

Comisión Interamericana del Atún Tropical  
Inter-American Tropical Tuna Commission



# TOY BET Management Strategy Evaluation game

2<sup>nd</sup> IATTC Tropical Tuna MSE Workshop, *by videoconference*, May 03-04, 2021



# Learning using trial and error

## **Real world:**

Costly, little or no repetitions



## **Videogame:**

Inexpensive, as many repetitions as wanted

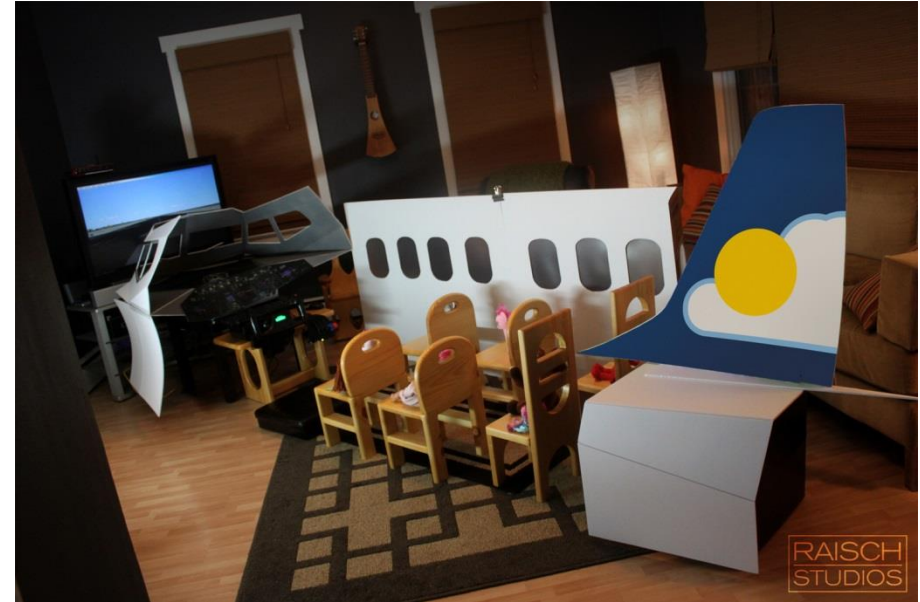


We can use the MSE concepts using simulation

## FLYING SIMULATOR



This game is much simpler than a realistic one

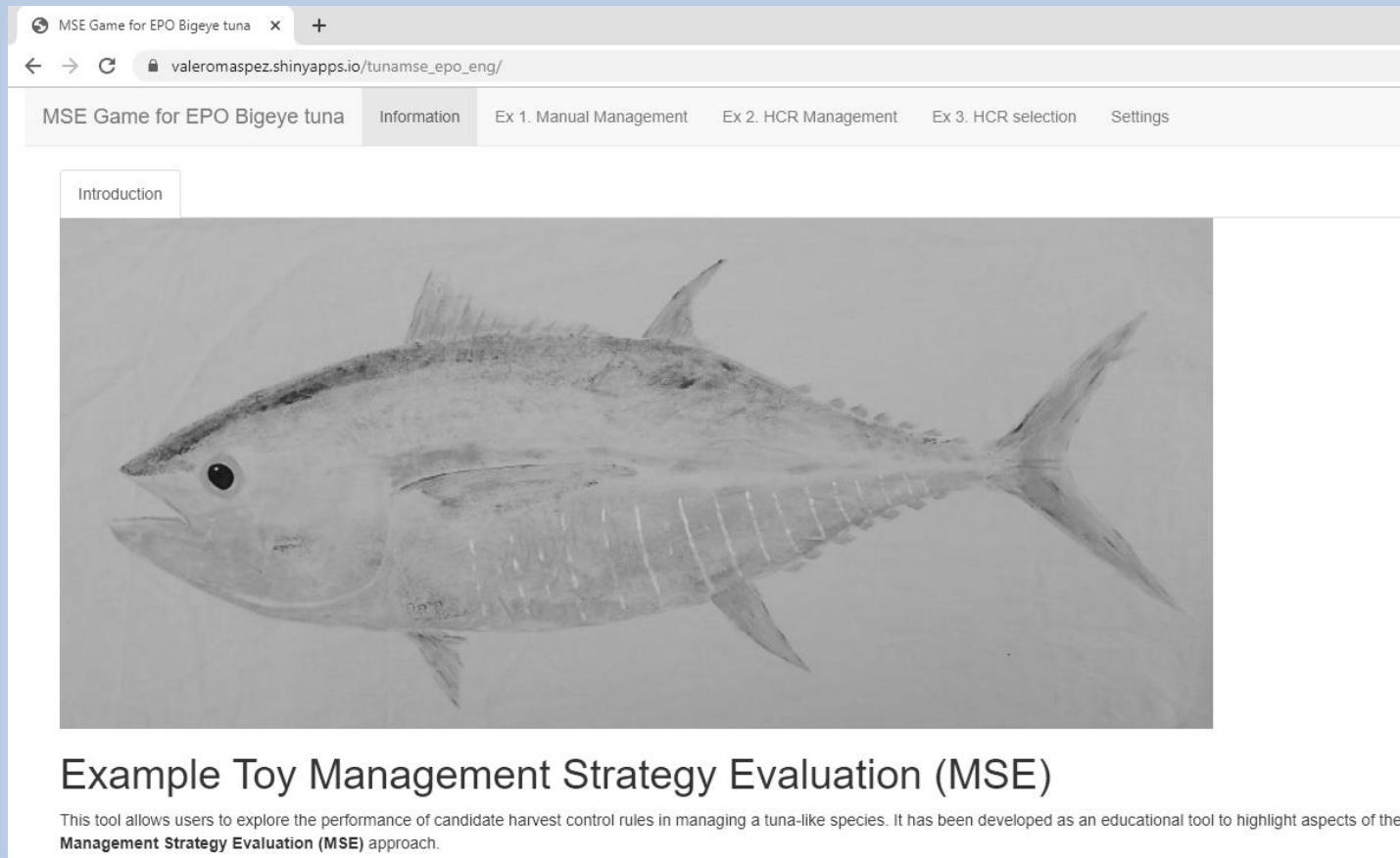


# What is this game about?

- Hands on exploration of Management Strategy Evaluation
- TunaMSE, simple tool to illustrate iteratively:
  - Population/Fishery model projections
  - Elements of the strategy evaluation process
    - Compare simple HCR
    - Interrogating performance measures to make comparisons between HCRs
  - Configured for EPO Bigeye tuna

# How to use this game

[https://valeromaspez.shinyapps.io/tunamse\\_epo\\_eng/](https://valeromaspez.shinyapps.io/tunamse_epo_eng/)



The screenshot shows a web browser window with the URL `valeromaspez.shinyapps.io/tunamse_epo_eng/`. The page title is "MSE Game for EPO Bigeye tuna". The navigation menu includes "Information", "Ex 1. Manual Management", "Ex 2. HCR Management", "Ex 3. HCR selection", and "Settings". The "Introduction" tab is active, displaying a grayscale image of a Bigeye tuna fish. Below the image, the text reads: "Example Toy Management Strategy Evaluation (MSE)" and "This tool allows users to explore the performance of candidate harvest control rules in managing a tuna-like species. It has been developed as an educational tool to highlight aspects of the Management Strategy Evaluation (MSE) approach."

# How to interpret game results

MSE Game for EPO Bigeye tuna   Information   **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)

Performance indicators: plots

Performance indicators: values

The interface displays four performance indicator plots. The top-left plot shows Biomass /  $B_{MSY}$  over time (1980-2010), with a red arrow pointing to the y-axis label. The top-right plot shows Catch (0000) over time, with a red arrow pointing to the y-axis label. The bottom-left plot shows Exploitation rate /  $F_{MSY}$  over time, with a red arrow pointing to the y-axis label. The bottom-right plot is a phase diagram with Exploitation rate /  $F_{MSY}$  on the y-axis and Biomass /  $B_{MSY}$  on the x-axis, showing a trajectory of the fishery's state over time. A yellow circle highlights the current state of the fishery in the phase diagram.

Biomass

Catch

Exploitation rate

# How to play the game

MSE Game for EPO Bigeye tuna

Information

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)

60

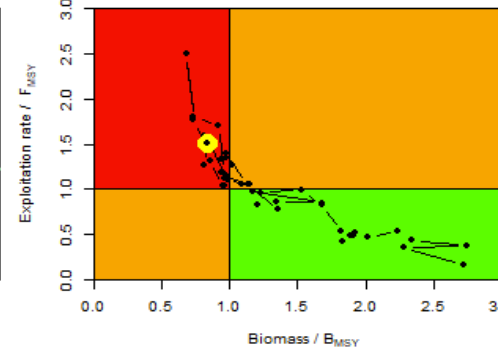
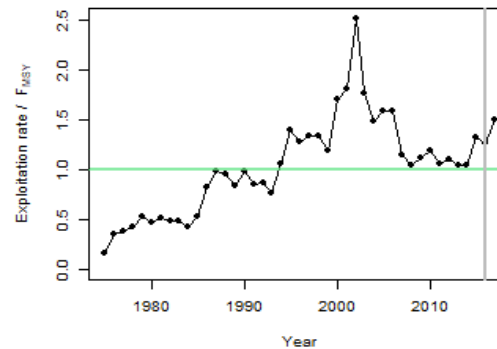
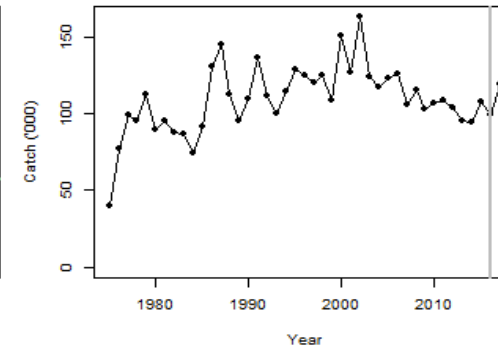
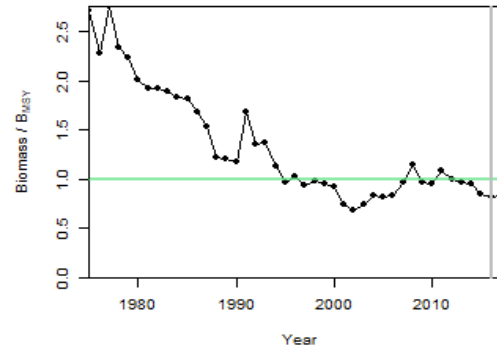
Catch limit duration (yrs)

1

Apply management

Restart

Performance indicators: plots



Performance indicators: values



Future catch  
60,000 t

Management  
cycle 1 year



# Game settings and output

MSE Game for EPO Bigeye tuna

Information

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)

300

Catch limit duration (yre)

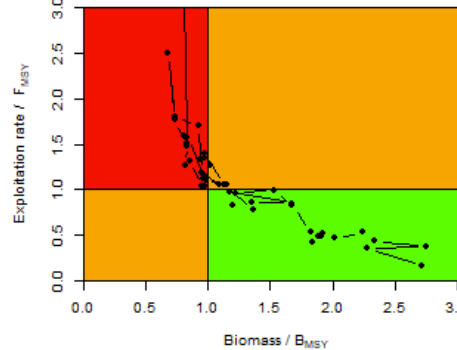
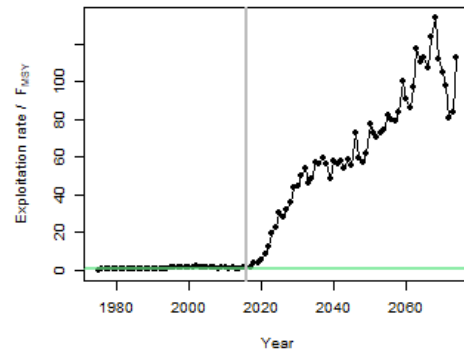
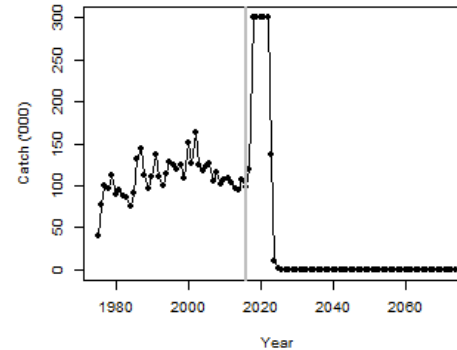
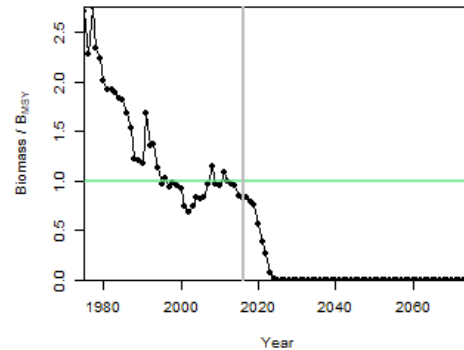
35

Apply management

Restart

Future catch  
300,000 t

Performance indicators: plots



Performance indicators: values

	Stock status (B/Bmsy)	Fishing intensity (F/Fmsy)	Prob. green	Catch (kt)	Catch variation (%)
Current (2075)	0.00	85.25	0.00	0.00	61.46
Overall (2018- 2075)	0.06	51.06	0.00	28.91	18.53

Last year

Overall



Management  
cycle 35 years

# Performance metrics

- Stock Status -  $B/B_{MSY}$
- Exploitation level -  $F/F_{MSY}$
- Probability of being in the Kobe plot green area
- Catch (median)
- Catch variability
- Probability of being above  $B_{LIMIT}$
  
- Are all metrics equally important?
- What is the time period of interest? Short, medium, long term?

# Exercise (1) – manual management

- Try projections with different catch levels and management cycle lengths.
- Use graphs and performance metrics to check game outcomes and try different catch levels to keep the stock close to  $B_{MSY}$
- Examples:
  - 3 projection years, Catch = 60 kt
    - Followed by:
  - 3 projection years, Catch = 100 kt
    - Followed by:
  - 3 projection years, Catch = 120 kt

# Exercise (2) – HCR management

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:**  
Constant Catch

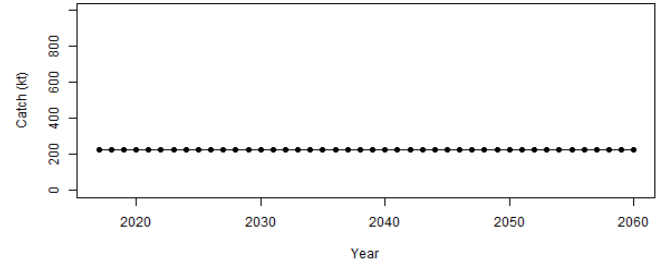
**Catch ('000t)**  
0 225

The catch limit in every year

**Number of simulations**  
15

Run simulations

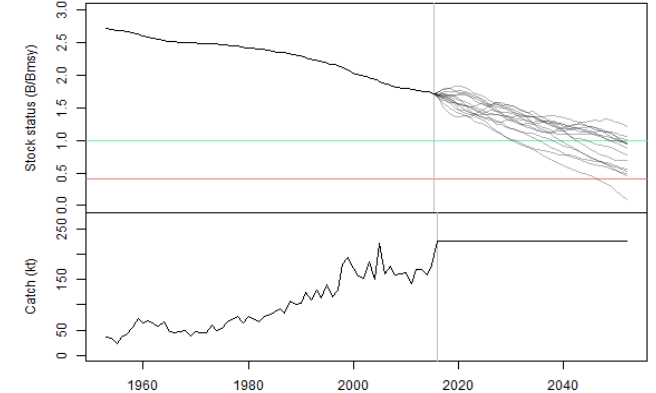
**Harvest control rule**



Catch (kt)

Year

**Simulation outcomes**



Stock status (BBmsy)

Catch (kt)

Year

# Exercise (2) – HCR management

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

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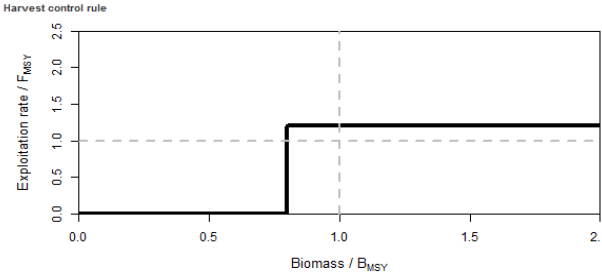
**Type of HCR:**  
Threshold Exp. Rate

**Maximum exploitation rate (F<sub>target</sub>):**  
1.2

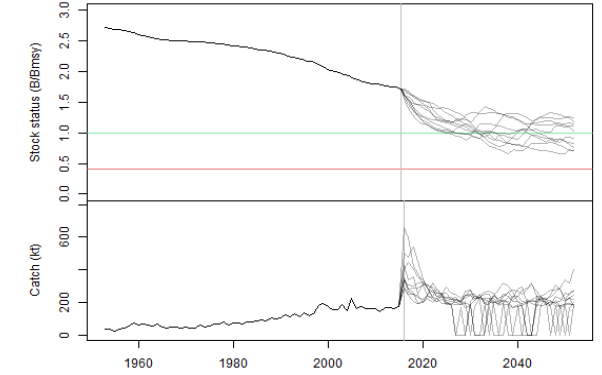
**Range (B<sub>lim</sub> & B<sub>thresh</sub>):**  
0.8

**Number of simulations:**  
10

**Harvest control rule**



**Simulation outcomes**



# Exercise (2) – HCR management

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

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Type of HCR:

Maximum exploitation rate (F<sub>targ</sub>)

Range (B<sub>lim</sub> & B<sub>thresh</sub>):

Number of simulations

**Harvest control rule**

**Simulation outcomes**

Catch (kt)	HCR	Type	Catch	Exp. rate	F <sub>mult</sub>	B <sub>lim</sub>	B <sub>thresh</sub>	Median Depletion (%)	*Prob. green	*Catch	*Catch var.
	1	Knife-edge	NA	NA	1.2	0.8	0.8	37.7	0.694	207.5	0.227
	2	Slope	NA	NA	1.2	0.4	1	37.9	0.675	209.2	0.172

# Exercise (2) – HCR management

C:/MSE/Engagement/TunaMSE/runapp.r - Shiny  
 http://127.0.0.1:3980 Open in Browser Publish

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

**Candidate HCRs** Plots

Select the HCR that best achieves your management objectives.

The performance indicators have been recorded for each of the HCRs 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?**

3

Use this to choose which HCR to plot trajectories for.

**Key**

**HCR control parameters**

Catch is the constant catch  
 \*Exp. rate is the constant exploitation rate.  
 Fflag, Blim and Bthresh define the threshold harvest control rule.

**Performance indicators**

Median depletion (%) - Median of Unfished B.  
 \*Prob. green : probability of being above B > BMSY and F < FMSY.  
 \*Catch : median over sims of the catch.  
 \*Catch var. : median over sims of the catch variation.

HCR	Type	Catch	Exp. rate	Fmult	Blim	Bthresh	Median Depletion (%)	*Prob. green	*Catch
1	Threshold	NA	NA	1.2	0.8	0.8	37.7	0.694	207.5
2	Threshold	NA	NA	1.2	0.4	1	37.9	0.675	209.2
3	Threshold	NA	NA	0.8	0.4	1.2	49.2	0.981	184.8

C:/MSE/Engagement/TunaMSE/runapp.r - Shiny  
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Toy Tuna MSE Ex 1. Manual Management Ex 2. HCR Management Ex 3. HCR selection Settings

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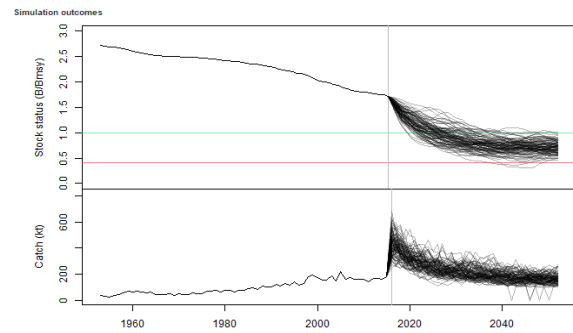
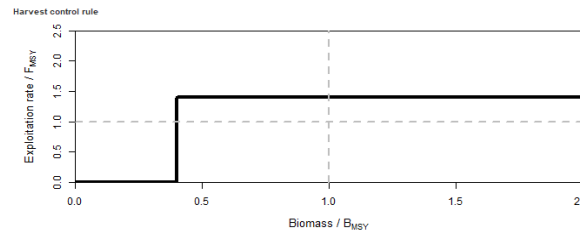
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 \*Catch : median over sims of the catch.  
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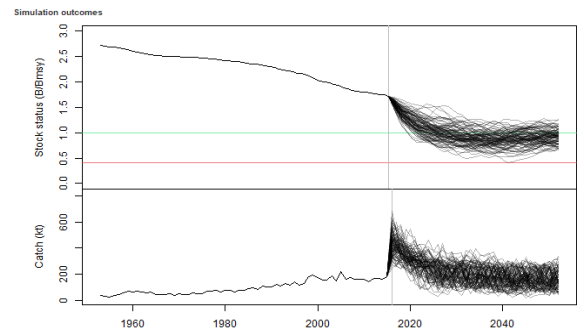
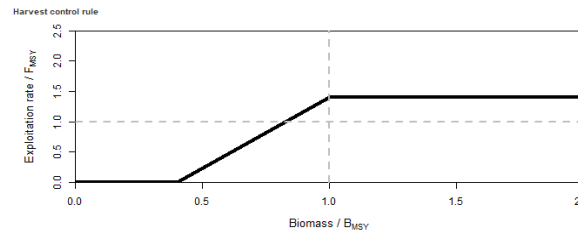
# Examples of game results

## HCR 1



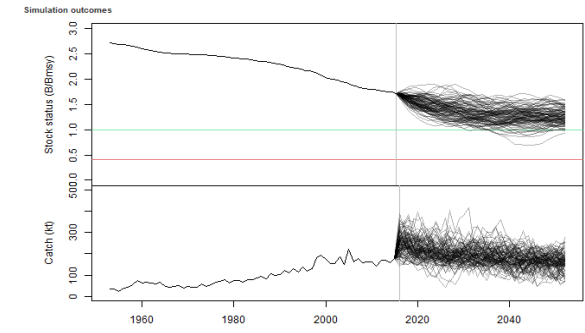
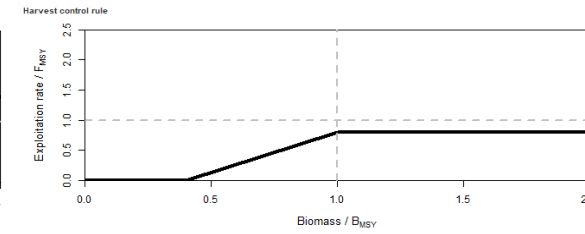
## Aggressive

## HCR 2



## Moderate

## HCR 3



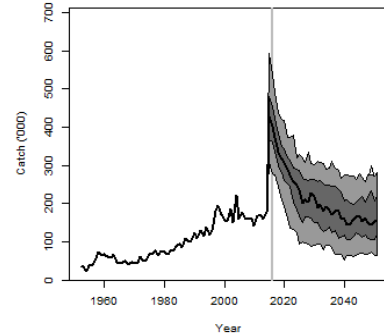
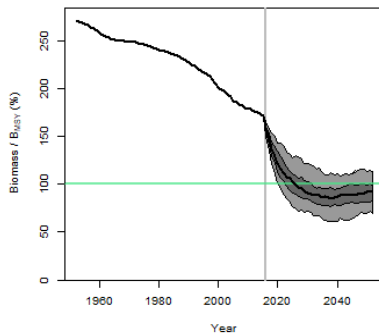
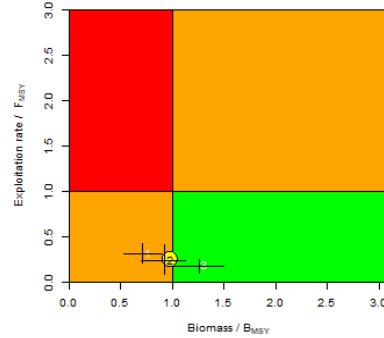
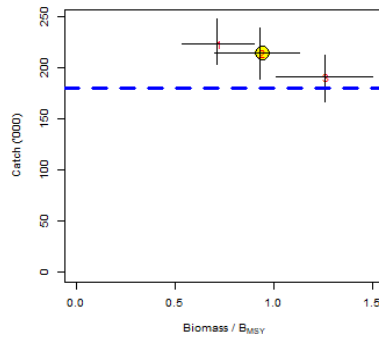
## Conservative



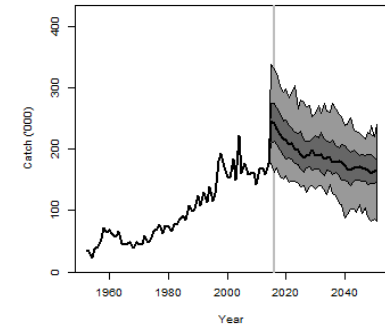
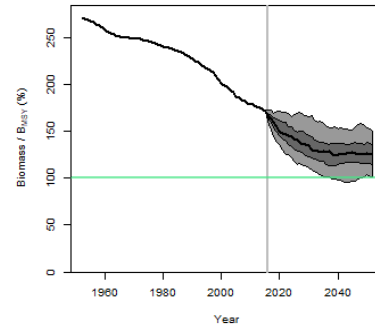
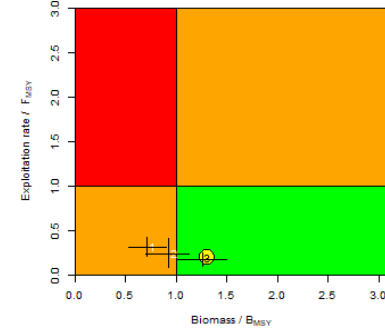
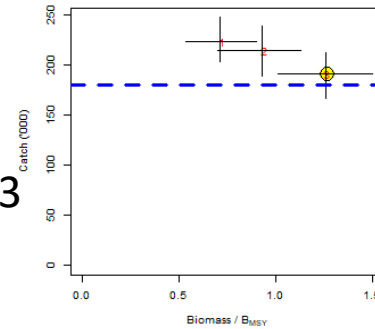
# Examples of game results

HCR	Type	Catch	Exp. rate	Fmult	Blim	Bthresh	Median Depletion (%)	*Prob. green	*Catch	*Catch var.
1	Threshold	NA	NA	1.4	0.4	0.4	26.3	0.306	223.3	0.11
2	Threshold	NA	NA	1.4	0.4	1	34	0.419	214	0.2
3	Threshold	NA	NA	0.8	0.4	1	46.3	0.972	191.5	0.113

HCR 2



HCR 3



# CIAT IATTC



Questions?