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Can we manage with a 'Percent change' approach: a desk MSE

Gulf May SSC Meeting 2024



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Authors & Acknowledgements

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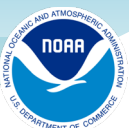
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Challenges: Stock assessment uncertainty

- Absolute abundance is notoriously challenging to estimate within stock assessments
 - Ralston et al. (2011) $\sigma \gtrsim 0.4$ (CV~0.3) for Gulf stocks ([Siegfried & Calay, January 2023, GMFMC SSC](#))
- Scientific uncertainty in abundance exacerbated by biased, unknown, or changing landings estimates

If our catch data only gave us an unbiased relative trend, rather than accurate total removals, can we develop a management approach that works?



Purpose



Long term:

1. Examine the impact that unknown magnitude of recreational landings data may have on management performance for Gulf of Mexico stocks.
2. Identify alternate management approaches that may better perform when absolute values of recreational landings are unknown.

Motivation - MRIP-FES Inventory and Triage

Discussion of MRIP-FES Inventory for the Gulf of Mexico (Tab F, No. 7) – Dr. Froeschke

“Working assumption is that potential changes to MRIP-FES would be a scaling issue only rather than impact stock status.

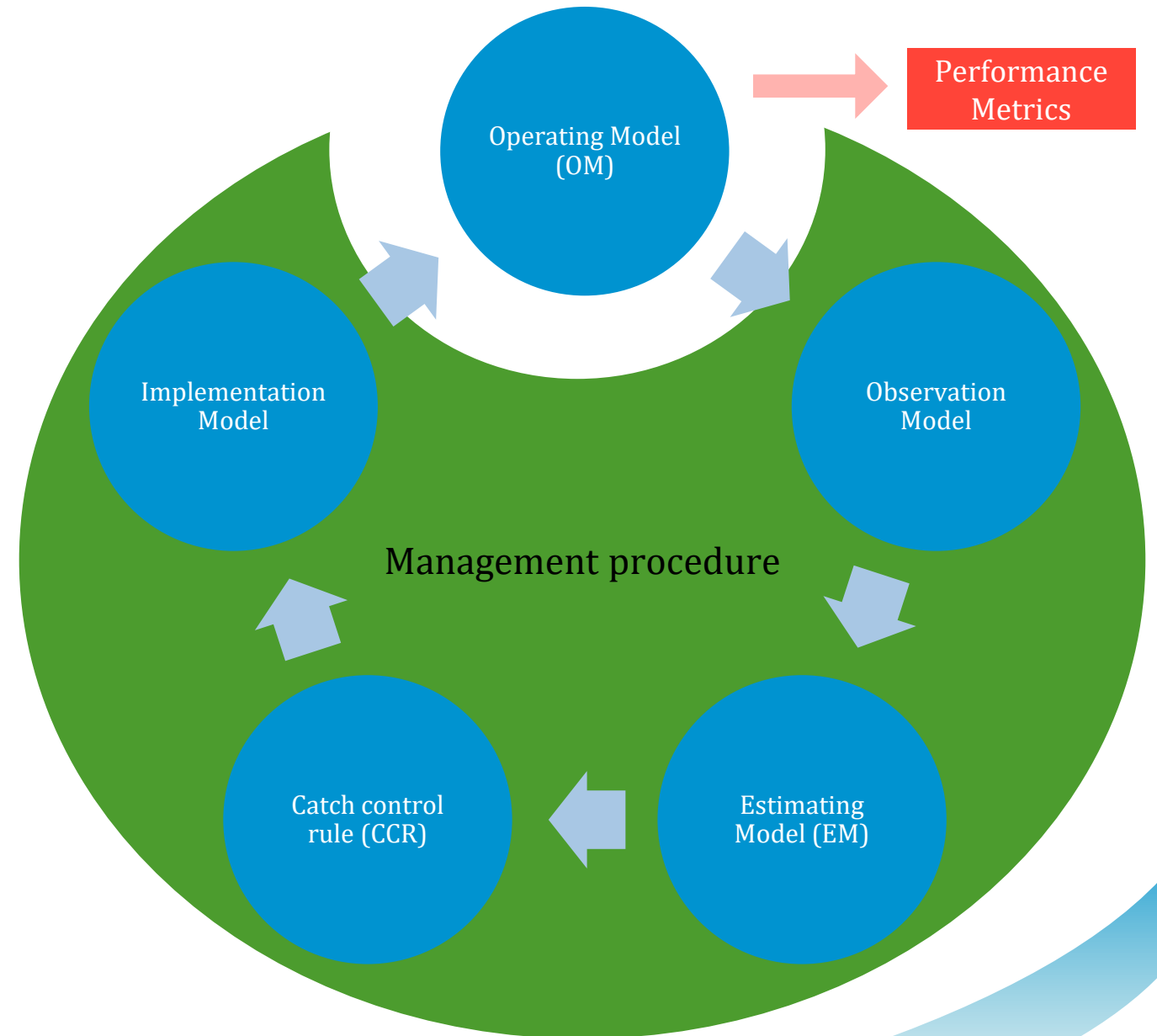
- For example, if the estimated effort is reduced by 40%, the daily catch rate (recreational) would decline in-turn by 40% thus, no anticipated effect on recreational season duration (e.g., Greater Amberjack recreational season)”*

and, can we test the ‘percent change’ or ratio approach to catch limit changes



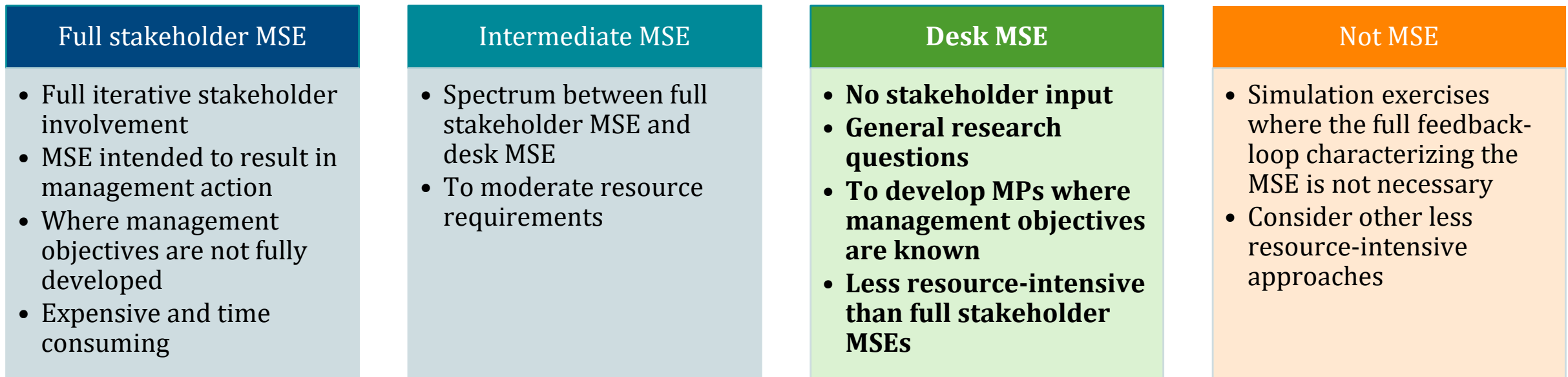
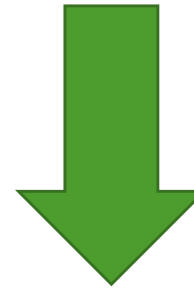
Methods: MSE

Management strategy evaluation:
uses simulation to test the performance of alternative management procedures against pre-specified objectives over a range of uncertainties



Methods: Desk MSE

- Science Center-led initiative



Walter, Peterson, Marshall, Deroba, Gaichas, Williams, Stochs, Tommasi, Ahrens (2023) When to conduct, and when not to conduct, management strategy evaluations. ICES JMS. 80(4):719–727. 10.1093/icesjms/fsad031

Methods: SSMSE



github.com/nmfs-fish-tools/SSMSE

Goals

- Create a generalized, standardized tool that directly uses existing Stock Synthesis stock assessments as Operating Models (OMs) in MSE.
- Bundle it into an R package

A screenshot of the GitHub repository page for 'nmfs-fish-tools/SSMSE'. The page shows the repository name, navigation tabs (Code, Issues, Pull requests, Discussions, Actions, Projects, Wiki, Security, Insights), and repository statistics (9 Unwatch, 8 Star, 3 Fork). The main content area displays a commit history table with columns for commit message, commit ID, time, and commit count. The 'About' section on the right describes the project as 'Management Strategy Evaluation (MSE) using Stock Synthesis (SS)' and includes a 'stock-synthesis' tag and a 'Readme' link.

Commit Message	Commit ID	Time	Commits
k-doering-NOAA fix: change check on om and em start year	fca696a	14 days ago	484
.github/workflows fix, tests: add token to calc-coverage		14 days ago	
R fix: change check on om and em start year		14 days ago	

```
remotes::install_github("nmfs-fish-tools/SSMSE")
```


Methods: Stock Synthesis and the Southeast

- Stock assessment models have already received extensive peer review during the assessment process
- Stock Synthesis offers a rich set of options, allowing nuanced OMs to help capture complexity of Gulf stocks and fisheries, e.g.,:
 - Discards
 - Shrimp bycatch
 - Environmental drivers (e.g., red tides)

Stock Synthesis in the Gulf

Species	SEDAR
Yellowedge Grouper	SEDAR 85
Spanish Mackerel	SEDAR 81
Gray Snapper	SEDAR 75
Red Snapper (3-area)	SEDAR 74
Red Snapper (2-area)	SEDAR 52
Gag Grouper	SEDAR 72
Greater Amberjack	SEDAR 70
Scamp	SEDAR 68
Vermilion Snapper	SEDAR 67
Red Grouper	SEDAR 61
Gray Triggerfish	SEDAR 43
King Mackerel	SEDAR 38 Update
Cobia	SEDAR 28 Update
Tilefish	SEDAR 22



Methods: SSMSE

Not quite ready for prime-time for Gulf assessment models yet.... but, we're actively debugging and working with developers to resolve issues

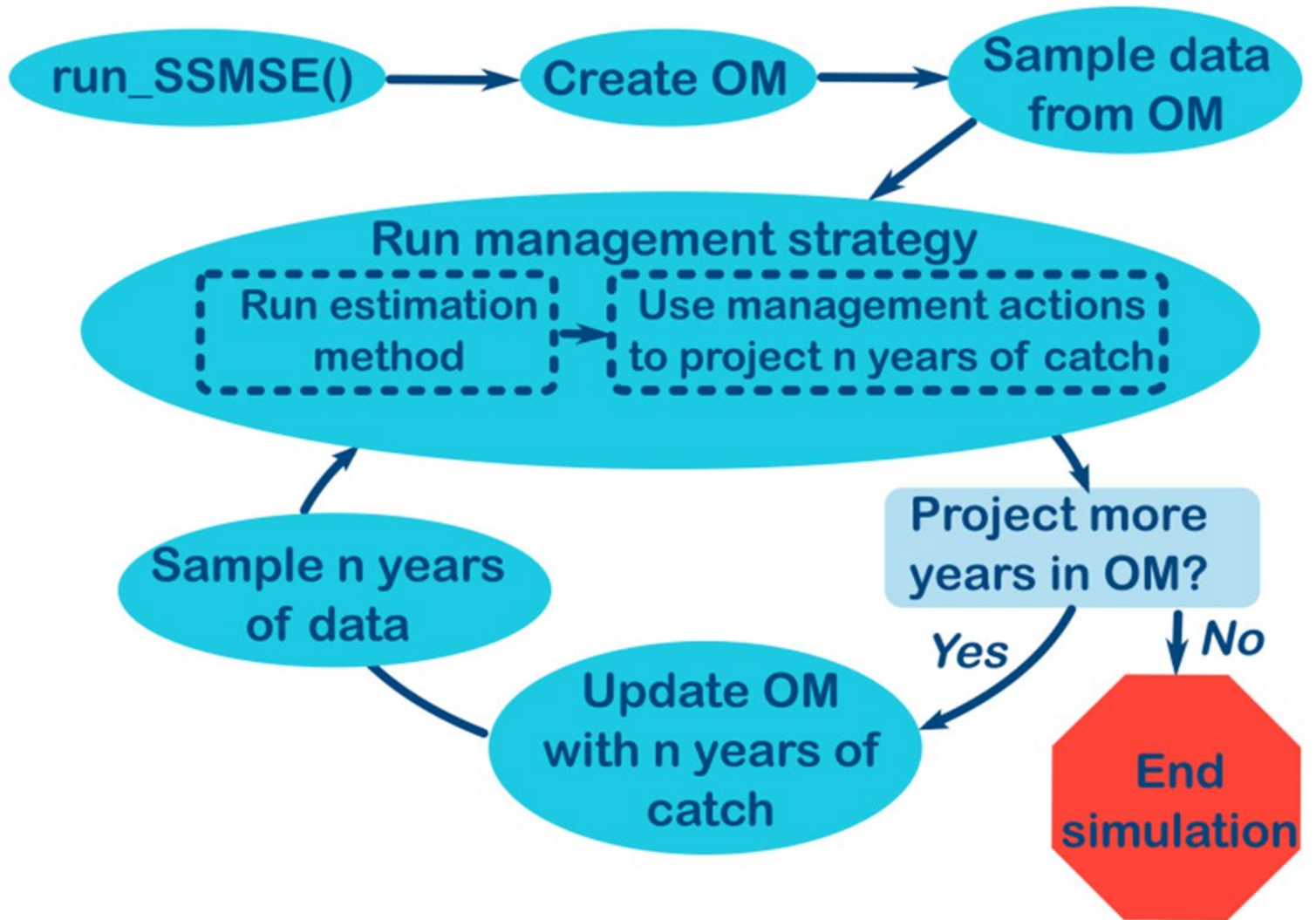


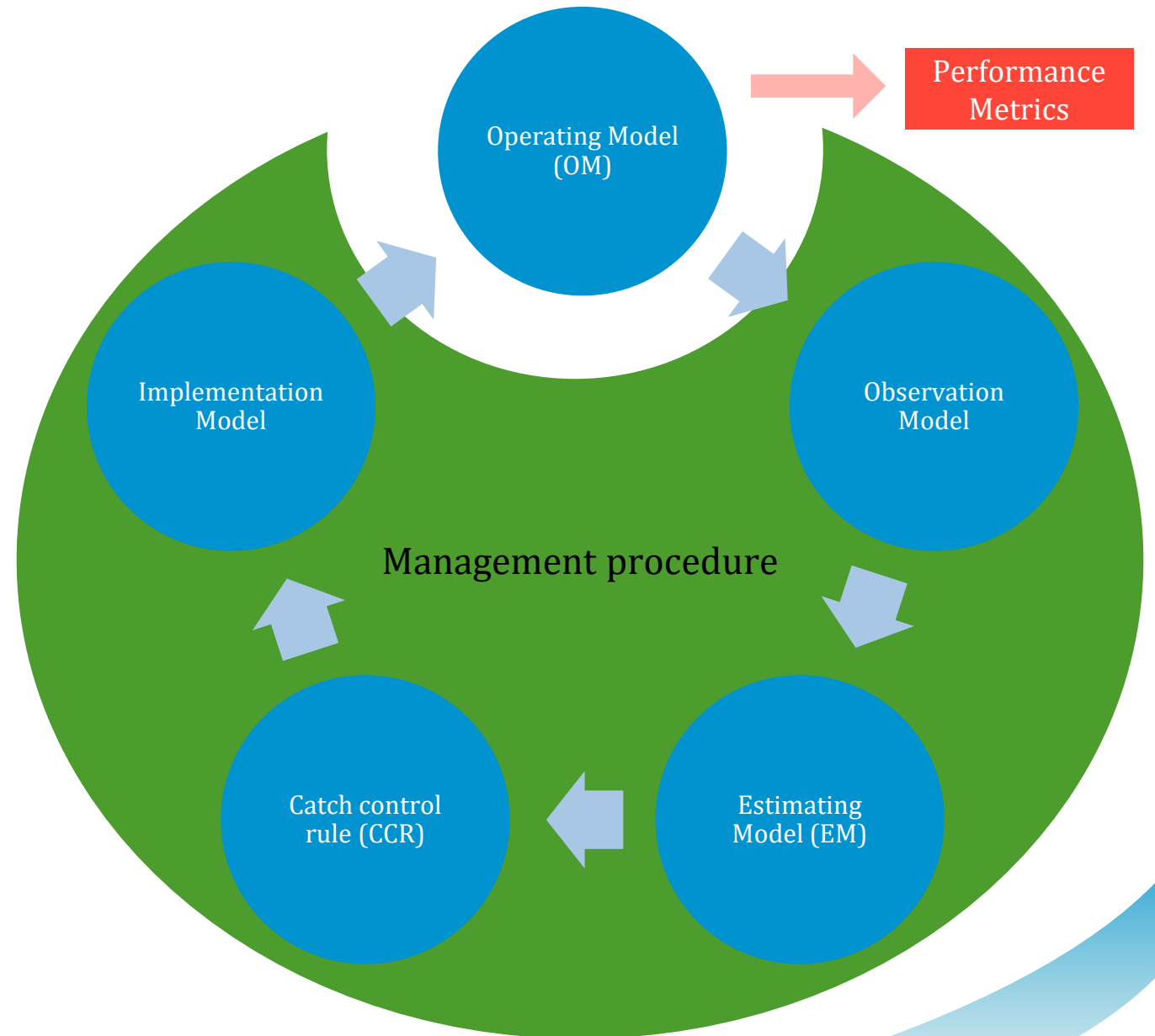
Figure 2: Schematic illustrating the steps within the `run_SSMSE()` function. Note for simplicity, this diagram only shows steps for a single iteration, even though multiple iterations and/or scenarios could be called through `run_SSMSE()`.

Kathryn Doering, Nathan Vaughan, et al. (2023) SSMSE: an R package for management strategy evaluation with Stock Synthesis operation models. JOSS. 8(90), 4937. 10.21105/joss.04937.

Methods: MP

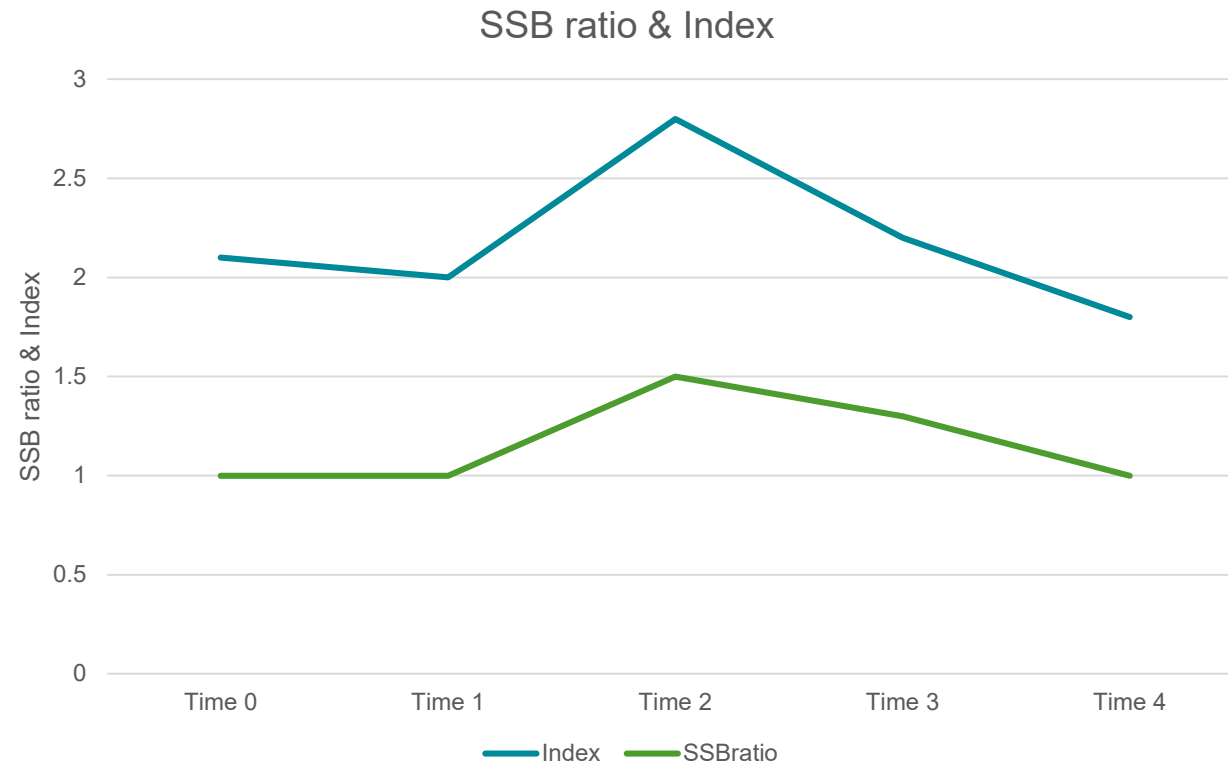
Management procedure (MP): predefined 'recipes' for how to adjust management advice based on the behavior of the stock

- Model-based MP - uses a population dynamics model (e.g., stock assessment) as the estimating model within a management procedure
- Empirical MP - uses an indicator of relative abundance (e.g., survey index) as the basis for adjusting management advice within a management procedure
- E.g., Lane Snapper Data-limited Approach (SEDAR 49), ICCAT Bluefin tuna, SAFMC Dolphin fish (in progress)



Empirical MP: Relationship between Index and SSB ratio

	Index	SSBratio
Time 0	2.1	1
Time 1	2	1
Time 2	2.8	1.5
Time 3	2.2	1.3
Time 4	1.8	1

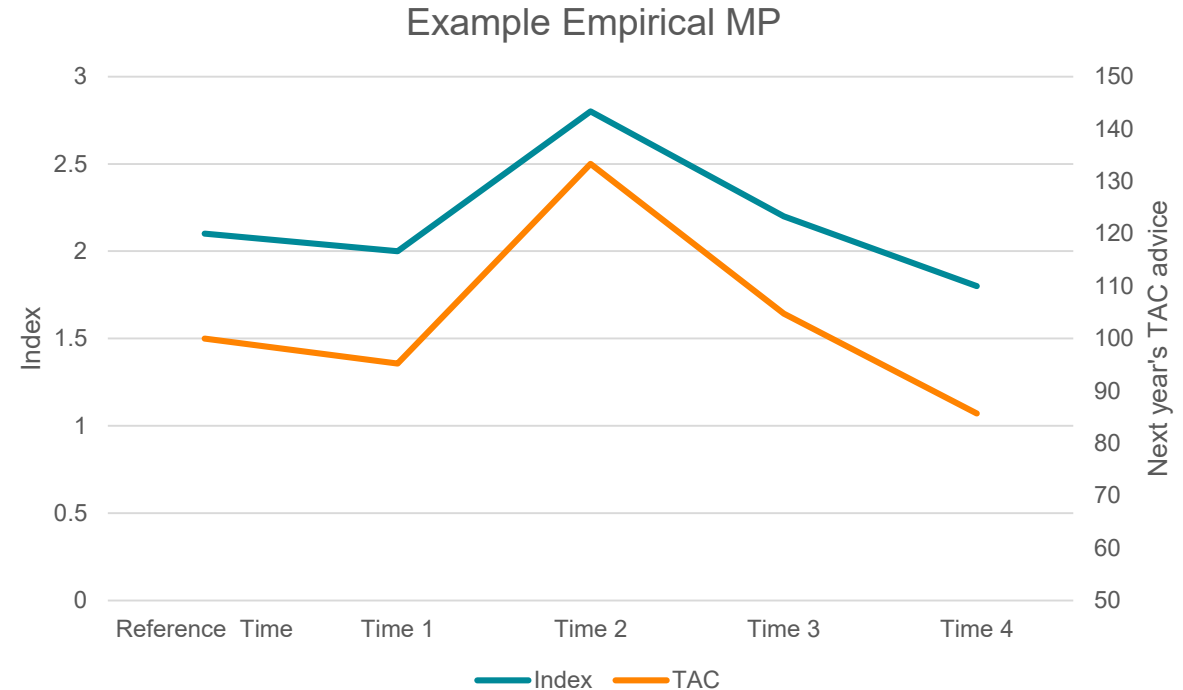


Assuming: $Index = q \times SSB$

$SSBratio = SSB / SSB_{MSY}$

Empirical MP: Simple Example Empirical MP

Empirical MP		
	Index	TAC
Reference Time 0	2.1	100
Time 1	2	95
Time 2	2.8	133
Time 3	2.2	105
Time 4	1.8	86



Adjust TAC advice based on current index value to maintain index:TAC ratio at reference year.

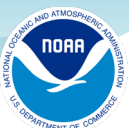
$$TAC_{y+1} = (Index_y / Index_0)^* \times TAC_y$$

* Where allowable TAC change is limited to 20% upwards or downwards in each year.

Proposed MP: Ratio MP (percent change)

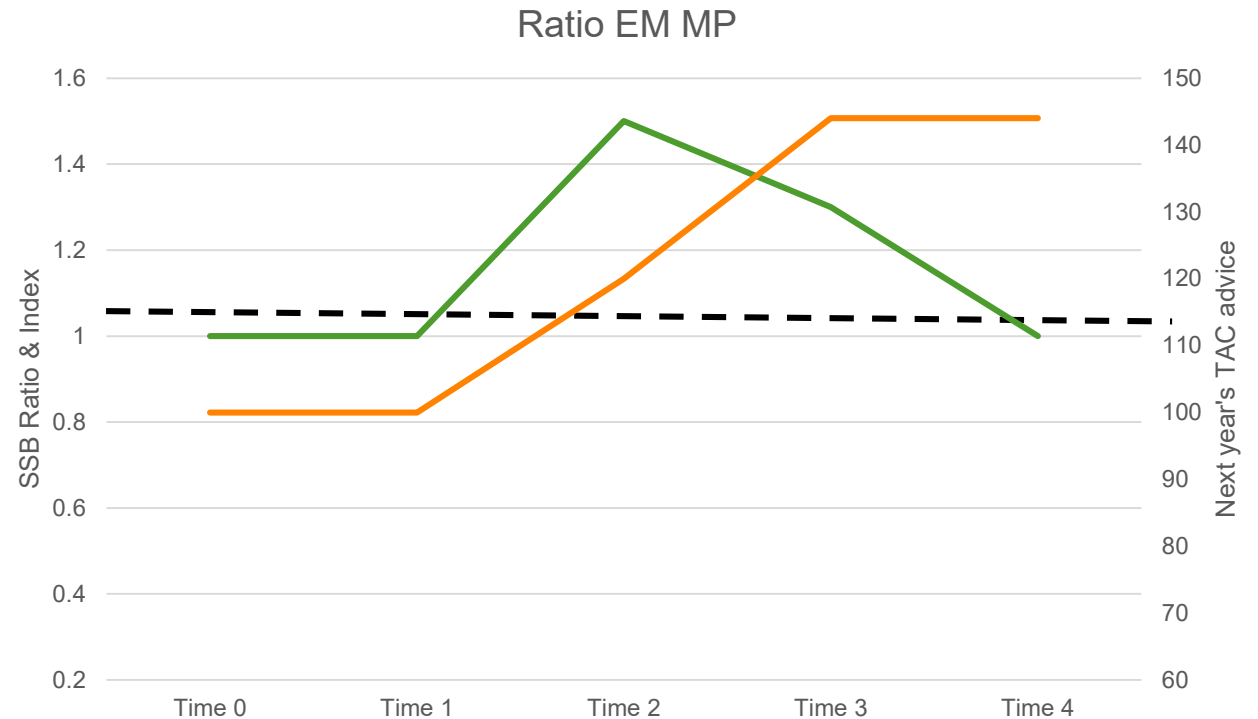
Adjust last year's TAC by this year's SSB ratio (SSB / SSB_{MSY})

- Borrow intuition behind empirical MPs and adding to the value of a model-based MP
 - Stock assessment to update MSY-based reference points (e.g., SSB_{MSY} ; no need for reference period as in empirical MP)
- Uses relative reference points instead of absolute reference points
- Ground management advice in the scale that we use to measure TAC



Ratio MP: Proposal

	SSBratio	TAC
Time 0	1	100
Time 1	1	100
Time 2	1.5	120
Time 3	1.3	144
Time 4	1	144



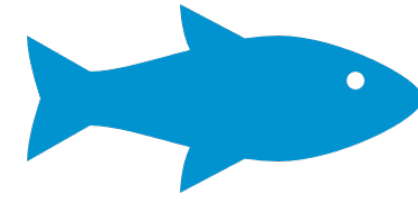
2 options:

$$TAC_{y+1} = \left(\left((SSBratio^* \times TAC_y) - TAC_y \right) \times c \right) + TAC_y$$

$$TAC_y = \exp(\log(SSBratio^* \times TAC_y) \times c) + TAC_y$$

- Where TAC change is limited to 20% up or down.
- Option to dampen TAC change. Example: multiply by constant $c < 1$. $c=1$ would result in a 1:1 change in SSB ratio and percent change in TAC.

Methods: Proof-of-Concept MSE design



OM1: Base
No mismatch in landings

MP1: current forecast-based approach; model-based

MP2: Ratio / percent change MP approach; model-based

OM2: Mismatch
Simple mismatch in landings

MP1: current forecast-based approach; model-based

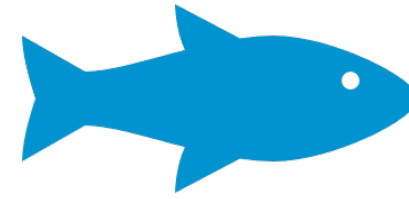
MP2: Ratio / percent change MP approach; model-based

Assumptions:

1. Constant allocation
2. No data-management lag
3. No implementation error
4. Spatiotemporally constant bias in rec landings
5. Stationary projections

* some of these may optionally be addressed in future work

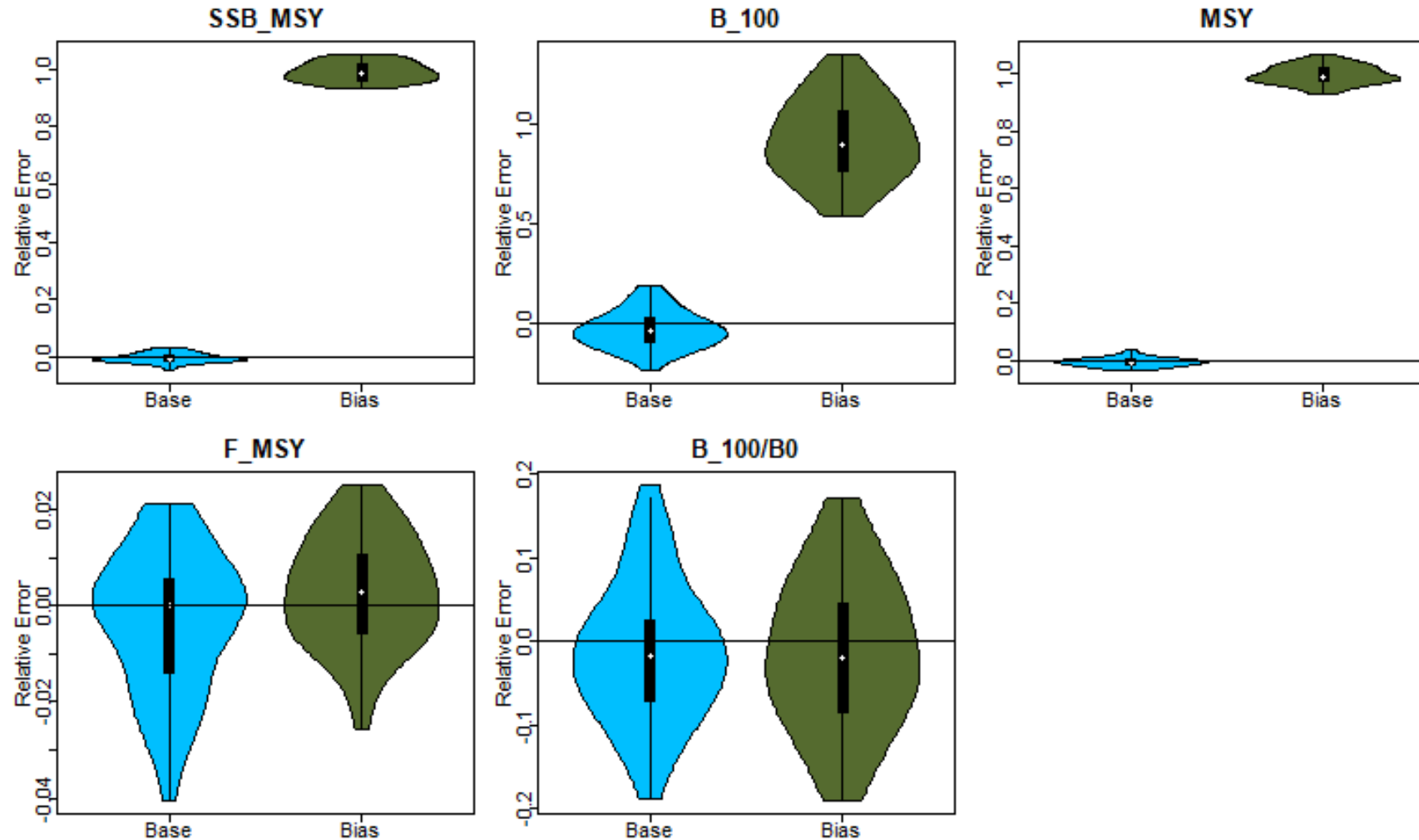
Proof of concept: Simple cod*



- Developmental SS3 model: 1 survey & 1 fleet
 - 10 year projection
 - 3 year management cycle / assessment interim period
 - No implementation error
 - 50 iterations / OM-MP
 - Forecast MP: use FBtarget, where Btarget = 0.4; TAC = OFL
 - Bias: OM landings = 1/2 EM landings
- RatioMP:
 - Damping option 1, $c=0.75$
 - $\Rightarrow 10\%$ change in SSBRatio $\propto 7.5\%$ change in TAC
 - Minimum 20% allowable change

** Simple cod is the SSMSE default assessment and is the only assessment currently running using this FES code*

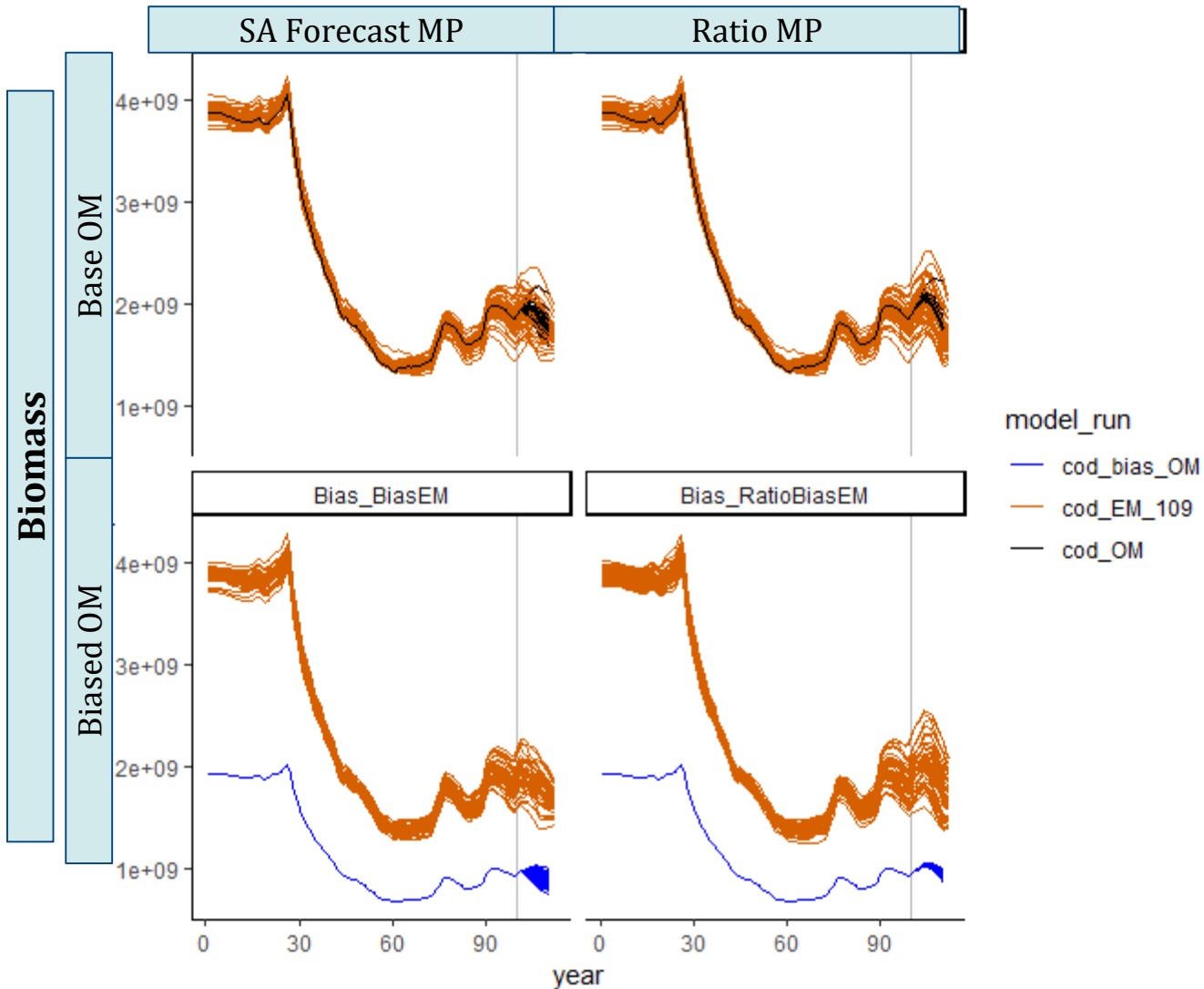
Proof of concept: Simple cod EM results



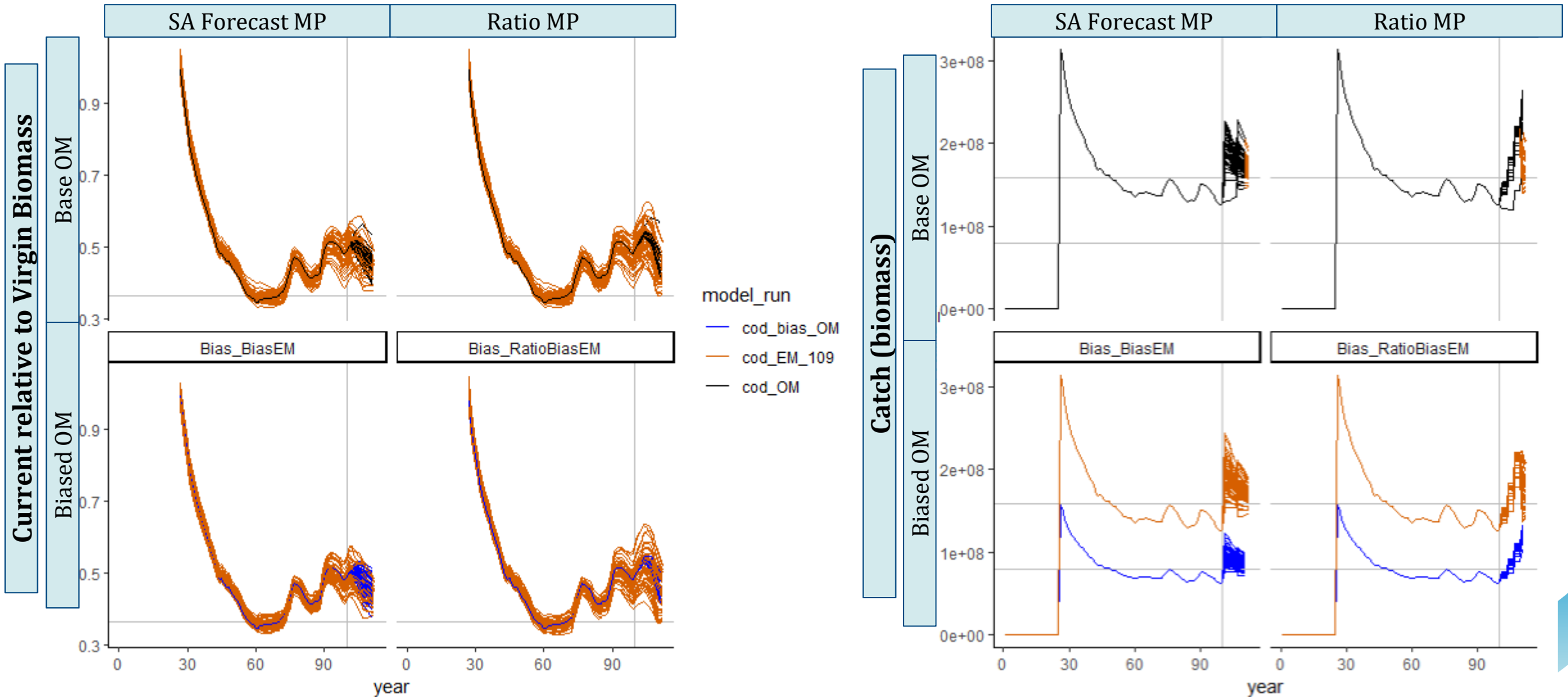
Absolute values
(incorrect, as expected)

Relative status
(Correct)

Proof of concept: Simple cod MP results



Proof of concept: Simple cod MP results



Proof of Concept: Takeaways

When the mismatch between OM and EM catches is constant in a stock assessment with 1 fleet:

- Stock assessment is capable of measuring relative stock status even if mismatch between OM and EM catches
- Forecast and Ratio MPs are capable of managing with or without catch mismatch



Proof of concept was successful, produced expected results, and we can move forward with increased complexity and realism



Work progress

Ongoing Progress to Date

- SSMSE development
- Convert Gulf assessments into SSMSE OMs

Next Steps

- Continued SSMSE development
- Apply simple 2x2 OM-MP grid to Gulf stocks
- Expand OM and/or MP scenarios

Ancillary Benefits

- Beta test of SSMSE
- Build foundation for future Gulf MSEs

Potential research directions

Note a desire for results that may be broadly useful in other regions

- **Measure management performance when spatiotemporal variation in FES conversion**
- **Management response when multiple fleets of different properties and not all are biased**
- Consider performance of alternate MPs, including: interim assessments, empirical MPs, etc.
- Explore optimal configuration / tuning of RatioMP for Gulf stocks
- Additional: implementation error, nonstationarity, etc.

Discussion questions

- General feedback on Ratio MP / percent change approach?
- What research directions should we prioritize for continued development?
- Which species should we prioritize for this work?

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Extra slides



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Commercial vs Recreational Comparison

Species	Recreational Allocation (after reallocation due to MRIP-FES)	Recreational Proportion by Weight (if no allocations)
Yellowedge Grouper	None	2% of Total Removals
Spanish Mackerel	None	82% of Total Landings
Gray Snapper	None	85% of Total Landings
Red Snapper	49% Recreational	
Gag Grouper	61% Recreational	
Greater Amberjack	73% Recreational (80%, Amendment 54)	
Scamp	None	37% of Total Landings
Vermilion Snapper	None	43% of Total Landings
Red Grouper	24% Recreational (40.7%, Amendment 53)	
Gray Triggerfish	79% Recreational	
King Mackerel	None	68% of Total Landings
Cobia	None	96% of Total Landings
Tilefish	None	0.07% of Total Landings



Motivation - MRIP Fishing Effort Survey (FES) Pilot Study

NEWS

NOAA Fisheries Announces Large-scale Study on its Recreational Fishing Effort Survey

August 29, 2023

NOAA Fisheries has conducted a pilot study on our recreational Fishing Effort Survey. Preliminary results suggest the order of the questions in the survey may lead to overestimation of fishing effort, though a more robust study is necessary to confirm.

[Feature Story](#) | [New England/Mid-Atlantic](#), [Southeast](#)

Problems:

1. Order that questions are asked in the FES can bias responses
2. Private and shore effort may be lower than FES survey estimates
3. Affects landings and discards estimates input into stock assessments for multiple Gulf of Mexico stocks