilding prior to first MP setting
- MP must cause biomass decline to meet defined tuning objectives
- B1 requires the biggest biomass decrease.

Spawning Biomass

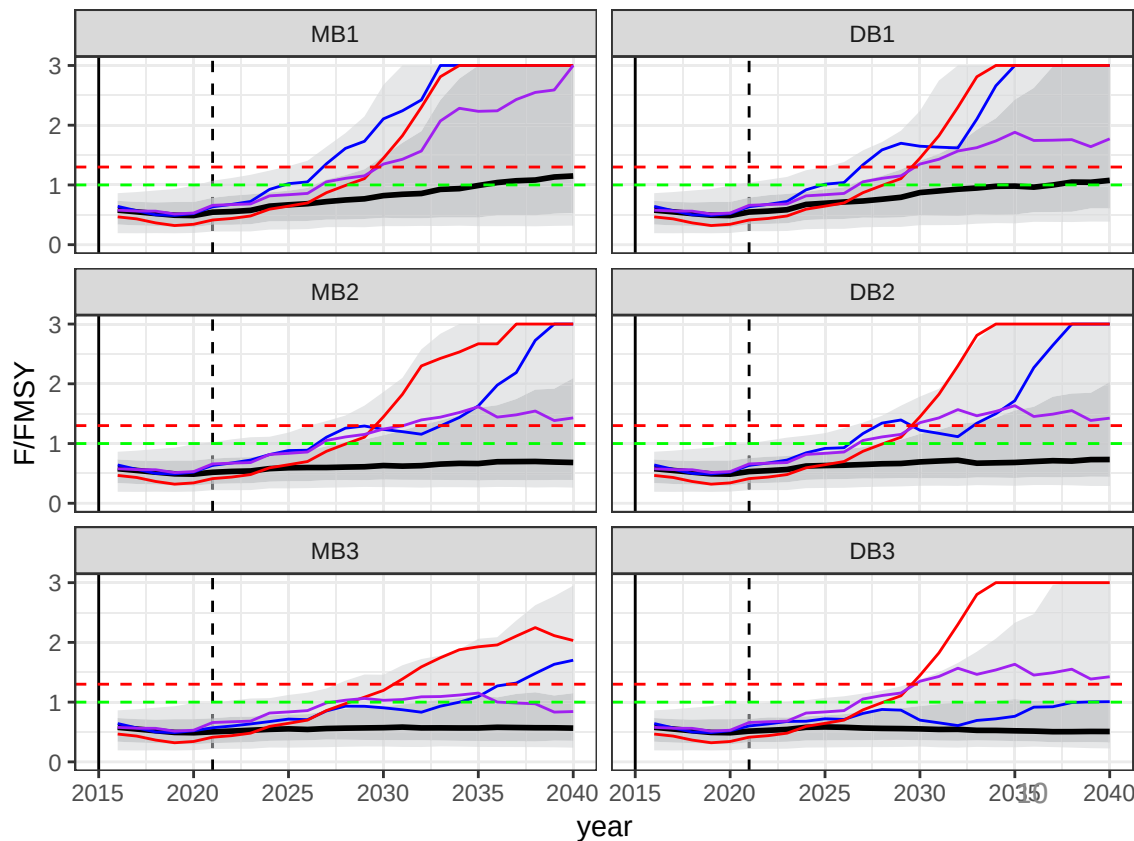
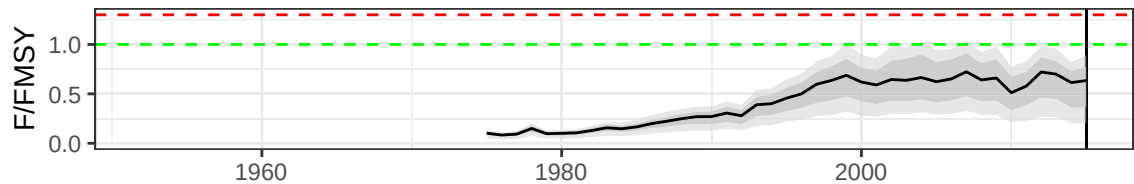


Key Results of Candidate MP Evaluations

Fig. 8

- F often very high post 2030

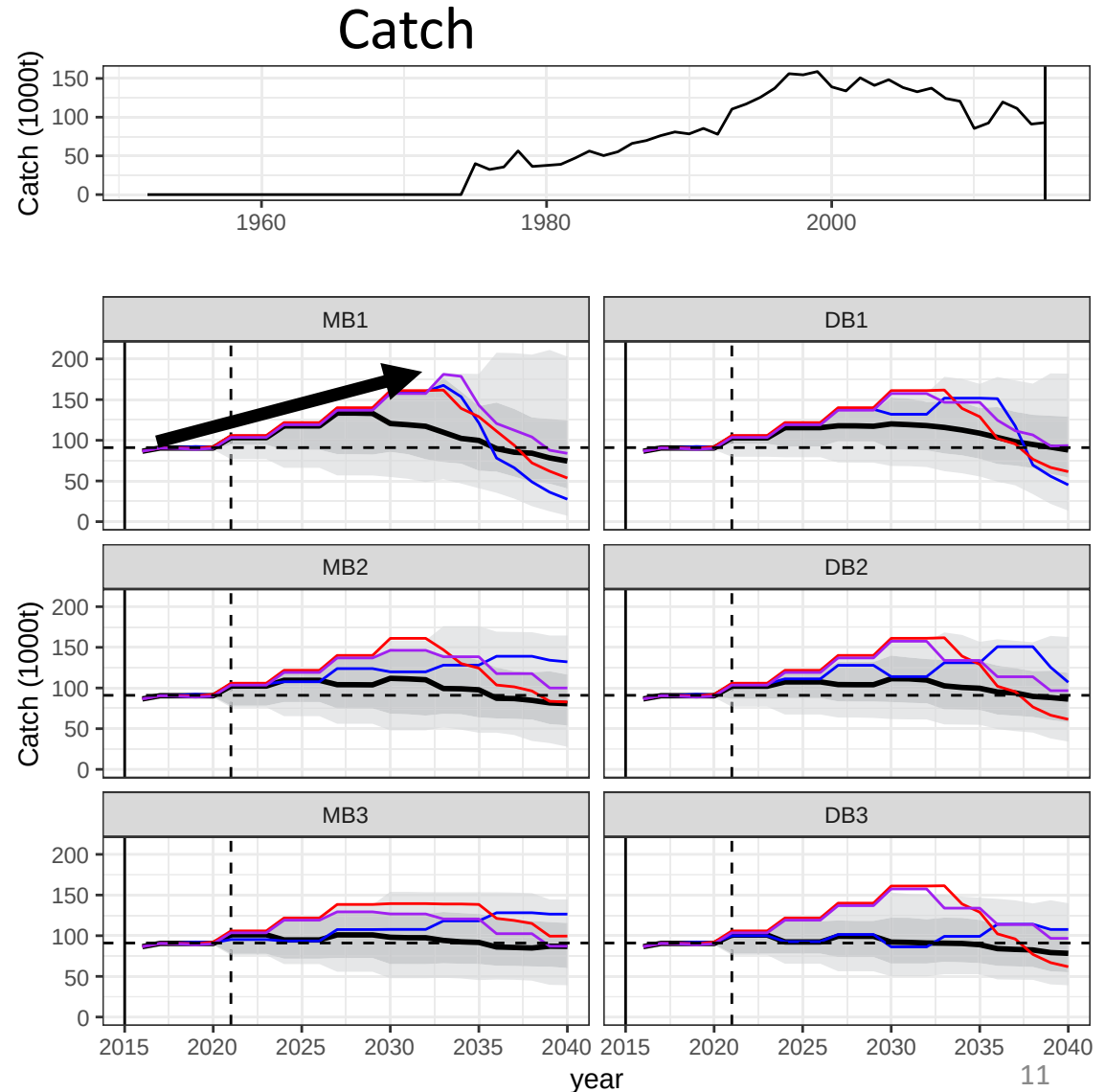
Fishing Intensity



Key Results of Candidate MP Evaluations

Fig. 9

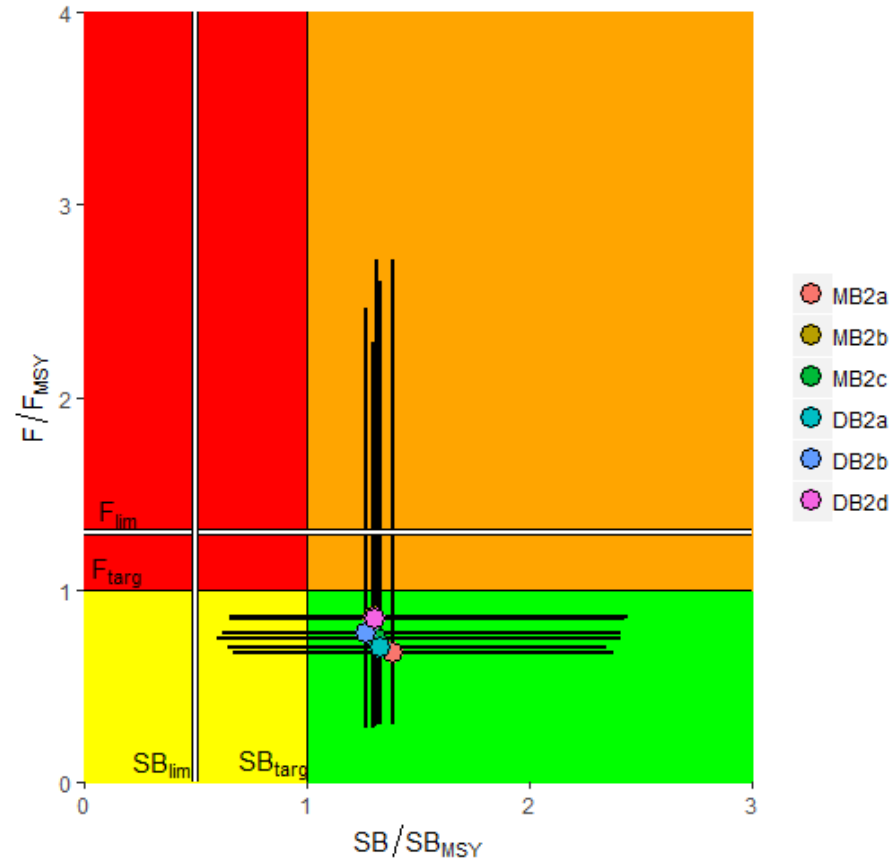
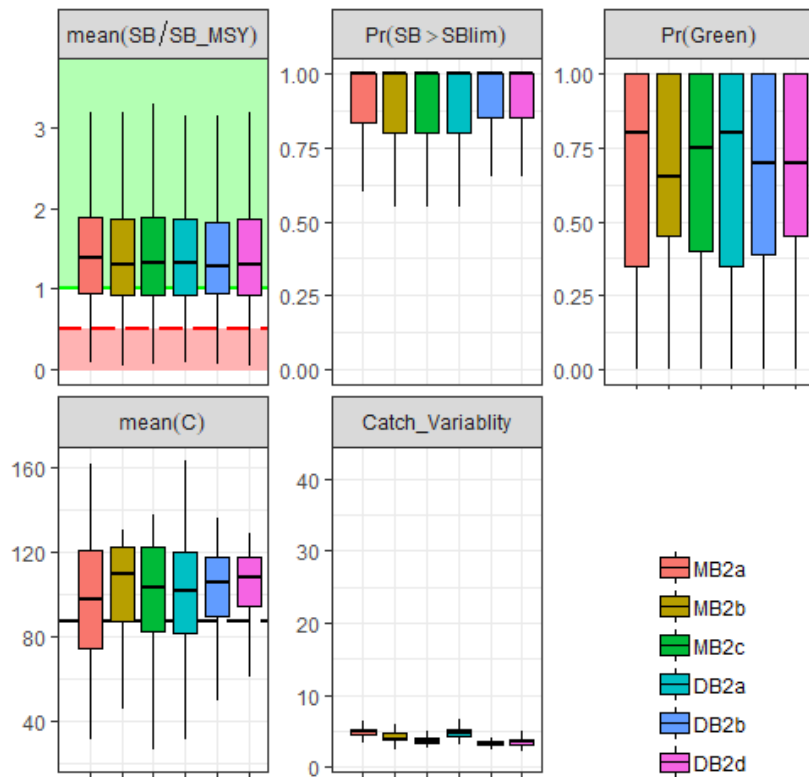
- Biomass decline achieved by increasing catch, mostly for B1
- B2, B3 fairly stable



Considerations for next iteration

- 1) Current stock status is seemingly not over-exploited.
- 2) Catches have been declining in recent years.
- 3) Tuning objective B1 tends to require substantial catch increases.
- 4) There appears to be no incentive for industry to increase catches at this time.

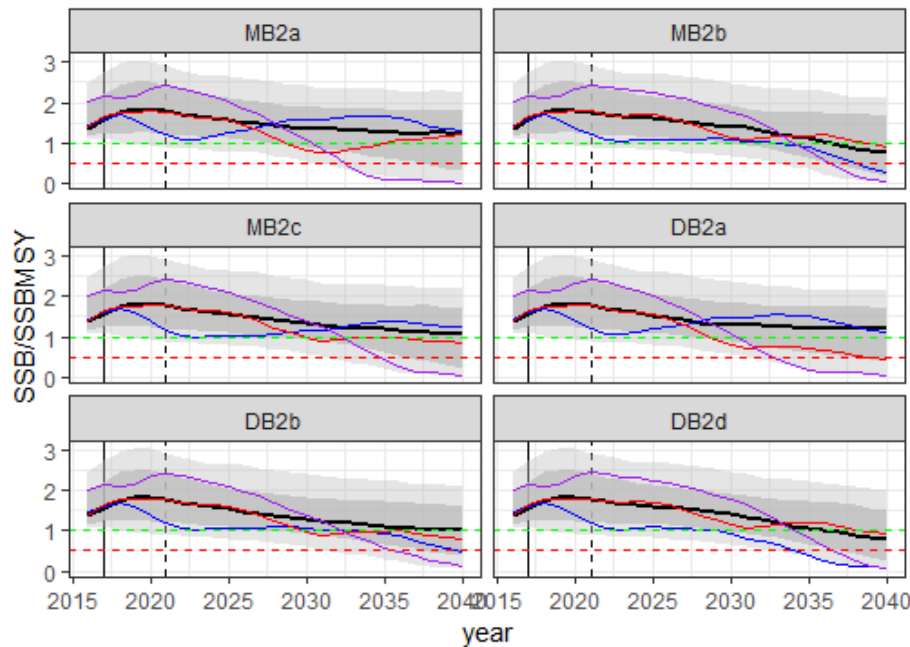
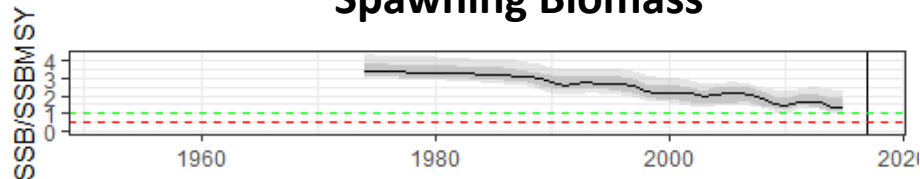
Given a single tuning objective(B2), how do 6 different MPs perform?



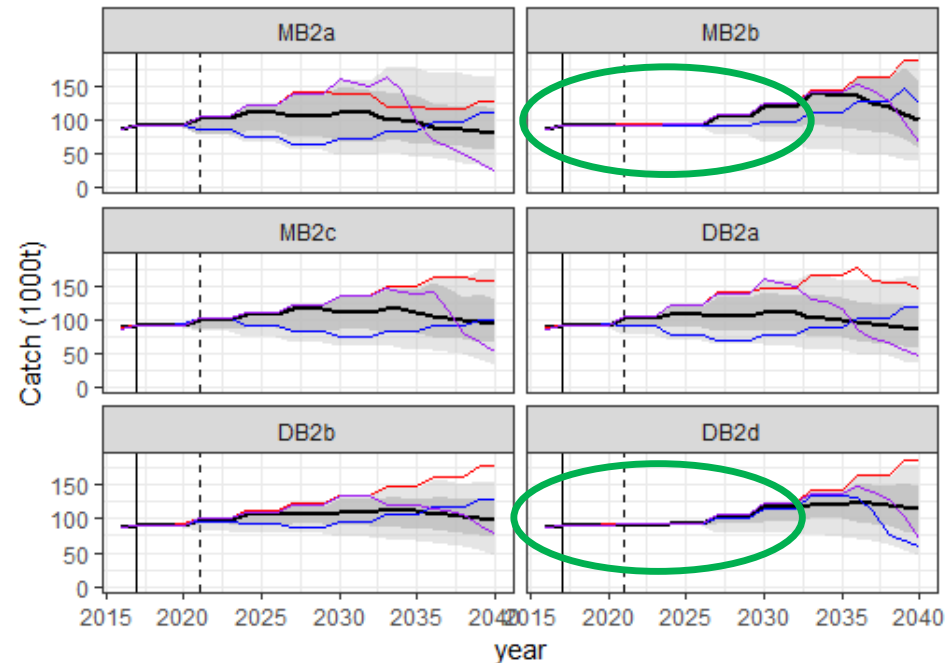
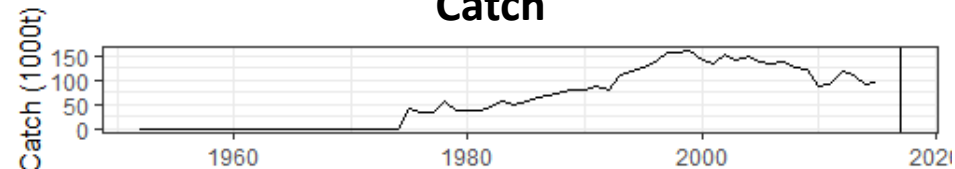
For the bigeye MPs tested, tuning objectives largely determine MP performance.

Given a single tuning objective(B2), how do 6 different MPs perform?

Spawning Biomass



Catch



More time can be spent developing “smarter” MPs if managers can clearly describe what is desirable.

e.g. greater initial TAC stability

1) Reduced set of tuning objectives for phase 2?

- E.g. Is it worth retaining B1?

2) Frequency of quota setting?

- First MP setting: 2021
- Then every 3 years

3) TAC change constraints?

- May be possible to increase initial stability

4) Implementation lag?

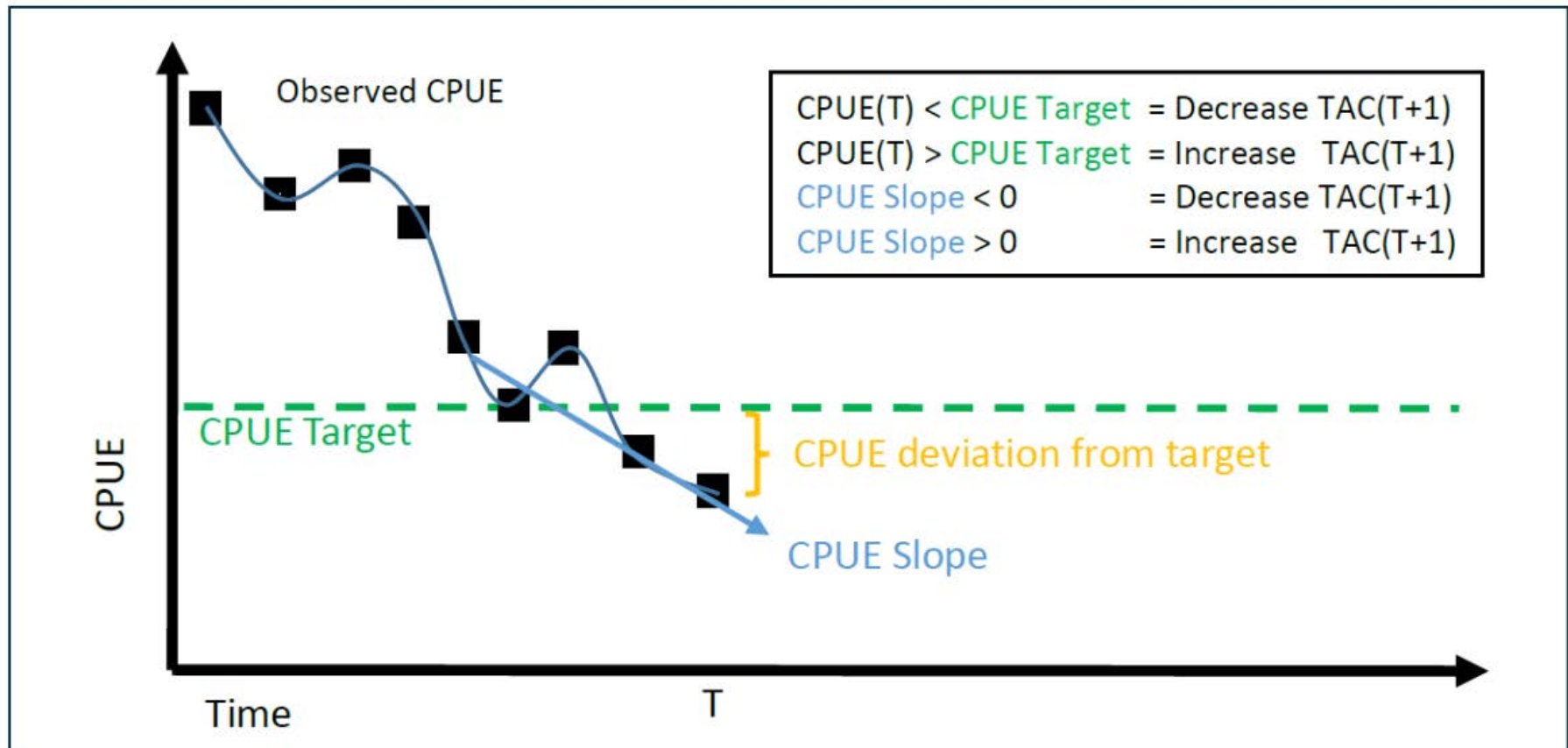
- MP data (CPUE) available to 2019 for 2021 TAC

धन्यवाद
Merci
Thanks!



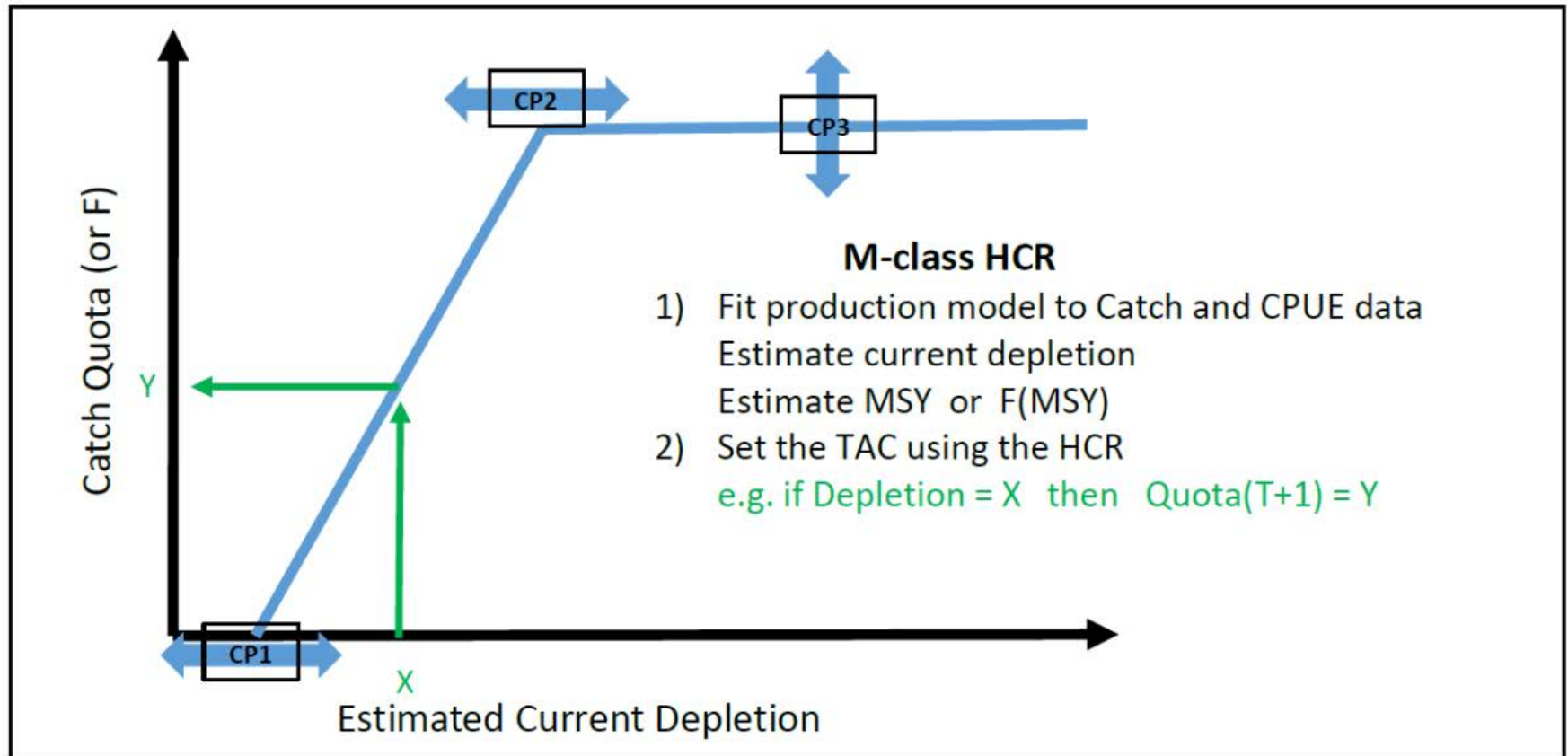
Empirical CPUE-based MP

"D" class (data-based) MPs



Model-based MP

"M" class (model-based) MPs





Korean Roundtable for Sustainable Tuna

Accelerating Tuna Sustainability via FIPs and MSC

Doohyun Park

Ocean Programme Officer, WWF-Korea

NIFS

Sea, the Future
Sea, the Hope

ISSF

INTERNATIONAL
SEAFOOD
SUSTAINABILITY
FOUNDATION

Areas Beyond National Jurisdiction (ABNJ) Tuna Management Workshop
19-20 February 2020

National Institute of Fisheries Sciences
Busan, Republic of Korea



© WWF



Outline

- **WWF – How we work**
- **Market Incentives – FIPs, MSC**
- **Korean Roundtable for Sustainable Tunas**
- **KORST – ISSUES**
- **Global FIP Alliance for Sustainable Tunas (G-FAST)**



WWF in numbers

1961/2014

WWF was founded in 1961 and WWF-Korea was founded in 2014

+100

WWF is in over 100 countries, on 6 continents

+5M

WWF has over 5 million supporters

+5000

WWF has over 5,000 staff worldwide

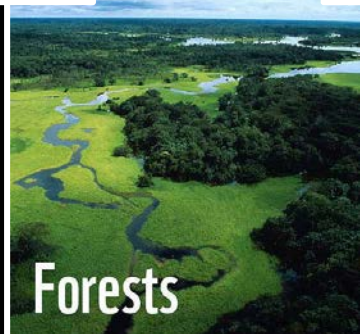
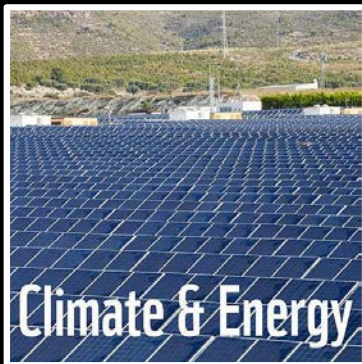




Our Mission

To stop the degradation of the planet's natural environment and to build a future in which people live in harmony with nature, by:

- Conserving the world's biological diversity
- Ensuring that the use of renewable natural resources is sustainable
- Promoting the reduction of pollution and wasteful consumption.





Tackling the Causes: Cross-cutting Drivers

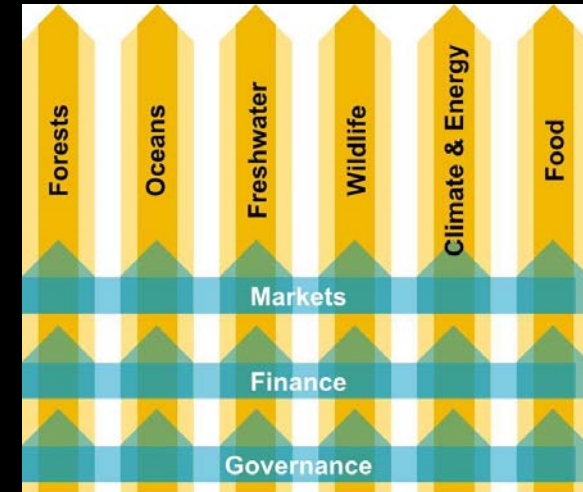


Transforming international markets so goods and services are produced and consumed more sustainably.

Moving away from financial systems that favour short-term returns over long-term wealth creation that supports inclusive development and protection of natural assets.

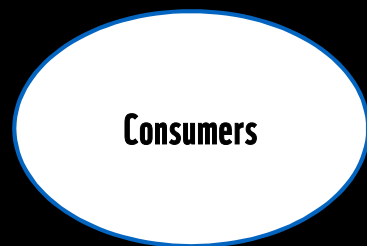


Tackling the inequitable global governance system where the vast majority of people affected by environmental change remain voiceless and unable to influence change.





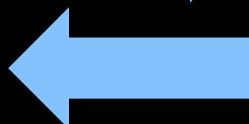
Markets want Sustainable Tunas!



Demands for sustainable tuna



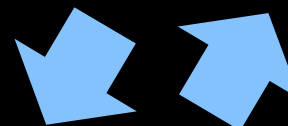
Communication/Awareness



Partnership w NGOs



- ✓ Financial support, if needed
- ✓ Procurement Preference/Agreement
- ✓ Other business deals that help FIPs



Supply Certified or from FIP fisheries

Fishery
Improvement
Project



Tuna Vessel
Owners





WWF Global Seafood Charter

WHO?

Consumer-facing retailers, brand owners, buyers, traders, processors, & vessel owners

HOW?

- ✓ Publicly announced “Sustainability Commitments”
“By 20XX, XX% of all seafood... MSC/ASC-certified or from FIP fisheries”
- ✓ Invest in FIP & AIP
- ✓ Invest in Fishery Conservation Projects (FCP)
- ✓ Raise awareness
educating their employees/consumers/partners about the benefits of the MSC & ASC





WWF Tuna Procurement Guidelines



Canned: SKJ, YFT, ALBC, BET
Fresh & Frozen: YFT, BET

1. MSC-certified tuna products – Chain of Custody, MSC Logo
2. Fishery Improvement Project
3. ISSF Participation
4. ISSF's Conservation and Management Measure, esp Proactive Vessel Register(PVR) Commitments
5. Other sustainability improvement measures





MSC Fisheries Standard



PRINCIPLE 1: Sustainable fish stocks

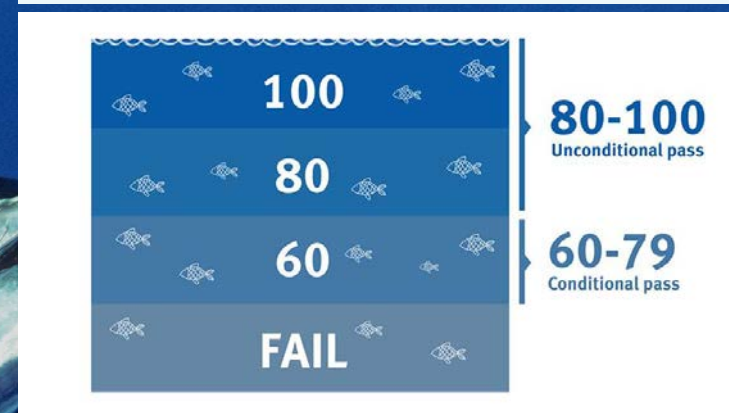
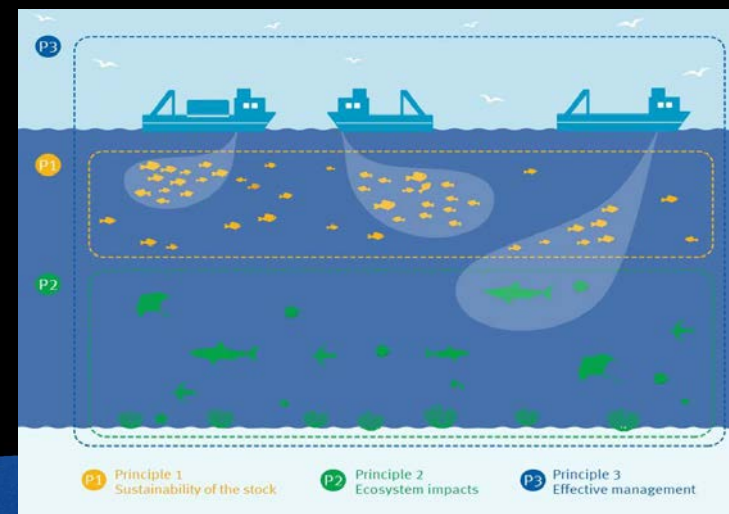
The fishery must operate so that fishing can continue indefinitely and is not overexploiting the resource.

PRINCIPLE 2: Minimal environmental impact

Fishing operations should be managed to maintain the structure, productivity, function, and diversity of the ecosystem on which the fishery depends.

PRINCIPLE 3: Effective management

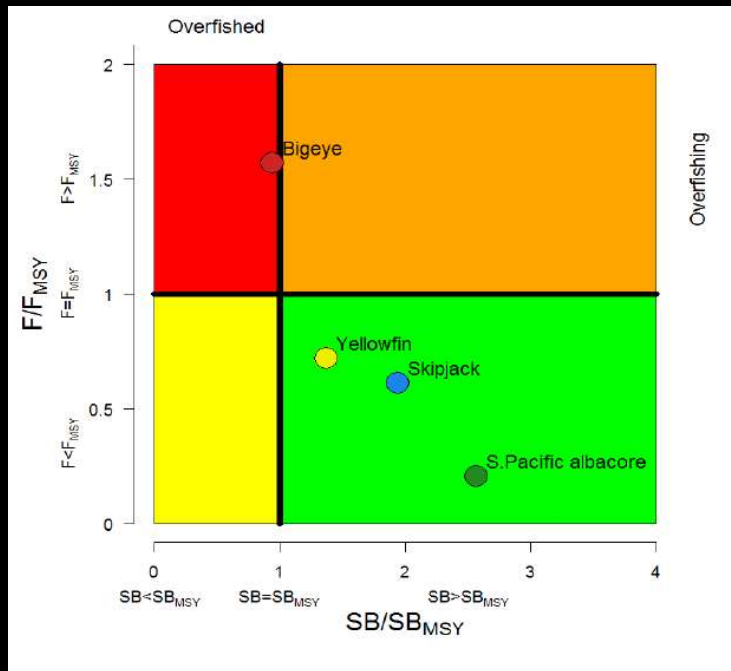
The fishery must meet all local, national, and international laws and must have a management system in place to respond to changing circumstances and maintain sustainability.



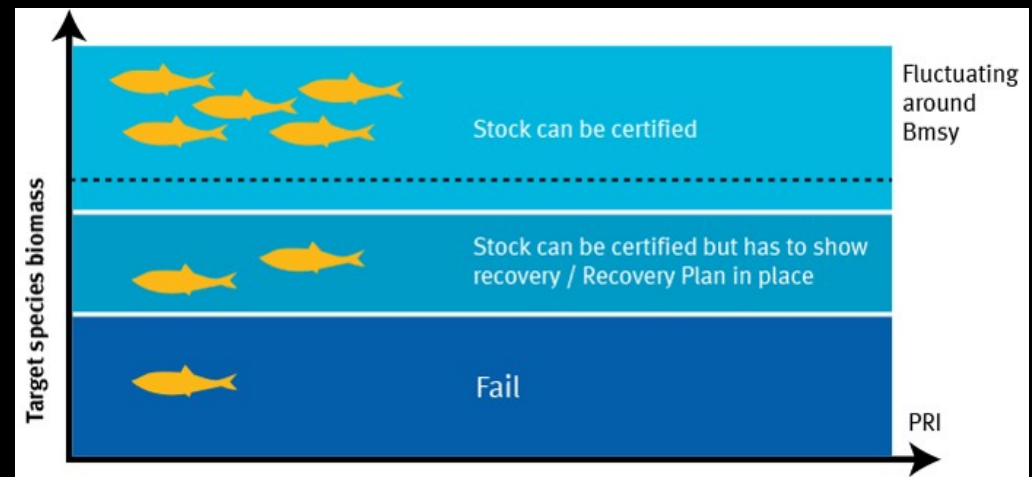
Source: MSC



P 1 Sustainable Fish Stocks – t-RFMOs



RFMO Stock Status
Stock Assessment Outcome
MSY(B_{msy} , F_{msy}), Reference Points, TAC,
Rebuilding Modelling



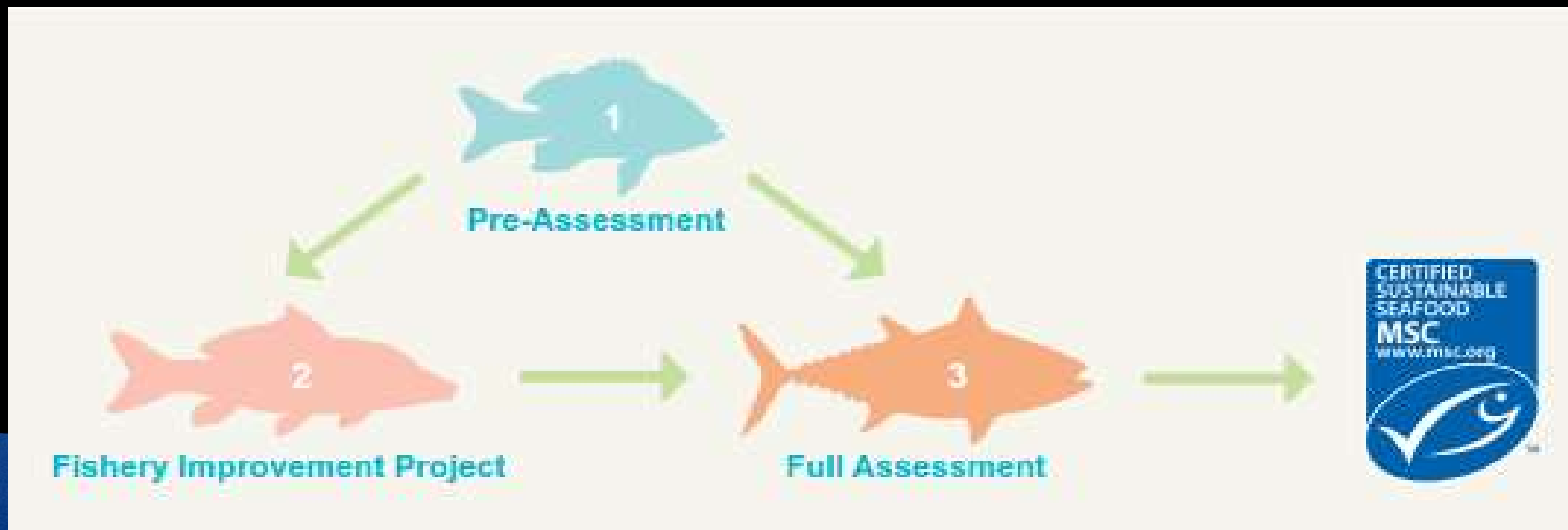
Harvest Strategy, Harvest Control Rule,
Information/Assessment
(WCPFC CMM 2014-06)

Source: flatfish





Fishery Improvement Projects



WWF uses a three-step process to help a fishery identify its sustainability issues, implement improvements (if needed), and achieve certification

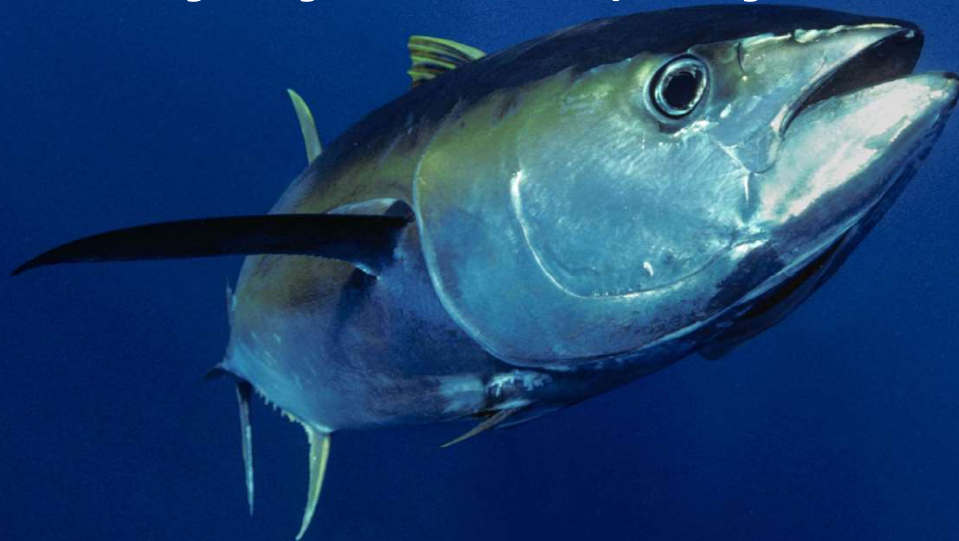




FIPs Help Accelerate Tuna Sustainability



- Providing a smart and strong voice in the supply chain
- (Bottom-up joining in the top-down supply chain efforts)
- Being consistent in advocacy to governments and RFMOs
- Developing/implementing best practices before RFMOs
- Gaining recognition, ultimately through MSC certification





Tuna FIPs – More than just MSC-certified

Tuna FIPs



Market states

Retailers/buyers

Sustainable procurement

Risk management

Key Issues in the MSC Standards

- MSC can assess all impacts of purse sein FAD – bycatch, ghost fishing, marine debris (plastics), FAD beaching?
- Management Strategy in place at RFMOs?

What retailers/buyers want to see - beyond MSC

- Longline fisheries – RFMO's minimum observer requirements
- Traceability – REM, Blockchain, etc





WWF-Korea Maritime Institute Joint Symposium

- 18th July 2018, Seoul
- Gov't, DWF Industry and NGOs
- 1st Multi-stakeholder dialogue seeking collaboration to support the shift of Korean DWF industry towards sustainability, after IUU Yellowcard 2013-2015
- Import control measures of market states (EU, USA)
- Stock status of major t-RFMOs
- Market incentives - MSC/FIPs, ISSF's Conservation and Management Measures and Tools
- Sustainable seafood consumption movements
- Innovations - Blockchain in seafood traceability, "Bait to Plate"
- Japanese tuna round-table

Commitments - Continue regular multistakeholder dialogues





Korean Roundtable for Sustainable Tuna (KORST)

Key Features

- A pre-competitive business partnership supported by NGOs
- Jun, Nov 2019, Seoul
- Corporate owners of tuna purse seiners and longliners
- Gov't, NGOs, CABs
- WCPO (WCPFC) and more
- SKJ, YFT
- FAD-related measures
- Market Incentives: MSC, FIPs, Traceability/Transparency
- Policy advocacy at t-RFMOs (16th WCPFC, Dec 2019, PNG)
- Market Engagement: TESCO, New England Seafood International
- Jun, Nov 2020 (Skipper workshop, WCPFC MSE workshop, etc)

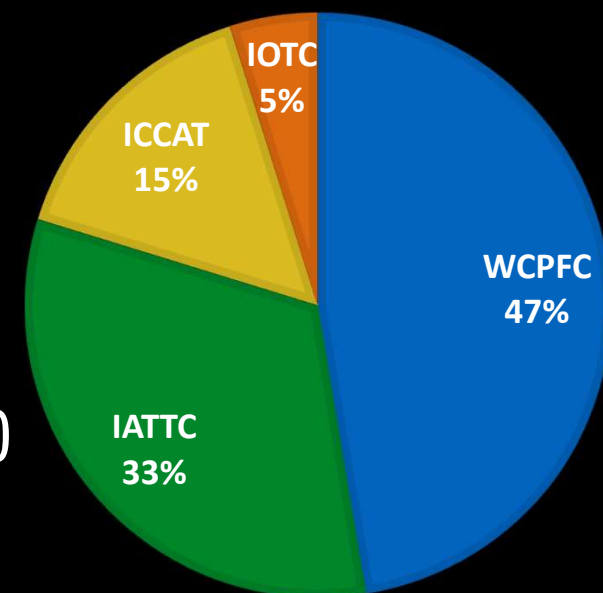




Korean Roundtable for Sustainable Tuna (KORST)

Key Features

- 4 corporate vessel owners
 - 169 tuna vessels flagged KR (146) and coastal states under J/V arrangements (23)
 - 50 PSs and 119 LLs in key t-RFMOs
 - 1st MSC Certified tuna fisheries in Korea
- ✓ *Tropical Pacific yellowfin and skipjack free-school purse seine fishery* (18th Oct 2019 - 17th Oct 2024)
 - ✓ 11 KR-flagged purse seiners / 161,747.16 metric tonnes
 - ✓ SKJ: 108,598.7 mt / 53.20% of all SKJ in Korea
 - ✓ YFT: 53,148.46 mt / 80.3% of all YFT in Korea



3331.13 MT of YFT, BET, ALBC will be added in April 2020
Pan Pacific yellowfin, bigeye and albacore longline fishery, MSC Full Assessment





Some Key Sustainability Issues

1. Precautionary Harvest Strategies (Advocacy)

- Target & Limit Reference Points
- Harvest Control Rules

2. Bycatch mitigation (Action by Vessel Owners)

- FAD management (purse seine)
- Observer coverage (longline)
- Sharks, rays, sea turtles (purse seine & longline)

3. Effective & Fair Enforcement (Advocacy)

- Transparency
- Observer Security & Safety





WCPFC HCRs – Urgent action needed



*“... **MSC** noting the **MCS** decision **to align the Harvest Control Rules ... across all MSC certified tuna fisheries in the WCPFC...** an urgent need to ensure that the WCPFC stayed **on track with the time lines in place of Harvest Control Rules** under WCPFC CMM 2014 – 06 ... **a firm deadline for the adoption of Harvest Control Rules for the four key tuna species at the WCPFC by end of 2021...** if this condition was not met, **it will result in the suspension on of the regions MSC certified fisheries in 2022.**”*

Source: Pacific Islands Tuna Industry Association





Urgent, but not impossible

	South Pacific Albacore	Skipjack	Bigeye	Yellowfin
2021	Develop harvest control rules (e) and Management strategy evaluation (f) - SC provide advice on performance of candidate harvest control rules. - TCC consider the implications of candidate harvest control rules. - Commission consider advice on progress towards harvest control rules. <u>Adopt a Harvest Control Rule.</u>	Harvest Strategy for Skipjack in place	Develop harvest control rules (e) and Management strategy evaluation (f) - SC provide advice on performance of candidate harvest control rules. - TCC consider the implications of candidate harvest control rules. - Commission consider advice on progress towards harvest control rules. Adopt a Harvest Control Rule	Develop harvest control rules (e) and Management strategy evaluation (f) - SC provide advice on performance of candidate harvest control rules. - TCC consider the implications of candidate harvest control rules. - Commission consider advice on progress towards harvest control rules. Adopt a Harvest Control Rule



Directed meetings



Forum participation &
Capacity building



Position papers



Scientific output





WWF Global FIP Alliance for Sustainable Tuna (G-FAST)

G-FAST

- Focus on vessel owners & comprehensive FIPs only
- Make rapid progress towards MSC standard
- Participate with WWF in consistent gov't. & RFMO advocacy
- Priority in WWF Tuna Procurement Guidelines

8 large purse seine comprehensive FIPs

- 180 major purse seiners, 20% of global tuna catch
- Span all 4 tropical tuna RFMOs
- 850,000 metric tons annually / 17% of all global catch

WWF is actively recruiting more FIPs for G-FAST in NE Asia





G-FAST: Participating FIPs



	Oceans	Fleets	Species	Mgmt	Landings (MT)
TUNA CONS	EPO	45 PSs	YFT, ALBC, SKJ	IATTC	113, 568
OPAGAC	All	47 PSs	YFT, BET, SKJ	IATTC, ICCAT, IOTC, WCPFC	385, 000
Indian Ocean Tuna (SIOTI)	IO	40 PSs	YFT, BET, SKJ	IOTC	243,000
Eastern Atlantic Tuna (EASTI)	AO	40 PSs	YFT, BET, SKJ	ICCAT	160,000
Pacific Ocean Tropical Tuna (US Pacific Ocean Group)	WCPO, EPO	11 PSs	YFT, BET, SKJ	WCPFC, IATTC	80,000

A large bluefin tuna is the central focus, its head replaced by a realistic-looking panda head. The panda has its characteristic black and white fur, large black eye patches, and a gentle smile. It is surrounded by several other bluefin tunas swimming in the same direction. The background is a deep blue-green underwater scene with light rays filtering down from above.

Thank you!

**“ WOULD YOU CARE MORE
IF I WAS A PANDA? ”**

The Bluefin Tuna is being fished to extinction
So like a few other species, it would appreciate your help



www.wwf.com