Kobe Plots and using Uncertainty

IOTC Capacity building Workshop

Overview

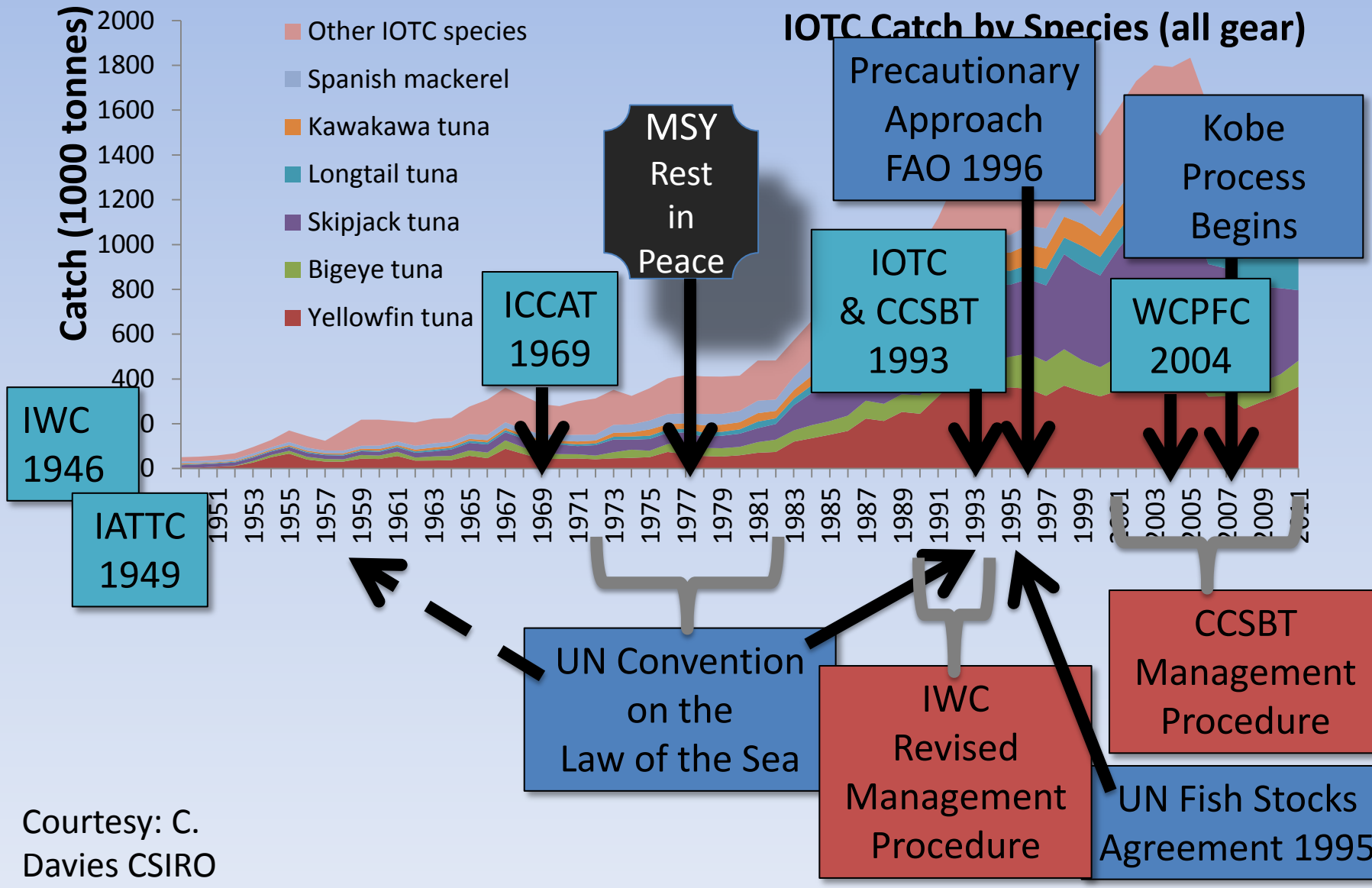
- Context and why this is important
- Defining Overfishing vs Overfished
- Understanding Risk and Putting Res 13/10 in context.

Why we are here?

Management Procedures are:

- mechanisms, including data collection
- evaluation of trends and status and a decision rule, that aim to apply the precautionary approach to the management of fish stocks.

Context – historical development

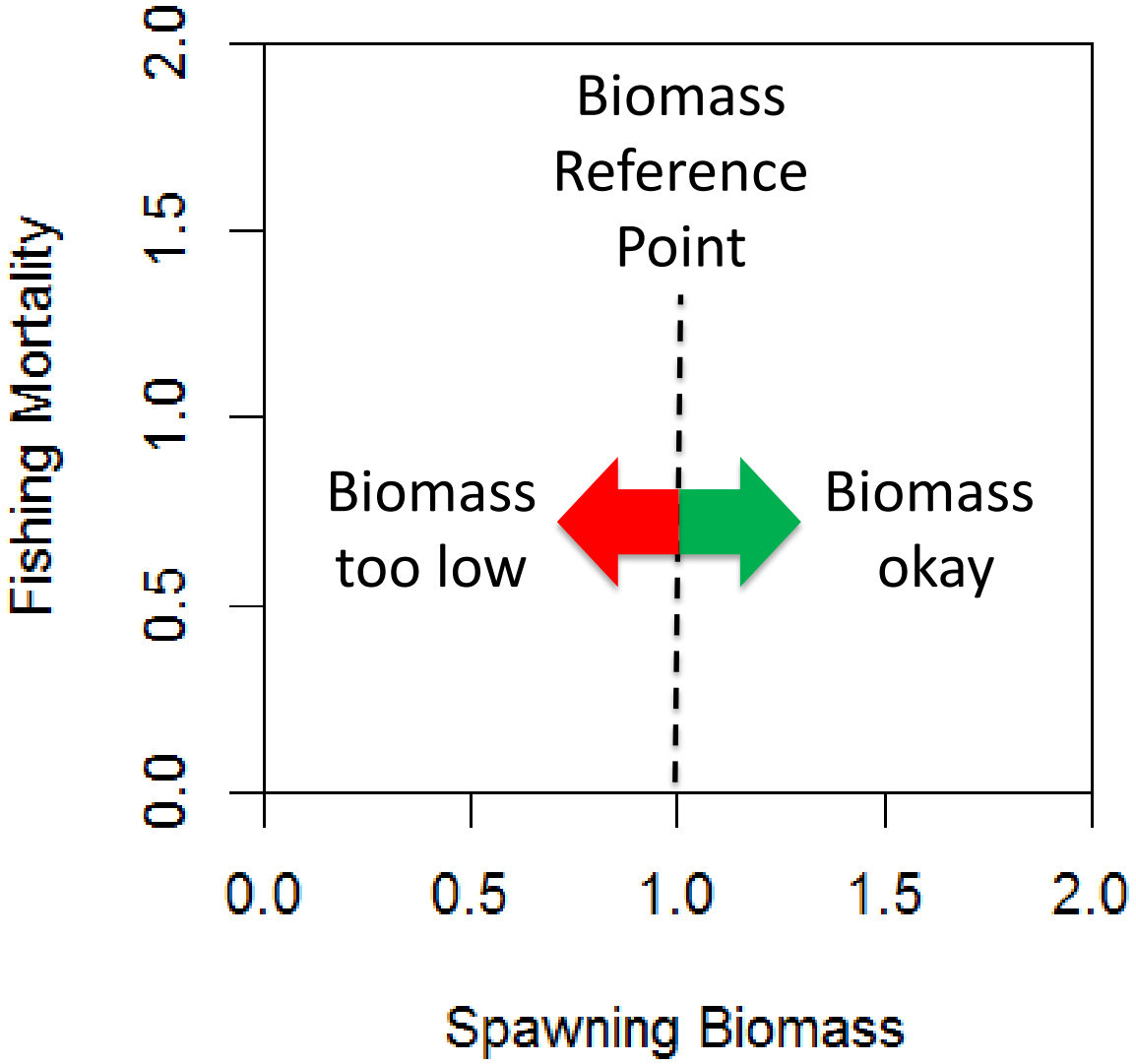


Courtesy: C. Davies CSIRO

The Kobe Process Introduces Phase Plots and Decision Matrices to Tuna RFMOs

The Kobe Plot

(a fishery summary)



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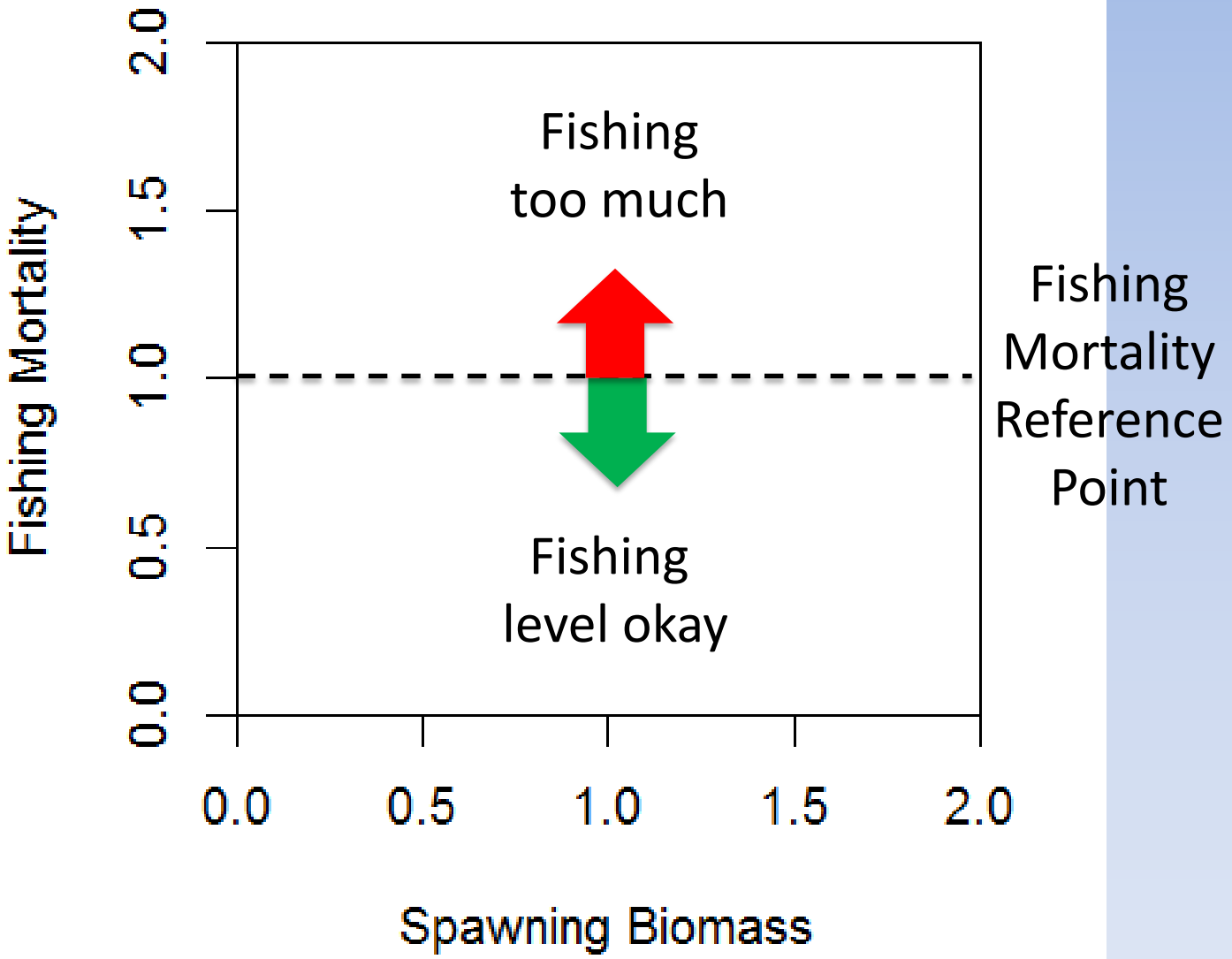
The Kobe Plot

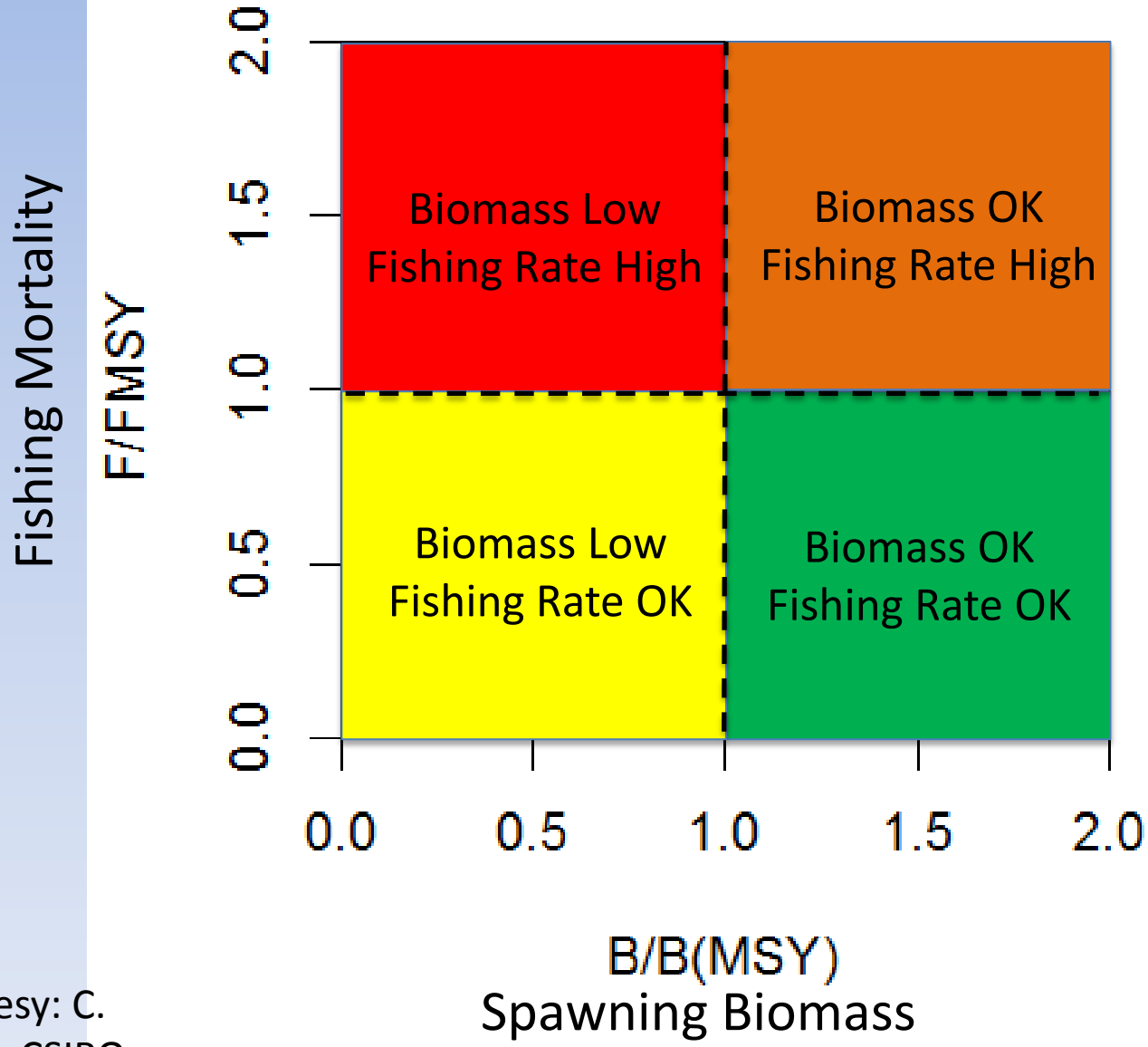
(a fishery summary)



Courtesy: C. Davies CSIRO

The Kobe Plot

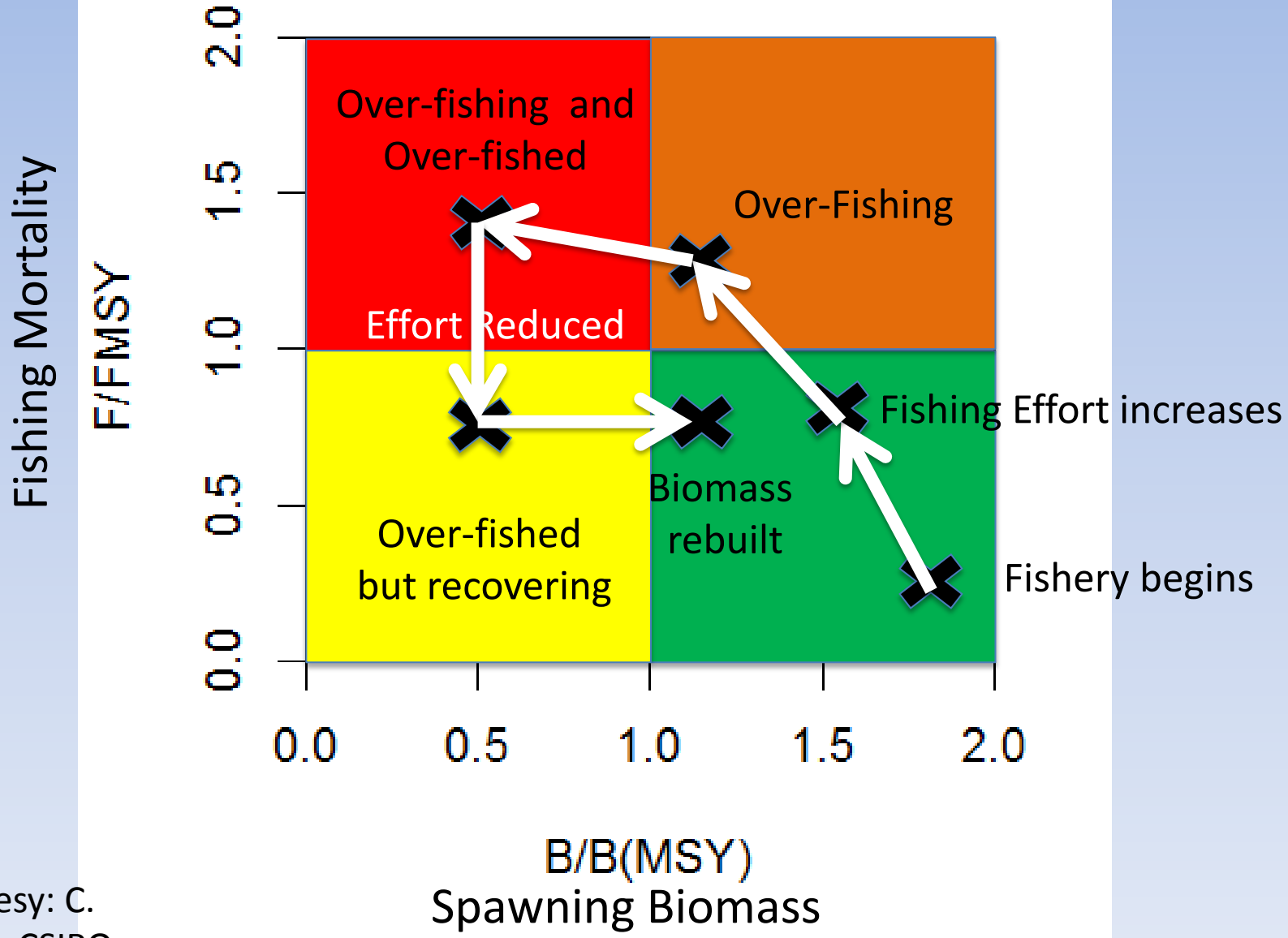
Where is your fishery now?



Courtesy: C. Davies CSIRO

The Kobe Plot

A common fishery story



Courtesy: C. Davies CSIRO

Exercise

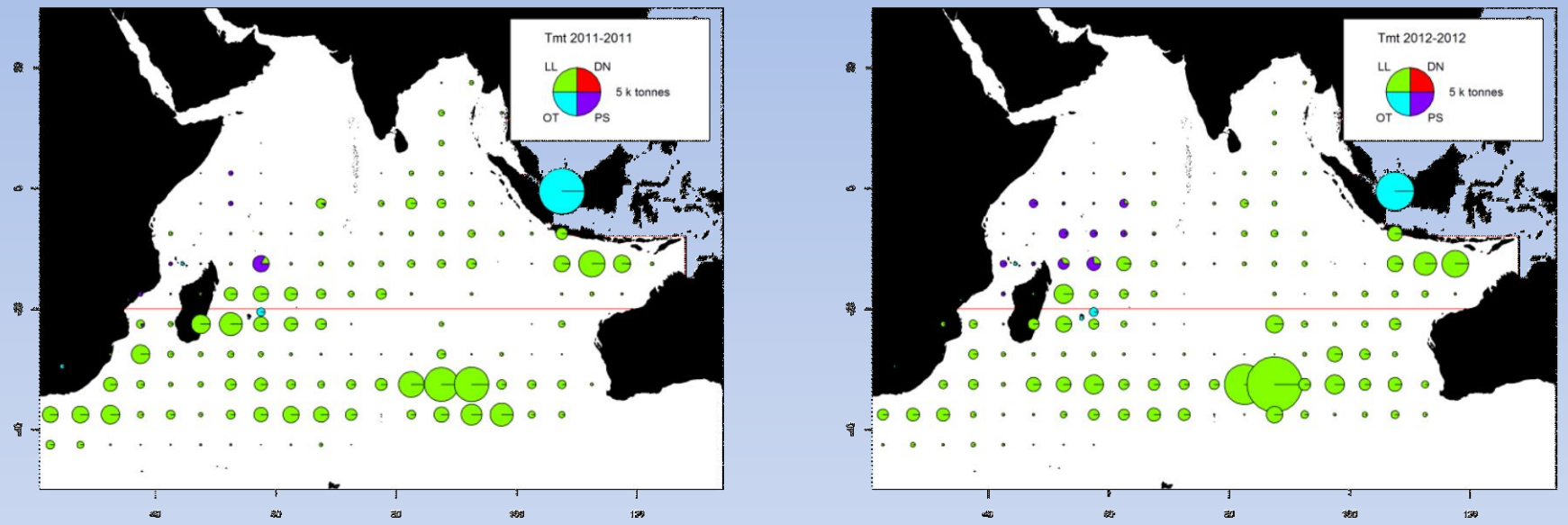


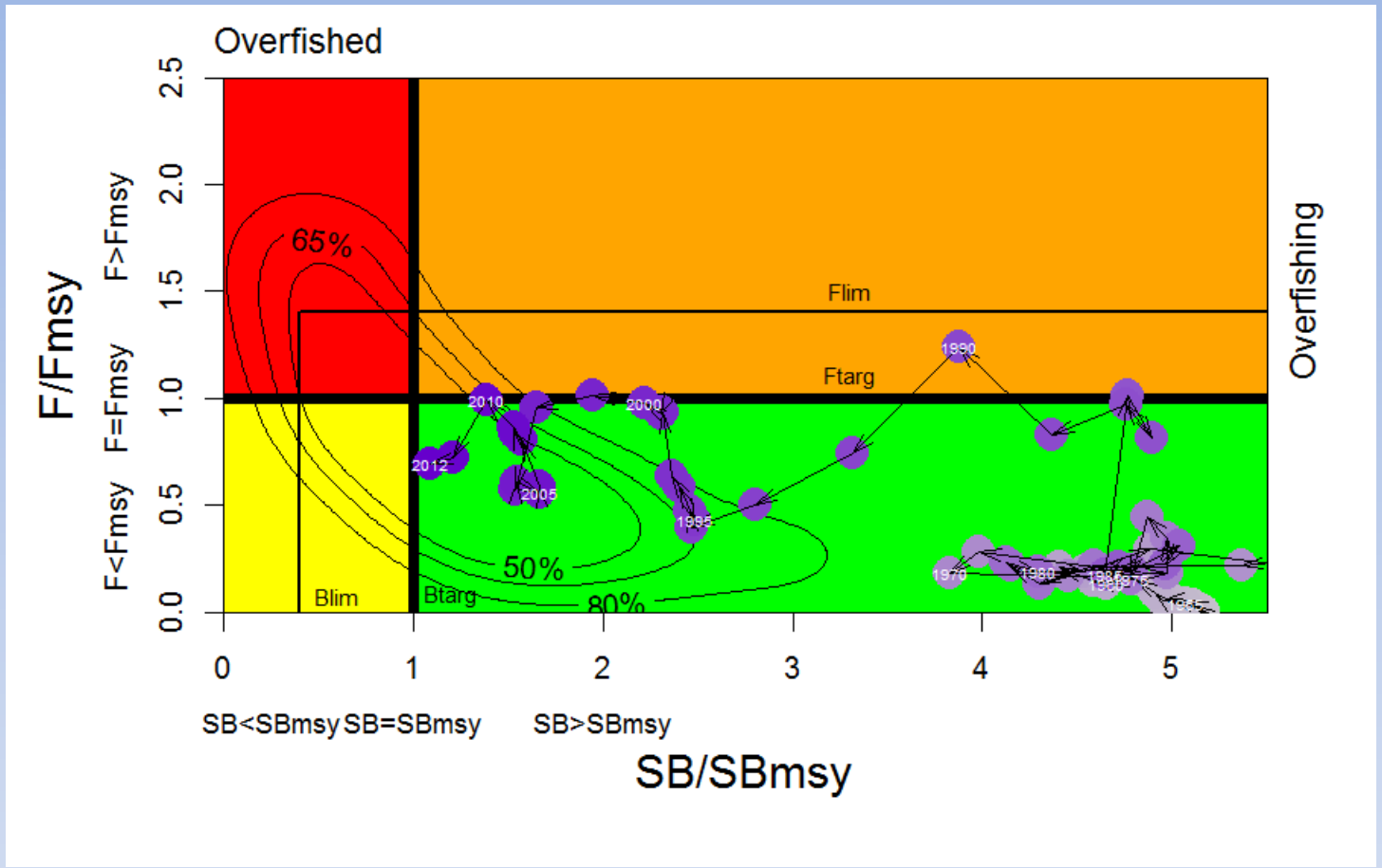
Fig. 3a–b. Albacore: Time-area catches (total combined in tonnes) of albacore estimated for 2011 (left) and 2012 (right) by year and type of gear. Longline (LL, green), Driftnet (DN, red), Purse seine (PS, purple), Other fleets (OT, blue). Time-area catches are not available for all fleets; catches for those were assigned by 5x5 square and month using information from other fleets. (Data as of May 2014)

Would you ?

a) Reduce catches
b) Fish at same level
c) Increase catches
d) NO Management Action

Why?

How comfortable are you with being in the red?


Overfished
Overfishing
F/Fmsy
F>Fmsy
F=Fmsy
F<Fmsy
SB/SBmsy
SB<SBmsy
SB=SBmsy
SB>SBmsy
Flim
Ftarg
Blim
Btarg
65%
50%
80%
2010
2000
2012
2005
1995
1990
1970
0.0
0.5
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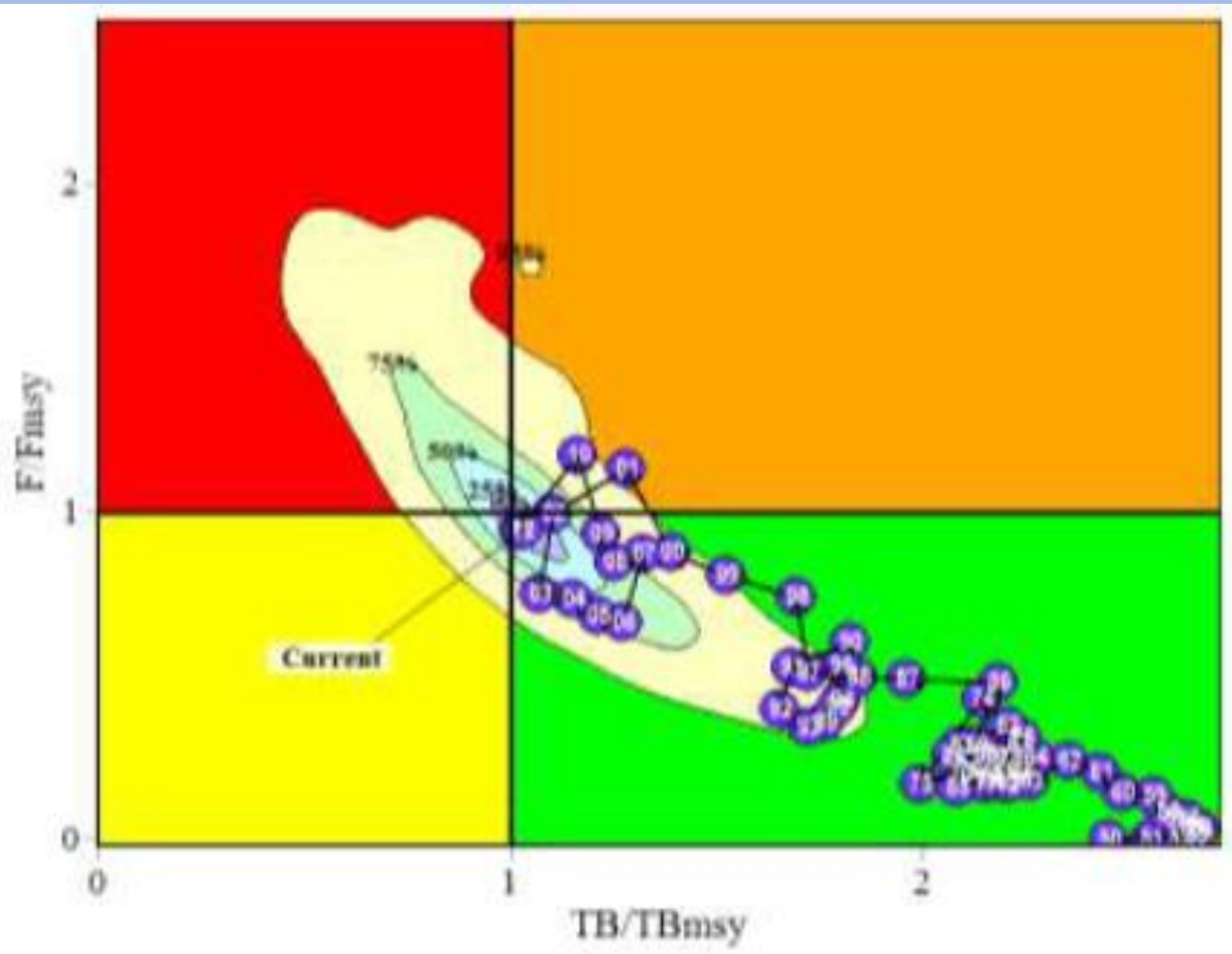
2.0
2.5
0
1
2
3
4
5

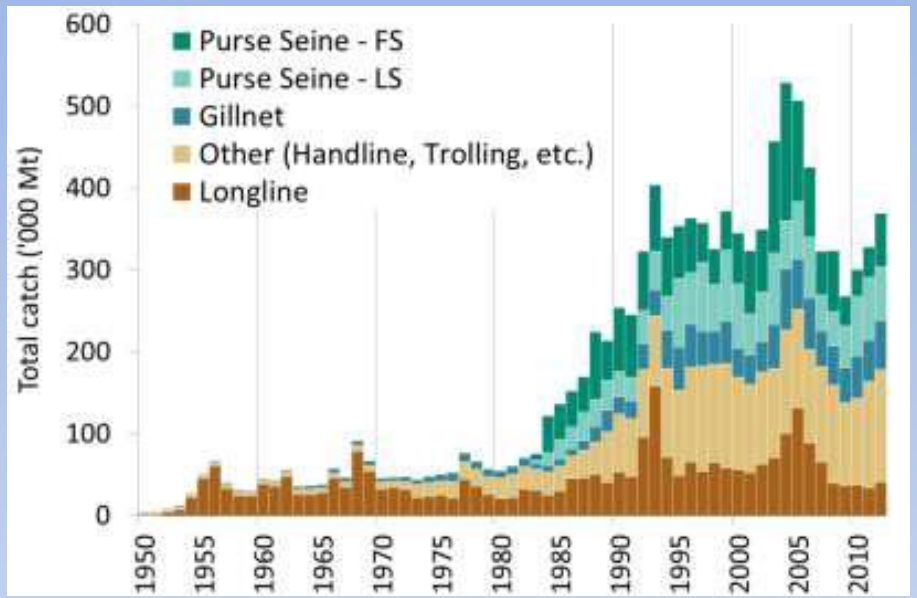

F/Fmsy
TB/TBmsy
0
1
2
Current

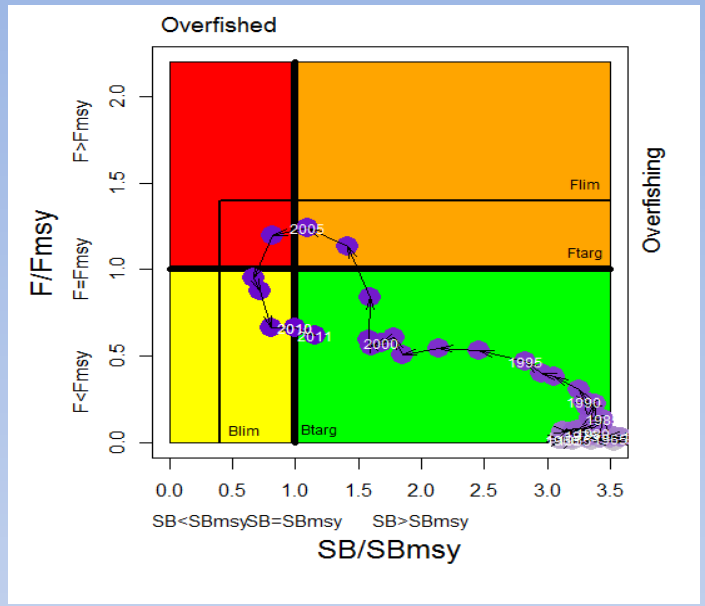
Discussion questions (Using stock summaries and Uncertainty)

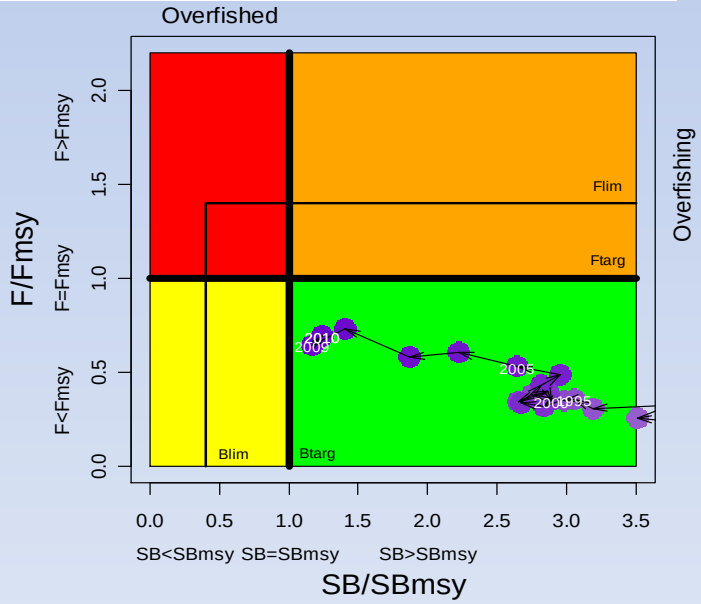
Yellowfin Summary

Catch 2012:	**368,663 t**
Average catch 2008–2012:	**317,505 t**
MSY (in thousands):	**344 t (290-453)**
F_{2010}/F_{MSY} (80% CI):	**0.69 (0.59–0.90)**
SB_{2010}/SB_{MSY} (80% CI):	**1.24 (0.91–1.40)**
SB_{2010}/SB_{1950} (80% CI):	**0.38 (0.28–0.38)**

The decrease in longline and purse seine effort in recent years has substantially lowered the pressure on the Indian Ocean stock as a whole, indicating that **current fishing mortality has not exceeded the MSY-related levels in recent years**. As the security situation in the western Indian Ocean has improved, a rapid reversal in fleet activity in this region may lead to an **increase in effort which the stock might not be able to sustain, as catches would then be likely to exceed MSY levels. Catches increased by 68 Kt in 2012 as compared to 2011, warranting a new assessment soon.**

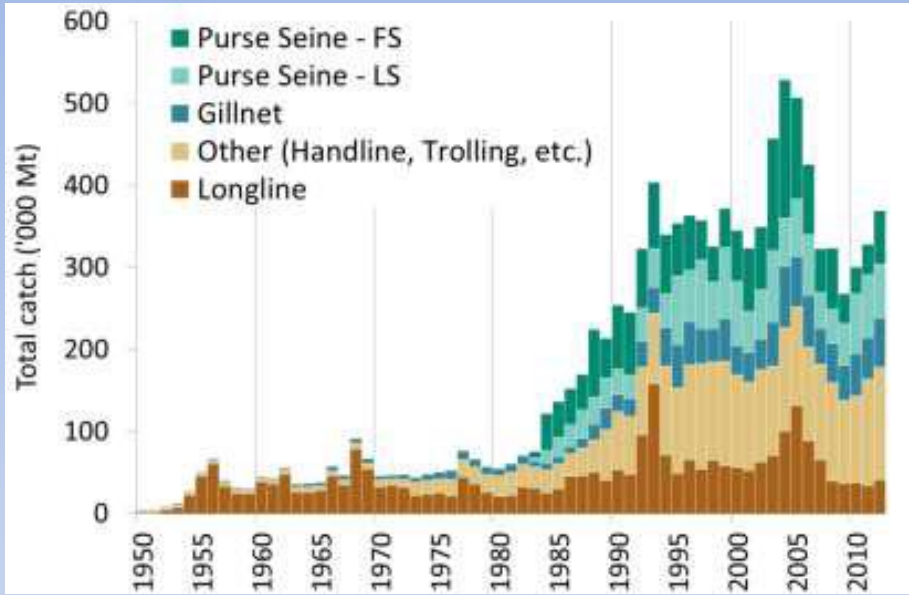


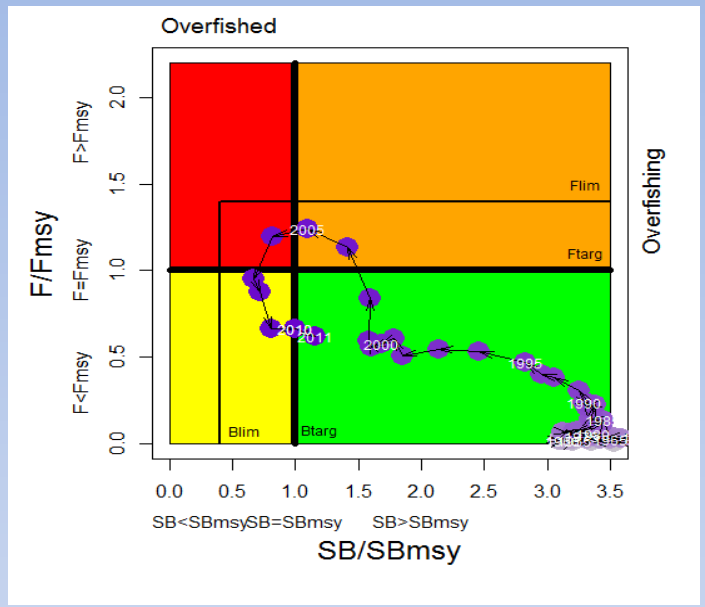




2011: 302K t; 2012: 368K t.:
What guidance to be given?

Kobe 2 Strategy Matrix





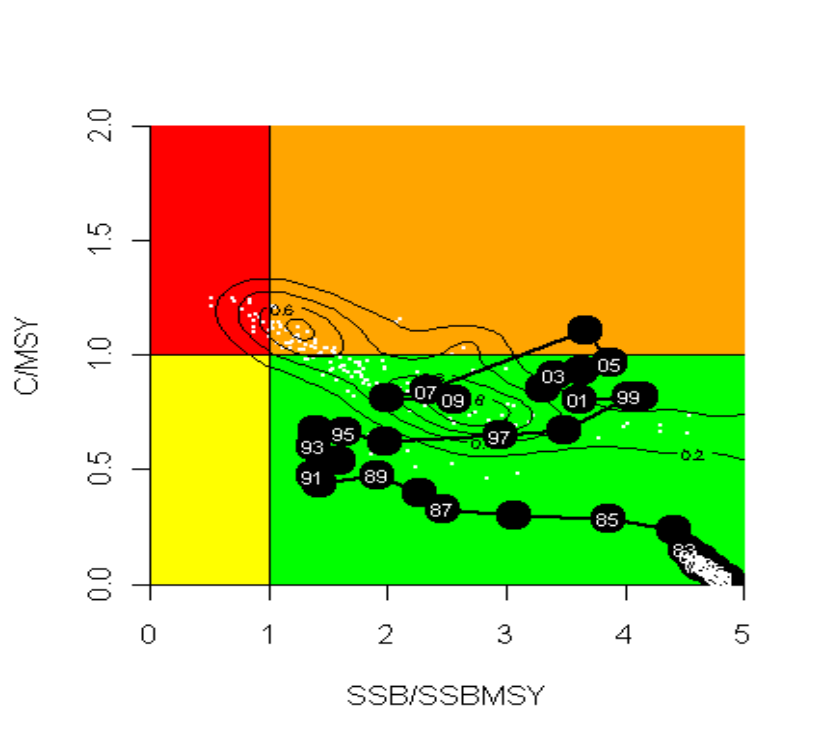
Reference point and projection timeframe	Alternative catch projections (relative to 2010) and probability (%) of violating reference point				
	60% (165,600 t)	80% (220,800 t)	100% (276,000 t)	120% (331,200 t)	140% (386,400 t)
$SB_{2013} < SB_{MSY}$	<1	<1	<1	<1	<1
$F_{2013} > F_{MSY}$	<1	<1	58.3	83.3	100
$SB_{2020} < SB_{MSY}$	<1	<1	8.3	41.7	91.7
$F_{2020} > F_{MSY}$	<1	41.7	83.3	100	100

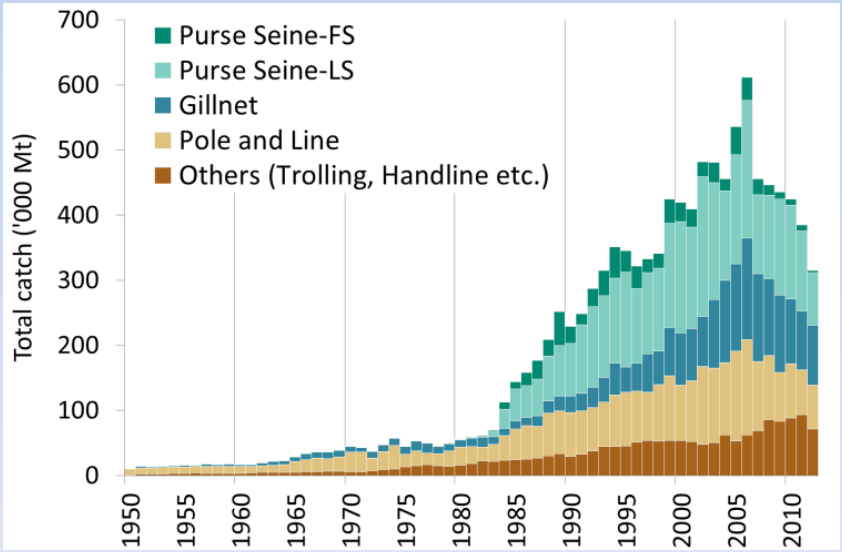
TABLE 1. Skipjack tuna: Status of skipjack tuna (*Katsuwonus pelamis*) in the Indian Ocean

Area[1]	Indicators		2013 stock status determination
Indian Ocean	Catch 2012: Average catch 2008–2012:	314,537 t 400,980 t	
	MSY (1000 t): F_{2011}/F_{MSY} : SB_{2011}/SB_{MSY} : SB_{2011}/SB_0:	478 t (359–598 t) 0.80 (0.68–0.92) 1.20 (1.01–1.40) 0.45 (0.25–0.65)	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.

Reference point and projection timeframe	**Alternative catch projections (relative to 2009) and weighted probability (%) scenarios that violate reference point**				
	60% (274,000 t)	**80%** (365,000 t)	**100%** (456,000 t)	**120%** (547,000 t)	**140%** (638,000 t)
$SB_{2013} < SB_{MSY}$	<1	5	5	10	18
$C_{2013} > MSY$ (proxy for F_{2009}/F_{MSY})	<1	<1	31	45	72
$SB_{2020} < SB_{MSY}$	<1	5	19	31	56
$C_{2020} > MSY$ (proxy for F_{2009}/F_{MSY})	<1	<1	31	45	72





Would you ?

a) Reduce catches
b) Fish at same level
c) Increase catches
d) NO Management Action

Why?

How comfortable are you with being in the red?

Background-Point 4 in Resolution 13/10

In addition the IOTC Scientific Committee shall develop and assess potential harvest control rules (HCRs) to be applied, considering the status of the stocks against the reference points assessed in paragraph 3 for albacore, bigeye tuna, skipjack tuna, yellowfin tuna and swordfish. Based on the results of the MSE and considering the guidelines set forth in the UNFSA and in Article V of the IOTC Agreement, the IOTC Scientific Committee will recommend to the Commission HCRs for these tuna and tuna-like species, which among other factors, taking account of the following objectives:

a) For stocks which assessed status will match with the lower right (green) quadrant of the Kobe Plot, aim at maintaining the stocks in a **high probability** within this quadrant;

b) For stocks which assessed status will match with the upper right (orange) quadrant of the Kobe Plot, aim at ending overfishing with a **high probability** in as **short a period as possible;**

c) For stocks which assessed status will match with the lower left (yellow) quadrant of the Kobe plot, **aim at rebuilding these stocks in as short a period as possible**;

d) For stocks which assessed status will match with the upper left quadrant (red), aim at ending overfishing with **a high probability and at rebuilding the biomass of these stocks in as short a period as possible**.

Precautionary Management/ THE MSE Process

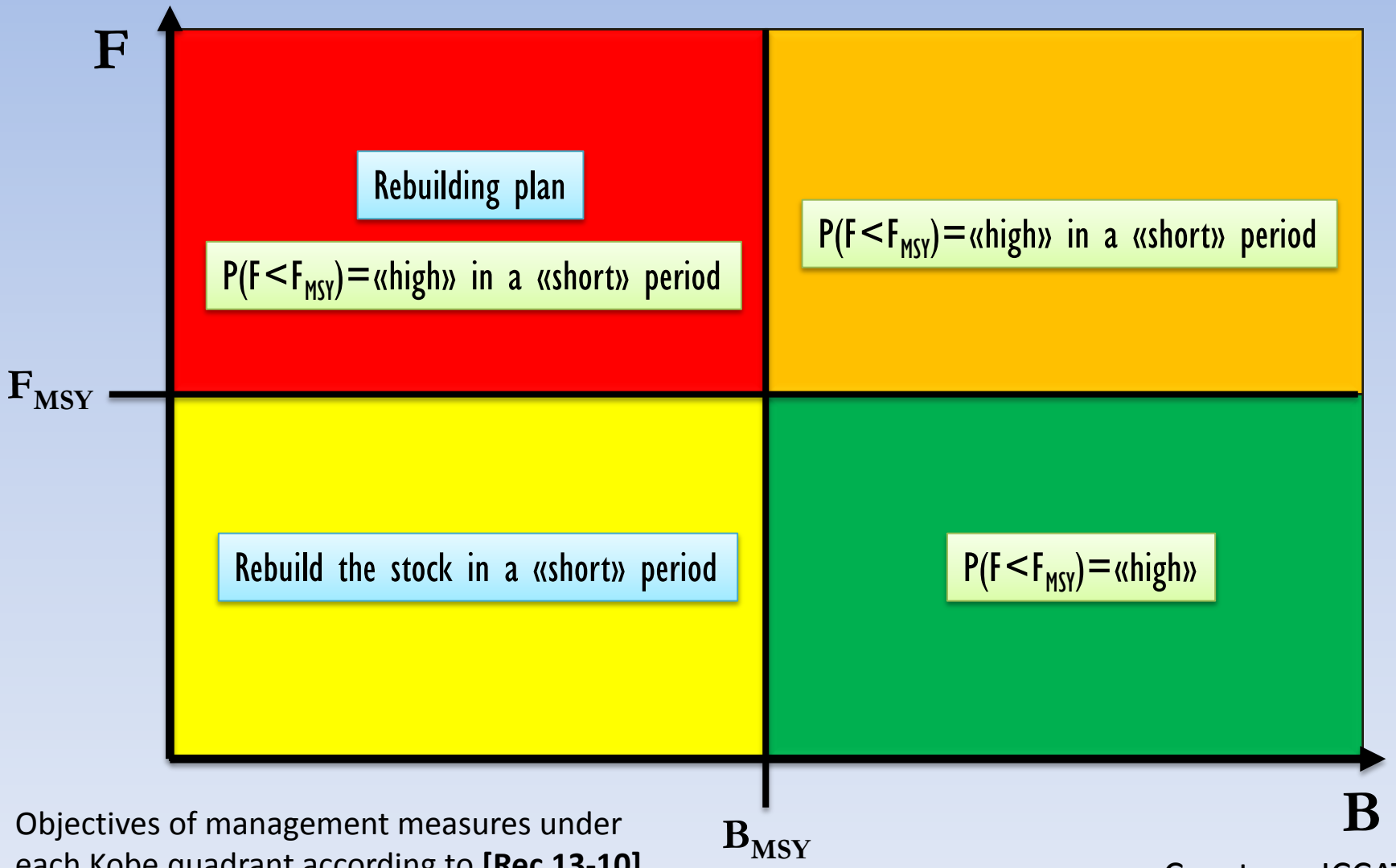
Objectives

- 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)

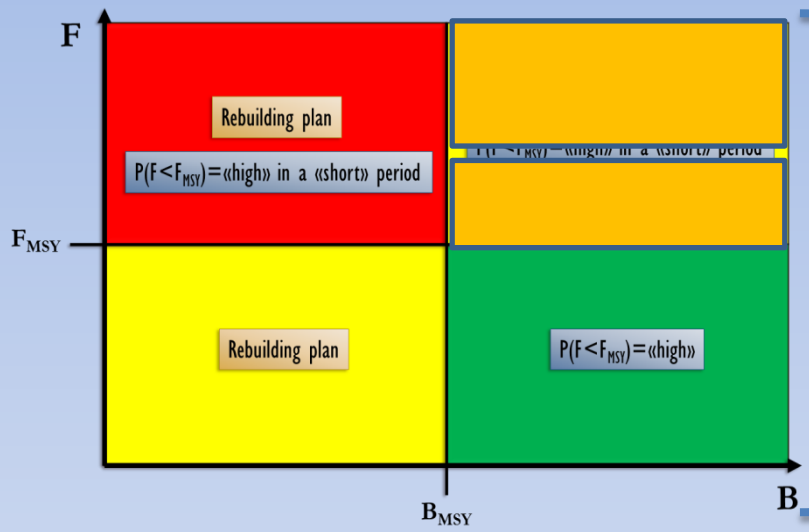
Harvest Control Rules (HCR) -Objectives



Objectives of management measures under each Kobe quadrant according to **[Rec 13-10]**

Courtesy: ICCAT

Harvest Control Rules (HCR)

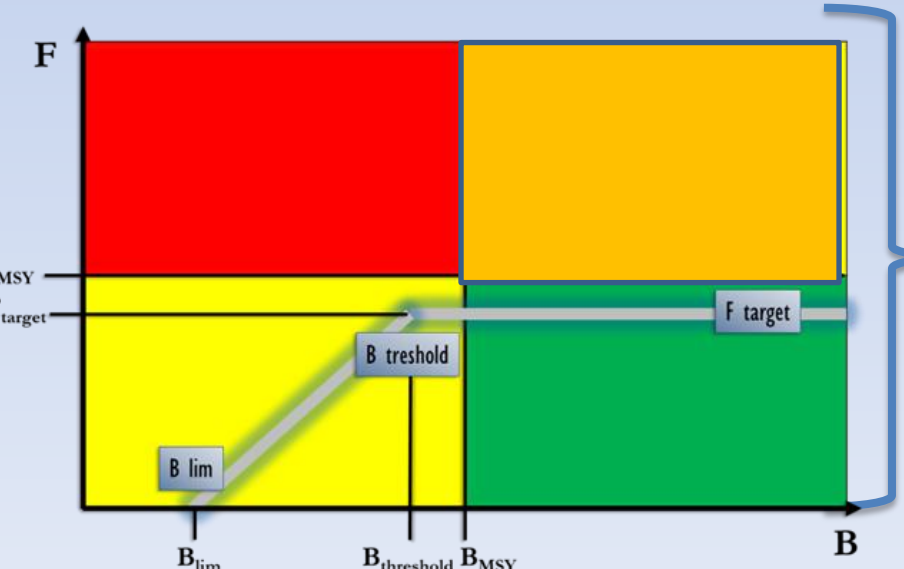


HIGH probability

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 and 1] x F_{MSY}

B threshold

[0.6, 0.8 and 1] x B_{MSY}

B lim

$0.4B_{MSY}$

Courtesy: ICCAT

Inherently this involves a risk: Biomass/Minimizing Risk (Probability)

Spawning Biomass has been low for some years:

Are these low Sp Biomass due to a passing weakness in year class strengths, and no additional action should be taken?

Or

Is this the start of overfishing, and additional action is warranted?

Defining Risk

- **You're a farmer who's just brought in his crop of soy beans. Do you sell now, or store the beans for sale later. You run a risk that the price will rise later if you sell now, and you run a risk of falling prices if you store the grain.**

- **You're an equities investor holding some stock. Do you sell or continue holding? You too run a risk that price will rise later if you sell now, and you too run a risk if you hold now and the share price falls.**

- **You're owner of a fishing boat business, booking clients for the upcoming season. Do you add an extra boat and crew to increase catch? You run a risk of having too many clients if regulations unexpectedly reduce harvest. You also run a risk of having too few clients if regulations are unexpectedly relaxed.**

Defining Risk/Probability

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The Day to day terminologies of risk

- Weather - Probability
- Sports - Odds
- Gambling – Bets

Adverse events- Low probability

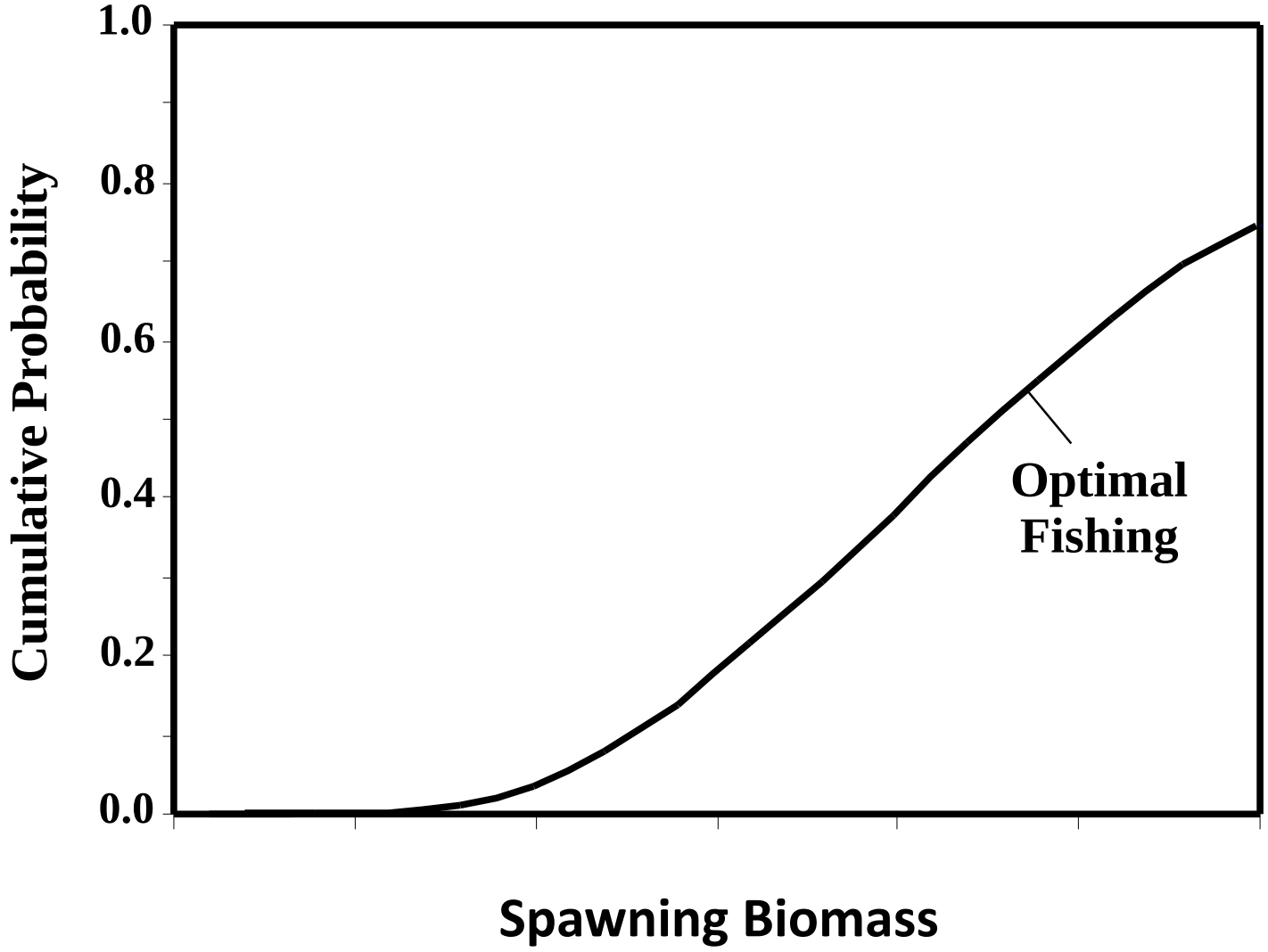
- Weather – Hurricanes/Cyclones
- Sports – Australia wins the World Cup Football
  Ireland wins World Cup Cricket

You're a Fisheries Manager and Spawning Biomass has been low….

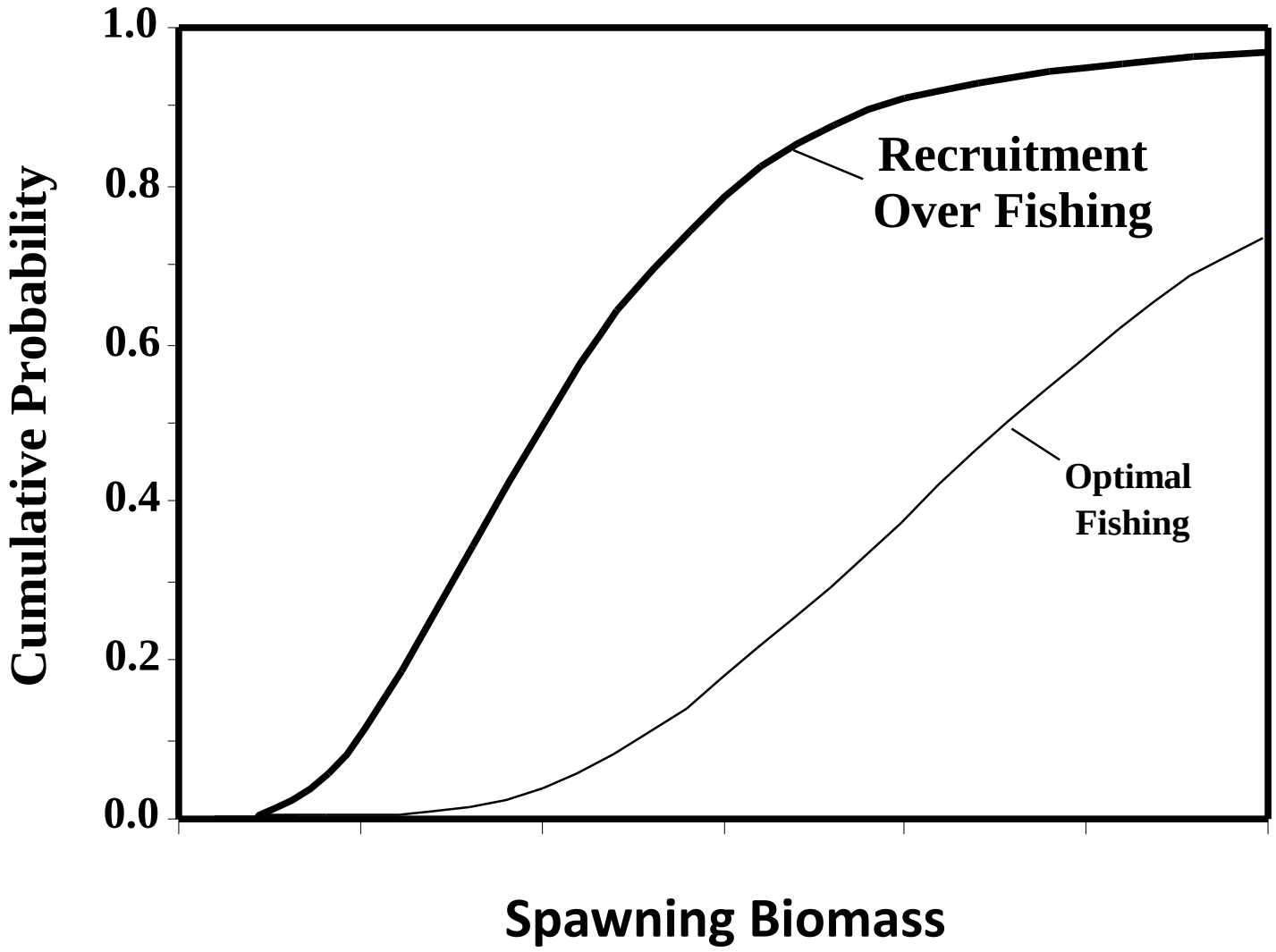
Risk for the fisheries manager is the probability of making the wrong decision:

- **Unnecessarily Restricting Fisheries when fishing is optimal; or**
- **Not Protecting Stocks when they are overfished.**

Management Action is NOT Needed

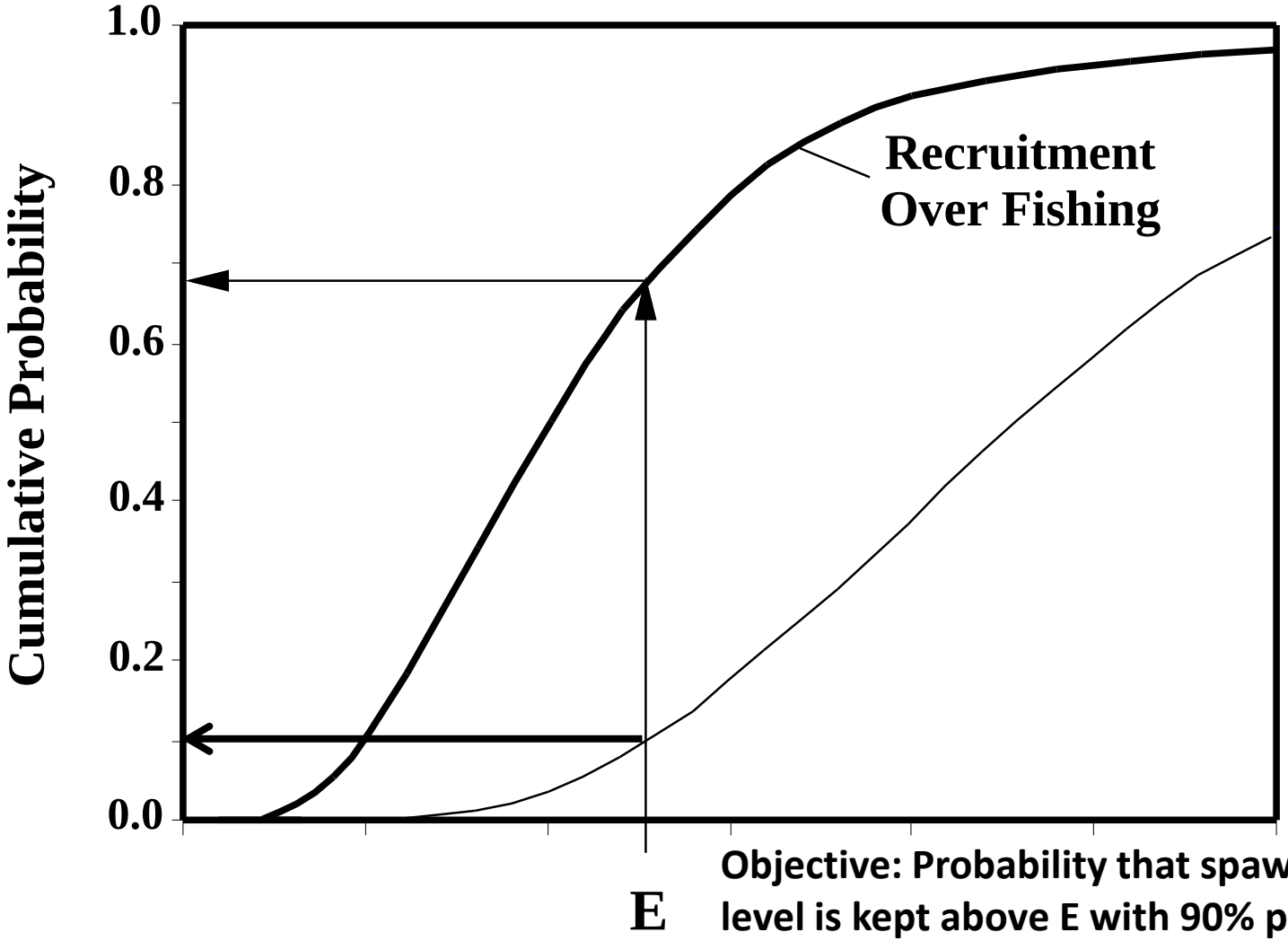


Management Action IS Needed

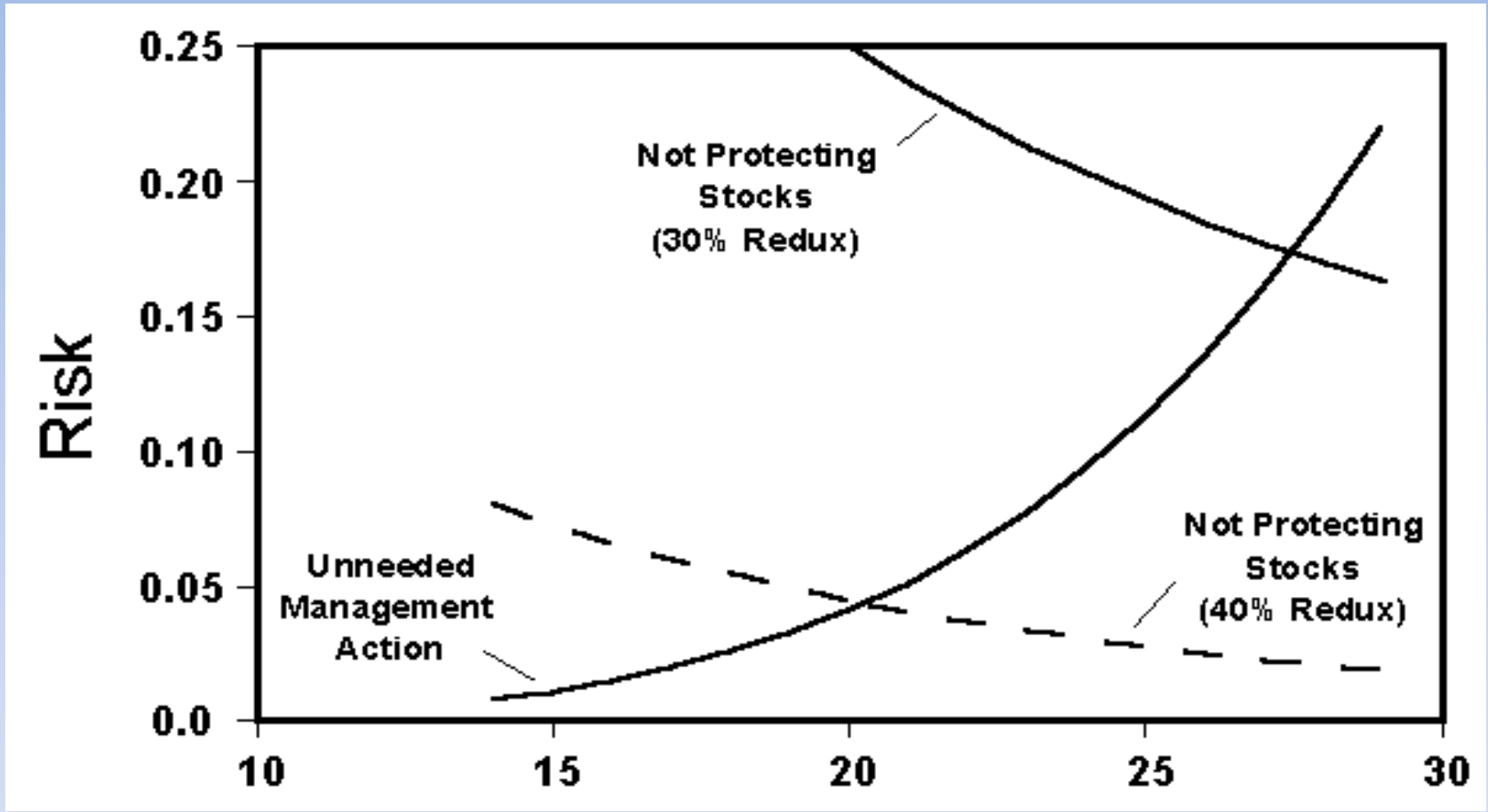


Management Action IS Needed

Even with recruitment overfishing, Spawning Biomass are ABOVE "E" in 32% of calendar years.

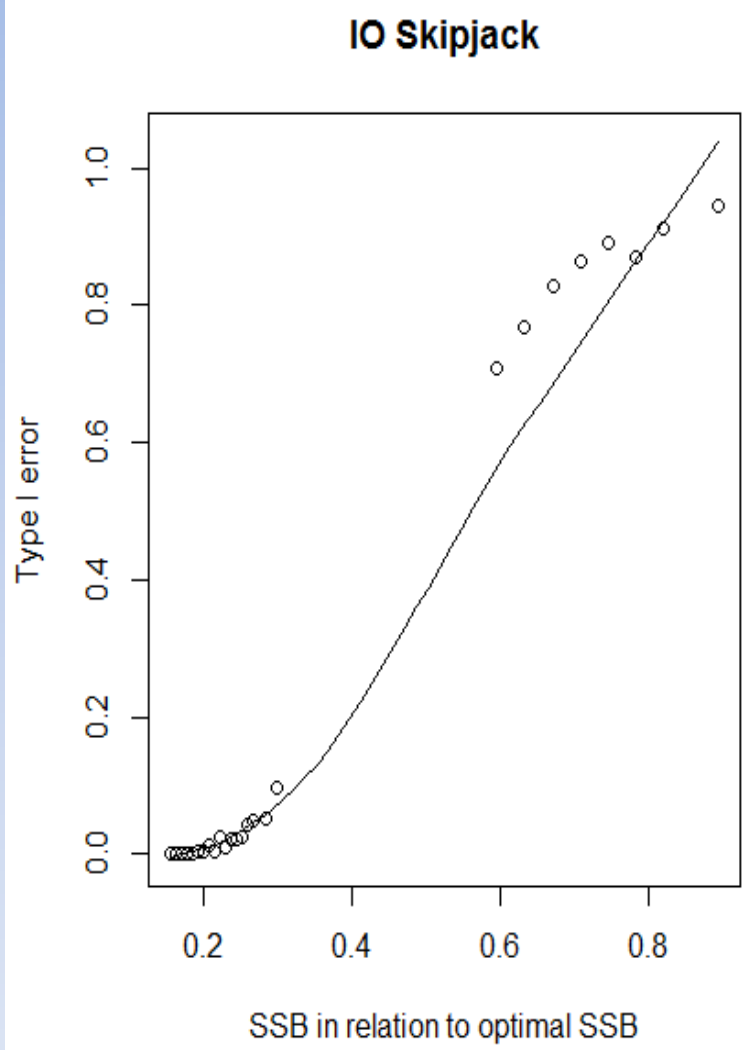


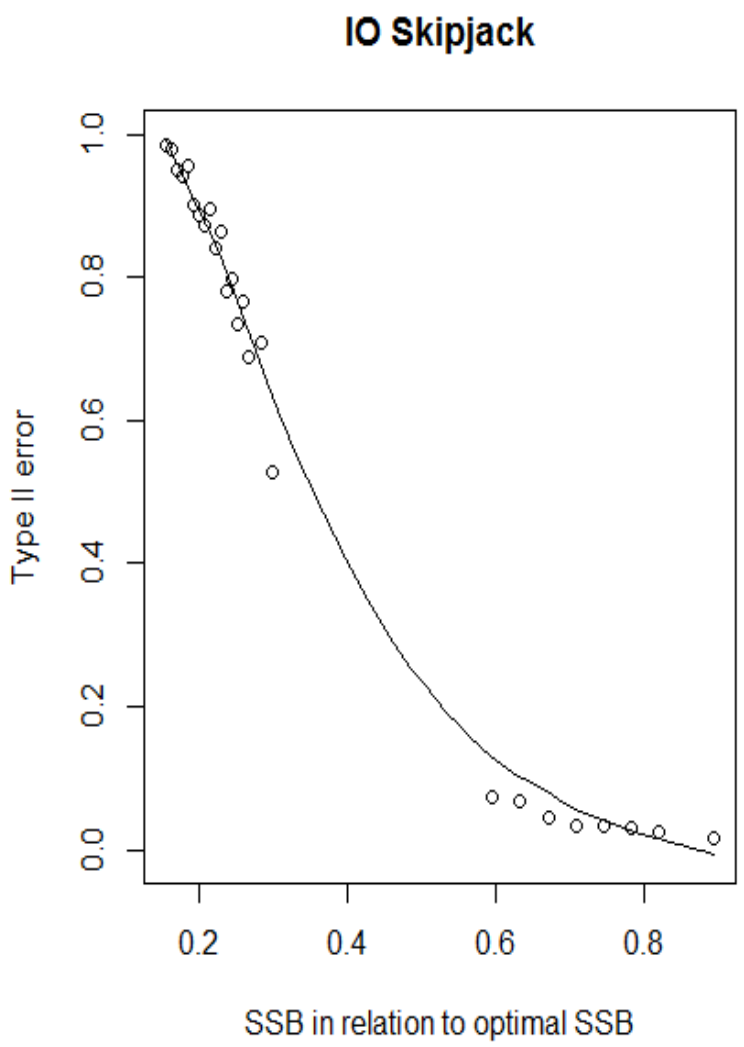
Objective: Probability that spawning biomass level is kept above E with 90% probability


Risk
0.25
0.20
0.15
0.10
0.05
0.0
10
15
20
25
30
Not Protecting
Stocks
(30% Redux)
Unneeded
Management
Action
Not Protecting
Stocks
(40% Redux)
Biomass

IOTC Interim Reference Points Resolution 13/10

Stock	Target Reference Point	Limit Reference Point
Albacore	B_{MSY}; F_{MSY}	$B_{LIM} = 0.40\ B_{MSY}$; $F_{LIM} = 1.40\ F_{MSY}$
Bigeye tuna	B_{MSY}; F_{MSY}	$B_{LIM} = 0.50\ B_{MSY}$; $F_{LIM} = 1.30\ F_{MSY}$
Skipjack tuna	B_{MSY}; F_{MSY}	$B_{LIM} = 0.40\ B_{MSY}$; $F_{LIM} = 1.50\ F_{MSY}$
Yellowfin tuna	B_{MSY}; F_{MSY}	$B_{LIM} = 0.40\ B_{MSY}$; $F_{LIM} = 1.40\ F_{MSY}$
Swordfish	B_{MSY}; F_{MSY}	$B_{LIM} = 0.40\ B_{MSY}$; $F_{LIM} = 1.40\ F_{MSY}$


IO Skipjack
Type I error
0.0
0.2
0.4
0.6
0.8
1.0
0.2
0.4
0.6
0.8
SSB in relation to optimal SSB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Type II error
0.0
0.2
0.4
0.6
0.8
1.0
0.2
0.4
0.6
0.8
SSB in relation to optimal SSB

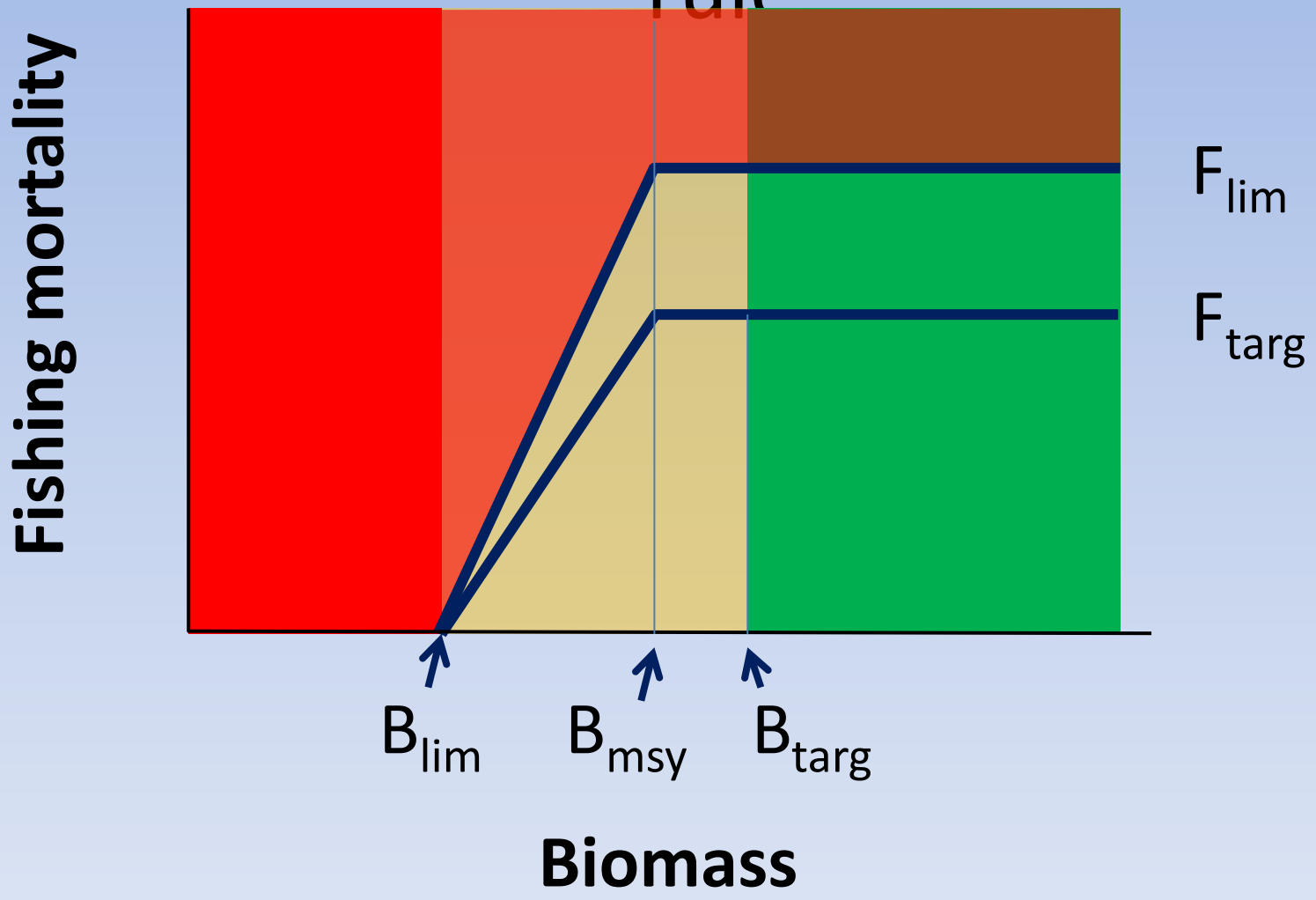
Auto-correlation	Harvest Rate (F/F_{MSY})					
	0.25	0.5	0.75	1	1.25	1.5
0.1	0	0	0	1	1	3
0.15	0	0	0	1	1	3
0.2	0	0	0	1	1	3
0.25	0	0	0	1	2	3
0.3	0	0	1	1	2	3
0.35	0	0	1	1	2	3
0.4	0	0	1	1	2	3
0.45	0	0	1	1	2	4
0.5	0	0	1	1	2	4
0.55	0	1	1	2	3	4
0.6	0	1	2	2	3	4
0.65	0	1	2	2	3	5
0.7	0	1	2	2	3	+76
0.75	1	2	2	3	4	+76
0.8	3	3	3	3	4	+76
0.85	3	4	4	4	20	+76
0.9	4	5	4	6	64	+76

Simple HCR and Recovery Time (Limit)

Simple HCR and Recovery Time (Target)

Auto-correlation	Harvest Rate (F/F_{MSY})					
	0.25	0.5	0.75	1	1.25	1.5
0.1	0	1	1	3	7	+76
0.15	0	1	2	3	7	+76
0.2	1	1	2	3	7	+76
0.25	1	1	2	3	7	+76
0.3	1	1	2	4	8	+76
0.35	1	1	2	4	8	+76
0.4	1	1	2	4	71	+76
0.45	1	2	3	4	73	+76
0.5	1	2	3	5	75	+76
0.55	2	2	3	5	+76	+76
0.6	2	2	3	5	+76	+76
0.65	2	3	4	6	+76	+76
0.7	3	3	4	6	+76	+76
0.75	3	4	5	17	+76	+76
0.8	4	4	6	21	+76	+76
0.85	5	6	10	41	+76	+76
0.9	6	7	18	+76	+76	+76

Reference points and harvest control rule



Biological reference points

- Biomass-based BRP:

  B_{msy}, B_{lim}, $B_{0.1}$, $B_{x\%}$, MSY, ABC…

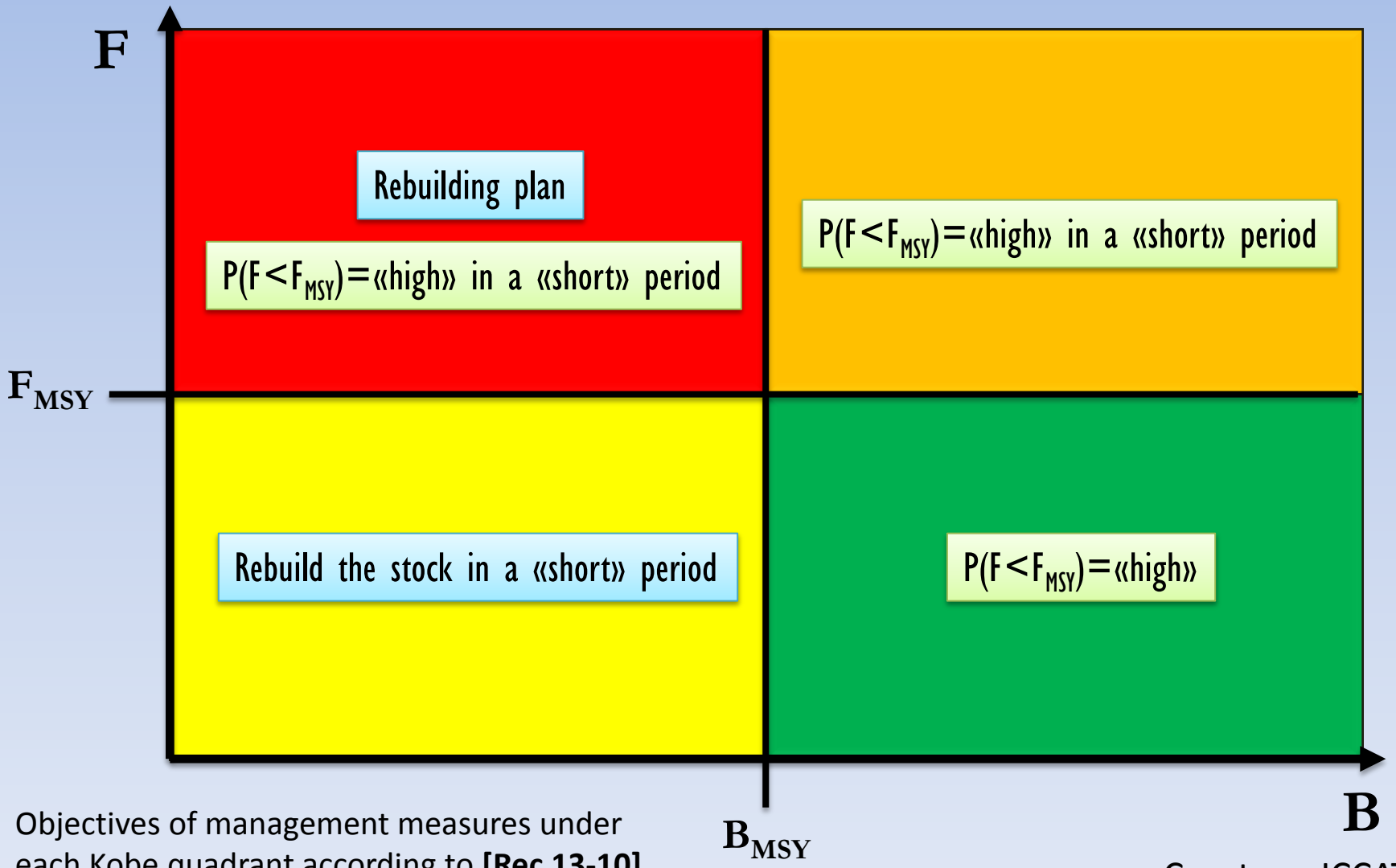
- Fishing mortality-based BRP:

  F_{msy}, F_{lim}, F_{crash}, F_{max}, $F_{0.1}$, $F_{x\%}$…

- Trigger points:

  Based on easily obtained fishery indicators (catch, effort, size etc.) but somewhat arbitrary X%.

Harvest Control Rules (HCR) -Objectives

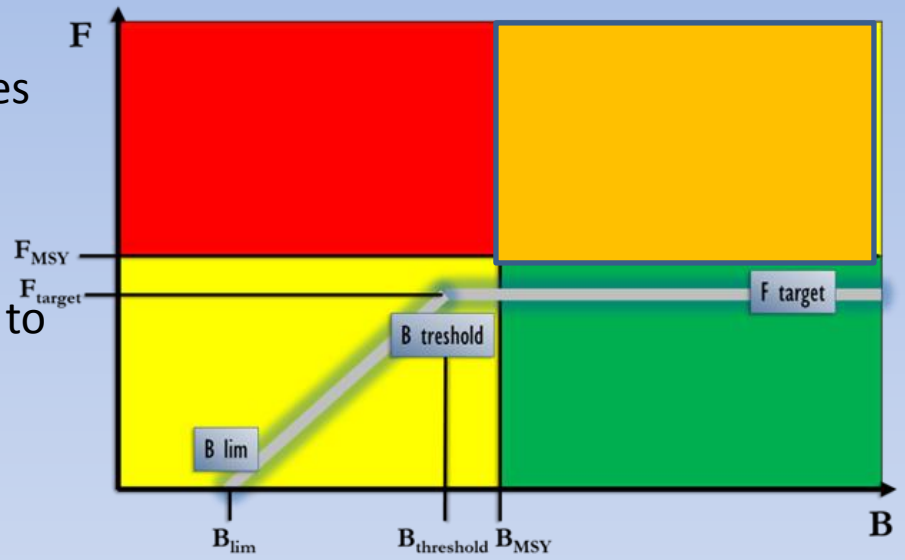


Objectives of management measures under each Kobe quadrant according to **[Rec 13-10]**

Courtesy: ICCAT

Harvest Control Rules (HCR)

- **Ref Points** are only relevant if placed as **part of harvest strategies** or decision rules pre-agreed (HCR).
- **Harvest Control Rules** (HCR): Set of pre-agreed rules that will be applied in order to ensure that a given fishery continually seeks to achieve TRPs and avoid LRPs



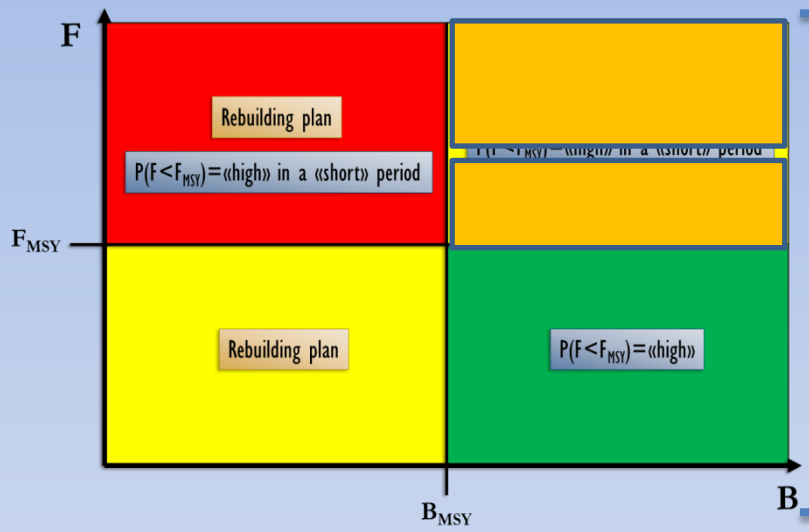
Generic form of the HCR recommended by SCRS in 2010 that would be consistent with UNFSA (Report of the 2010 WGSAM)

IOTC

- [**Rec 13-10**] Point 4: **provides HCR framework** but parameters not defined ("high" or "low" probability, timeframes)

Courtesy: ICCAT

Harvest Control Rules (HCR)

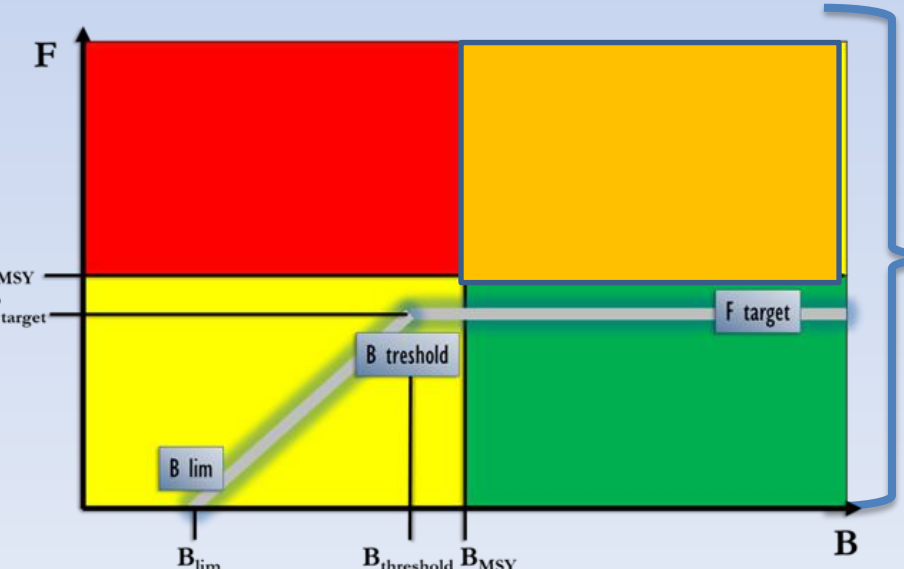


HIGH probability

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 and 1] x F_{MSY}

B threshold

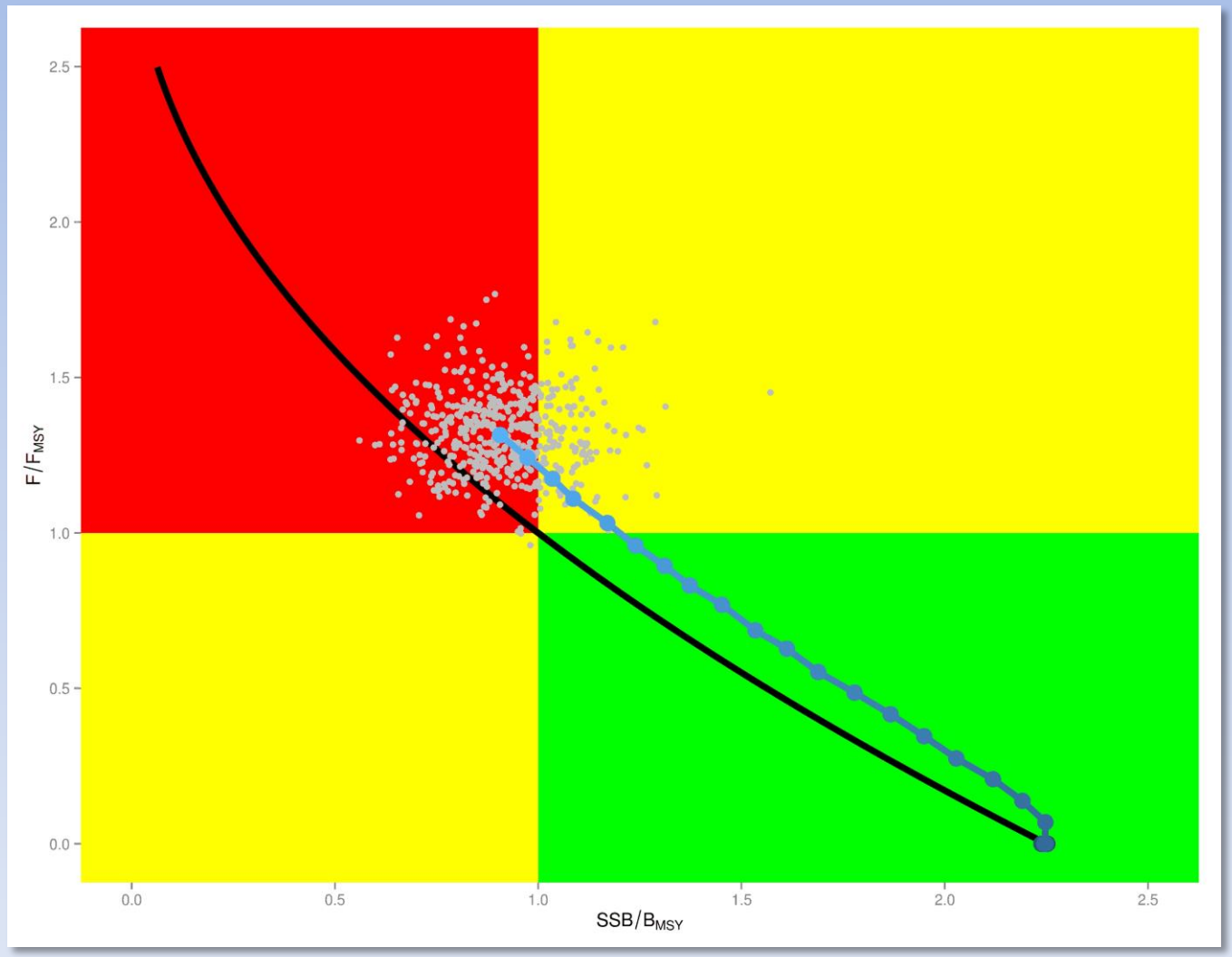
[0.6, 0.8 and 1] x B_{MSY}

B lim

$0.4B_{MSY}$

Courtesy: ICCAT

Harvest Control Rules (HCR) –Theoretical Implementation

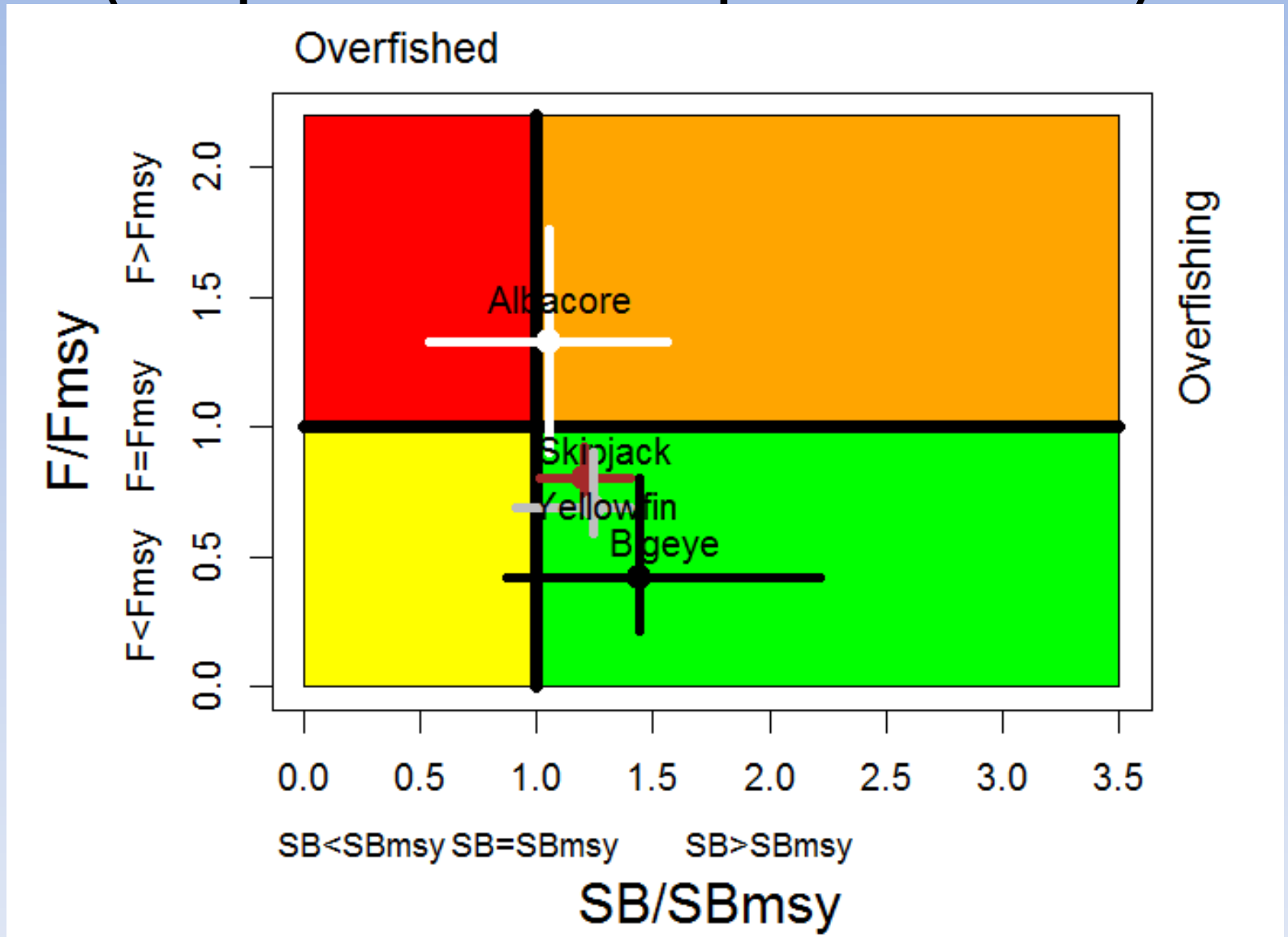


Courtesy: ICCAT

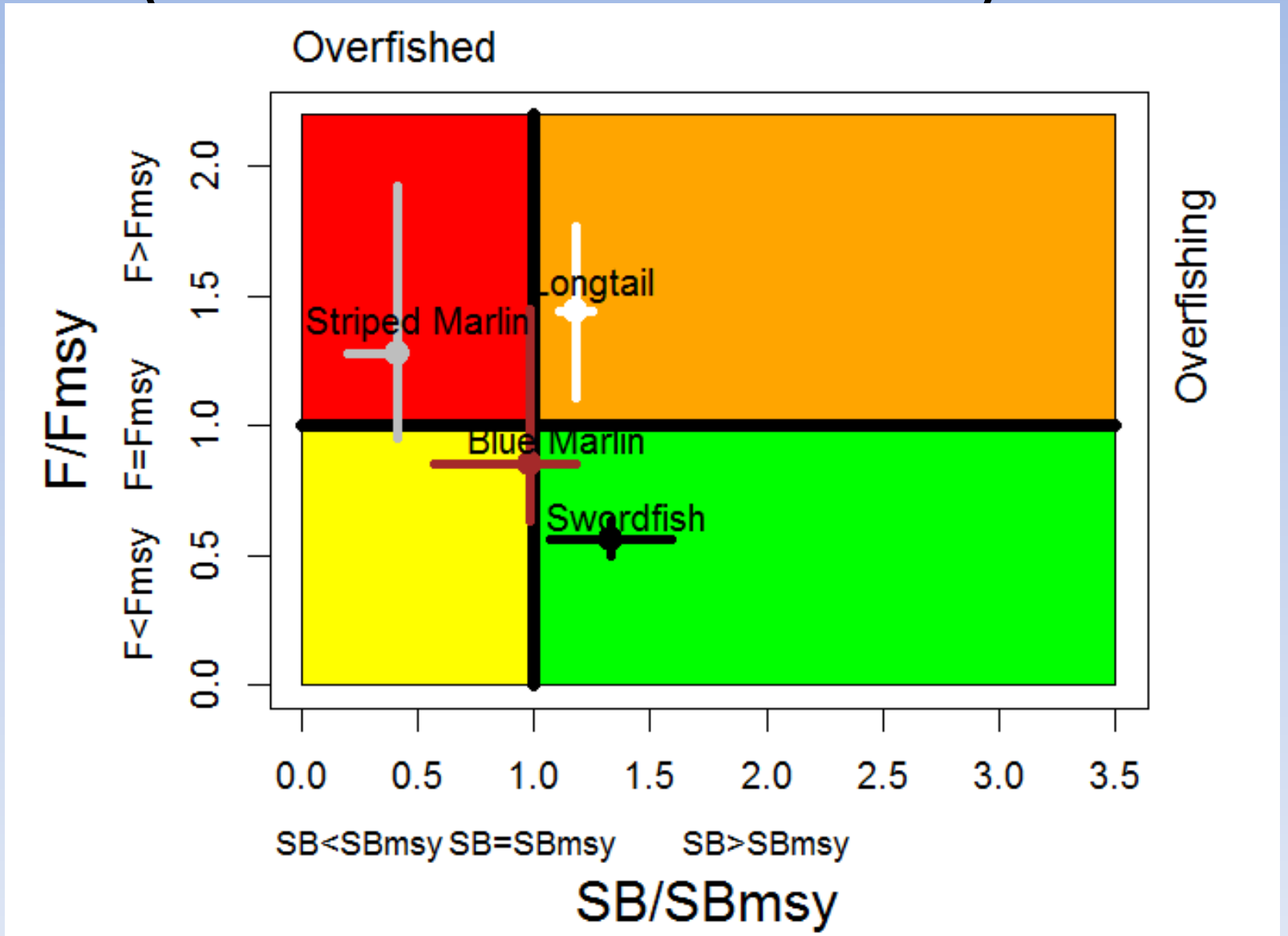
Inherently what you need to decide

- Balance long-term yield to long-term stock biomass.
- In case of adverse conditions, evaluate how long it may take to recover.

IOTC Stock Status Overview (Tropical and Temperate Tuna)



IOTC Stock Status Overview (Billfish and Neritic Tuna)



Understanding IOTC Recommendations and Resolutions

IOTC Recommendations

- Not binding, may be implemented on a voluntary basis
- Transitional, or intermediate

IOTC Resolutions

- Binding on CPCs, but there is an objection procedure
- Implementation required at national level
- Compliance is assessed for each CPCs

2012 – Introducing PA

- No mention in the Agreement of Precautionary Approach (as in WCPFC)
- Had to implement through Resolution
- Two proposed Resolutions in 2012-
  - One setting up principles of Precautionary Approach (launching an MSE process)-Adopted
  - Setting up interim reference points-Turned into Recommendation

RESOLUTION 12/01: ON THE IMPLEMENTATION OF THE PRECAUTIONARY APPROACH

- AGREES, in accordance with paragraph 1 of Article IX of the IOTC Agreement, to the following:
  - To apply the precautionary approach, in accordance with relevant internationally agreed standards, in particular with the guidelines set forth in the UNFSA, and to ensure the sustainable utilization of fisheries resources as set forth in Article V of the IOTC Agreement.
  - In applying the precautionary approach, the Commission shall adopt, after due consideration of the advice supplied by the Scientific Committee,
    - stock-specific reference points (including, but not necessarily limited to, target and limit reference points), relative to fishing mortality and biomass, and
    - associated harvest control rules, that is, management actions to be taken as the reference points for stock status are approached or if they are breached

Reference Points

- Not enough support for a Resolution (from India).
- Not familiar with concepts related to the PA-Members asked for definitions from FAO manual
- Casting existing Management Measures as a harvest control rule would have been too complicated
- Adopt interim reference points-aware that in absence of HCR don’t define a Management Strategy.

Resolution 13/10

- Agreed to adopting the Interim Target and limit reference points of Resolution 12/08.
- An evaluation of these interim reference points was also part of this exercise. In addition, stock status advice would be provided with these interim reference points in mind.
- Calls for an MSE to assess these reference points (and others from the literature).
- Provides some guidance on HCR's that keep stock trajectories in the green part of the Kobe Plot as much as possible or bring it back to that area in case it is in other quadrants indicating overfishing or overfished.

Interim HCR- on-going thinking

- Based on a catch limit, with allocation negotiated when needed?
- Based on extending time closures (not area)?
- Effort reduction (closures for a month etc.)?
- If future measures are proposed, they can be cast as a provisional harvest control rule

Target and limit reference points

Stock	Target Reference Point	Limit Reference Point
Skipjack	Bmsy; Fmsy	0.4*Bmsy; 1.5*Fmsy
Yellowfin	Bmsy; Fmsy	0.4*Bmsy; 1.4*Fmsy
Bigeye	Bmsy; Fmsy	0.5*Bmsy; 1.3*Fmsy
Swordfish	Bmsy; Fmsy	0.4*Bmsy; 1.4*Fmsy
Albacore	Bmsy; Fmsy	0.4*Bmsy; 1.4*Fmsy

Stock status

Stocks under IOTC mandate are in relatively **good shape (at optimal utilization)**, but no room for further fleet expansion.

Stock	Indicators	Advice
Bigeye	F_{2012}/F_{MSY}= 0.42 (0.21–0.80) $SB_{2012}SB_{MSY}$= **1.44 (0.87–2.22)**	Probably not overfished, and overfishing is probably not occurring. Probably near full utilization
Yellowfin	$F_{2010/}F_{MSY}$=0.69 (0.59–0.90) $SB_{2010/}SB_{MSY}$= 1.24 (0.91–1.40)	Probably not overfished, and overfishing is probably not occurring. Probably near full utilization
Skipjack	$F_{2011/}F_{MSY}$= 0.8 (0.68-0.92) $SB_{2011/}SB_{MSY}$= 1.2 (1.01-1.4)	Highly productive species and robust to overfishing.
Albacore	$F_{2010/}F_{MSY}$ = 1.33 (0.9–1.76) $SB_{2010/}SB_{MSY}$=1.05 (0.54–1.56)	F above MSY levels. Further declines likely due to effort displacement (piracy). Almost exclusively LL.
Swordfish	$F_{2010/}F_{MSY}$= 0.79 (0.58-0.84) $SB_{2010/}SB_{MSY}$= 1.31 (1.13-1.46)	The overall stock size and fishing pressure are estimated to be within acceptable limits
Striped Marlin	$F_{2011/}F_{MSY}$= 1.28 (0.95–1.92) $B_{2011/}B_{MSY}$= 0.416 (0.2–0.42)	Stock is overfished, though maybe recovering due to recent decline in catch levels.
Blue Marlin	$F_{2011/}F_{MSY}$= 0.85 (0.63–1.45) $B_{2011/}B_{MSY}$= 0.98 (0.57–1.18)	The overall stock size is optimal. Fishing rates are likely below F_{MSY}, though highly uncertain.
Longtail	$F_{2011/}F_{MSY}$=1.11–1.77 $B_{2011/}B_{MSY}$=1.11–1.25	Increased catches in recent years indicate that the stock is experiencing overfishing though is not overfished. This is primarily due to a change in effort from Tropical to Neritic Tuna.

Current and Future work

- Albacore operational model set up for MSE.
- Skipjack operational model set up for MSE.
- Eventually, have a model that incorporates all Tropical Tuna Species and develop MSE procedures simultaneously.
- Dialogue initiated on identifying clear management objectives.

Define the following

- Overfishing
- Overfished
- Provide a theoretical objective in the context of MSE
- Provide some Harvest Strategy that can be easily implemented?