

A Decision Support Tool for evaluating the impacts of short- and long-term management decisions on the Gulf of Mexico Red Snapper Resource

Yuying Zhang*, Daniel Goethel, Matt Smith, Laura Picariello, Yong Chen, Luiz Barbieri, Chris Verlinde, & Juan Agar

*: yzhang13@fiu.edu

07/07/2022

What is MSE?

MSE shorts for "Management Strategy Evaluation"

*Management strategy evaluation uses **computer simulation** methods to quantify the risk associated with a suite of potential fisheries **management actions** (Jones et al. 2009; Punt and Hobday 2009; Kraak et al. 2010; Milner-Gulland et al. 2011).*



MSE components



- Biological reference points
- Harvest control rules
- Allocation among fishing sectors
- Size regulations
- Fishing season
- ...
- Observational errors
- Process errors
- Implementation errors
- Assessment errors
- ...
- Total catch
- Catch variation
- Terminal SSB
- Lowest SSB
- ...

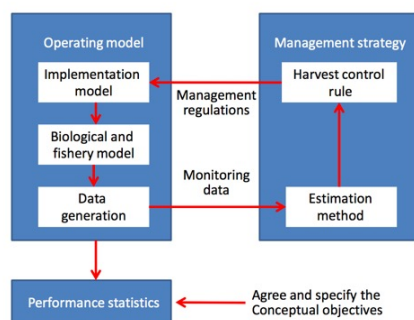


07/07/2022

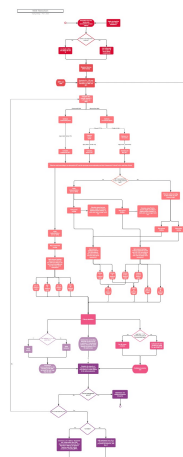
2

Advantages of the GoM Red Snapper MSE Tool

I. Model Structure



(Punt et al., 2016)



3

Advantages of the GoM Red Snapper MSE Tool

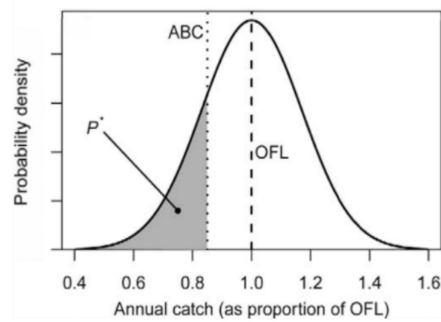
I. Model Structure

- Probability-based catch levels
OFL & ABC

Probability of Overfishing (OFL -> ABC)

P^* %

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



4

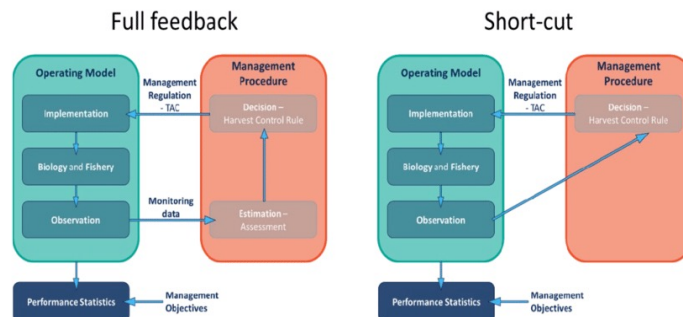
Advantages of the GoM Red Snapper MSE Tool

I. Model Structure

- Assessment error

(Pastoors et al., 2020)

Full MSE vs
Shortcut MSE



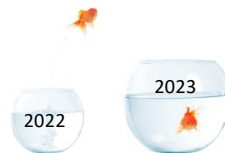
07/07/2022

5

Advantages of the GoM Red Snapper MSE Tool

I. Model Structure

- Management procedure – adjusting ACL
Carryover Provision & Penalty



If the recreational sector did not harvest its ACL, but the commercial harvest exceeded the commercial ACL such that landings for the stock exceeded 100% of the stock ACL, then the recreational ACL for that stock would not be eligible for a carryover in the following fishing year, even though that sector had foregone yield in the previous fishing year.

If the combined sector landings exceed the sector ACL or the stock ACL, there will be no carryover, even if one sector component did not harvest its quota for that fishing year.

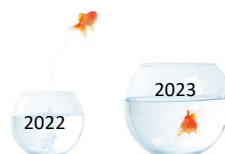
The amount to be carried over to the following year, when added, cannot result in an ABC which is greater than the OFL. (We set two options, 95% of the OFL, or 50% of the difference between ABC and OFL.)

6

Advantages of the GoM Red Snapper MSE Tool

I. Model Structure

- Management procedure – adjusting ACL
Carryover Provision & Penalty



Carryover - If ACT isn't fully harvested

- ☒ No Carryover
- ☐ Carryover to the same sector, component, or state next year, but make sure the actual landing doesn't exceed 95% of the OFL.
- ☐ Carryover to the same sector, component, or state next year, but make sure the actual landing doesn't exceed 50% of the difference between ABC and OFL.

(Diagne *et al.*, 2015)

Penalty - If the actual landing exceeds ACT

- ☐ No Penalty
- ☒ Before 2032, under the rebuilding plan; after 2032, based on the fishery status. The exceeded recreational catch will be deducted from the next year.

7

Advantages of the GoM Red Snapper MSE Tool

I. Model Structure

- Pre-cautionary approach – buffers on quotas
- Estimating ACT from ACL

Acceptable Catch Target (ACT) Buffer

| | | |
|------------------------------------|------------------------------------|---|
| For the Commercial Sector | <input type="text" value="0.00"/> | % |
| For the Federal For-hire Component | <input type="text" value="9.00"/> | % |
| For the Private Angling Component | <input type="text" value="20.00"/> | % |

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

Alternative 2: Modify the red snapper OFL, ABC, ACLs, and recreational ACTs for 2022 and subsequent years based on the OFL and ABC recommendation of the Scientific and Statistical Committee (SSC) at the March 8 - 10, 2022, SSC meeting. These catch limits are based on data derived from the Great Red Snapper Count (GRSC), including a post-stratification analysis of the data for Florida, and on the LGL Ecological Associates, Inc. study (LGL study) of the absolute abundance of red snapper off Louisiana.

| Catch Limit Type | Current Catch Limits | Calculation |
|----------------------|----------------------|--------------------------------|
| OFL | 18,910,000 | N/A |
| ABC | 16,310,000 | 13.7% less than OFL |
| Total ACL | 16,310,000 | ACL = ABC |
| Commercial ACL | 8,318,100 | 51% of ABC |
| Recreational ACL | 7,991,900 | 49% of ABC |
| Federal For-Hire ACL | 3,380,574 | 42.3% of Recreational ACL |
| Federal For-Hire ACT | 3,076,322 | 9% less than For-Hire ACL |
| Private Angling ACL | 4,611,326 | 57.7% of Recreational ACL |
| Private Angling ACT | 3,659,061 | 20% below Private Angling ACL |
| Florida ACL | 2,066,889 | 44.822% of Private Angling ACL |
| Alabama ACL | 1,212,687 | 26.298% of Private Angling ACL |
| Mississippi ACL | 163,702 | 3.55% of Private Angling ACL |
| Louisiana ACL | 881,686 | 19.12% of Private Angling ACL |
| Texas ACL | 286,363 | 6.21% of Private Angling ACL |

8

Advantages of the GoM Red Snapper MSE Tool

II. User-friendly Inputs

Follow the Management Options below:

1 General Inputs

2 Natural Mortality

3 Recruitment

4 Management Options I - Harvest Control Rule

5 Management Options II - Allocations

6 Management Options III - Regulations

7 Management Options IV - Release Mortality

8 Management Options V - Recreational Sector Options for ACT

9 Management Options VI - Penalty & Carryover

10 Management Options VII - Private Angling Quota among States

General Inputs

Natural Mortality

Recruitment

Management Options I

Management Options II

Management Options III

Regulations

Legal Size

Minimum Legal Size for Commercial Fleets

13.00

inch

Minimum Legal Size for Recreational Fleets

16.00

inch

Bag Limit for Recreational Fleets

For Federal For-hire Fleets

2

of fish per bag

For Private Angling Fleets

2

of fish per bag

Go Back

Show Step

Management Options IV

Management Options V

Management Options VI

Management Options VII

Harvest Control Rule

Constant F

Y

X

0.00

0.20

0.40

0.60

0.80

1.00

Probability of Overfishing (OFL -> ABC)

Y*

40.00

%

Acceptable Catch Target

The ACT buffer for the Commercial Sector

0.00

%

For the Federal For-hire Component

9.00

%

For the Private Angling Component

20.00

%

0.4

0.6

0.8

1.0

1.2

1.4

1.6

Annual catch (as proportion of OFL)

9

Advantages of the GoM Red Snapper MSE Tool

II. User-friendly Inputs – Standard Versions

Follow the Management Options below:

- General Inputs
- Natural Mortality
- Recruitment
- Management Options I - Harvest Control Rule
- Management Options II - Allocations
- Management Options III - Regulations
- Management Options IV - Release Mortality
- Management Options V - Recreational Sector Options for ACT
- Management Options VI - Penalty & Carryover
- Management Options VII - Private Angling Quota among States

General Inputs

[Click with Default Settings](#)

Descriptions

- Based on 2016 Stock Assessment
- Model Type: Stock Synthesis 3
- Time Step: 1 year
- Start Projection: 2016-01-01
- Projection for 20 years (6 generations)
- Uncertainty is estimated from 100 iterations.
- Observational error for initial abundance: CV 0.2
- Observational error for initial distribution: 1000 effective sample size
- No mixing for adults between East and West stocks.
- The current natural mortality follows the Lorenzen curve.
- Fraction before spawning: 0.5 year
- Observational error for recruitment ratio between East and West Stocks: 1000 effective sample size
- One age-length key for both the East & West Stocks (The age-length key are inputs of the stock assessment model).
- Biological Reference Points:
SB_{MSY}: 1230000000000000 eggs
F_{MSY}: 0.0088
- Fishery Status: Green
- Cite for Release Mortality (Log-normal Distribution): 0.05
- Use default seeds in the format of a csv file.

[Next Step](#)

Natural Mortality

Recruitment

Management Options I

Management Options II

1~5 Inputs – from stock assessment

Natural Mortality

Recruitment

7 Management Options

HCR

Allocations

Regulations

Release Mortality

Recreational Sector Options for ACT

Penalty & Carryover

Private Angling Quota among States

10

Advantages of the GoM Red Snapper MSE Tool

II. User-friendly Inputs – Professional Version

Follow the Management Options below:

- Stock Assessment Model Input
- General Inputs
- Mixing Pattern
- Initial Population
- Biological Parameters
- Natural Mortality
- Recruitment
- Management Options I - Harvest Control Rule
- Management Options II - Allocations
- Management Options III - Regulations
- Management Options IV - Release Mortality
- Management Options V - Recreational Sector Options for ACT
- Management Options VI - Penalty & Carryover
- Management Options VII - Private Angling Quota among States

Stock Assessment Model Input

General Inputs

Time Step: 1 year

Start Projection: 2016-01-01

Stock Assessment Frequency: 3 Years

Forward Projection: 20 Years

Last Age in the Plus Group: 20

Uncertainty: 100 Iterations

Observational Error for Initial Distribution: 1000 effective sample size

Observational Error for Recruitment Ratio between East and West Stocks: 1000 effective sample size

Random Seed Setting:
☐ Use seconds of the system's clock
☐ Default seed csv
☐ Self-defined seed csv

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

Mixing Pattern

Initial Population

Biological Parameters

Natural Mortality

Biological Parameters

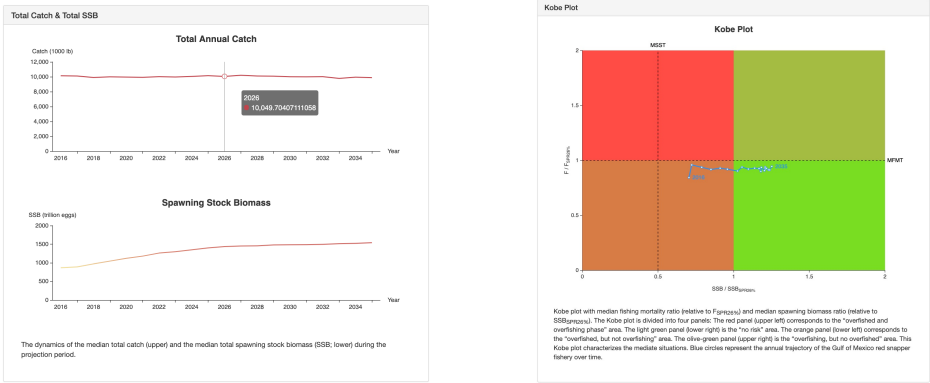
| Age | Stock 1 Weight-at-age (kg) | Stock 1 Fecundity (9 of eggs) | Stock 2 Weight-at-age (kg) | Stock 3 Fecundity (9 of eggs) |
|-----|----------------------------|-------------------------------|----------------------------|-------------------------------|
| 0 | 0.01 | 0 | 0.01 | 0 |
| 1 | 0.04 | 0 | 0.04 | 0 |
| 2 | 0.08 | 300000 | 0.08 | 300000 |
| 3 | 0.15 | 3900000 | 0.15 | 3900000 |
| 4 | 1.87 | 9070000 | 1.87 | 9070000 |
| 5 | 2.1 | 30000000 | 2.1 | 30000000 |
| 6 | 2.86 | 34710000 | 2.86 | 34710000 |
| 7 | 3.61 | 49950000 | 3.61 | 49950000 |
| 8 | 4.31 | 64270000 | 4.31 | 64270000 |
| 9 | 4.95 | 78780000 | 4.95 | 78780000 |
| 10 | 5.52 | 92700000 | 5.52 | 92700000 |
| 11 | 6.01 | 9550000 | 6.01 | 9550000 |
| 12 | 6.44 | 10010000 | 6.44 | 10010000 |
| 13 | 6.8 | 10700000 | 6.8 | 10700000 |
| 14 | 7.1 | 11000000 | 7.1 | 11000000 |
| 15 | 7.26 | 11000000 | 7.26 | 11000000 |
| 16 | 7.31 | 11000000 | 7.31 | 11000000 |
| 17 | 7.28 | 11000000 | 7.28 | 11000000 |
| 18 | 7.09 | 11000000 | 7.09 | 11000000 |
| 19 | 6.81 | 120670000 | 6.81 | 120670000 |
| 20 | 6.52 | 120220000 | 6.52 | 120220000 |

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

11

Advantages of the GoM Red Snapper MSE Tool

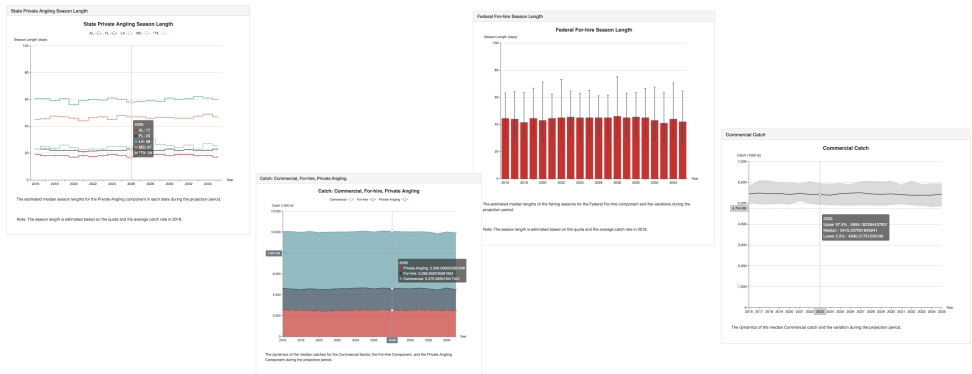
III. Dynamic Outputs – Single Scenario



12

Advantages of the GoM Red Snapper MSE Tool

III. Dynamic Outputs – Single Scenario (examples also in the “Demo” menu)

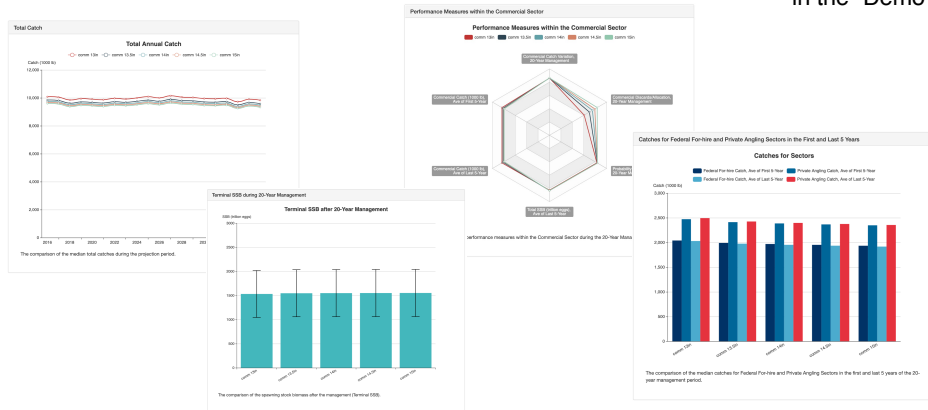


07/07/2022

13

Advantages of the GoM Red Snapper MSE Tool

III. Dynamic Outputs – Comparison of MSE Scenarios (examples also in the “Demo” menu)



07/07/2022

14

Advantages of the GoM Red Snapper MSE Tool

IV. Web-based MSE tool -- Why?

- **Feedback** should be included in the operating model to highlight useful management strategies that warrant management objectives.
- **Interactions** among stakeholders can improve their understanding of the fishery stock assessment and management, and raising the acceptance of the final management decisions.
- Consistent **communication** and outreach will eventually improve comprehension and transparency of management decisions.

gomredsnappermse.tool.fiu.edu (mainsite)

redsnapperdev.fiu.edu (dev site) – will be tested extensively in Summer 2022

15

Advantages of the GoM Red Snapper MSE Tool

IV. Web-based MSE tool

- 2 Versions: Standard and Professional

| | Standard Version (shoutcut MSE for general public) | Professional Version (full MSE for stock assessment scientists) |
|-------------------------|---|---|
| Initial setting | Must be the same with the latest stock assesment. | Can be different from the latest stock assesment. |
| Natural mortality | Must be the same among years. | Can be different from year to year (under construction). |
| Recruitment | Either from historical data or fixed Beverton-Holt Model | Can also modify Beverton-Holt Model parameters. |
| Stock mixing assumption | No mixing. | Mixing occurs between the East and West Gulf (under construction). |
| Assesment error | Add errors to the "true" age-based abundance and fishing mortality. | Generate a set of survey data, then input that into SS3 to get updated fisheries and other related parameters (under construction). |
| Selectivity setting | Must be the same with the latest stock assesment. | The asymptote of the selectivity curve can be modified (under construction). |

- 3 Roles: Admin, Register, and Public User

16













Advantages of the GoM Red Snapper MSE Tool

V. Communications – Method 1: Make scenarios viewable to others

List Your Scenarios

* Can only make 3 records public!

Record Count: 4

| | Scenario Name | Description | Created By | Created On | Changed By | Changed On | Is Public | Standard Scenario |
|---|---------------|--------------------|-----------------|---------------------|-----------------|---------------------|-------------------------------------|-------------------|
|    | Yuying test | interface 5 | Yuying Register | 2021-10-06 03:46:26 | Yuying Register | 2021-10-06 03:46:26 | <input checked="" type="checkbox"/> | True |
|    | for CERF | Oct | Yuying Register | 2021-10-06 03:47:27 | Yuying Register | 2021-10-06 03:47:27 | <input type="checkbox"/> | False |
|    | ZYY test 4 | interface 4 | Yuying Register | 2021-10-06 03:48:02 | Yuying Register | 2021-10-06 03:48:02 | <input type="checkbox"/> | True |
|    | 11dflco | test with latreese | Yuying Register | 2021-10-01 13:21:24 | Yuying Register | 2021-10-01 13:21:24 | <input checked="" type="checkbox"/> | False |

17

Advantages of the GoM Red Snapper MSE Tool

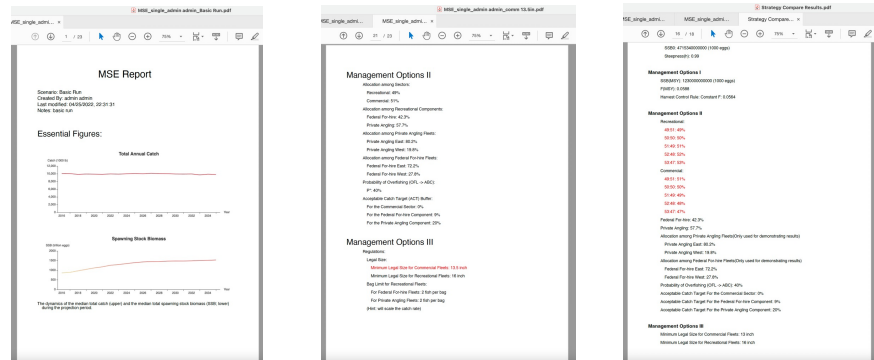
V. Communications – Method 1: Make scenarios viewable to others

| MSE Comparison | | | | | | | |
|---|---------------|-------------------|-------------|---------------------|-------------|---------------------|-------------------|
| Search ▾ | | | | | | | |
| * Please choose 4~7 records for comparison! | | | | | | | |
| Rows selected : 0 | | | | | | | |
| Record Count: 25 | | | | | | | |
| ◀ 0 1 2 ▶ Page size ▶ Actions ▶ ⏪ | | | | | | | |
| <input type="checkbox"/> | Scenario Name | Description | Created By | Created On | Changed By | Changed On | Standard Scenario |
| <input type="checkbox"/> | Basic Run | basic run | admin admin | 2020-10-07 16:15:43 | admin admin | 2020-10-07 16:15:43 | False |
| <input type="checkbox"/> | comm 13in | test legal size 1 | admin admin | 2020-10-07 17:45:08 | admin admin | 2020-10-07 17:45:08 | False |
| <input type="checkbox"/> | comm 13.5in | test legal size 2 | admin admin | 2020-10-07 17:47:17 | admin admin | 2020-10-07 17:47:17 | False |
| <input type="checkbox"/> | comm 14in | test legal size 3 | admin admin | 2020-10-07 17:48:25 | admin admin | 2020-10-07 17:48:25 | False |
| <input type="checkbox"/> | comm 14.5in | test legal size 4 | admin admin | 2020-10-07 17:51:26 | admin admin | 2020-10-07 17:51:26 | False |
| <input type="checkbox"/> | comm 15in | test legal size 5 | admin admin | 2020-10-07 17:52:24 | admin admin | 2022-01-04 21:39:30 | False |
| <input type="checkbox"/> | 49:51 | test allocation 1 | admin admin | 2020-10-11 14:46:20 | admin admin | 2020-10-11 14:46:20 | False |

18

Advantages of the GoM Red Snapper MSE Tool

V. Communications – Method 2: Download results and distribute



19

VI. Flexible for the future stock assessment updates

[illegible]

VI. Flexible for the future stock assessment updates

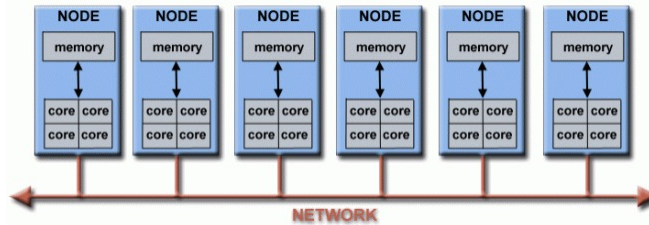
- Website: Python & Linux
- Database: MongoDB
- User-friendly Interface: JavaScript & html
- MSE operating model: R
- Stock assessment in future full MSE: SS3 (NOAA ToolBox)



Advantages of the GoM Red Snapper MSE Tool

VII. Website Performance

- Parallel Computing -16 CPUs + 32 GB RAM
- Pre run to save end-users' time



22

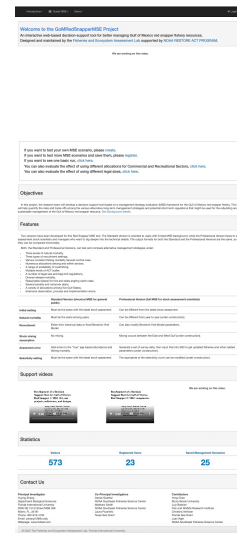
Slated for release in Fall 2022

gomredsnappermse.fiu.edu

- National Academies book *Data and Management Strategies for Recreational Fisheries with Annual Catch Limits* (2021)
(Chapter 5, Page 154-156) <http://nap.edu/26185>
- A simulation framework to assess management trade-offs associated with recreational harvest slots, discard mortality reduction, and bycatch accountability in a multi-sector fishery

(Bohaboy *et al.*, 2022)

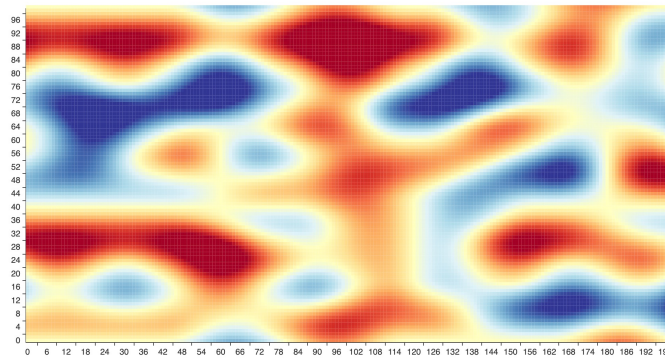
<https://doi.org/10.1016/j.fishres.2022.106268>



23

Directions for future collaborations

- Advanced MSE comparison (finished, but hide)

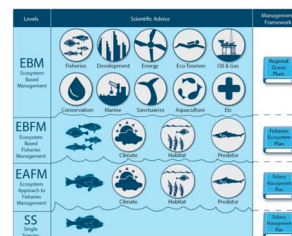
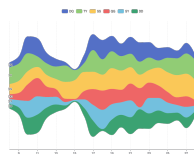
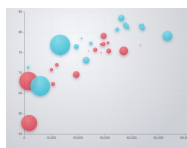


24

Directions for future collaborations

- Customized MSE for commercially-important species
- Multi-species MSE for ecosystem-based fishery management
- Data and results visualization
- A platform for stakeholders to communicate

FIU Fisheries and Ecosystem Assessment Lab: fiufeal.com



25

Acknowledgements

• Frank Parker *et al.*
from NOAA Restore Act Program

- John Foreschke
- Ryan Rindone
- LaTree Denson
- Nathan Vaughan
- Yingxin Li
- Vanessa Riveros
- Mario Jacas
- Yudong Tao
- Jie Li



26

References

Diagne, A., Crabtree, R.E., Hood, P., Holiman, S., Lamberte, T., and Lasseter, A. 2015. Final framework action to the fishery management plan for the reef fish resources of the Gulf of Mexico including environmental assessment, regulatory impact review, and regulatory flexibility act analysis: recreational accountability measures for red snapper. <https://doi.org/10.25923/jwe4-4j51>.

Pastoor, M., Andersen, M., Bartolino, V., Beauchamp, B., Benoît, H., Benson, A., Campbell, N., Coull, K., Döring, R., Gras, M., Gröhsler, T., Kempf, A., Levontin, P., Lordan, C., MacDonald, P., Mackinson, S., Methot, R., Mosegaard, H., Payne, M. and Ye, Y. 2020. WORKSHOP ON GUIDELINES AND METHODS FOR THE EVALUATION OF REBUILDING PLANS (WKREBUILD). 10.17895/ices.pub.6085.

Punt, A.E., Butterworth, D.S., de Moor, C.L., De Oliveira, J.A.A. and Haddon, M. 2016. Management strategy evaluation: best practices. *Fish and Fisheries*, 17: 303–334.