South Atlantic Dolphinfish MSE

8. Performance Summary

a. Performance Metrics (reference point calculation)

b. Performance Comparisons (projections, trade-offs, quilt plots)

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8a. Performance Metrics (reference point calculation)

MSY Calculations

MSY quantities were calculated using the standard approach of Botsford (1981) and Walters and Martell (2004) (Box 3.2 of that book) which efficiently calculates equilibrium yields for an age-structured population dynamics model using growth, maturity, the stock recruitment relationship and a fishery selectivity at age vector (this is a function in the MSEtool library).

Future changes in selectivity may be imposed by MPs that test alternative size limits. For this reason static MSY reference points were calculated based on operating model conditions in the final year of the historical simulation (2022).

Since the operating model has multiple fleets, aggregate selectivity was calculated as the mean selectivity across fleets weighted by their catch. Overfishing reference points were calculated on the basis of catch weight divided by total biomass (exploitation rate, UMSY). There are two advantages to this exploitation rate metric:

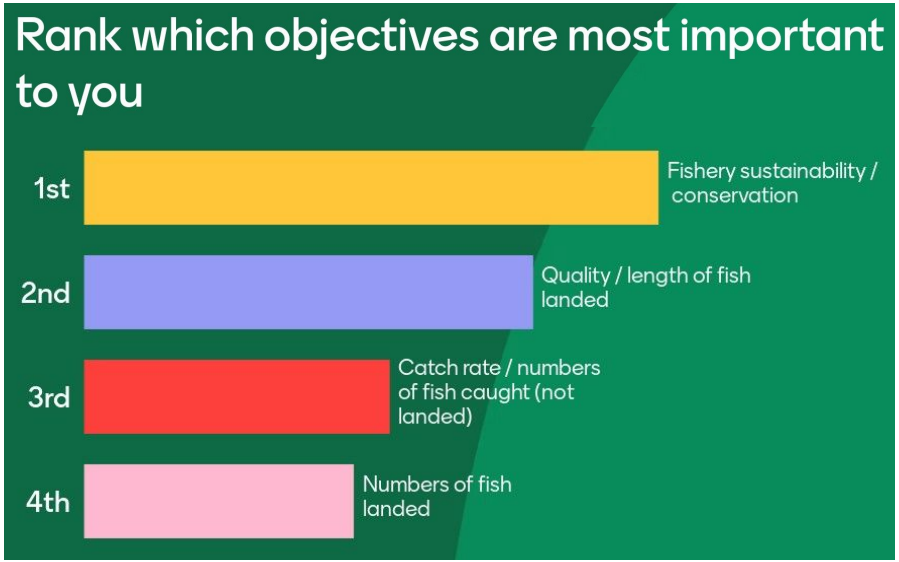
(1) future MP-driven selectivity changes affect the interpretation of apical F (F for the most selected age class);

(2) U calculation does not require the calculation of asymptotic age-selectivity that is challenging for spatial, seasonal, multistock models where temporal variability in recruitment creates transient effects.

8a. Conceptual Management Objectives

Conceptual Management objectives

1. **Status**
2. **Yield** by fleet and area
3. **Stability**
4. **Catch rate** by fleet and area
5. **Opportunity**
6. **Size** of fish caught by fleet and area



All metrics to be analyzed over all projection years (1-15 years), short (1-5 year), medium (5-10 year), long (10-15 year) time horizons

Peterson, C., Karnauskas, M., McPherson, M., Hadley, J., Blake, S., Byrd, J. 2024. Report of the South Atlantic dolphinfish management strategy evaluation stakeholder workshops. NOAA Tech. Memo. NMFS-SEFSC-781, 35 p. https://doi.org/10.25923/f628-n174

2. Operationalize Management Objectives

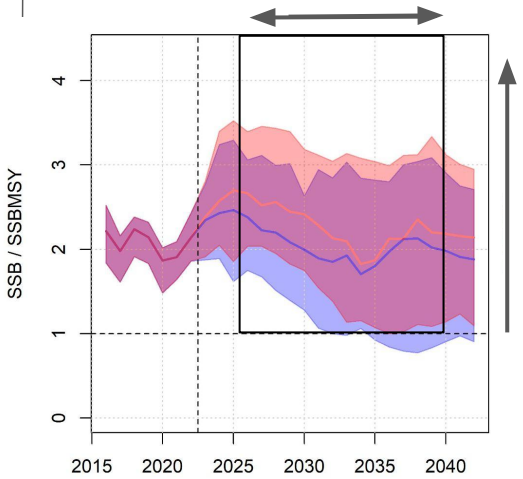
Management objectives

1. **Status:**
   - Stock should have a P* of [__]%
     - E.g., probability of overfishing in projection
   - Stock should have a less than [___]% probability of being overfished
2. **Yield** by fleet and area
3. **Stability**
4. **Catch rate** by fleet and area
5. **Opportunity**
6. **Size** of fish caught by fleet and area

Performance Metrics

P* - probability of not overfishing ($U<U_{MSY}$)

P(B>BMSY) - probability of not being overfished ($SSB > SSB_{MSY}$)



Fraction of simulations above SSBMSY from 2026 - 2040

P(B>BMSY)

98%

94%

2. Operationalize Management Objectives

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   - Maximize yield by fleet
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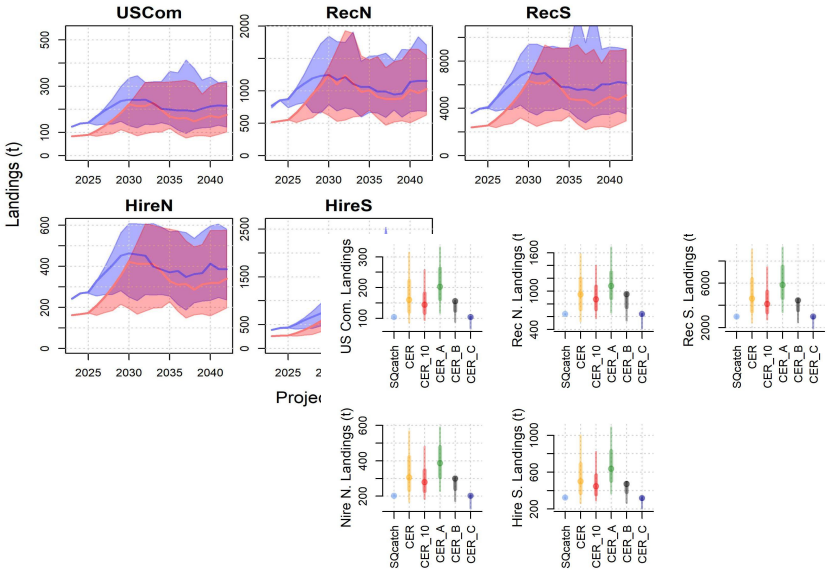
4. **Catch rate** by fleet and area
5. **Opportunity**
6. **Size** of fish caught by fleet and area

Performance Metrics

AvgLand$_f$ - average annual landings by fleet



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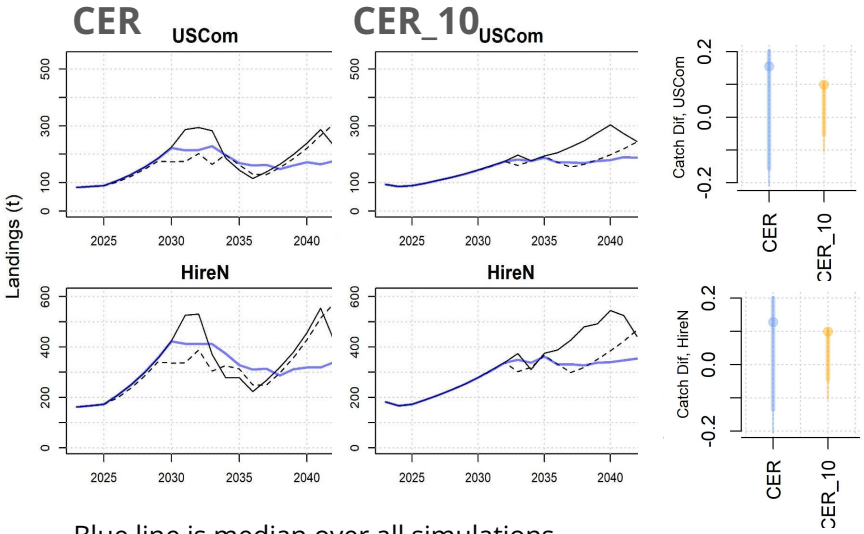
   - Maximize yield by fleet
3. **Stability**
   - Maintain stability in regulations
4. **Catch rate** by fleet and area
5. **Opportunity**
6. **Size** of fish caught by fleet and area

Performance Metrics

$AAVY_f$ - average annual variability in yield by fleet



Blue line is median over all simulations. The solid and dashed black lines are two example simulations.

2. Operationalize Management Objectives

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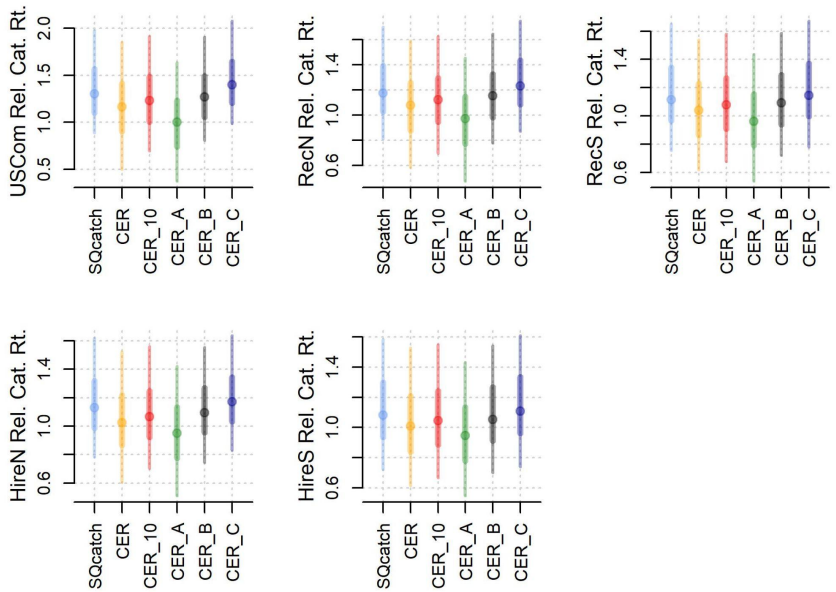
   - Maximize catch rate by fleet
5. **Opportunity**
6. **Size** of fish caught by fleet and area

Performance Metrics

$relCR_f$ - average catch rate relative to catch rate in 2022 for each fleet



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   - Maximize catch rate by fleet
5. **Opportunity**
   - Reduce probability of fishery closure and/or accountability measures
6. **Size** of fish caught by fleet and area

Performance Metrics

meetACL- proportion of years in which landings equal ACL by sector (commercial, recreational)

2. Operationalize Management Objectives

Management objectives

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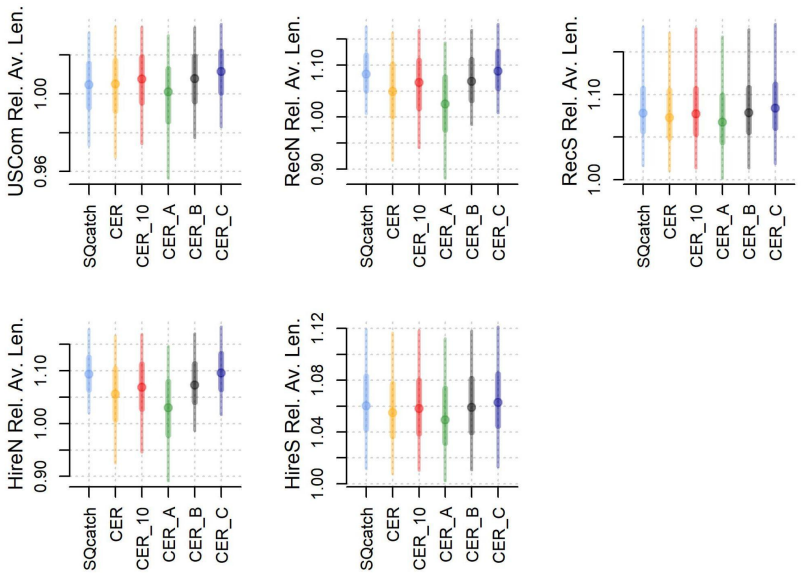
   - Maximize yield by fleet
3. **Stability**
   - Maintain stability in regulations
4. **Catch rate** by fleet and area
   - Maximize catch rate by fleet
5. **Opportunity**
   - Reduce probability of fishery closure and/or accountability measures
6. **Size** of fish caught by fleet and area
   - Maximize average length of catch by fleet

Performance Metrics

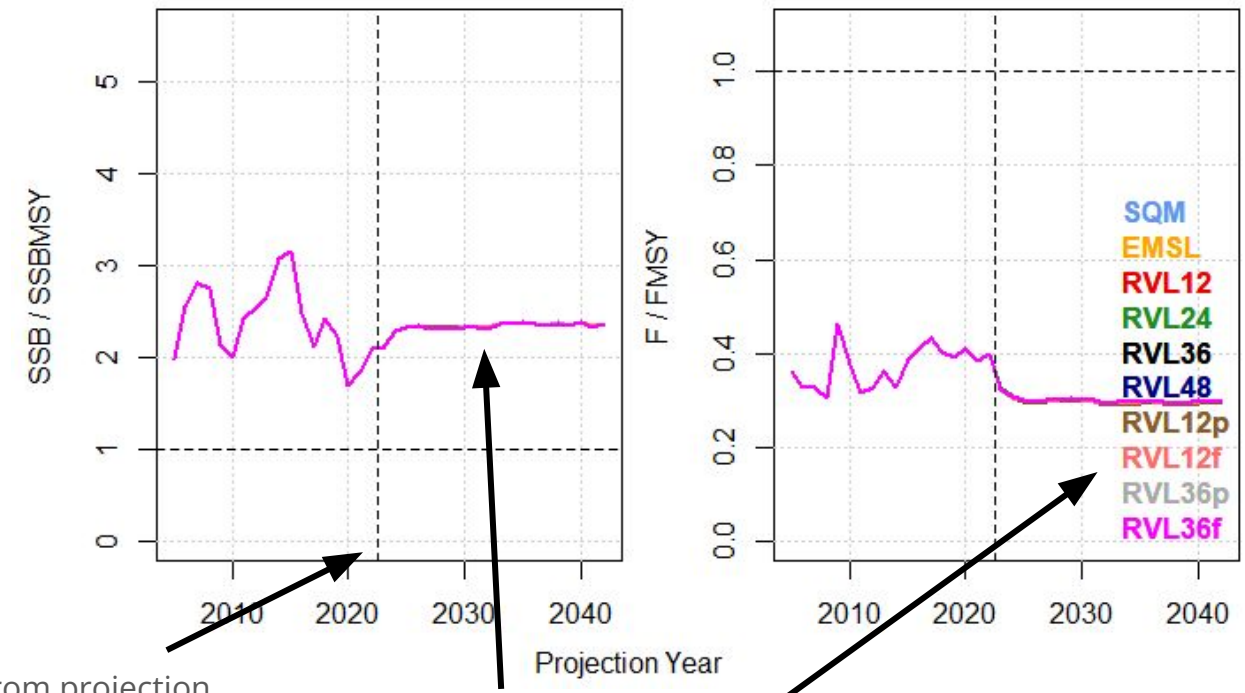
$avLen_f$ - average length of fish caught by fleet



b. Performance Comparisons **Regulatory Amendment 3 - Constant Catch**

Figures show the results of the simulation, with respect to stock status, under status quo management (constant catch) versus all of the Regulatory Amendment 3.

Results are median values over all 32 reference operating models (possible 'true' underlying systems).



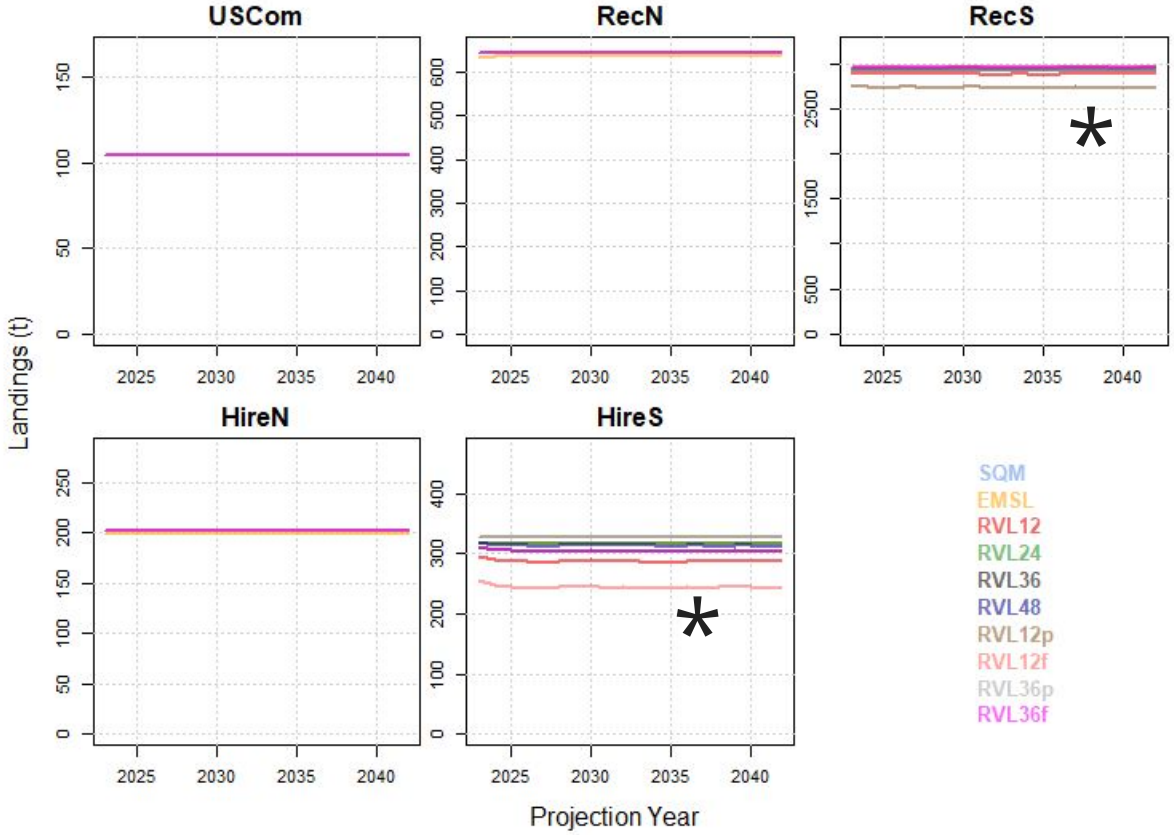
Starting from projection year 2023

Lines are overlapping, suggesting Reg Am 3 do not strongly affect stock-wide status

b. Performance Comparisons **Regulatory Amendment 3 - Constant Catch**

Figures show the results of the simulation, with respect to landings by fleet, under status quo management (constant catch) versus all of the Regulatory Amendment 3.

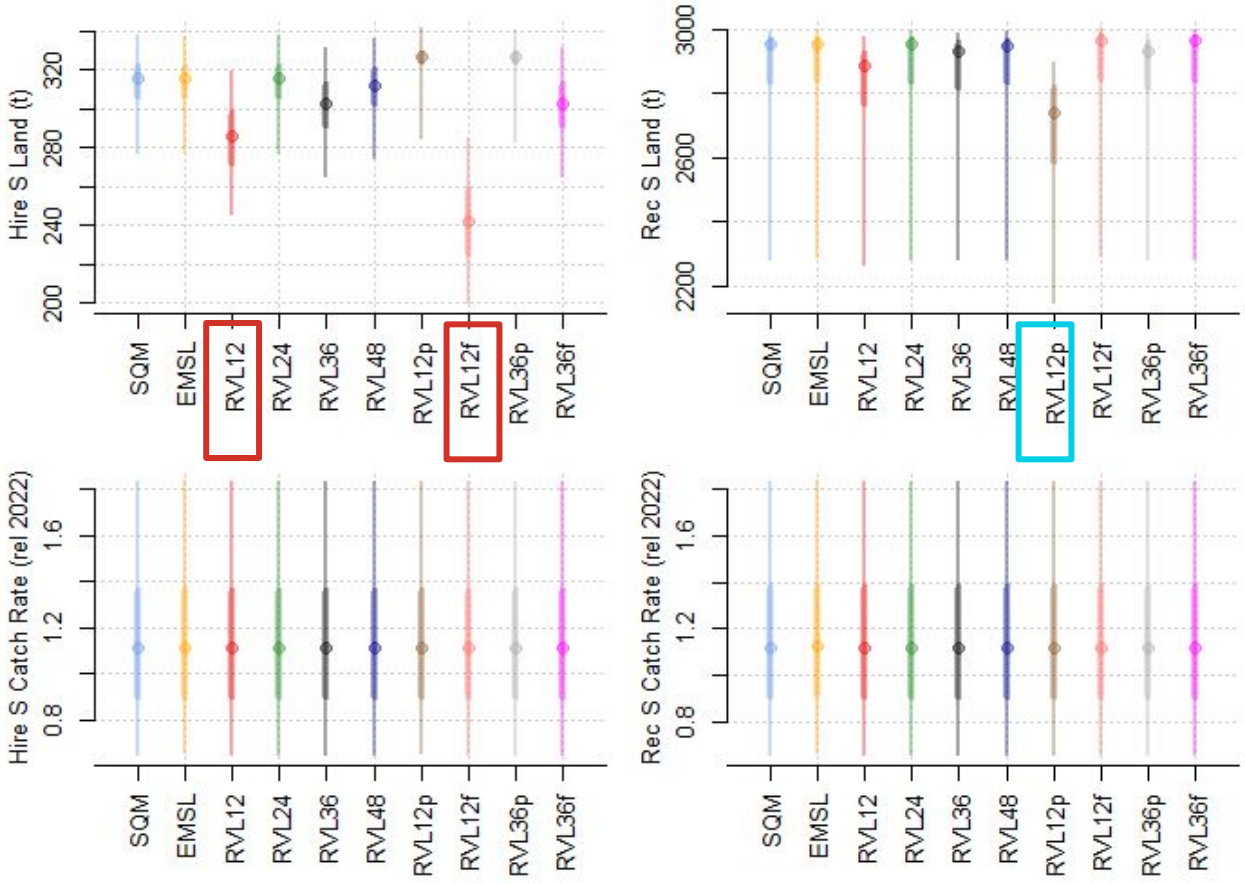
Results are median values over all 32 reference operating models (possible 'true' underlying systems).



* Notice strongest impacts of size and vessel limits the southern recreational fleets.

* Minimal impacts on landings for USComm and northern recreational fleets (EMSL slightly reduces landings in Northern regions)

b. Performance Comparisons **Regulatory Amendment 3 - Constant Catch**



Figures show the results of the simulation under status quo management (constant catch) versus all of the Regulatory Amendment 3.

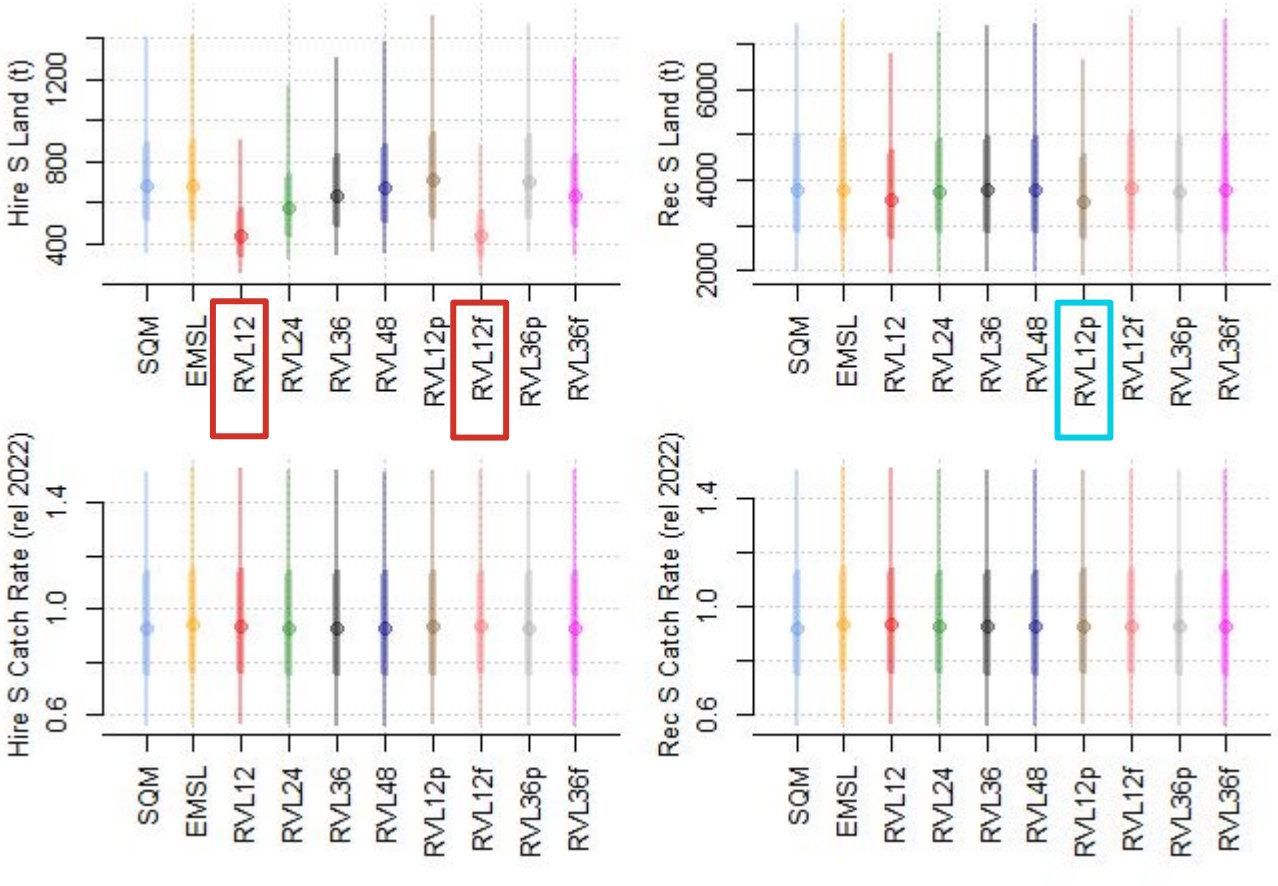
Results are median values, interquartile, and 95th percentile ranges over all 32 reference operating models (possible 'true' underlying systems).

Summarized landings (top row following previous slide) and catch rate (bottom row) for southern recreational fleets across all projection period.

Reduced landings in extreme vessel limit (12 fish in all recreational, private, or fore hire).

Regulatory Amendment 3 options have very little impact on catch rate (shown), variability in yield, and mean length of landings.

b. Performance Comparisons **Regulatory Amendment 3 - Constant Effort**



Figures show the results of the simulation under status quo management (constant catch) versus all of the Regulatory Amendment 3.

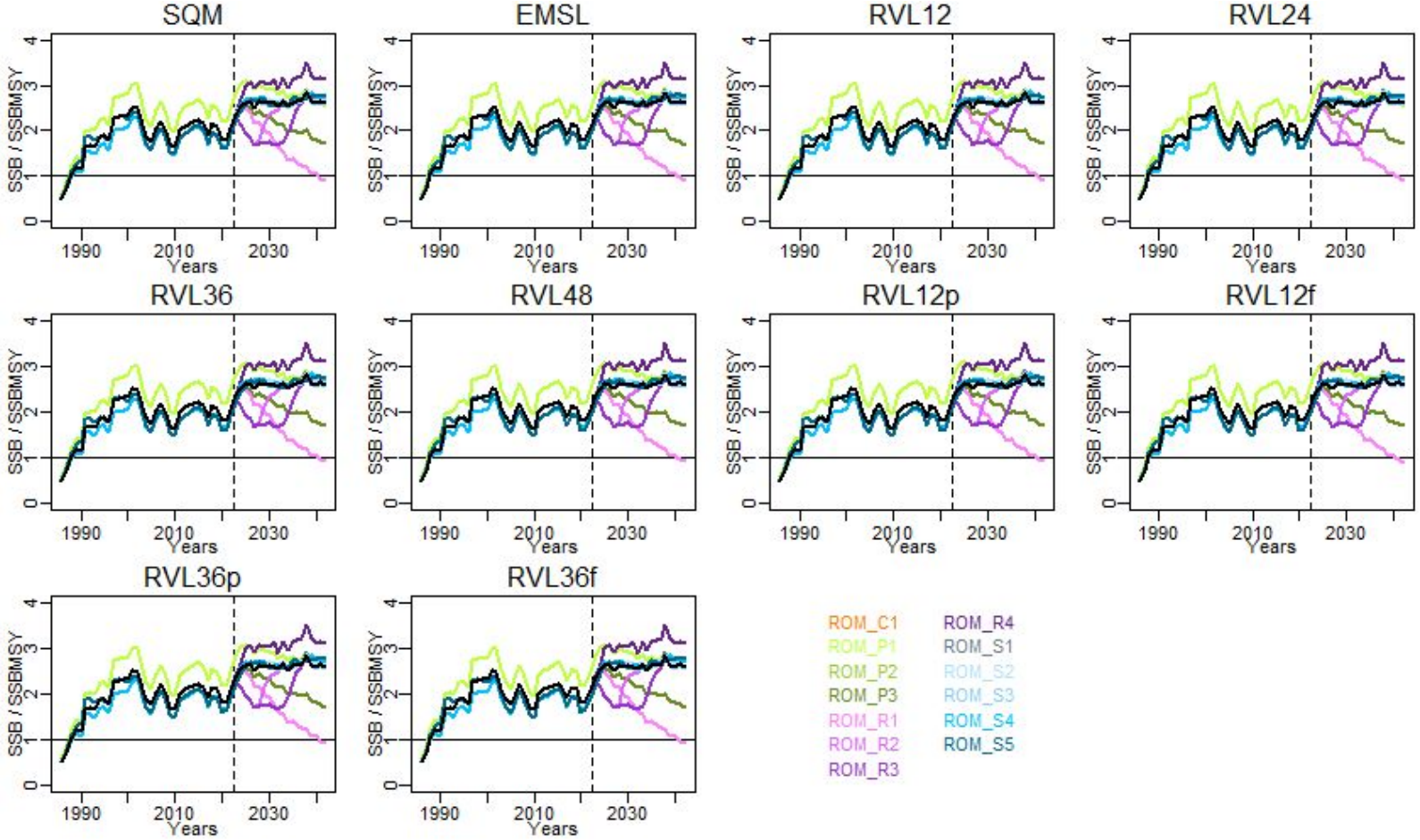
Results are median values, interquartile, and 95th percentile ranges over all 32 reference operating models (possible 'true' underlying systems).

Summarized landings (top row following previous slide) and catch rate (bottom row) for southern recreational fleets across all projection period.

Reduced landings in extreme vessel limit (12 fish in all recreational, private, or fore hire).

Regulatory Amendment 3 options have very little impact on catch rate (shown), variability in yield, and mean length of landings.

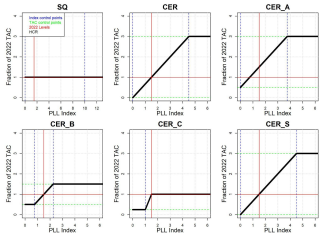
b. Performance Comparisons **Regulatory Amendment 3 - Constant Catch Robustness Results**



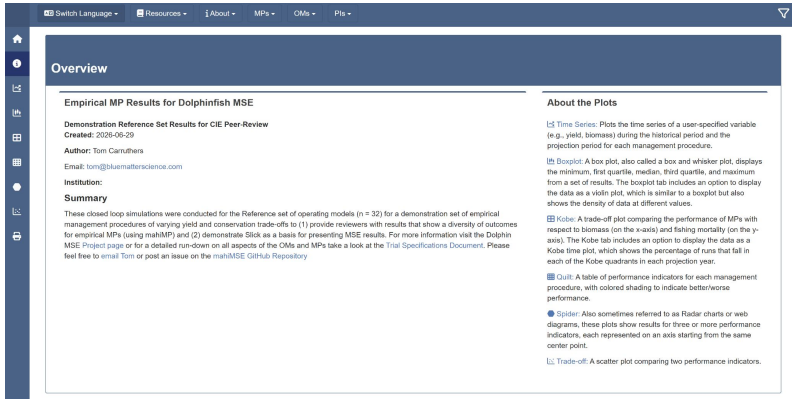
b. Performance Comparisons (projections, trade-offs, quilt plots)

Demonstration MSE Results

- 6 Demonstration CMPs
- All 32 Reference Grid OMs
- Metrics: SSB/SSBMSY, F/FMSY, Landings, Catch Rate, Catch Rate Retained, Mean Length, Catch Difference (abs % change)
- Time periods: Short (first 5 years of projection); Medium (years 5-10 of projection); Long (years 11-15 of projection); All (years 1-15 of projection)
- Calculated using mahiMSE and mahiRefSet packages
- Presented in the Slick App



Uncertainty	Level 1	Level 2
Natural Mortality	Low (m): 0.25 per season	High (M): 0.5 per season
Resilience (steepness)	Low (s): 0.7	High (S): 0.95
Catch levels of Disc and Unrep	Low (c): half NOAA calculated	High (C):100% NOAA calculated
Recruitment Level	Low (r) 75% historical mean levels	High (R) 100% historical mean levels
Viscosity	Low (v): prob. stay. = 0.4	High (V) prob. stay. = 0.6



b. Performance Comparisons (projections, trade-offs, quilt plots)

Time Series Plots

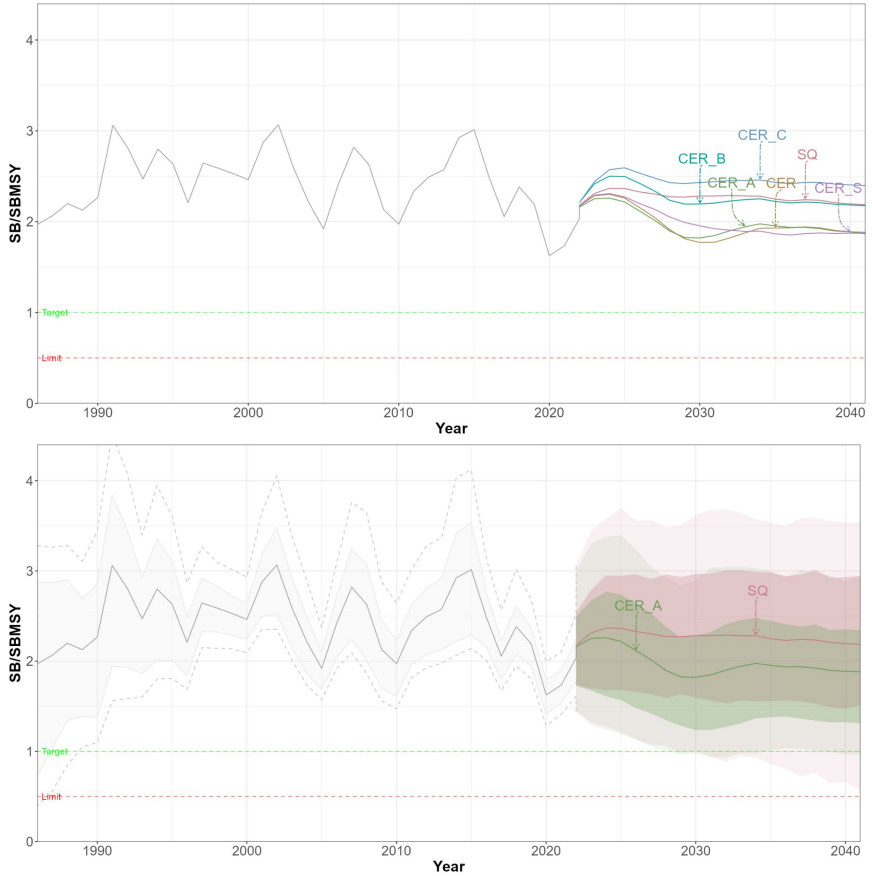
- SB/SBMSY
- F/FMSY
- Total Landings

Options

- By OM (can be filtered)
- By MP (can be filtered)
- Individual simulation

Diagnostics

- Catch stability
- Biomass oscillation (overcompensation)
- Exploitation rate stability
- Short-term vs long term outcomes
- Uncertainty in outcomes (mean, 50%, 80%)
- Trajectory



b. Performance Comparisons (projections, trade-offs, quilt plots)

Box Plots (concise overview)

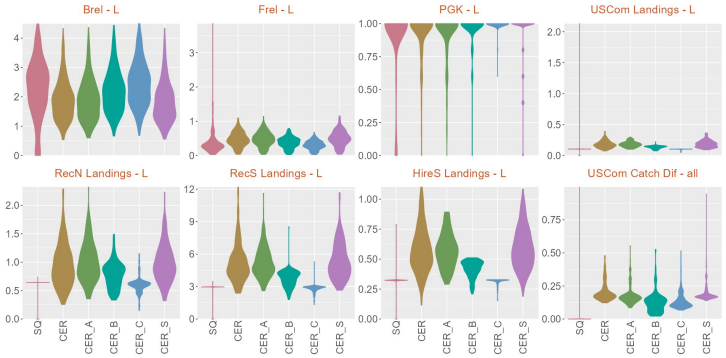
- All metrics

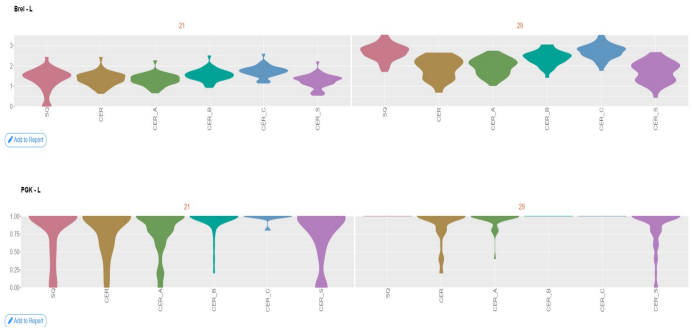
Options

- By OM (can be filtered)
- Violin / box / both

Diagnostics

- Uncertainty
- Skew
- Trade-offs
- Relative probability of outcomes





Performance Indicators

- [ ] Brel - all
- [ ] Brel - S
- [ ] Brel - M
- [x] Brel - L
- [ ] Frel - all
- [ ] Frel - S
- [ ] Frel - M
- [x] Frel - L
- [ ] PGK - all
- [ ] PGK - S
- [ ] PGK - M
- [x] PGK - L
- [ ] USCom Landings - all
- [ ] USCom Landings - S
- [ ] USCom Landings - M
- [x] USCom Landings - L
- [ ] RecN Landings - all
- [ ] RecN Landings - S
- [ ] RecN Landings - M
- [x] RecN Landings - L
- [ ] RecS Landings - all
- [ ] RecS Landings - S
- [ ] RecS Landings - M
- [x] RecS Landings - L
- [ ] HireN Landings - all
- [ ] HireN Landings - S
- [ ] HireN Landings - M
- [x] HireN Landings - L
- [ ] HireS Landings - all
- [ ] HireS Landings - S
- [ ] HireS Landings - M
- [x] HireS Landings - L
- [ ] USCom Catch Rate - all
- [ ] USCom Catch Rate - S
- [ ] USCom Catch Rate - M
- [x] USCom Catch Rate - L
- [ ] RecN Catch Rate - all
- [ ] RecN Catch Rate - S
- [ ] RecN Catch Rate - M
- [x] RecN Catch Rate - L
- [ ] RecS Catch Rate - all
- [ ] RecS Catch Rate - S
- [ ] RecS Catch Rate - M
- [x] RecS Catch Rate - L
- [ ] HireN Catch Rate - all
- [ ] HireN Catch Rate - S
- [ ] HireN Catch Rate - M
- [x] HireN Catch Rate - L
- [ ] HireS Catch Rate - all
- [ ] HireS Catch Rate - S
- [ ] HireS Catch Rate - M
- [x] HireS Catch Rate - L
- [ ] USCom Ret Catch Rate - all
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- [ ] USCom Ret Catch Rate - M
- [ ] USCom Ret Catch Rate - L
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- [ ] HireS Ret Catch Rate - L
- [x] USCom Catch Dif - all
- [ ] USCom Catch Dif - S
- [ ] USCom Catch Dif - M
- [ ] USCom Catch Dif - L
- [ ] RecN Catch Dif - all
- [ ] RecN Catch Dif - S
- [ ] RecN Catch Dif - M
- [ ] RecN Catch Dif - L
- [ ] RecS Catch Dif - all
- [ ] RecS Catch Dif - S
- [ ] RecS Catch Dif - M
- [ ] RecS Catch Dif - L
- [ ] HireN Catch Dif - all
- [ ] HireN Catch Dif - S
- [ ] HireN Catch Dif - M
- [ ] HireN Catch Dif - L
- [ ] HireS Catch Dif - all
- [ ] HireS Catch Dif - S
- [ ] HireS Catch Dif - M
- [ ] HireS Catch Dif - L
- [ ] USCom Mean length - all
- [ ] USCom Mean length - S
- [ ] USCom Mean length - M
- [ ] USCom Mean length - L
- [ ] RecN Mean length - all
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- [ ] HireS Mean length - M
- [ ] HireS Mean length - L

b. Performance Comparisons (projections, trade-offs, quilt plots)

Kobe Plots

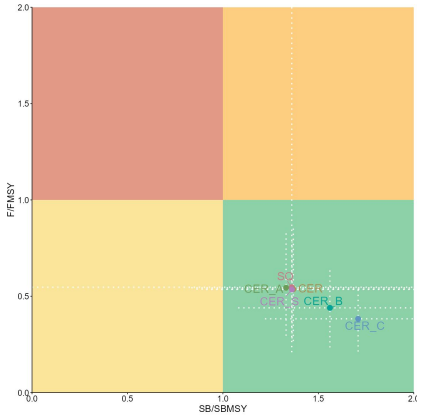
- Prob overfishing / overfished

Options

- A time period / over time
- Violin / box / both

Diagnostics

- Trend in F and B status
- Biological risk
- MP adaptation
- Short-term and long-term trade-offs
- Suitable tuning horizons (if tuned to PGK).



b. Performance Comparisons (projections, trade-offs, quilt plots)

Quilt Plots

- Tabulated Performance Values

Options

- Filtering
- Ordering

Diagnostics

- Trade-offs
- Collinearity
- Satisficing

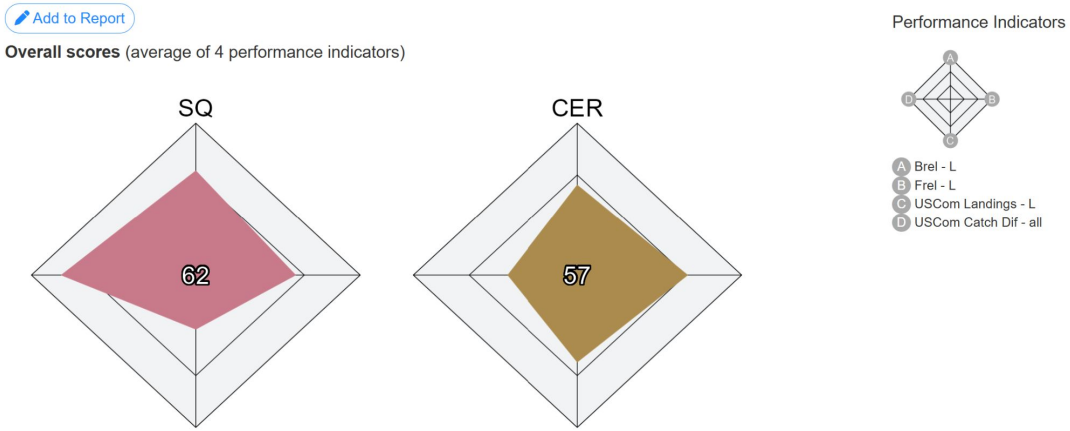
	Brel - L	Frel - L	PGK - L	USCom Landings - L	RecN Landings - L	RecS Landings - L	HireN Landings - L
	All	All	All	All	All	All	All
CER_S	1.87	0.513	0.875	0.191	1.04	5.48	0.672
CER	1.93	0.488	0.893	0.184	1.01	5.29	0.696
CER_A	1.93	0.492	0.897	0.184	1.02	5.3	0.679
CER_B	2.21	0.383	0.968	0.132	0.812	3.73	0.575
SQ	2.23	0.587	0.868	0.114	0.608	2.78	0.191
CER_C	2.43	0.313	0.984	0.0988	0.616	2.78	0.36

Copy CSV

b. Performance Comparisons (projections, trade-offs, quilt plots)

Spider Plots

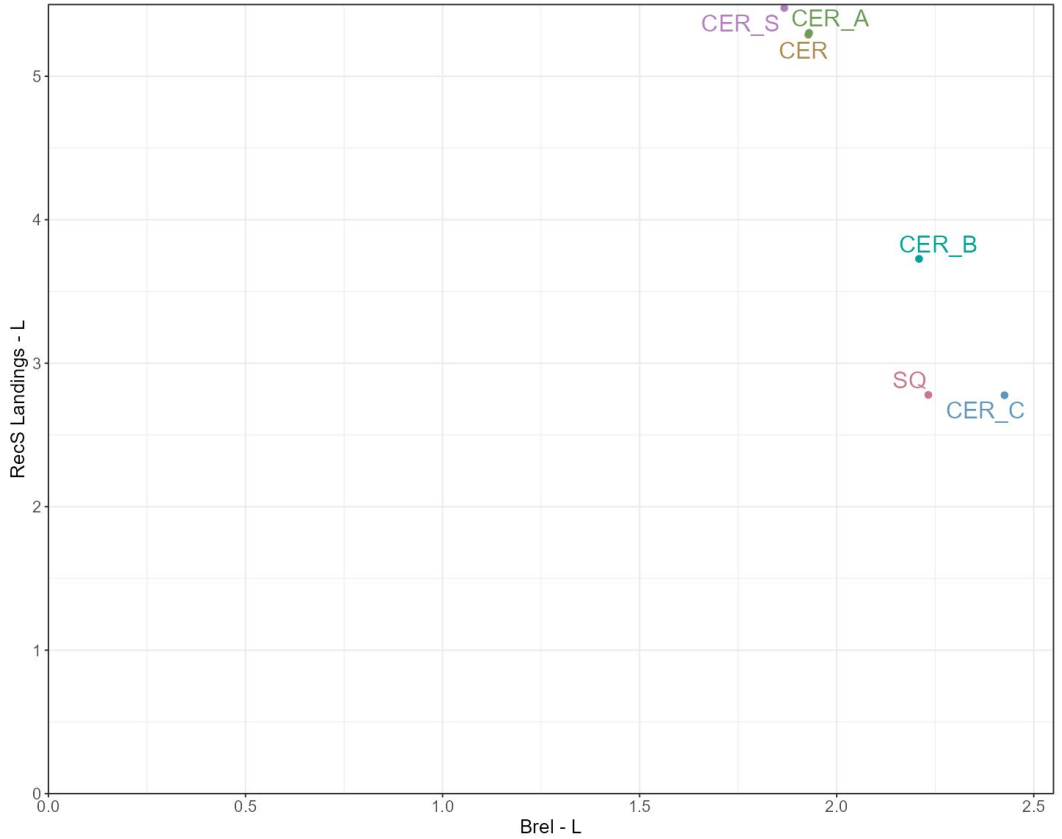
- Performance overview
- Difficult to interpret
- Dependant on ordering
- Hard to scale inverse metrics (F/FMSY, variation in catches)
- Imply an equal weighting
- AVOID!



b. Performance Comparisons (projections, trade-offs, quilt plots)

Trade-off plots

- Trade-off frontiers
- Dominant CMPs
- CMP design (what choices lead to a frontier consistently better across various metrics?)



Conclusions

Regulatory Amendment 3

Candidate management options were shown to have very little impact on key performance metrics for dolphin.

Demonstration CMPs

- Slick App provides a transparent, convenient and flexible tool for presenting MSE results to managers and stakeholders (‘DIY’ MSE results).
- Presets for particular stakeholder groups could be useful (e.g., RecS metrics)
- Including time series for landings of specific fleets could be included.
- Current exploitation rates appear sustainable
- Stock is highly resilient even at low steepness and low recruitment scenarios.
- Typical PGK tuning (e.g. 60%) may lead to aggressive CMPs.
- Could be important to simulate effort dynamics to put realistic limits on exploitation rate.

Applicable TORs

5. Evaluate performance metrics.

a. Do performance metrics include all legally mandated management objectives as outlined in the Magnuson-Stevens Fishery Conservation and Management Act (i.e., to include status determination criteria with suitable risk tolerance to measure probability of overfishing and overfished status; and rebuild overfished stock in accordance with rebuilding requirements)?
b. Did performance metrics sufficiently capture additional manager and/or stakeholder objectives to achieve optimum yield, if relevant (i.e., to include desired management objectives such as: total catch, catch rate, catch size, fishing opportunity/season length, etc.)?

References

Peterson, C., Karnauskas, M., McPherson, M., Hadley, J., Blake, S., Byrd, J. 2024. Report of the South Atlantic dolphinfish management strategy evaluation stakeholder workshops. NOAA Tech. Memo. NMFS-SEFSC-781, 35 p. https://doi.org/10.25923/f628-n174

Hordyk, A., Huynh, Q., Carruthers, T.R., 2026. MSE Visualization and Decision Analysis. Available from: https://slick.bluematterscience.com.