

Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission



TOY BET Management Strategy Evaluation game

1st IATTC Tropical Tuna MSE Workshop, San Diego, California (USA), December 9-10 2019

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





August 10, 2018



**BREAKING
NEWS**

CNN

US [Crime + Justice](#) [Energy + Environment](#) [Extreme Weather](#) [Space + Science](#)

LIVE TV

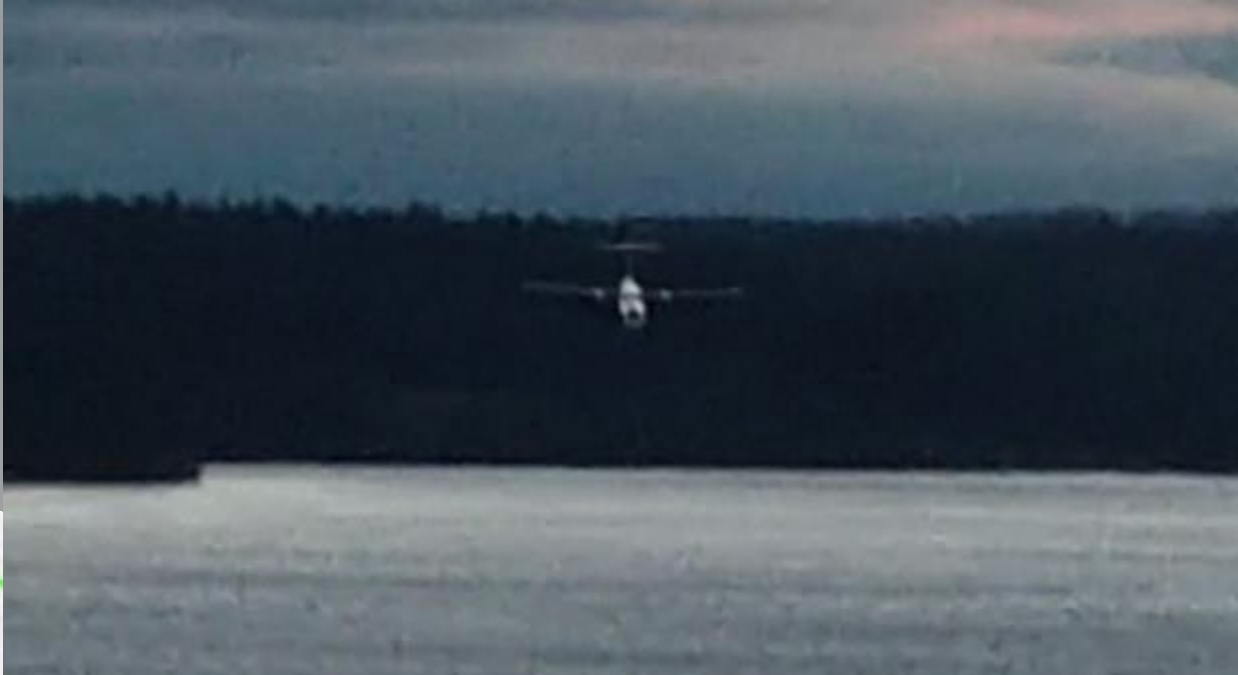
Edition ▾



The man who stole a plane said he didn't need much help: 'I've played some video games'

By Jason Hanna, CNN

🕒 Updated 10:42 AM ET, Mon August 13, 2018



John Waldron

The Guardian 

"I don't need that much help. I've played some video games before"



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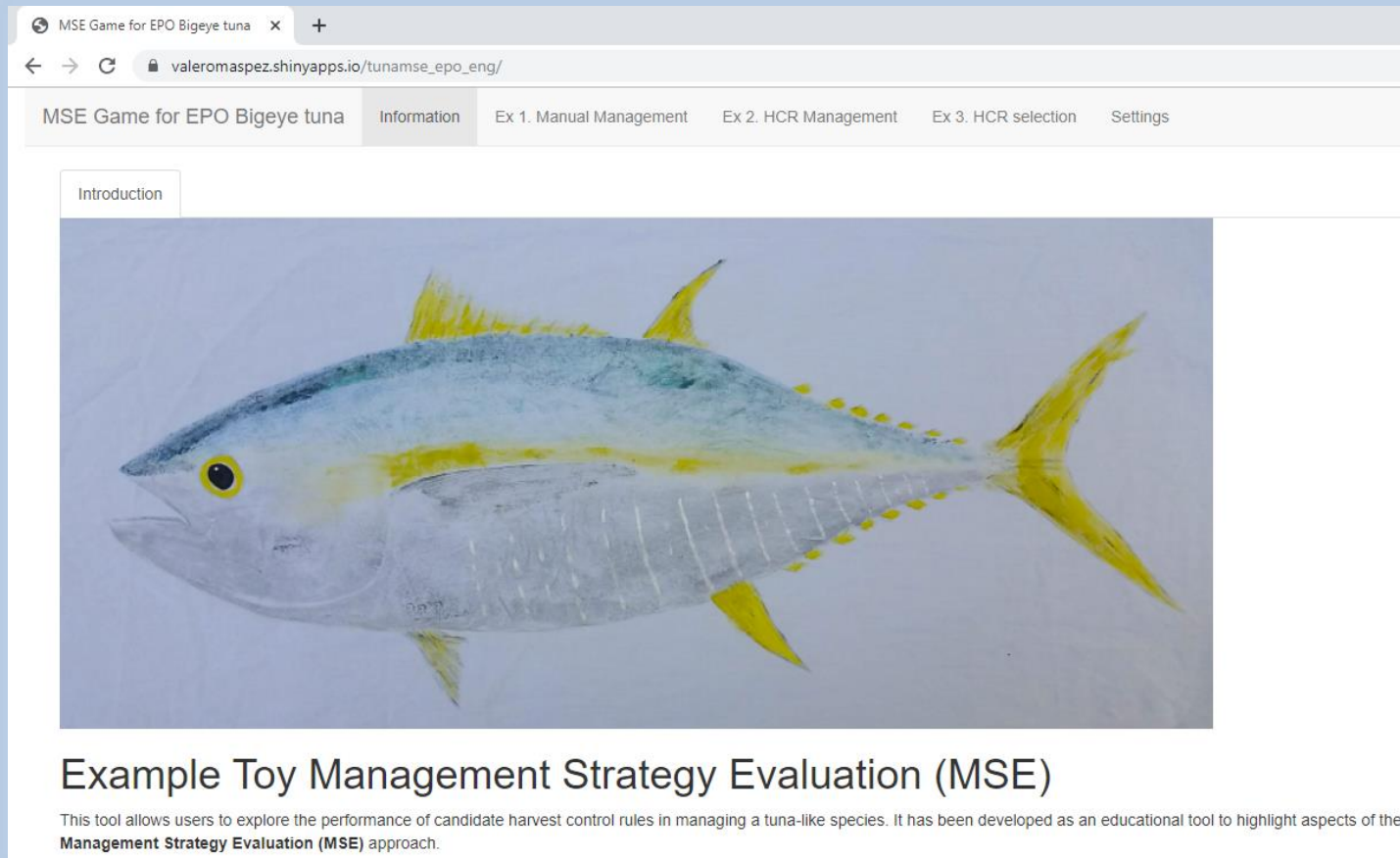
**COROLARY: Playing videogames is not doing the actual real work...
This game IS NOT an actual Management Strategy Evaluation**

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/



The screenshot shows a web browser window with the URL valeromaspez.shinyapps.io/tunamse_epo_eng/. The page has a navigation menu with the following items: "MSE Game for EPO Bigeye tuna", "Information", "Ex 1. Manual Management", "Ex 2. HCR Management", "Ex 3. HCR selection", and "Settings". The "Introduction" tab is selected, displaying a detailed illustration of a Bigeye tuna fish. Below the illustration, the text reads: "Example Toy Management Strategy Evaluation (MSE)" followed by a paragraph: "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 a point on the trajectory. The plot is divided into four colored regions: red (top-left), orange (top-right), green (bottom-right), and yellow (bottom-left).

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)

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 green horizontal line at 1.0. The top-right plot shows Catch ('000t) over time, fluctuating between approximately 50 and 150. The bottom-left plot shows Exploitation rate / F_{MSY} over time, with a green horizontal line at 1.0. The bottom-right plot is a phase diagram with Exploitation rate / F_{MSY} on the y-axis (0.0 to 3.0) and Biomass / B_{MSY} on the x-axis (0.0 to 3.0). The plot is divided into four quadrants: top-left is red, top-right is orange, bottom-left is yellow, and bottom-right is green. A black line with data points shows the trajectory of the fishery over time, starting in the red quadrant and moving towards the green quadrant.



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)

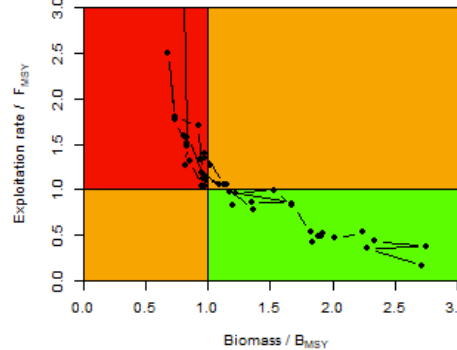
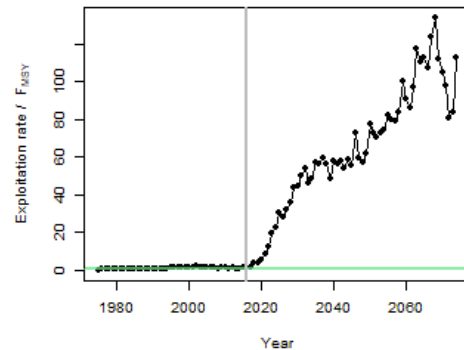
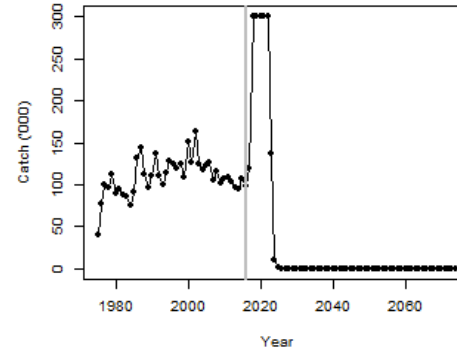
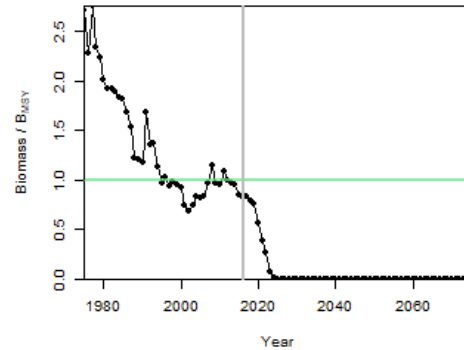
35

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
- Catch variability

- Are all indicators equally important?
- What is the time period of interest? Short, medium, long term?

Configuration panel

C:/MSE/Engagement/TunaMSE/runapp.r - Shiny
http://127.0.0.1:5444 | Open in Browser | Publish

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

10

Last year of simulation

100

Number of years to compute outputs over

50

Random number seed

42

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

0.4

Catch Reference ('000)

180

Implement Updates

Type of scenario

Not used now

Number of simulations

Not used now

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

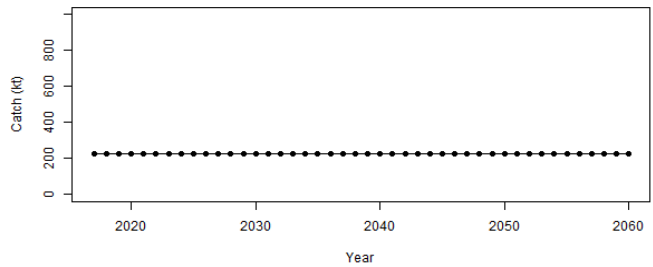
Catch ('000t)
0 225

The catch limit in every year

Number of simulations
15

Run simulations

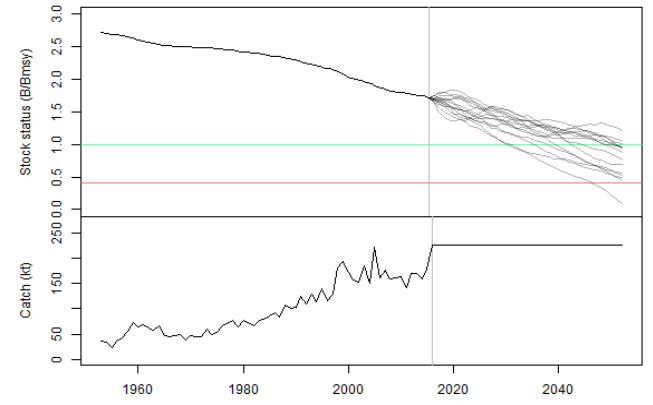
Harvest control rule



Catch (kt)

Year

Simulation outcomes



Stock status (BBmsy)

Catch (kt)

Year

The simulation outcomes graph consists of two vertically stacked panels. The top panel shows 'Stock status (BBmsy)' on the y-axis (0 to 3.0) and 'Year' on the x-axis (1960 to 2040). A single line starts at approximately 2.8 in 1960 and gradually declines to about 1.8 by 2020. At 2020, the line splits into multiple trajectories, representing different simulation runs. A horizontal green line is drawn at approximately 1.0, and a horizontal red line is drawn at approximately 0.5. The bottom panel shows 'Catch (kt)' on the y-axis (0 to 250) and 'Year' on the x-axis (1960 to 2040). The catch starts at approximately 50 in 1960 and increases steadily to about 200 by 2020. At 2020, the catch jumps to a constant value of 225, which is indicated by a vertical line in the graph.

Exercise (2) – HCR management

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

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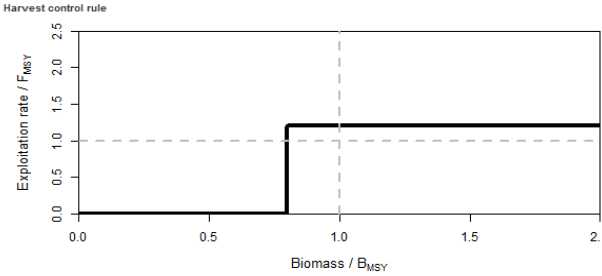
Type of HCR:
Threshold Exp. Rate

Maximum exploitation rate (F_{target}):
1.2

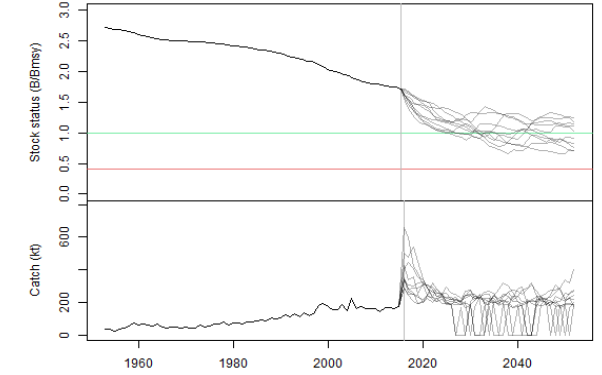
Range (B_{lim} & B_{thresh}):
0.8

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

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.

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Type of HCR:

Maximum exploitation rate (F_{target})

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

Number of simulations

Harvest control rule

Simulation outcomes

Catch (kt)	HCR	Type	Catch	Exp. rate	F _{mult}	B _{lim}	B _{thresh}	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.
 F_{flag}, B_{lim} and B_{thresh} define the threshold harvest control rule.

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.

HCR	Type	Catch	Exp. rate	F _{mult}	B _{lim}	B _{thresh}	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
 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

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Plot trajectories for which HCR?

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Use this to choose which HCR to plot trajectories for.

Key

HCR control parameters

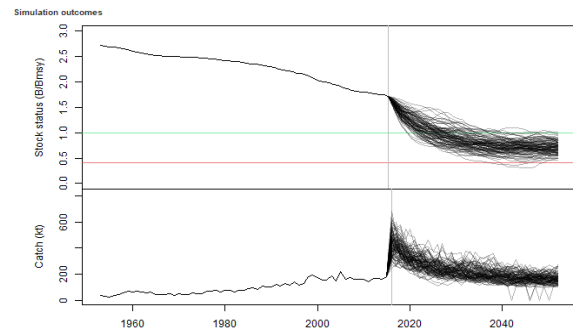
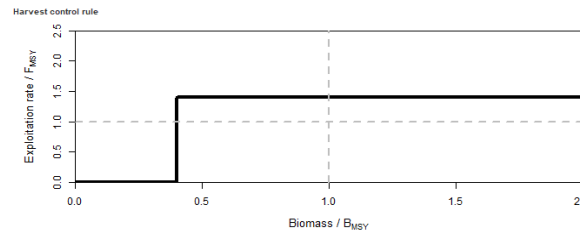
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 *Exp. rate is the constant exploitation rate.
 F_{flag}, B_{lim} and B_{thresh} define the threshold harvest control rule.

Performance indicators

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

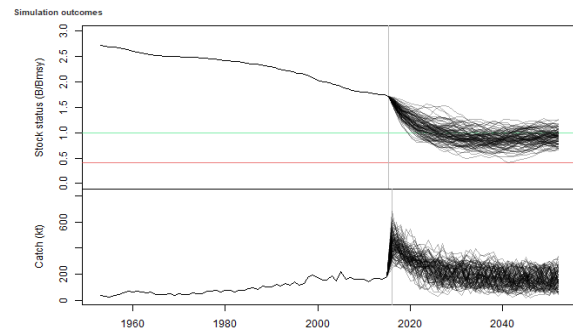
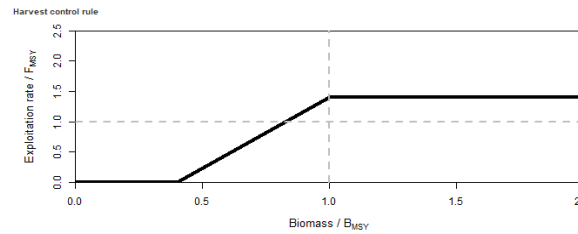
Examples of game results

HCR 1



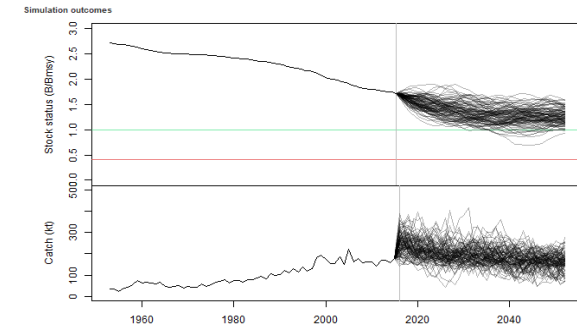
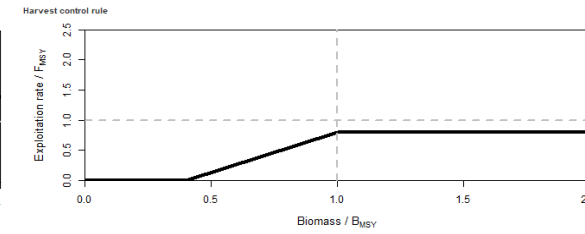
Aggressive

HCR 2



Moderate

HCR 3

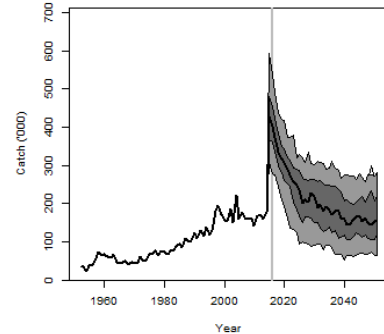
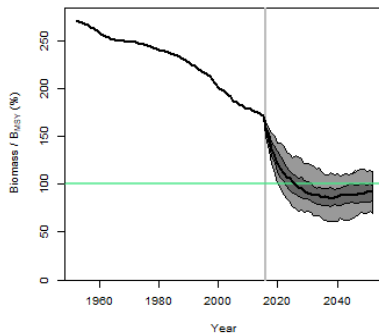
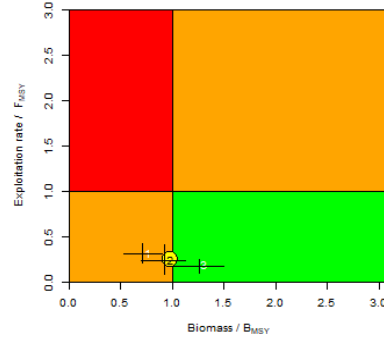
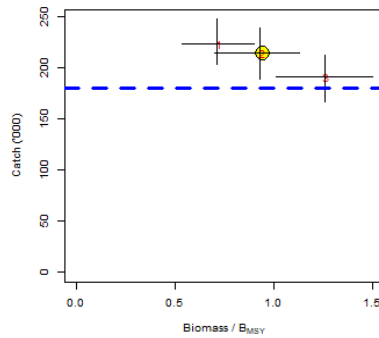


Conservative

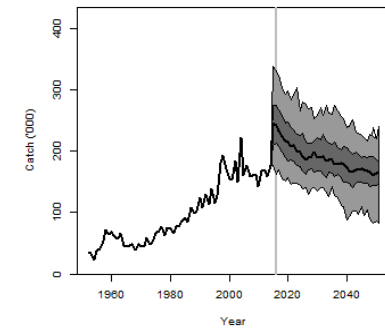
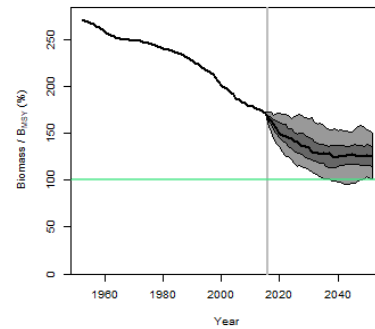
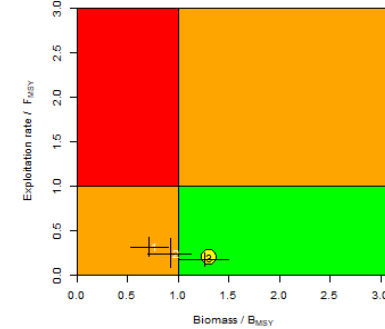
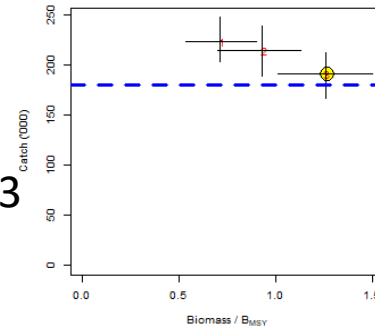
Examples of game results

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?