

Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission



TOY BET Management Strategy Evaluation game

3rd IATTC Tropical Tuna MSE Workshop, *by videoconference*, December 08-09, 2022



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/

MSE Game for EPO Bigeye tuna

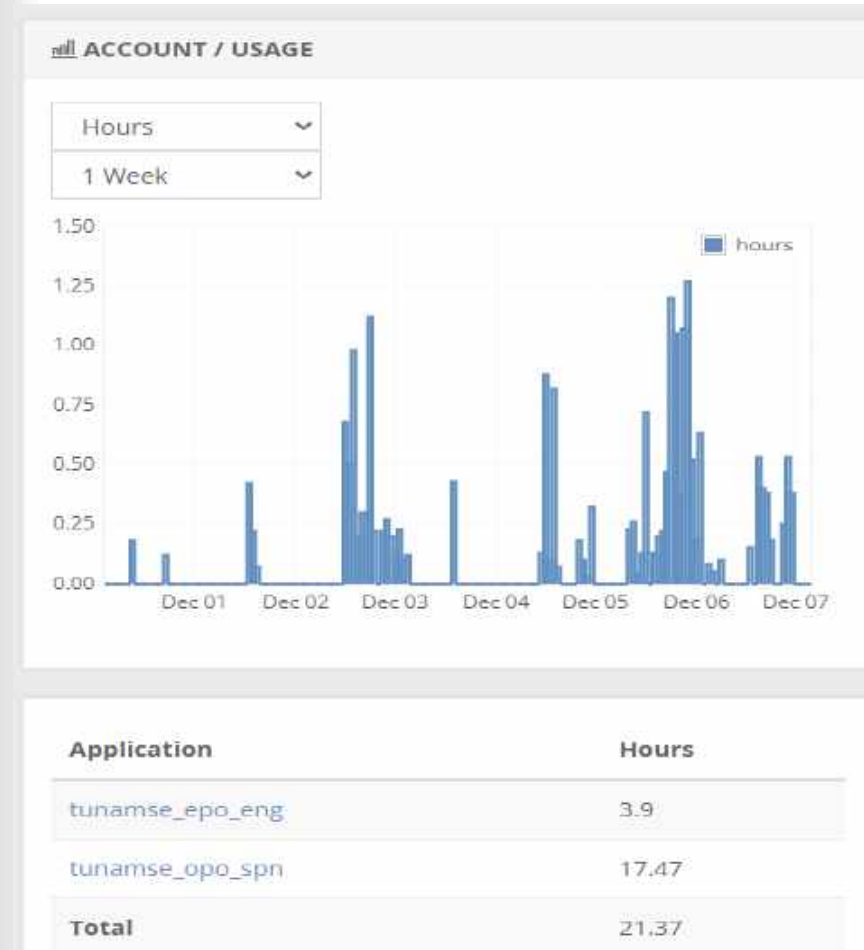
Information Ex 1. Manual Management Ex 2. HCR Management Ex 3. HCR selection Settings

Introduction



Example Toy Management Strategy Evaluation (MSE)

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

The four plots show the following data trends:

- Biomass / B_{MSY} vs Year:** Shows a general decline from 1980 to 2010, with a horizontal green line at 1.0. A red arrow points to the line.
- Catch (000) vs Year:** Shows high variability in catch over time, with a red arrow pointing to the line.
- Exploitation rate / F_{MSY} vs Year:** Shows an overall increasing trend in exploitation rate, with a horizontal green line at 1.0. A red arrow points to the line.
- Phase Plot:** Shows the relationship between F_{MSY} (y-axis) and B_{MSY} (x-axis). The plot is divided into four colored quadrants: red (top-left), orange (top-right), green (bottom-right), and yellow (bottom-left). A yellow dot marks the current state of the fishery, which is in the red quadrant, indicating overfishing and low biomass.

Performance indicators: values

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

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Catch limit (000t)

Catch limit duration (yrs)

Performance indicators: plots

Performance indicators: values

Year	Biomass / B_{MSY}	Catch (000)	Exploitation rate / F_{MSY}
1980	2.5	50	0.5
1990	1.5	100	1.0
2000	1.0	120	1.5
2010	0.8	100	1.0
2020	0.8	120	1.0



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

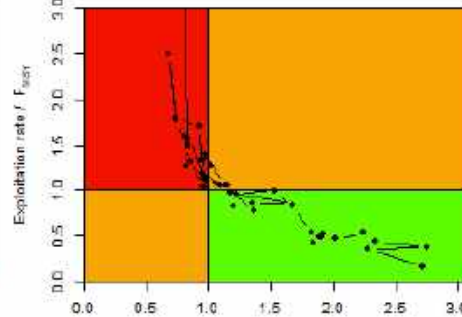
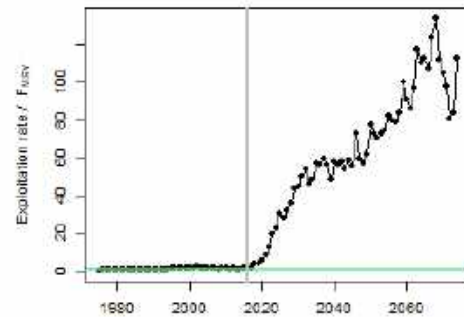
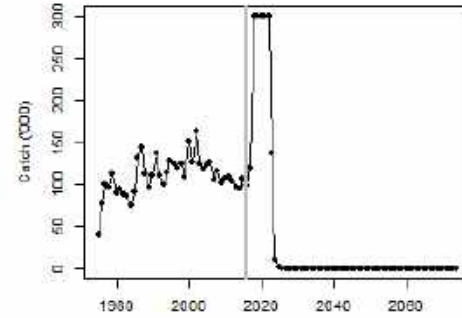
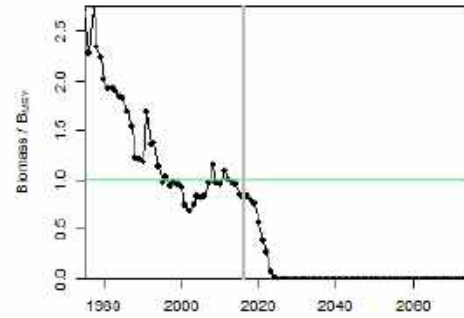
Catch limit duration (yrs)

35

Apply management

Restart

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



Future catch 300,000 t

Management cycle 35 years

Last year

Overall

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.

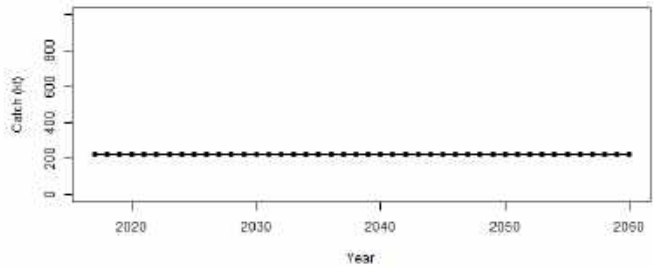
Note: The <simulation outcomes> graph is ONLY updated when the <Run Simulations> button is pressed.

Type of HCR:
Constant Catch

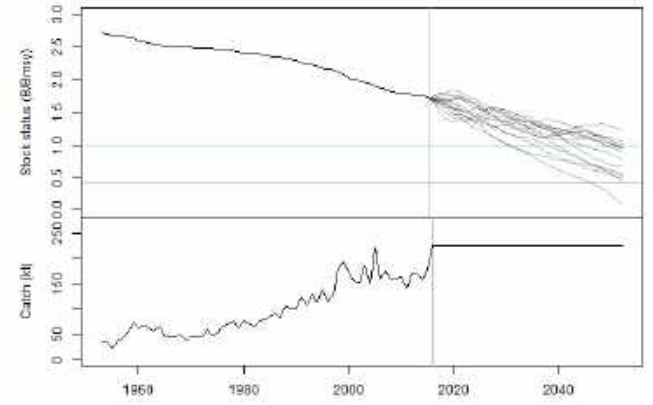
Catch ('000t)
0 25 50 75 100 125 150 175 200 225

The specified strategy:
Number of simulations
15
Run simulations

Harvest control rule



Simulation outcomes



Exercise (2) – HCR management

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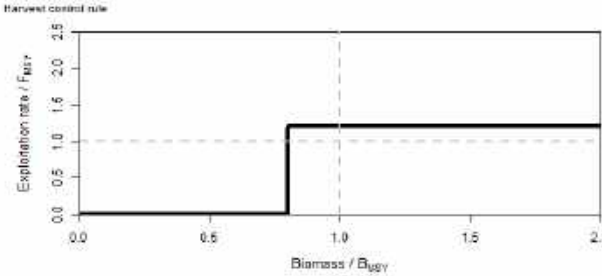
Type of HCR:
Threshold Exp. Rate

Maximum exploitation rate (F_{targ}):
0.0

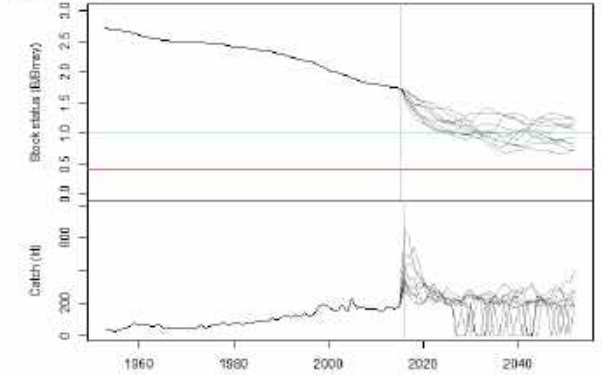
Range (B_{lim} & B_{thresh}):
0.0

Number of simulations:
10

Harvest control rule



Simulation outcomes



Exercise (2) – HCR management

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Type of HCR:
Threshold Exp. Rate

Maximum exploitation rate (F_{target})
0.5

Range (B_{lim} & B_{thresh}):
0.5 1

Number of simulations
10

Harvest control rule

Simulation outcomes

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

Median Depletion (%)

*Prob. green

*Catch

*Catch var.

Exercise (2) – HCR management

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 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?

Use this to choose which HCR to plot trajectories for:

Key

HCR control parameters

- Catch: initial catch
- Exp. rate: the constant exploitation rate
- Fmult: biomass growth multiplier
- Blim: biomass threshold above which harvest control is 0
- Bthresh: biomass threshold below which harvest control is 0

Performance indicators

- Median depletion (%): Median of B_{t+1}/B_t
- Prob. green: probability of being above B_{lim} and B_{thresh}
- Catch: median catch over the simulation

Candidate HCRs Plots

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	200.2
3	Threshold	NA	NA	0.8	0.4	1.2	48.2	0.661	184.8

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

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Performance indicators

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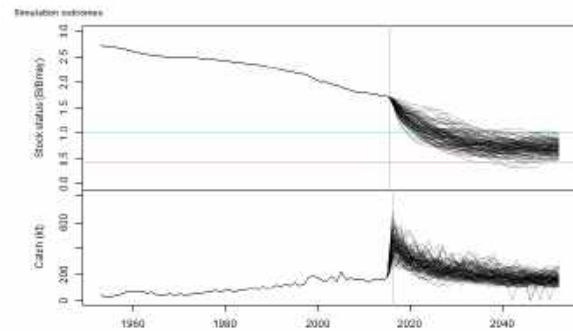
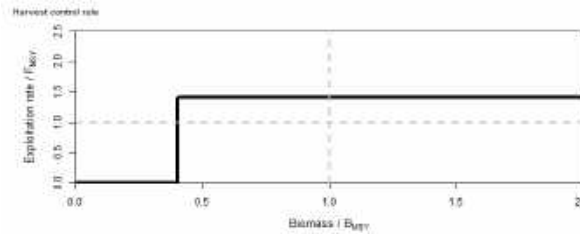
Candidate HCRs Plots

Harvest (H_{t+1} , %)

Catch (C_{t+1})

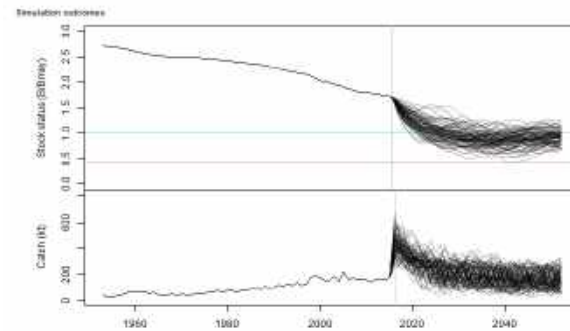
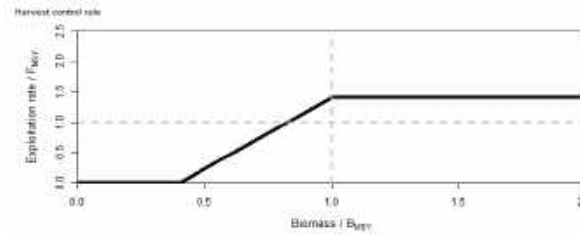
Examples of game results

HCR 1



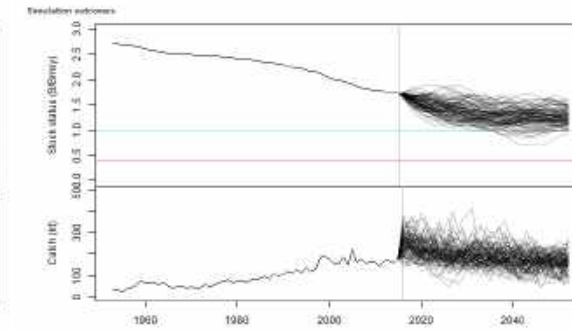
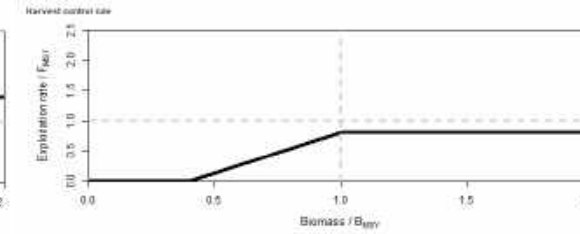
Aggressive

HCR 2



Moderate

HCR 3

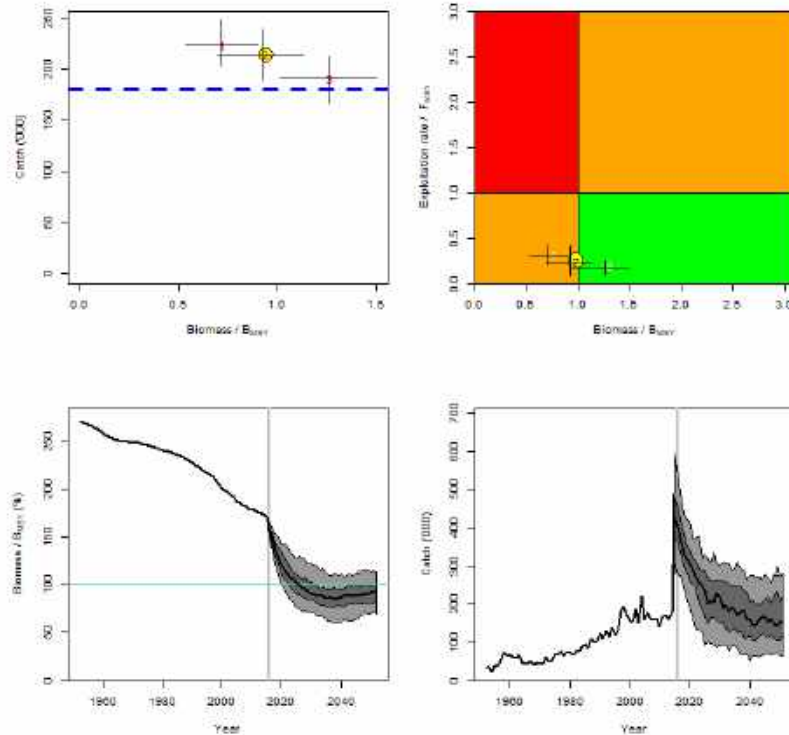


Conservative

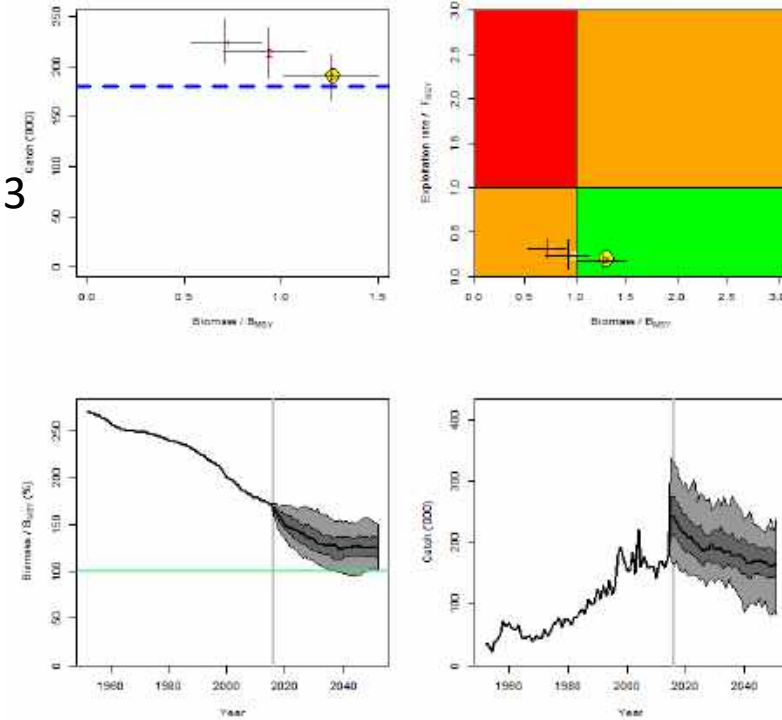
Examples of game results

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

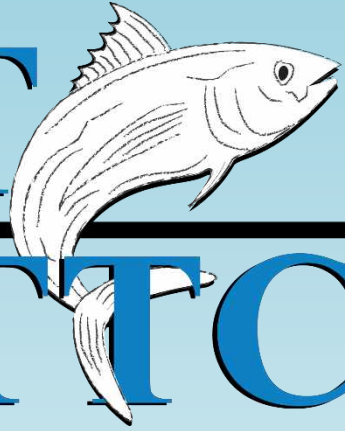
HCR 2



HCR 3



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Questions?