

Development of a Decision Support Tool for Gulf of Mexico Red Snapper

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03/14/2019

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Acknowledgement



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Why we need to develop a MSE tool?

- Feedback should be included in the operating model to highlight useful management strategies that warrant management objectives.
- Interactions among stakeholders can lead to improve in their understanding of the assessment-management system and acceptance of the final management decisions.
- Consistent communication and outreach will eventually improve comprehension and transparency of management decisions.
- Our decision-support tool will enhance the participation of stakeholders.

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Project Goals

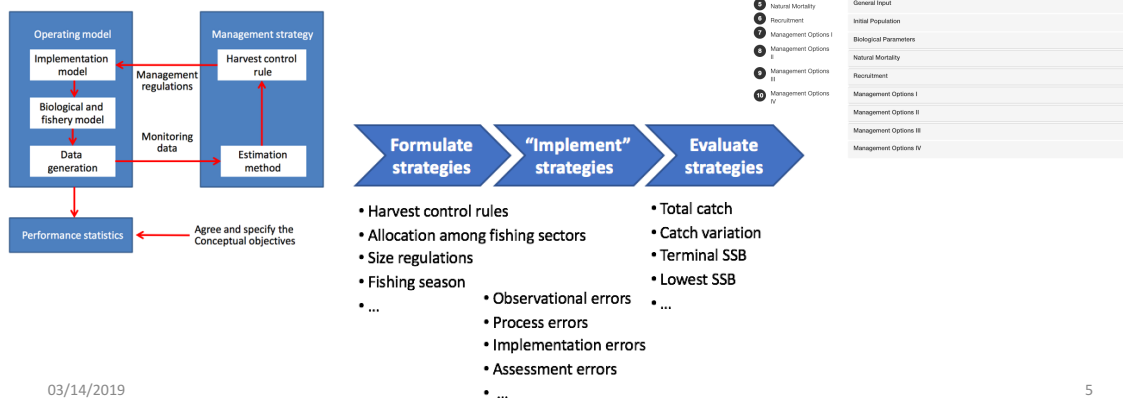
- **Developing a tool that necessary to perform a full MSE**
 - Not performing the MSE itself
 - Determination of management actions requires wide scale interaction among all stakeholders (including managers).
 - Once the tool is developed, user groups can use it to explore management options and tradeoffs among them.
- **Requires understanding:**
 - Biology (spatial structure, productivity dynamics, ...)
 - Fishery (selectivity, fishing behavior, ...)
 - Socioeconomic (profit, days fished, ...)
 - Management (reference points, rebuilding plans, TACs, ...)
 - Performance measures (stability of yield, population size, ...)

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In what parts stakeholders can participate?

- Model structure design
- Detailed constrains in the MSE components
- User-friendly interface



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Outline

- Backstage management of our website
- Our user-friendly interface
- Detailed model structure and components in our MSE tool

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Fishery

Login

Welcome to the GoMRedSnapperMSE Project

An interactive web-based decision-support tool for better managing Gulf of Mexico red snapper fishery resources.
Designed and maintained by the [Fisheries and Ecosystem Assessment Lab](#) supported by [NOAA RESTORE ACT PROGRAM](#).

Statistics

Visitors	Registered Users	Saved Management Scenarios
77	5	3

Objectives

In this project, the research team will develop a decision-support tool based on a management strategy evaluation framework for the Gulf of Mexico red snapper fishery. The tool will help quantify the risks and trade-offs among the various alternative long-term management strategies and potential short-term regulations that might be used for the rebuilding and sustainable management of the Gulf of Mexico red snapper resource.

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Fishery

Login

Welcome to the GoMRedSnapperMSE Project

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Sign In

Enter your login and password below:

Username:

Password:

[Sign In](#)

[Register](#)

Fill out the registration form

User Name *	y222zhang
First Name *	Yuying
Last Name *	Zhang
Email *	yuyingzhang@105078men.com
Password *	<input type="password"/>
Confirm Password	<input type="password"/>
<input type="checkbox"/> I'm not a robot	

[New ID](#)

Activation Email

Hello Yuying Zhang

Please go to activation page to finish your registration, your username is **y222zhang**

[Follow this link to activate](#)

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Fishery

Guest MSE

Yuying Zhang

List Process

Search

Record Count: 1

Process Name	Created By	Created On	Changed By	Changed On	Process Public	Process Simple
test new 3	admin admin	2019-01-16 11:07:11	admin admin	2019-01-16 11:07:11	True	True

Fishery

Guest MSE

Yuying Zhang

Guest simple version : test new 3

test new 3. [Return](#)

Follow the Management Options below:

1 Stock Assessment Model Input

2 Genral Input

3 Initial Population

4 Biological Parameters

5 Natural Mortality

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Stock Assessment Model Input

Stock1:

Model Type

Input File

Next Step

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List Process

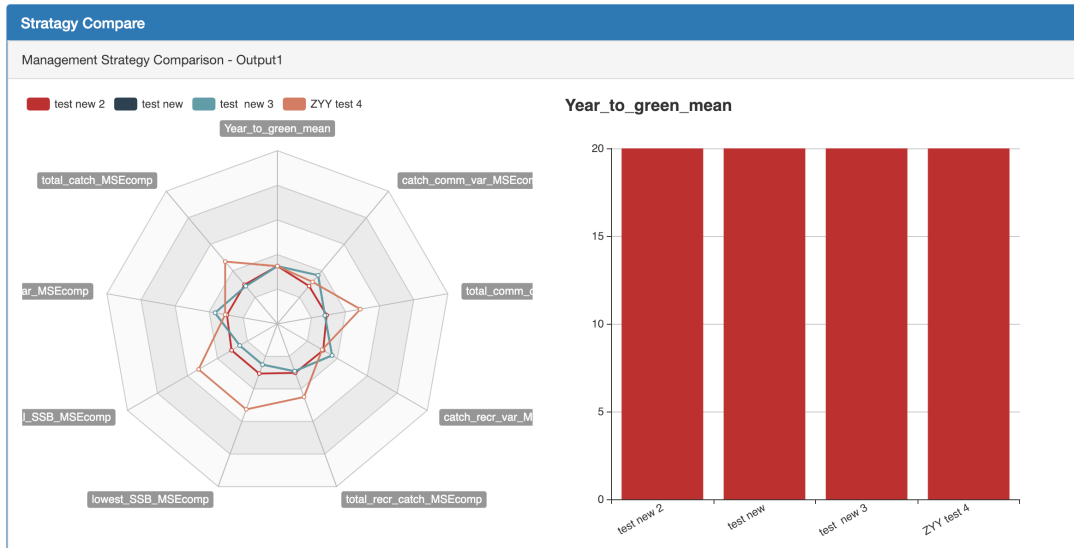
Search

Record Count: 5

	Process Name	Created By	Created On	Changed By	Changed On	Is Public	Is Simple
	ZYY test 5	admin admin	2019-01-21 18:37:00	admin admin	2019-01-21 18:37:00	<input type="checkbox"/>	<input type="checkbox"/>
	test new 2	admin admin	2019-01-16 10:27:24	admin admin	2019-01-16 10:27:24	<input type="checkbox"/>	<input type="checkbox"/>
	test new	admin admin	2019-01-16 11:04:50	admin admin	2019-01-16 11:04:50	<input type="checkbox"/>	<input type="checkbox"/>
	test new 3	admin admin	2019-01-16 11:07:11	admin admin	2019-01-16 11:07:11	<input type="checkbox"/>	<input type="checkbox"/>
	ZYY test 4	admin admin	2019-01-21 18:07:50	admin admin	2019-01-21 18:07:50	<input type="checkbox"/>	<input type="checkbox"/>

Process Name	Created By	Created On	Changed By	Changed On	Process Public	Process Simple
test new 2	admin admin	2019-01-16 10:27:24	admin admin	2019-01-16 10:27:24	True	True
test new	admin admin	2019-01-16 11:04:50	admin admin	2019-01-16 11:04:50	True	True
test new 3	admin admin	2019-01-16 11:07:11	admin admin	2019-01-16 11:07:11	True	True
ZYY test 4	admin admin	2019-01-21 18:07:50	admin admin	2019-01-21 18:07:50	True	True

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List Process

Search

Record Count: 5

	Process Name	Created By	Created On	Changed By	Changed On	Is Public	Is Simple
	ZYY test 5	admin admin	2019-01-21 18:37:00	admin admin	2019-01-21 18:37:00	<input type="checkbox"/>	<input type="checkbox"/>
	test new 2	admin admin	2019-01-16 10:27:24	admin admin	2019-01-16 10:27:24	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	test new	admin admin	2019-01-16 11:04:50	admin admin	2019-01-16 11:04:50	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	test new 3	admin admin	2019-01-16 11:07:11	admin admin	2019-01-16 11:07:11	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	ZYY test 4	admin admin	2019-01-21 18:07:50	admin admin	2019-01-21 18:07:50	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Process Name	Created By	Created On	Changed By	Changed On	Process Public	Process Simple
test new 2	admin admin	2019-01-16 10:27:24	admin admin	2019-01-16 10:27:24	True	True
test new	admin admin	2019-01-16 11:04:50	admin admin	2019-01-16 11:04:50	True	True
test new 3	admin admin	2019-01-16 11:07:11	admin admin	2019-01-16 11:07:11	True	True
ZYY test 4	admin admin	2019-01-21 18:07:50	admin admin	2019-01-21 18:07:50	True	True

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Future work

- Change the webpages from Hyper Text Transfer Protocol to Hyper Text Transfer Protocol Secure
- Change from single-thread process to multi-thread process
- Add affiliation in registration and also allow people to recover their passwords
- Give registered users more functions
- Allow users to switch from a professional version to a simple version
- Add a discussion board

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Fishery Security Management MSE Guest MSE admin admin										
Stock File										
List Stock File										
Search										
+ - Record Count: 1										
	File Name	Description	SSB(msy)	F(msy)	Created By	Created On	Changed By	Changed On	Is Default	Download
Q	OFL.zip	Official zip file for MSE	1230000000000000.0	0.0588	admin admin	2018-10-18 11:59:38	None	2018-10-18 11:59:38	<input checked="" type="radio"/>	Download

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Fishery

Security

Management

MSE

Guest MSE

admin admin

List Process

Search

MSE Management
MSE Comparison
Advanced MSE

Record Count: 5

	Process Name	Created By	Created On	Changed By	Changed On	Is Public	Is Simple
<input type="checkbox"/>	ZYY test 5	admin admin	2019-01-21 18:37:00	admin admin	2019-01-21 18:37:00	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	test new 2	admin admin	2019-01-16 10:27:24	admin admin	2019-01-16 10:27:24	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	test new	admin admin	2019-01-16 11:04:50	admin admin	2019-01-16 11:04:50	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	test new 3	admin admin	2019-01-16 11:07:11	admin admin	2019-01-16 11:07:11	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	ZYY test 4	admin admin	2019-01-21 18:07:50	admin admin	2019-01-21 18:07:50	<input type="checkbox"/>	<input type="checkbox"/>

Add Process

Process Name

Process Name

Process Description

Process Description

Save

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Fishery

Security

Management

MSE

Guest MSE

admin admin

Simple version : ZYY test 5

interface 5 . [Return](#)

Follow the Management Options below:

1 Stock Assessment Model Input

2 General Input

3 Initial Population

4 Biological Parameters

5 Natural Mortality

6 Recruitment

7 Management Options I

8 Management Options II

9 Management Options III

10 Management Options IV

Stock Assessment Model Input

Stock1:

Model Type

☐ Stock Synthesis 3 ☐ Virtual Population Analysis ☐ Statistical-catch-at-age

Input File

☒ Official Stock Assessment Model ☐ Self-defined Model

Next Step

General Input

Initial Population

Biological Parameters

Natural Mortality

Recruitment

Management Options I

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Simple version : ZYY test 5

interface 5 .

[Return](#)


Follow the Management Options below:

- 1 Stock Assessment Model Input
- 2 **General Input**
- 3 Initial Population
- 4 Biological Parameters
- 5 Natural Mortality
- 6 Recruitment
- 7 Management Options I
- 8 Management Options II
- 9 Management Options III
- 10 Management Options IV

Stock Assessment Model Input

General Input

Time Step ☐ half year ☒ 1 year

Start Projection 

Short-term Management

Long-term Management

Stock per Management Unit

Mixing Pattern ☒ No mixing ☐ Constant ☐ Same over years ☐ Time varies

Last Age in the Plus Group

Number of Iterations

Effective Sample Size For Initial Distribution

Random Seed Setting ☒ Default Seed CSV ☐ Self-defined CSV

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- 2 General Input
- 3 **Initial Population**
- 4 Biological Parameters
- 5 Natural Mortality
- 6 Recruitment
- 7 Management Options I
- 8 Management Options II
- 9 Management Options III
- 10 Management Options IV

Initial Population

Age	Stock 1 Mean (1000s)	Stock 2 Mean (1000s)
0	31555.4	107107
1	27451	53295.5
2	6382.54	6442.11
3	1983.92	2292.41
4	1241.4	4037.14
5	797.06	2435.63
6	535.25	1680.52
7	469.83	1658.56
8	343.24	619.23
9	391.21	803.05
10	344.02	889.84
11	215.9	688.69
12	148.51	474.12
13	91.78	220.21
14	64.27	114.96
15	34.16	67.33
16	26.83	74.02
17	13.61	67.24
18	4.13	36.61
19	5.91	41.09
20	20.54	340.44

Stock 1 Population CV (Normal Dist.)

Stock 2 Population CV (Normal Dist.)

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- 4 Biological Parameters
- 5 Natural Mortality
- 6 Recruitment
- 7 Management Options I
- 8 Management Options II
- 9 Management Options III
- 10 Management Options IV

Biological Parameters				
Age	Stock 1 Weight-at-age (kg)	Stock 1 Fecundity (# of eggs)	Stock 2 Weight-at-age (kg)	Stock 2 Fecundity (# of eggs)
0	0.01	0	0.01	0
1	0.04	0	0.04	0
2	0.28	350000	0.28	350000
3	0.74	2620000	0.74	2620000
4	1.37	9070000	1.37	9070000
5	2.1	20300000	2.1	20300000
6	2.86	34710000	2.86	34710000
7	3.61	49950000	3.61	49950000
8	4.31	64270000	4.31	64270000
9	4.95	76760000	4.95	76760000
10	5.52	87150000	5.52	87150000
11	6.01	95530000	6.01	95530000
12	6.44	102150000	6.44	102150000
13	6.8	107300000	6.8	107300000
14	7.1	111270000	7.1	111270000
15	7.36	114300000	7.36	114300000
16	7.57	116610000	7.57	116610000
17	7.75	118360000	7.75	118360000
18	7.89	119680000	7.89	119680000
19	8.01	120670000	8.01	120670000
20	8.22	123235000	8.22	123235000

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- 4 Recruitment
- 5 Management Options I
- 6 Management Options II
- 7 Management Options III
- 8 Management Options IV

Constant natural mortality

Decrease complexity

Increase complexity

Age	Mean M for Stock 1 (year ⁻¹)	Mean M for Stock 2 (year ⁻¹)
0	1	1
1	1.6	1.6
2	0.7	0.7
3	0.17	0.17
4	0.14	0.14
5	0.12	0.12
6	0.11	0.11
7	0.1	0.1
8	0.1	0.1
9	0.09	0.09
10	0.09	0.09
11	0.09	0.09
12	0.09	0.09
13	0.09	0.09
14	0.09	0.09
15	0.09	0.09
16	0.09	0.09
17	0.09	0.09
18	0.09	0.09
19	0.09	0.09
20	0.09	0.09

High M Low M Current M

CV for Stock1 Population (Log-normal Dist.) 0.20

CV for Stock2 Population (Log-normal Dist.) 0.20

Fraction before Spawning 0.50

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Recruitment

CV for Recruitment: 0.30

23.00 % to Stock 1 77.00 % to Stock 2

☐ From Historical

☐ Include Years Before 1984

Historical R (1000s)

☐ Lower 25% 113675.25

☐ Median 146166.88

☐ Mean 146166.88

☐ Upper 25% 187950.69

Other percentile % Calculate

☐ Exclude Years Before 1984

Historical R (1000s)

☐ Lower 25% 97081.76

☐ Median 116746.32

☐ Mean 116746.32

☐ Upper 25% 140394.06

Other percentile % Calculate

☒ From Formula

☒ Modified Beverton-Holt Model

☐ R0 Include Years Before 1984

R0 110125.84

☒ R0 Exclude Years Before 1984

R0 163211.14

SSB0 4715340000000.00

Steepness 0.99

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Management Options I

Biological Reference Points

SSB_{MSY} 123000000000000.00 eggs

F_{MSY} 0.0588

Fisheries Status

F

MFMT

MSGF

SSB

Harvest control rule

☐ Constant C ☒ Constant F

F

0.0588

0.041

SSB

CV for Implementation Uncertainty 0.20

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- Management Options I
- 8 Management Options II**
- 9 Management Options III
- 10 Management Options IV

Management Options II

Allocation among Sectors

Recreational	Commercial
<input type="text" value="51.00"/> %	<input type="text" value="49.00"/> %

Allocation among Recreational Sectors

For Hire	Private
<input type="text" value="45.10"/> %	<input type="text" value="54.90"/> %

Allocation among For Hire Segments

Headboat	Charter Boat
<input type="text" value="50.00"/> %	<input type="text" value="50.00"/> %

Probability of Overfishing (OFL -> ABC)

P* %

Acceptable Catch Target (ACT) Buffer

For Commercial Sector	<input type="text" value="0.00"/> %
For Private Sector	<input type="text" value="20.00"/> %
For Forhire Sector	<input type="text" value="20.00"/> %

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- II
- 9 Management Options III**
- 10 Management Options IV

Management Options III

Regulations

Minimum Size

Commercial	<input type="text" value="13.00"/> inch
Recreational	<input type="text" value="16.00"/> inch

Recreational Bag Limit

For For Hire	<input type="text" value="10"/> # of fish per bag
For Private	<input type="text" value="10"/> # of fish per bag

(Hint: will scale the catch rate)

Release Mortality

Recreational Stock1 Open	<input type="text" value="11.80"/> %	Recreational Stock1 Closed	<input type="text" value="11.80"/> %
Recreational Stock2 Open	<input type="text" value="11.80"/> %	Recreational Stock2 Closed	<input type="text" value="11.80"/> %
Commercial hardline Stock1 Open	<input type="text" value="56.00"/> %	Commercial hardline Stock1 Closed	<input type="text" value="55.00"/> %
Commercial hardline Stock2 Open	<input type="text" value="60.00"/> %	Commercial hardline Stock2 Closed	<input type="text" value="74.00"/> %
Commercial longline Stock1 Open	<input type="text" value="64.00"/> %	Commercial longline Stock1 Closed	<input type="text" value="55.00"/> %
Commercial longline Stock2 Open	<input type="text" value="81.00"/> %	Commercial longline Stock2 Closed	<input type="text" value="74.00"/> %

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- 9 Management Options III
- 10 Management Options IV

Management Options IV

Recreational Season length

☒ Determined by ACT

(Hint: bag limit for for hire is, current 10/day, planned 10/day)

Catch Rate for For Hire 220000.00 lb/day

(Hint: bag limit for private is, current 10/day, planned 10/day)

Catch Rate for Private 220000.00 lb/day

☐ Input by User

(Hint: bag limit for for hire is, current 10/day, planned 10/day)

Catch Rate for For Hire 220000.00 lb/day

Length of Season for For Hire 3.00 day

(Hint: bag limit for private is, current 10/day, planned 10/day)

Catch Rate for Private 220000.00 lb/day

Length of Season for Private 3.00 day

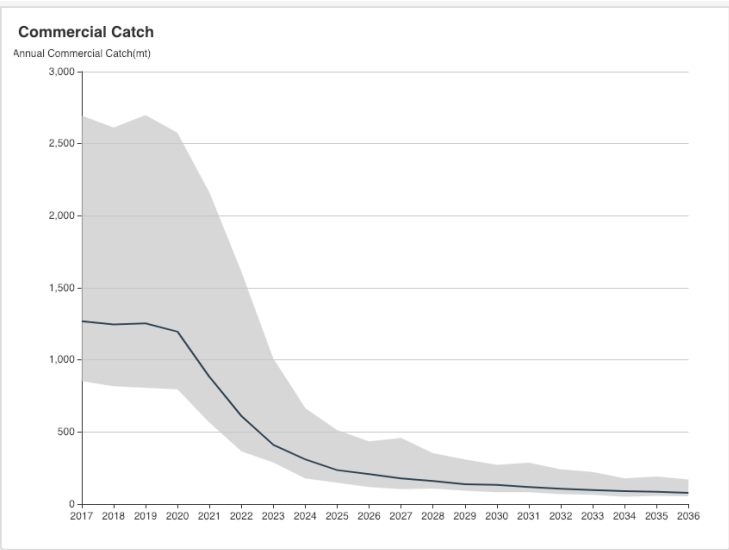
[Go Back](#) [End Step](#)

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- 2 Commercial Catch
- 3 Recreational Catch
- 4 For Hire Catch
- 5 Private Catch
- 6 General Fishing Mortality
- 7 Total SSB
- 8 SSB in Stock1
- 9 SSB in Stock2

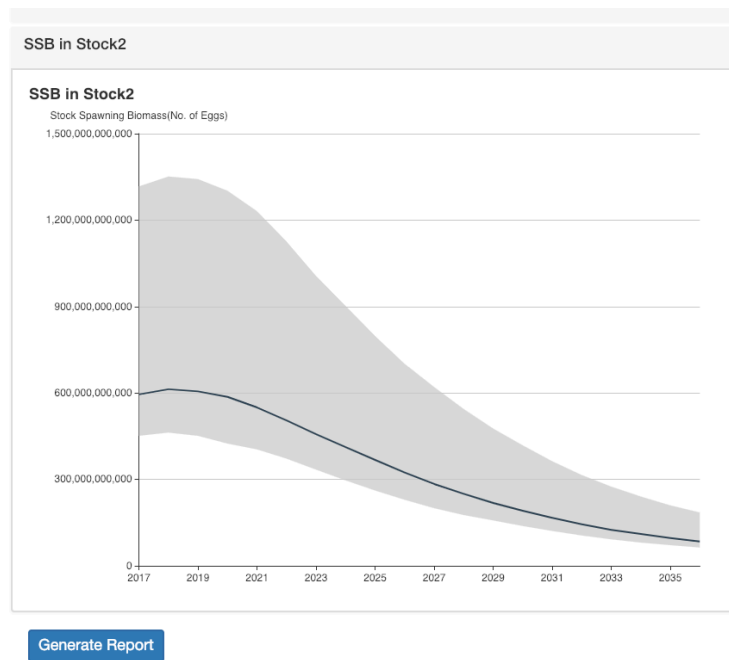


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9 SSB in Stock2



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Fishery Security Management MSE Guest MSE admin admin

MSE Comparison

Search

* Please choose 3~8 records for comparison!

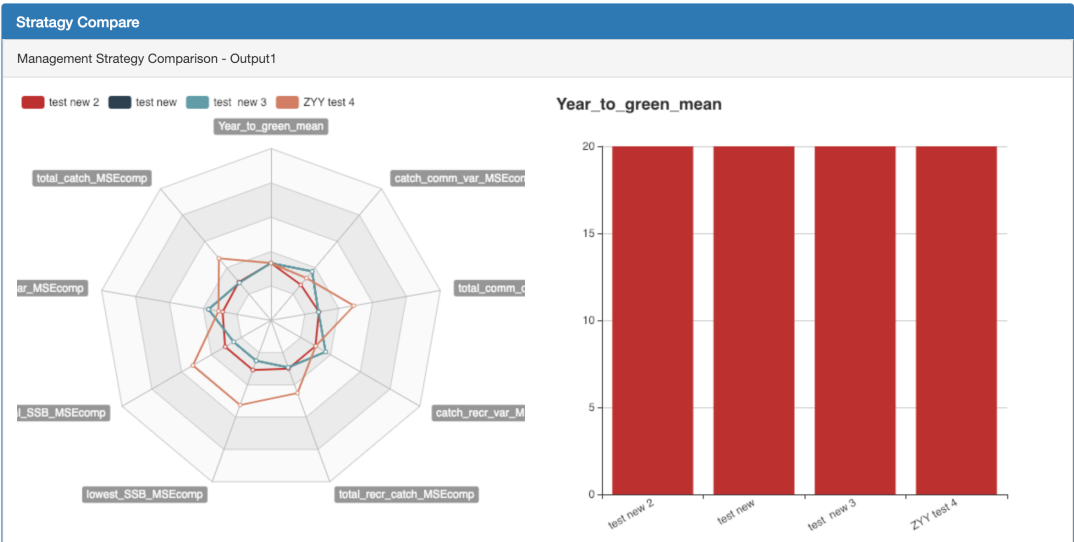
Actions Record Count: 5

	Process Name	Created By	Created On	Changed By	Changed On	Process Simple
<input type="checkbox"/>	test new 2	admin admin	2019-01-16 10:27:24	admin admin	2019-01-16 10:27:24	True
<input type="checkbox"/>	test new	admin admin	2019-01-16 11:04:50	admin admin	2019-01-16 11:04:50	True
<input type="checkbox"/>	test new 3	admin admin	2019-01-16 11:07:11	admin admin	2019-01-16 11:07:11	True
<input type="checkbox"/>	ZYY test 4	admin admin	2019-01-21 18:07:50	admin admin	2019-01-21 18:07:50	True
<input type="checkbox"/>	ZYY test 5	admin admin	2019-01-21 18:37:00	admin admin	2019-01-21 18:37:00	True

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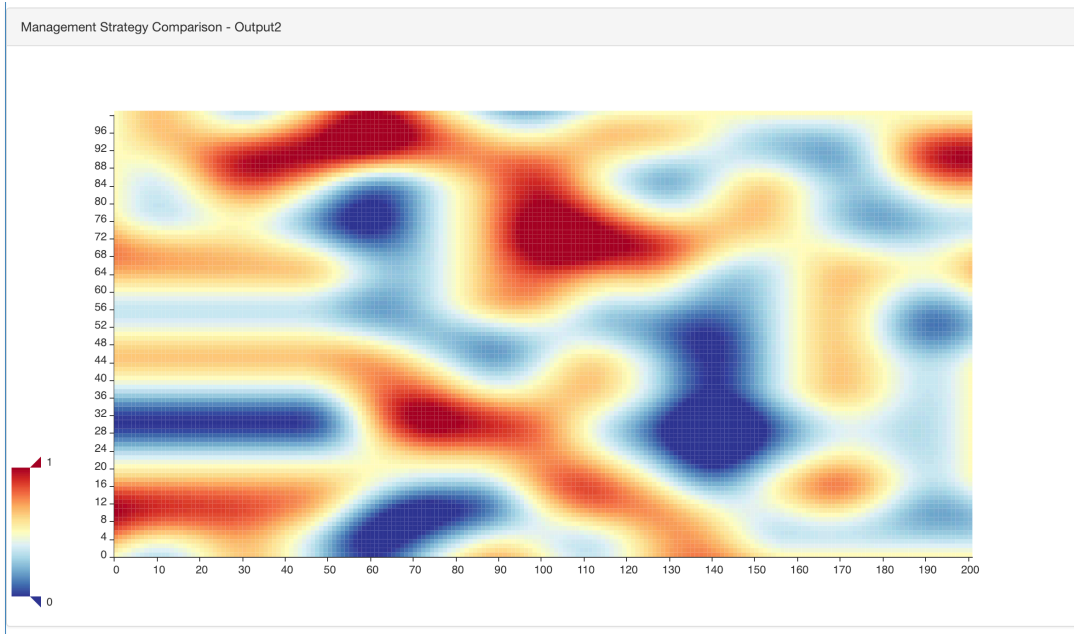
<http://gomredsnappermsetool.fiu.edu/>



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Future work

- Add more performance measures
- Improve MSE comparison
- Finish the advance comparison
- Create an auto output function for comparisons
- Simulate the consequence of annual quota changes to States' recreational landings

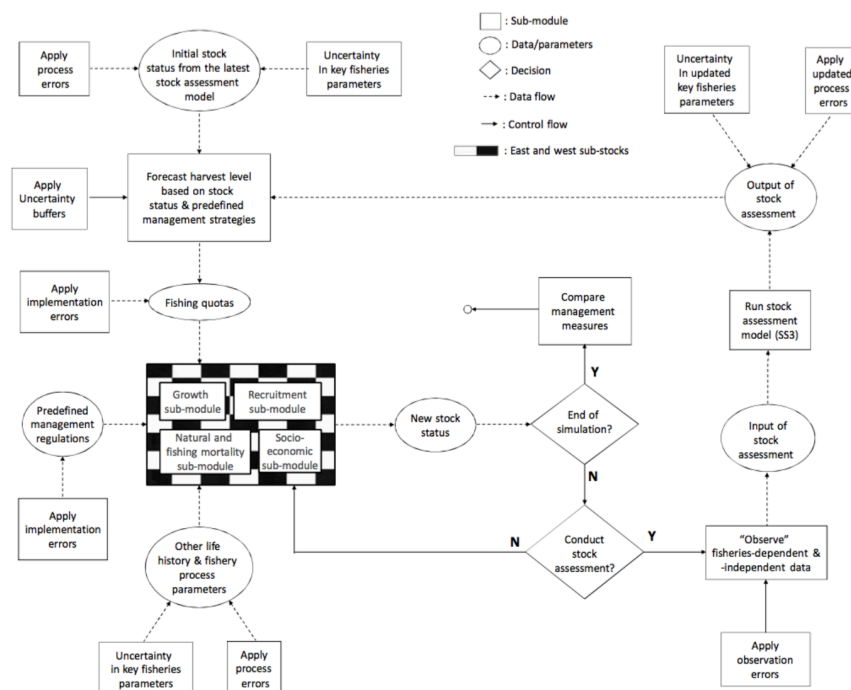
<https://gulfcouncilportal.shinyapps.io/RedSnapperDecisionSupportTool/>

- Add tooltip text

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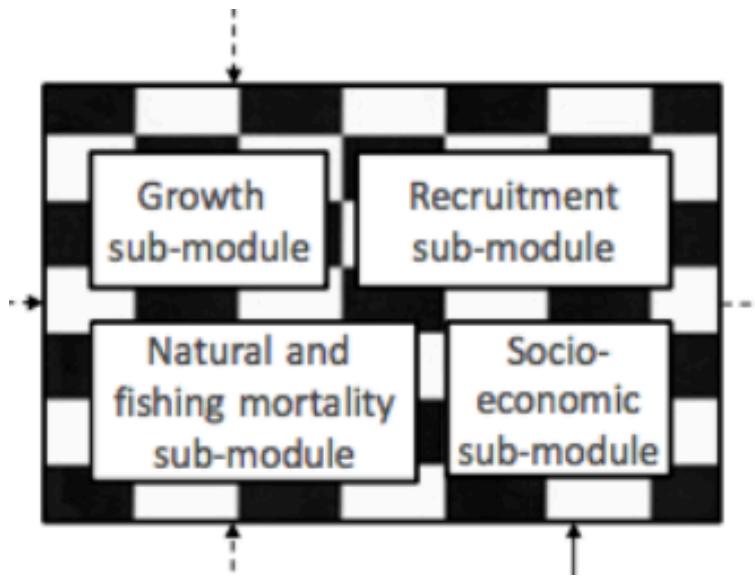
Conceptual model structure



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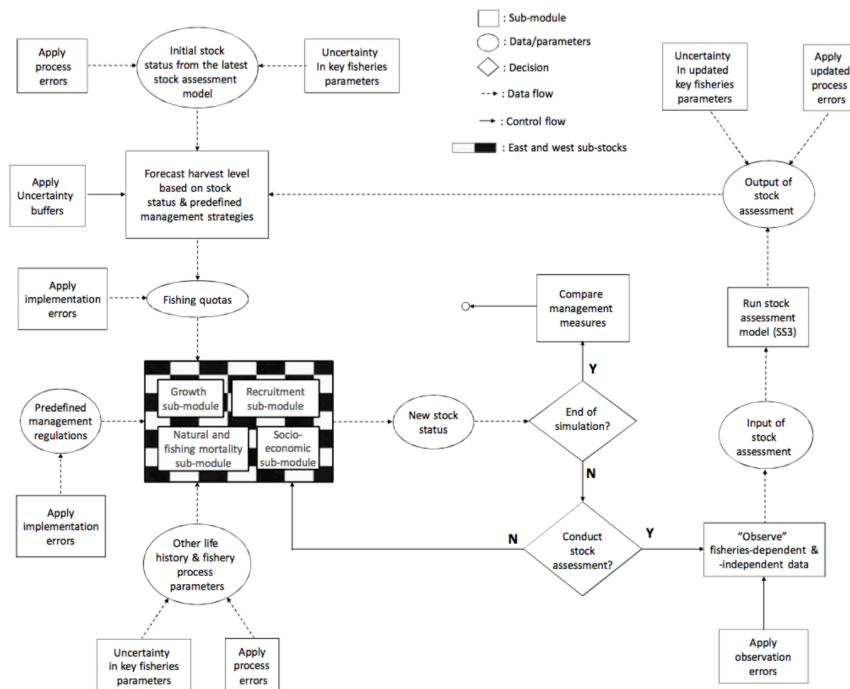
Conceptual model structure



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Conceptual model structure



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Uncertainty

Environmental variations (processor error)
Structural uncertainty (processor error)
Partial observability (observational error)
Partial controllability (implementation error)
Imperfect data sampling for stock assessment
(assessment error)
...

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Detailed model structure and uncertainty

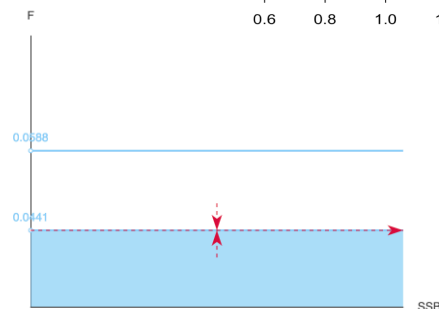
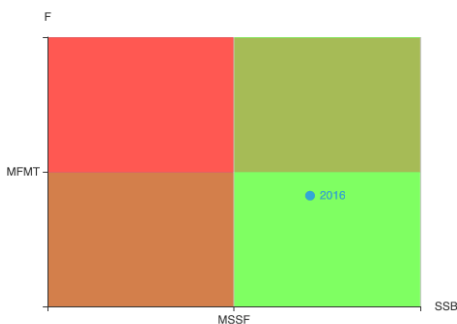
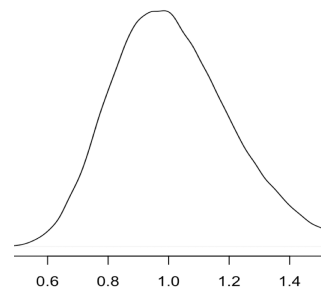
Step 1: Planned fishing mortality (F)

$$F^* = F \times \varepsilon_F$$

$$\ln(\varepsilon_F) \sim \text{Normal}(0, \sigma_F^2)$$

CV for
Implementation
Uncertainty

0.20



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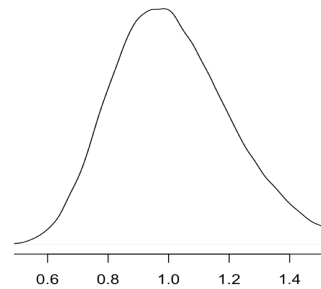
36

Detailed model structure and uncertainty

Step 2: Inherit stock abundance
(N) and age structure

$$N^* = N \times \varepsilon_N$$

$$\ln(\varepsilon_N) \sim \text{Normal}(0, \sigma_N^2)$$



Use a multinomial sampling
approach for age structure

Effective Sample Size For
Initial Distribution

1000

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Detailed model structure and uncertainty

Original



ESS=1000



ESS=1000



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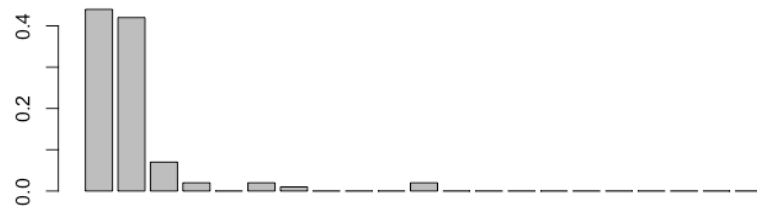
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Detailed model structure and uncertainty

Original



ESS=100



ESS=100



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Detailed model structure and uncertainty

Original



ESS=10



ESS=10



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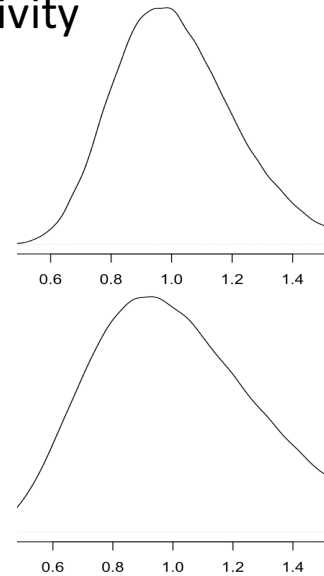
40

Detailed model structure and uncertainty

Step 3: Set life history (M and R), and fisheries process parameters (selectivity and relative F)

$$M^* = M \times \varepsilon_M$$
$$\ln(\varepsilon_M) \sim \text{Normal}(0, \sigma_M^2)$$

$$R^* = R \times \varepsilon_R$$
$$\ln(\varepsilon_R) \sim \text{Normal}(0, \sigma_R^2)$$



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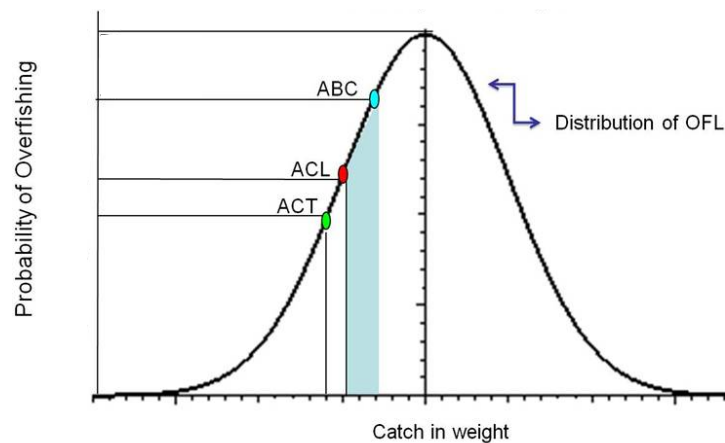
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Detailed model structure and uncertainty

Step 4: Short-term projection for Catch (C) and estimate OFL, ABC and ACL

Probability of Overfishing (OFL → ABC)

P^* %

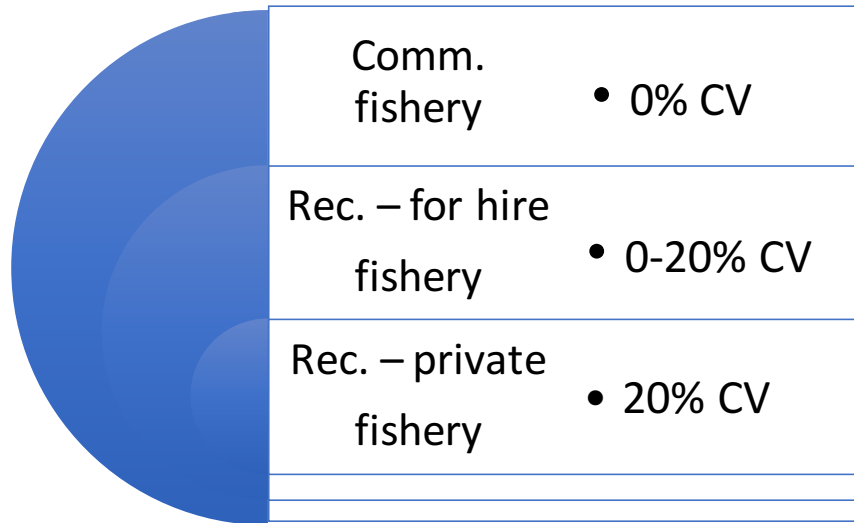


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Detailed model structure and uncertainty

Step 5: Estimate ACT and apply that to fisheries



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Detailed model structure and uncertainty

Step 6: Accountability measures (AM)

Overage for a certain year will be subtracted from the next two years

Management Options IV

Recreational Season length

☒ Determined by ACT

(Hint: bag limit for for hire is, current 10/day, planned 10/day)

Catch Rate for For Hire lb/day

(Hint: bag limit for private is, current 10/day, planned 10/day)

Catch Rate for Private lb/day

☐ Input by User

(Hint: bag limit for for hire is, current 10/day, planned 10/day)

Catch Rate for For Hire lb/day

Length of Season for For Hire day

(Hint: bag limit for private is, current 10/day, planned 10/day)

Catch Rate for Private lb/day

Length of Season for Private day

Go Back

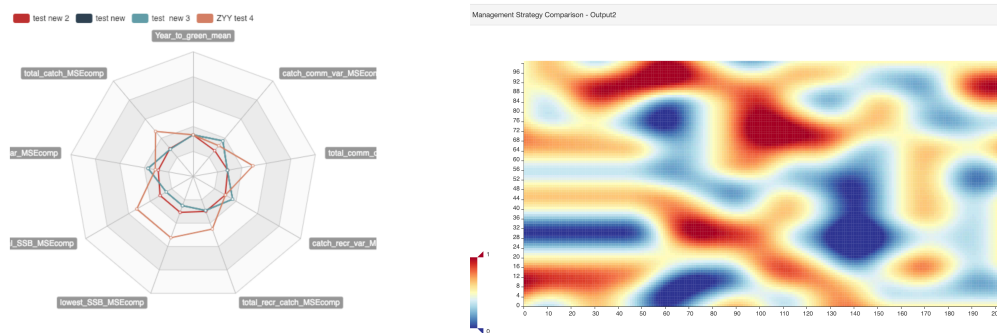
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Detailed model structure and uncertainty

Step 7: Repeat Step 1, but skip Steps 2 and 3

Step 8: Long-term projection to record the details of the simulated fishery and summarize the statistics of performance measures



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Future work

- Evaluate various harvest control rules
- Add assessment error
- Test various stock mixing patterns
- Set higher and lower M to mimic regime shift
- Add more carryover provision alternatives and different strategy to derive ABC from OFL

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Any suggestions or comments?

- Is what we did consistent with reality?
- Is what we plan to do necessary?
- Do we miss anything?