Dolphin MSE Update

October 2026 SSC

Overview:

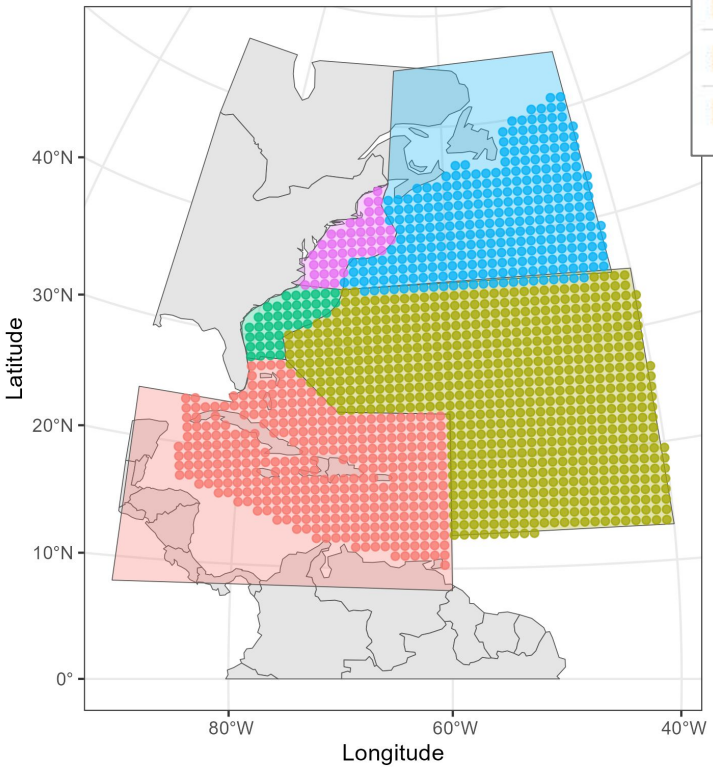
1. MP performance & feedback
2. CIE review
3. MP in Council framework

Dolphin MP Performance

(1) Recall regulatory amendment 3 scoping and outcomes
(2) Dynamic MP design and performance
(3) Performance metrics

MSE Tool

Code	Alternative code	Description
CAR+FLK	CAR+SFL	Caribbean, South Florida and the Keys
NCA	SAR	Off Caribbean, South Florida and the Keys
NCFL	SE	Wilmington down to Mid Florida
NED	NED	Off North coast
NNC+VBM	NC+NE	Wilmington to Montauk



Code	Fleet	Areas	Description
USCom	USA commercial longline	All	US pelagic longline fleet
RecN	Recreational North	NNC+VBM	Private recreational fishing
RecS	Recreational South	CAR+FLK, NCFL	Private recreational fishing
HireN	For hire North	NNC+VBM	Headboat / party boat / charter
HireS	For hire South	CAR+FLK, NCFL	Headboat / party boat / charter
Intl	International	CAR+FLK, NCA, NED	Assumed to have the same seasonal distribution as the USCom fleet.
Disc	Discard	CAR+FLK, NCA, NNC+VBM	Assumed to have same catches as UnRep fleet and the same seasonal distribution as the USCom fleet.
UnRep	Unreported	CAR+FLK	Assummed to have the same catches as the Disc fleet and the same seasonal distribution as the USCom fleet.

Regulatory Amendment 3 Scoping

SQM = status quo management

EMSL = expand min size limit (20” FL) for all commercial and private

RVL12 = recreational vessel limit of 12 fish

RVL24 = recreational vessel limit of 24 fish

RVL36 = recreational vessel limit of 36 fish

RVL48 = recreational vessel limit of 48 fish

RVL12p = recreational vessel limit of 12 fish for private rec only

RVL12f = recreational vessel limit of 12 fish for for-hire rec only

RVL36p = recreational vessel limit of 36 fish for private rec only

RVL36f = recreational vessel limit of 36 fish for for-hire rec only

Status quo management

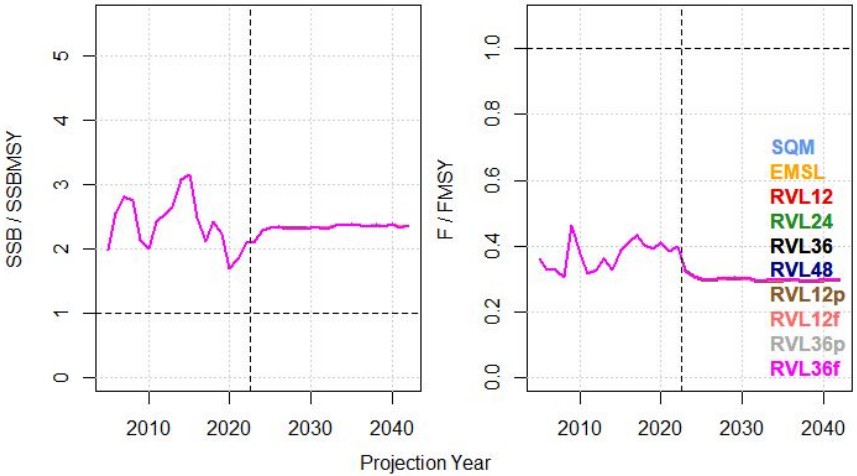
- 1,719,953 lbs commercial ACL
- 22,850,811 lbs recreational ACL
- Recreational vessel limit of 54 fish / bag limit 10 fish
- 20” FL minimum size in SC, GA and FL

Modeled as Constant Catch

Modeled as Constant Effort

Regulatory Amendment 3 Scoping

Reg Am 3 do not strongly affect stock-wide status (as shown by overlapping median lines)

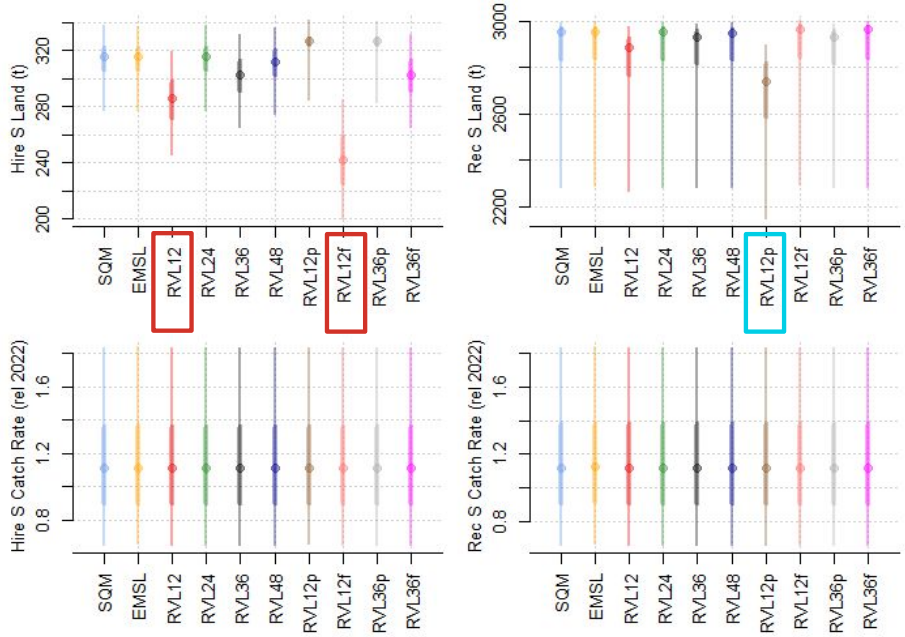


Figures show the results of the simulation, with respect to stock status, under status quo management (constant catch) versus all of the Regulatory Amendment 3.

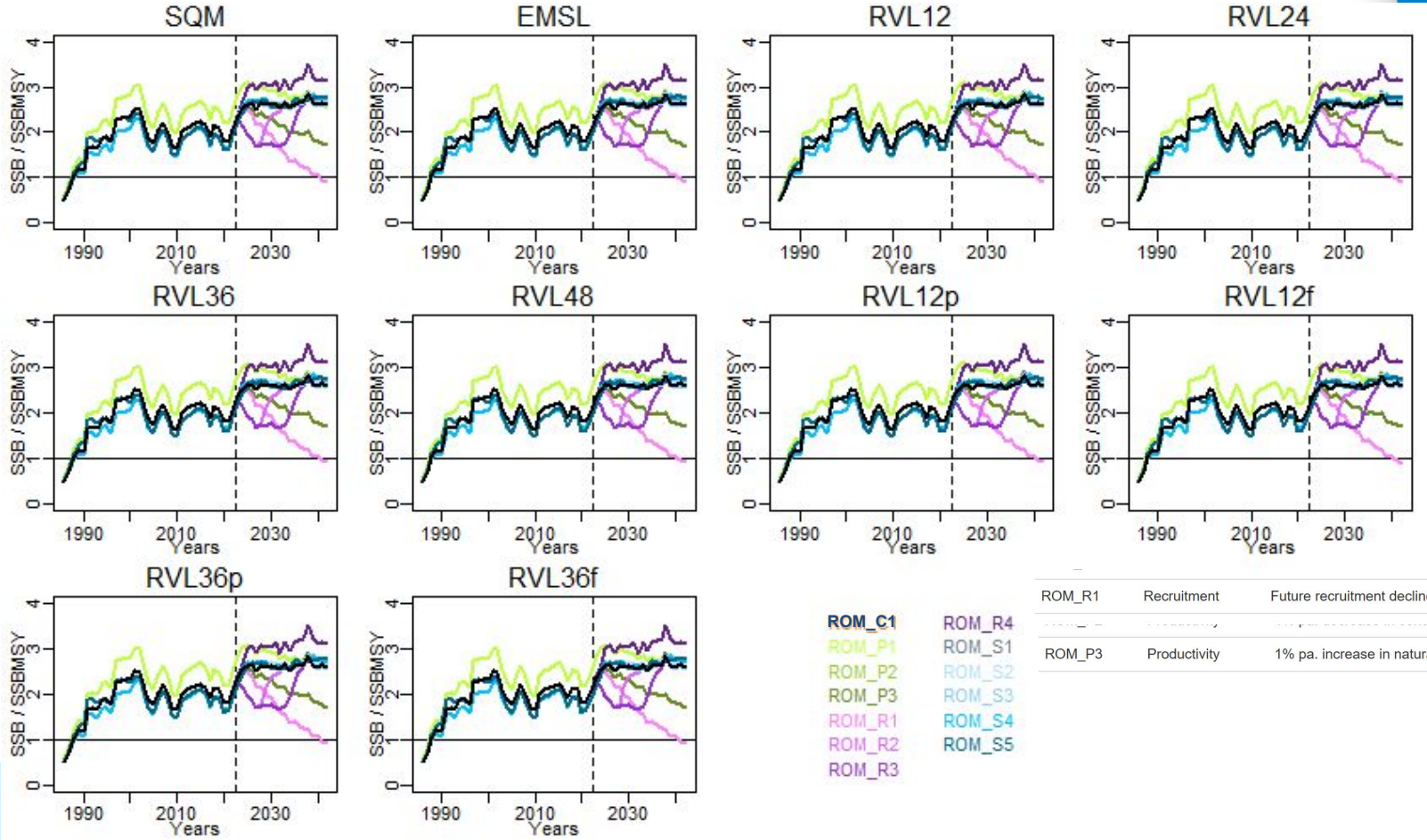
Results are median values (interquartile range) over all 32 reference operating models (possible 'true' underlying systems).

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.



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



ROM_R1	Recruitment	Future recruitment declines 1% per year
ROM_P3	Productivity	1% pa. increase in natural mortality rate (all ages)

Management Result

In light of results, advancement of Regulatory Amendment 3 was halted at June Council

https://safmc.net/posts/june-council-meeting-addresses-commercial-management-headboats-black-sea-bass-and-dolphin/?utm_medium=email&utm_source=govdelivery

Dolphin MP Performance

(2) Dynamic MP design and performance

Management Procedure Design

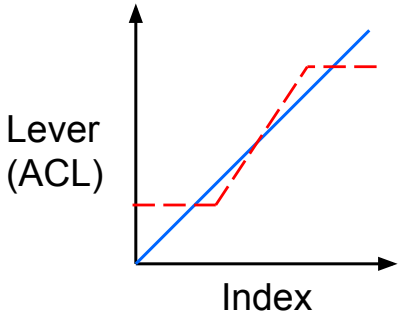
Static versus **dynamic**

Management levers

- **ACL** by fleet and area
- **Effort** (access) relative to today by fleet and area
- **Vessel limit** by fleet
- **Minimum size limit** by fleet and area



Control rule – specifies how change in index relates to recommended change in management lever



Infinite flexibility to meet your needs

MPs can run the gambit from static management (like we have now) to completely dynamic and responsive where ABC is adjusted each year, including anything in between.

Static catch but only adjustment to avoid closed fishery (2015)



Annual updates to ABC following index of abundance

Design is wholly dependent on manager and stakeholder needs.

Empirical MPs

SQ (Status Quo) (tune param: catch)

Constant catch at 2022 levels, up to 20% upward and downward TAC adjustments.

CER (Constant Exploitation Rate) (tune param: catch/Index)

Constant Catch/Index at 2022 levels up to 3x 2022 catch

CER_A (Aggressive) (tune param: catch/Index)

As CER but +50% 2022 Catch

CER_B (Bounded) (tune param: catch/Index)

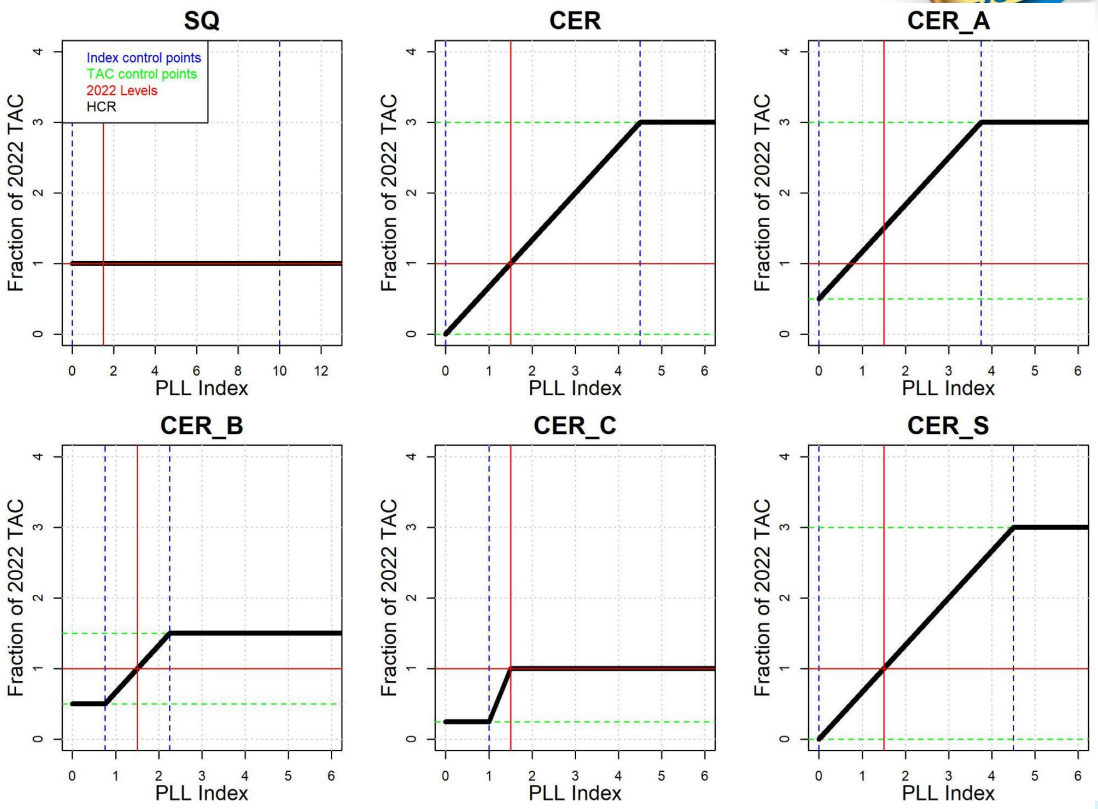
As CER but bounded to +/- 50% 2022 Catch

CER_C (Conservative) (tune param: max catch)

Min 25%, Max 100% 2022 catches

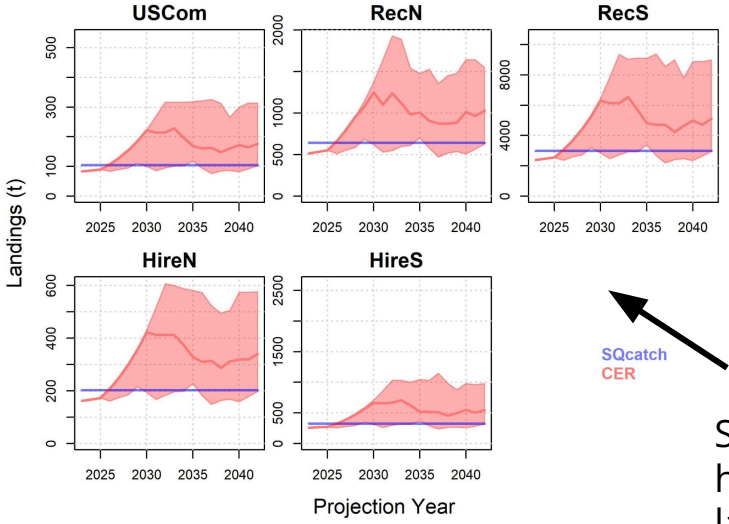
CER_S (Stable) (tune param: catch/index)

As CER but up to 10% upward and downward TAC adjustments.

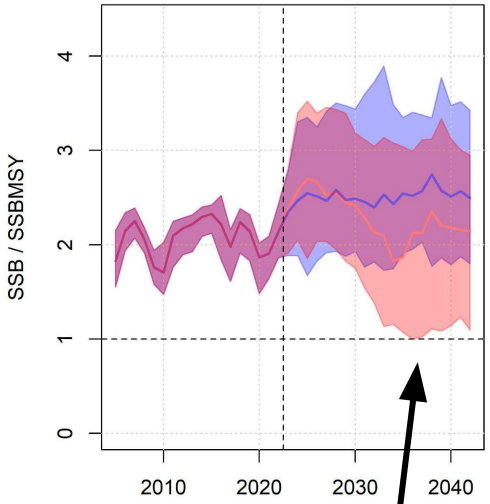


3. Empirical Management Procedures

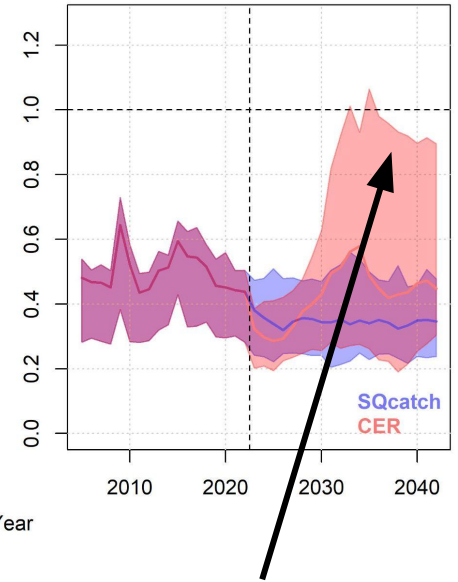
Constant 2022 Catches for US fleets (SQcatch) vs Constant Exploitation Rate for US fleets (CER) [CER has a maximum change of 20% catch between years]



Substantially higher expected landings



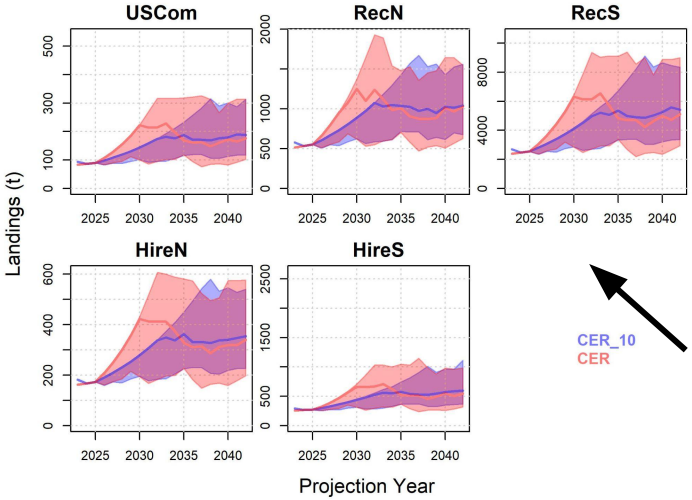
Low probability of overfished status (SSB < SSBMSY)

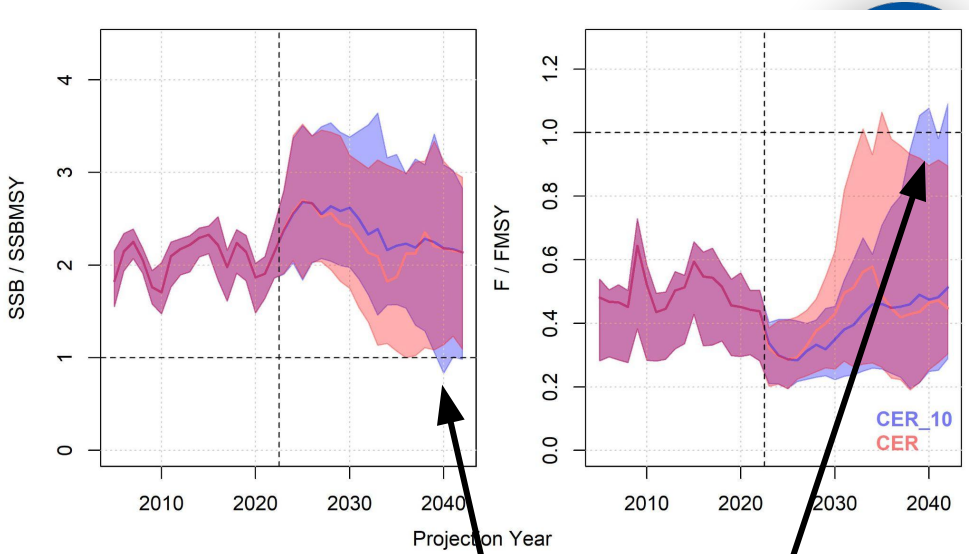


Low probability of overfishing (F > FMSY)

3. Empirical Management Procedures

Constant Exploitation Rate for US fleets (CER) [max 20% change in catch] vs CER with max 10% change in catch (CER_10)



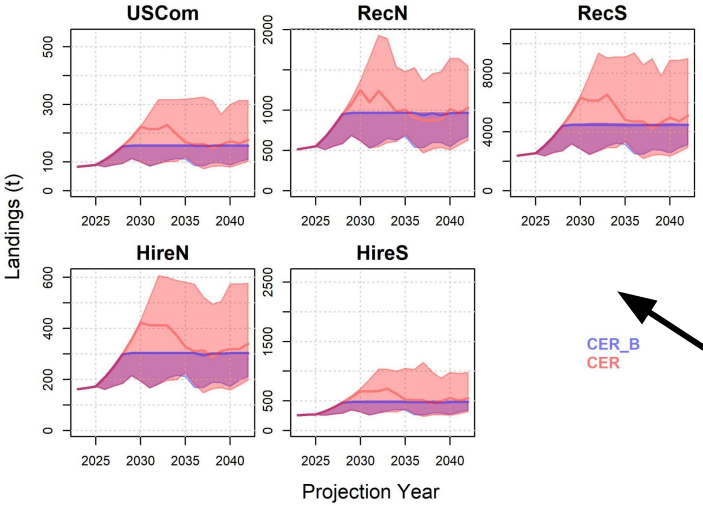


Smaller near-term catch traded- off against somewhat higher and more stable landings over longer term.

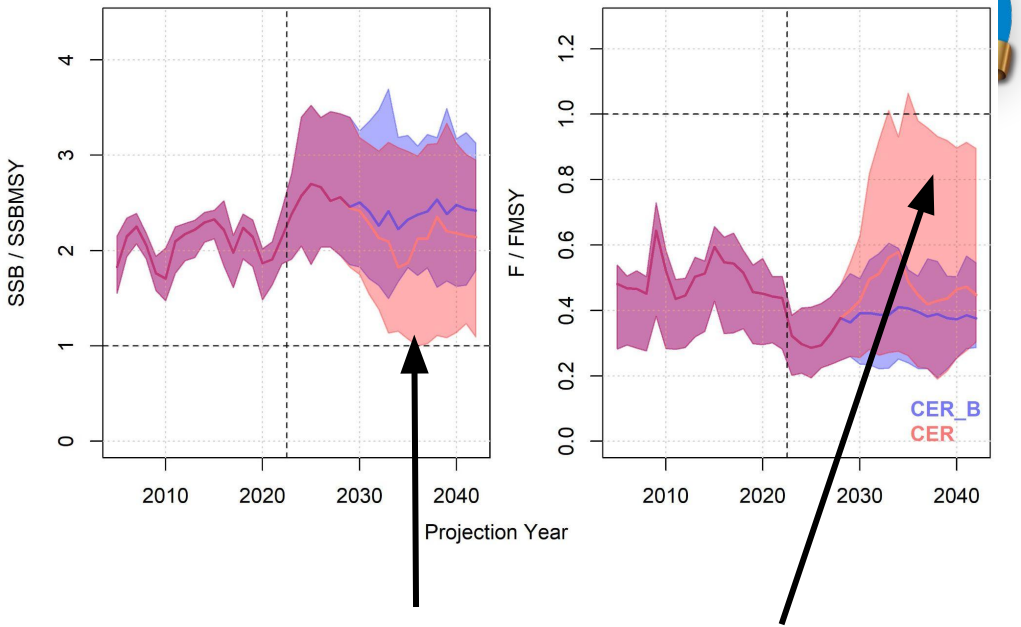
Less flexible MP (CER_10) has slightly higher risks of overfishing and overfished status over longer term.

3. Empirical Management Procedures

Constant Exploitation Rate for US fleets (CER) vs Constant Exploitation Rate for US fleets with bounds of 50% and 150% 2022 catches (CER_B)



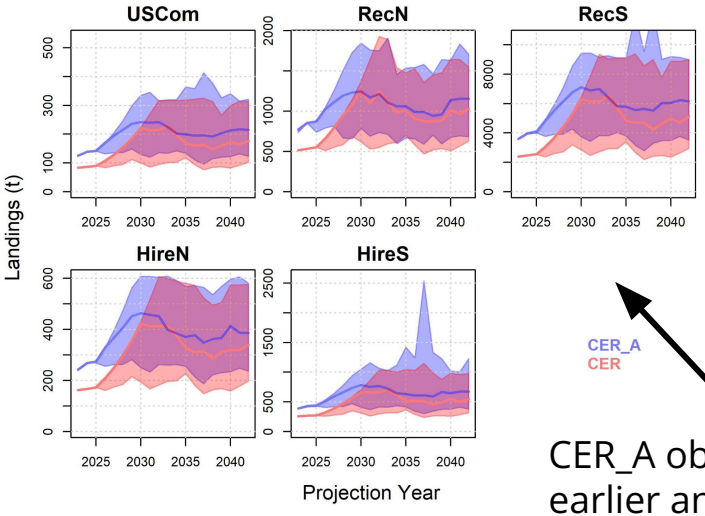
CER_B hits upper bound frequently



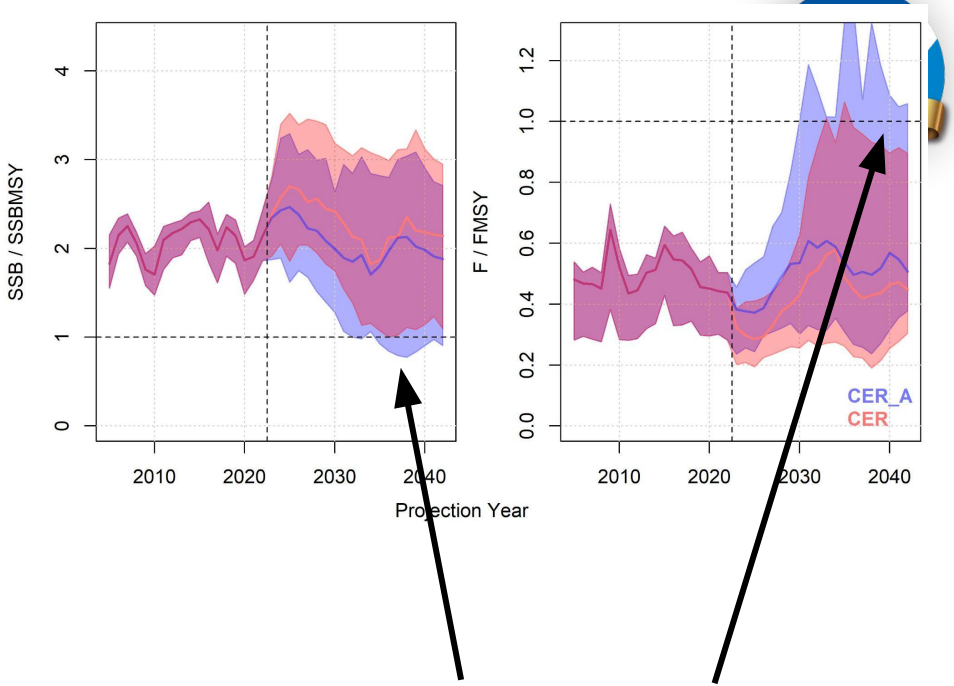
Bounded MP has substantially lower risks of overfishing and overfished status. Trading biological risk against maximum potential landings via an upper bound on catches.

3. Empirical Management Procedures

Constant Exploitation Rate for US fleets (CER) vs Aggressive high exploitation rate version with lower bound of 50% 2022 catches (CER_A)



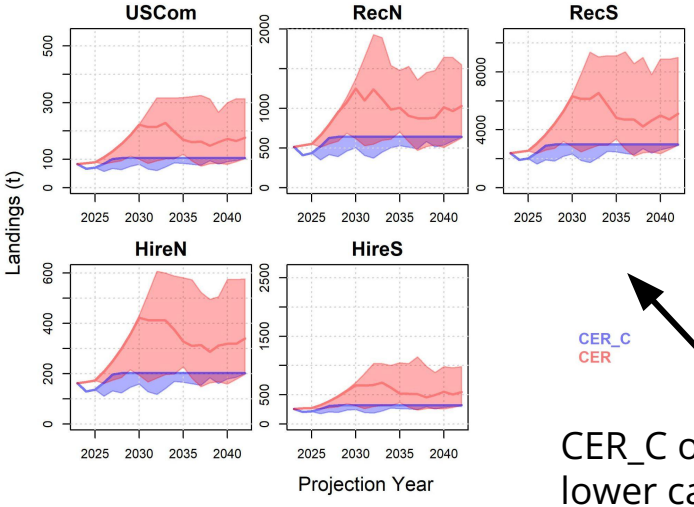
CER_A obtains higher landings earlier and consistently higher thereafter.



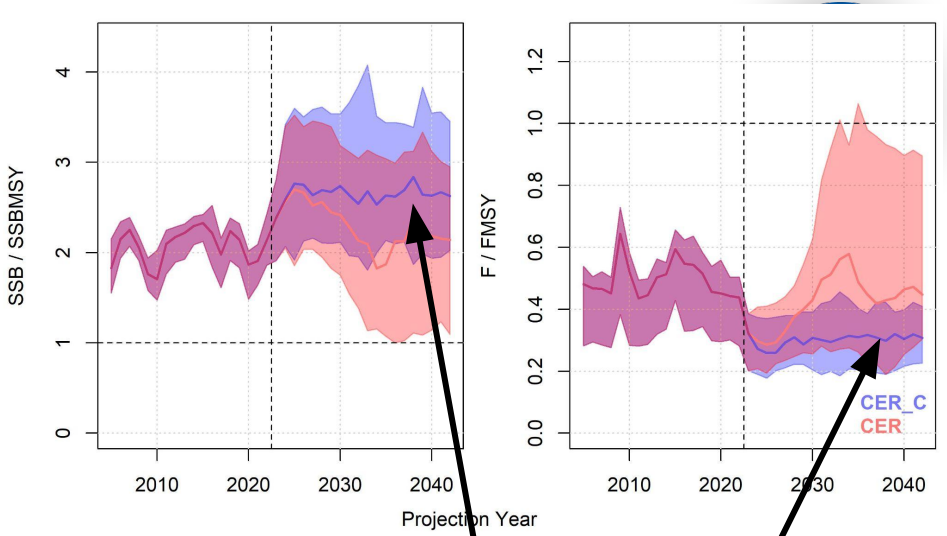
Higher risks of overfishing / overfished status from the more aggressive CER_A, however still < 10%

3. Empirical Management Procedures

Constant Exploitation Rate for US fleets (CER) vs Aggressive high exploitation rate version with lower bound of 50% 2022 catches (CER_A)

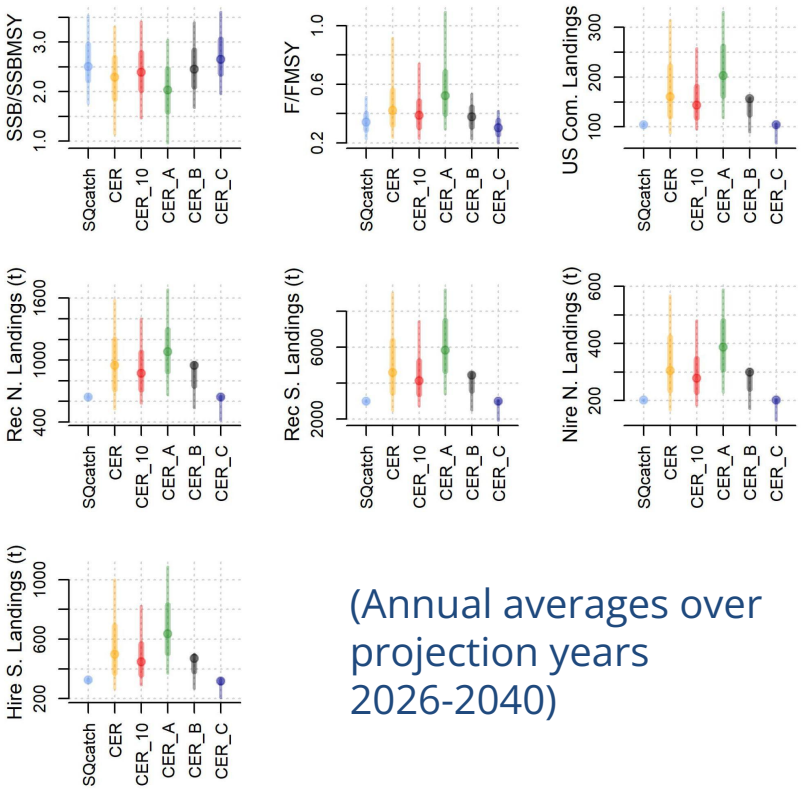


CER_C obtains substantially lower catches.

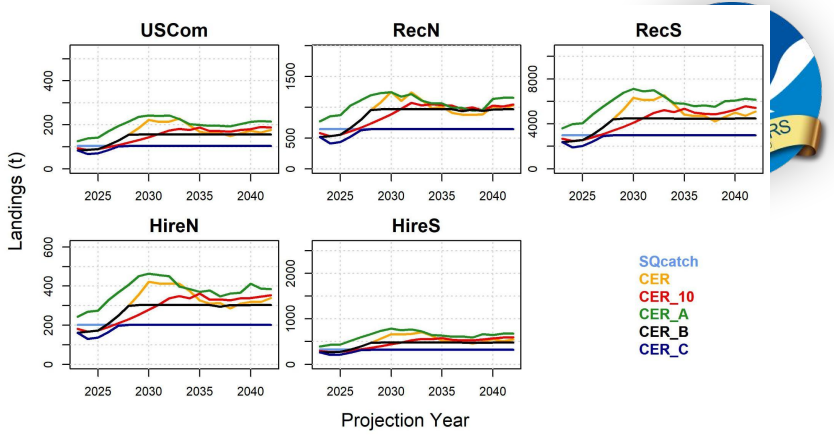


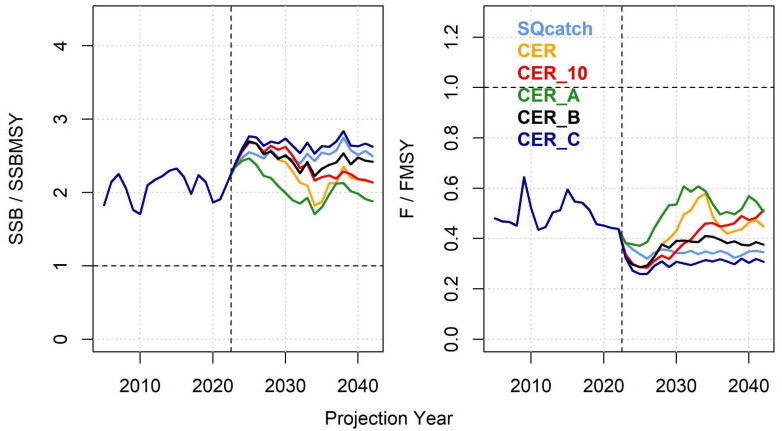
Almost zero risk of overfishing / overfished status from the more conservative CER_C

Empirical MPs: Example summaries



(Annual averages over projection years 2026-2040)





Download Slick results: https://blue-matter.github.io/mahiMSE/tsd/data/Slick/mahiSlick_1.slick
Run Slick online: https://shiny.bluematterscience.com/app/slick

MP Tuning

Purpose

To control for one of the two principal performance trade-offs (expected yield, conservation) allowing for more intuitive comparison of CMP performance.

It is desirable to make this a limit where possible, a requirement by which all MPs must ‘pass’.

Tuning Metrics

Probability of Green Kobe (probability of underfishing and underfished status)

Tuning Levels

Primary: 60% PGK

Alternative: 70% PGK

Tuning parameters

To avoid complex optimization problems, it is normally the case that CMPs are configured such that a single parameter controls the exploitation level. For the mahiMP, this is the slope of the HCR defined by catch / index.

Tuning OMs

One or more reference set OMs (some times all ref set OMs).

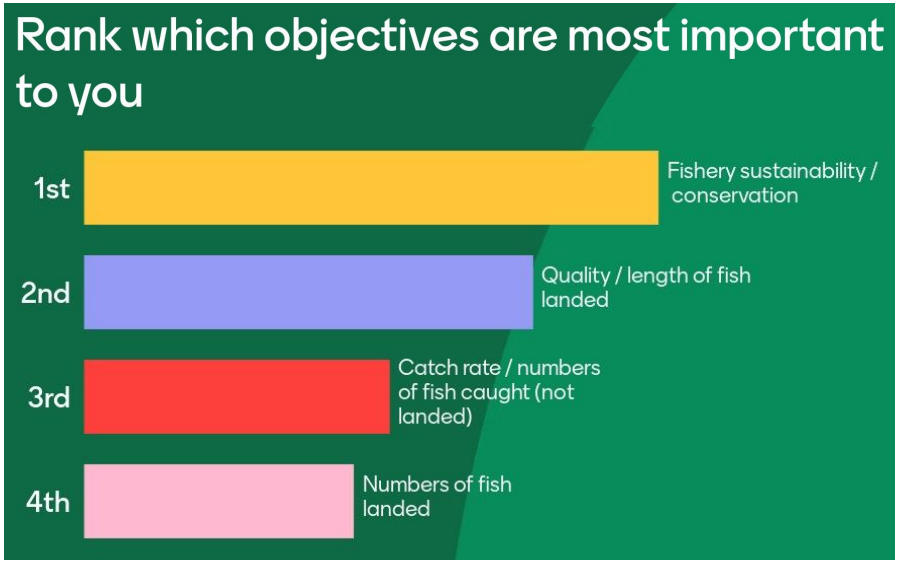
Dolphin MP Performance

(3) Performance metrics

Management Objectives

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 short (1-5), medium (5-10), long (10-15) time horizons

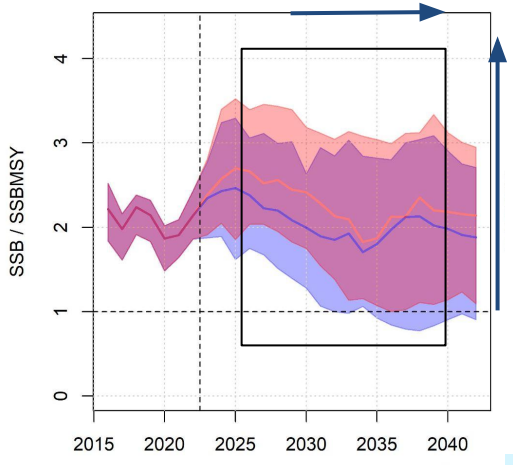
Performance Metrics

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 overfishing ($U>U_{MSY}$)
P(B>BMSY) - probability of not being overfished ($SSB > SSB_{MSY}$)
PGK - probability of being in the green quadrant of the Kobe matrix; combined P* and P(B>BMSY)



Fraction of simulations above SSBMSY from 2026 - 2040

P(B>BMSY)
98%
94%

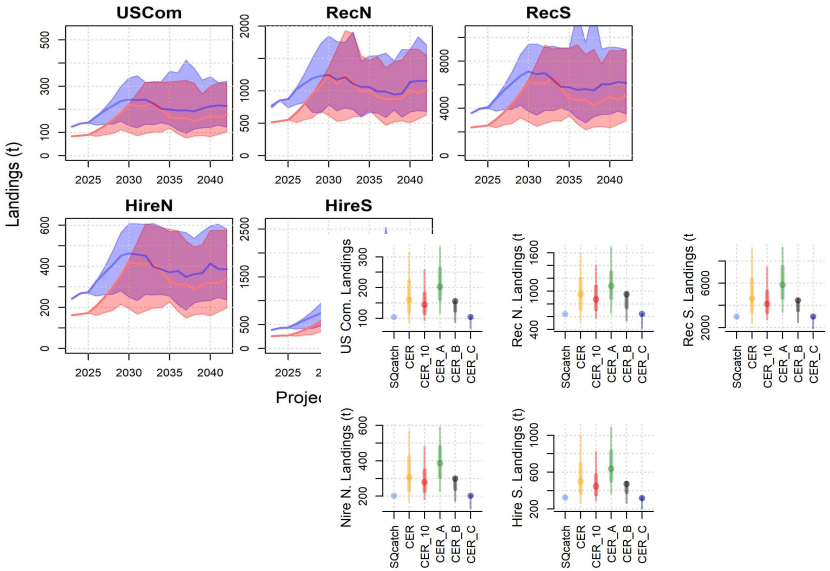
Performance Metrics

Management objectives

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   - 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
   - Maximize yield by fleet
3. **Stability**
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



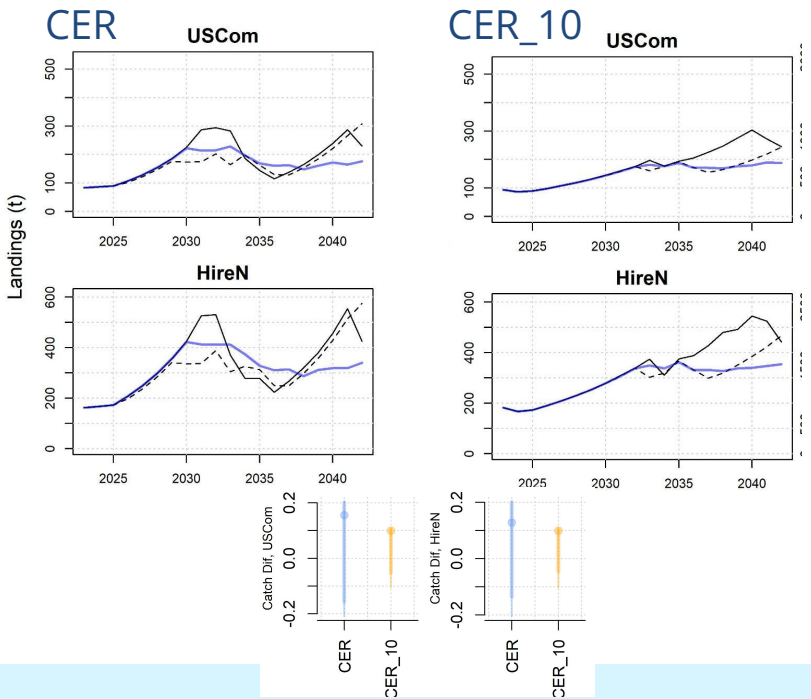
Performance Metrics

Management objectives

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     - E.g., probability of overfishing in projection
   - Stock should have a less than [___]% probability of being overfished
2. **Yield** by fleet and area
   - 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



Performance Metrics

Management objectives

1. **Status:**
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4. **Catch rate** by fleet and area
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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

Performance Metrics

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
   - 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

Performance Metrics

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

Performance Metrics



Management objectives	Performance Metrics
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 ◦ 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	avLen$_f$ - average length of fish caught by fleet LgSze - proportion of catch where mean length > 40”

ACTION ITEM

Advise on MP design and performance

- Define tuning target
  - Status is unlikely to be limiting for this stock
  - Consider other tuning criteria
- Provide feedback on MP design / levers
  - Stability, data-management lag, minimum management change
  - Longer management update intervals
  - Additional indices
  - Control rules specific to regions
  - MPs that use regional catches in addition to indices (availability)
  - Alternative smoothing (polynomial smoothness or means)
- Provide feedback on desired management performance
  - Considering trade-offs like yield vs. stability

Dolphin MSE CIE Review

(1) Overview and links to materials
(2) Recommendations

CIE Review

SEDAR 104 (July 28 - 31, 2026; Charleston, SC):
https://sedarweb.org/assessments/sedar-104-dolphin-management-strategy-evaluation/

Project landing page: https://blue-matter.github.io/mahiMSE/

Review of:

- Management context and need, stakeholder objectives, stock biology, data inputs, OM design and conditioning, MSE framework, data simulation, management procedures, results analyses
- Provided Technical Specification Document, quarto (rmd) of data analysis, github code, results and Slick app

CIE Review

Expert reviewers: Daniel Howell, Ernesto Jardim, Gary Melvin

SSC Reviewers: Jeff Buckel, Kelsey Roberts

SSC Chair: Matt Damiano

Car is built. MSE framework passed peer review.

Ensure appropriate inputs / gas. Recommendations for alternate inputs.

Now to determine where we are going. Management procedure development.



Recommendations

Revisit data

- Develop alternate spatiotemporal index to underpin OM movement dynamics
- Revisit / update landings (real catches 2023-2026), length composition data, treatment of dead discards
- Generate forecasts of environmental indicators
- Analyze recreational effort as a function of biomass

Operating Models Inputs

- Recondition OMs on alternate spatiotemporal index (to reduce dependence on VAST index)
- Add high international landings reference OM
- Add correlated K - hi M life history robustness scenario
- Add environmentally-driven OMs to robustness set, alternately driving recruitment or catchability
- Remove viscosity from OM grid – movement more appropriately captured with alternate index

Recommendations

MP development

- Additional MP testing and development required
- Provide ZeroCatch reference MP and high catch MP
- Develop stability MP – where management advice is static unless change is needed
- Consider nonlinearity in effort
- MP tuning

Performance Metrics

- Revise mean size in catch metric to reflect stakeholder needs (Mean size >40”)
- Add MeetACL metric
- Fraction of catch discarded

Recommendations

Results presentation

- Provide table of assumptions
- Update Slick app to include additional time series plots
- Demonstrative figures to illustrate robustness OMs and insensitivity to selectivity

Future work / exploratory analyses

- Impact of time-lag
- MP as a rebuilding tool
- MP as a status barometer
- Value of information analyses

Project schedule & timeline

- **October - November 2026:** data update; OM reconditioning; MP development
- **December 2026 Council:** Present updated MSE and MPs
- **December 2026 - February 2027:** refine and tune MPs
- **March 2027 Council:** Present tuned MPs
- **Spring 2027 SSC:** final MSE framework and MP sign-off
- **June 2027 Council:** final MP selection

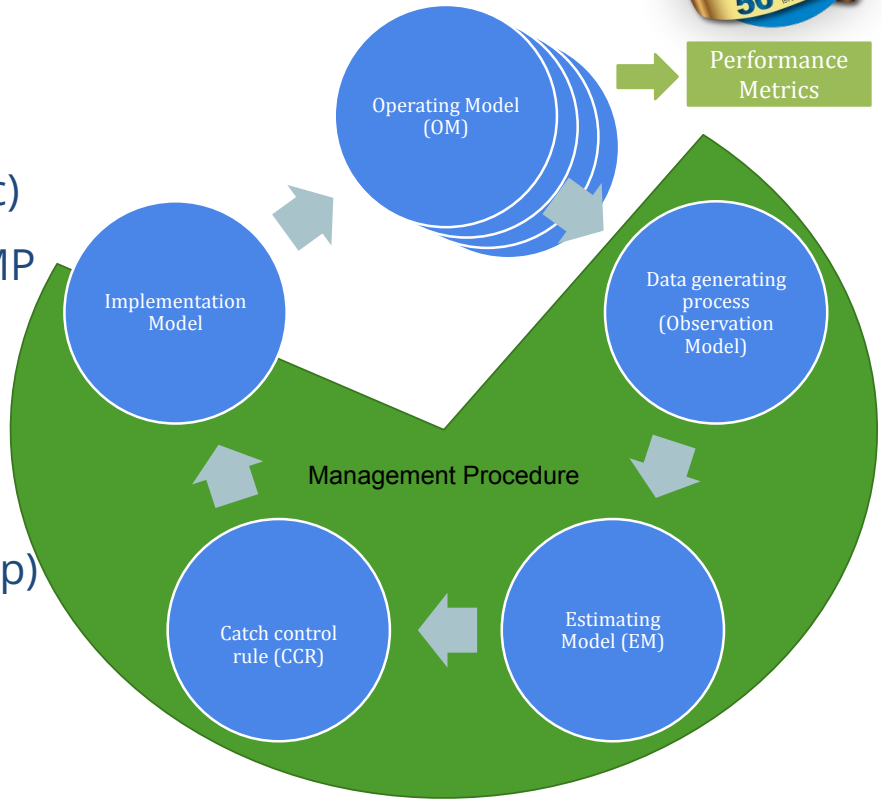
How does an empirical MP fit?

(1) Develop theory
(2) Conceptual demo
(3) Roles and application
(4) Discussion

Management Strategy Evaluation (MSE)

Interdisciplinary process designed to develop robust management procedures (MPs):

1. Identify fishery-specific management objectives (highlighting social and economic)
2. Identify relevant uncertainties over which MP should be robust
3. Develop operating models (e.g., alternate 'true' states of nature)
4. Identify management procedures that are responsive to stock dynamics (feedback loop)
5. Simulate MP behavior across OMs into the future and then measure MP success using performance statistics

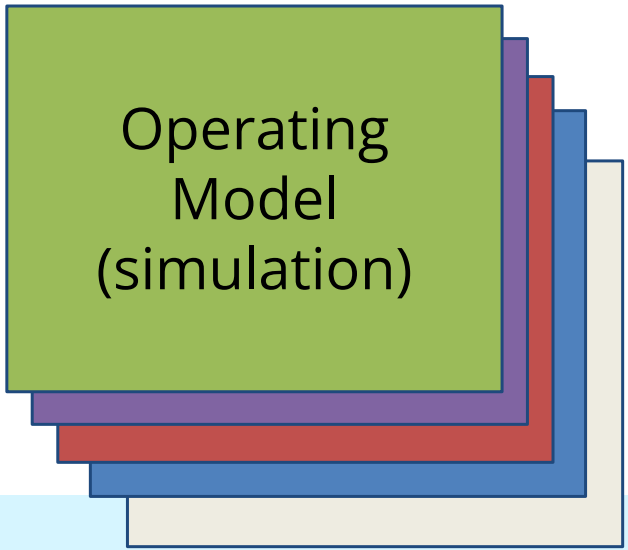


Encompass uncertainty

Develop multiple states of nature (operating models) to encompass reasonable uncertainty in the stock, data, fishery, future.

Test management procedures across all operating models to ensure robustness.

With MSE, we transparently acknowledge uncertainties that hinder our ability to determine status.





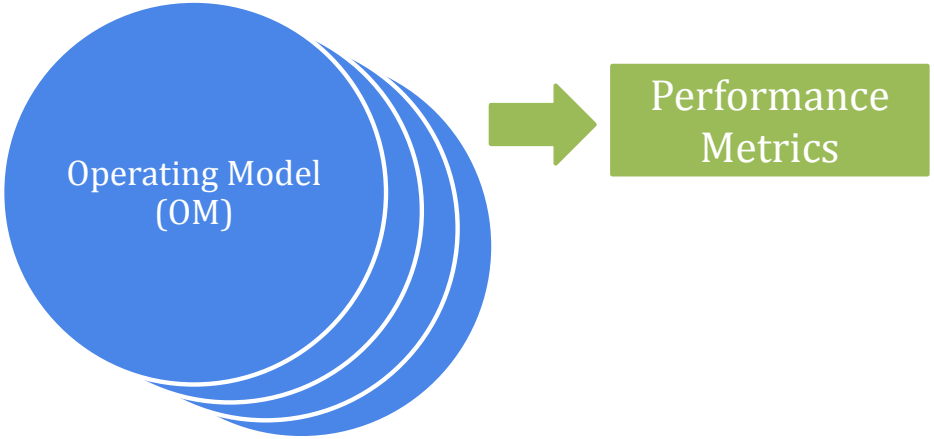
Note status may vary across OMs

Performance

Performance metrics – quantified statistics reflective of management objectives used to measure MP performance

- Necessarily include:
  - Probability of overfished
  - Probability of overfishing
  - Rebuild overfished stock
- Desired social, economic, Ecological objectives to define optimum yield

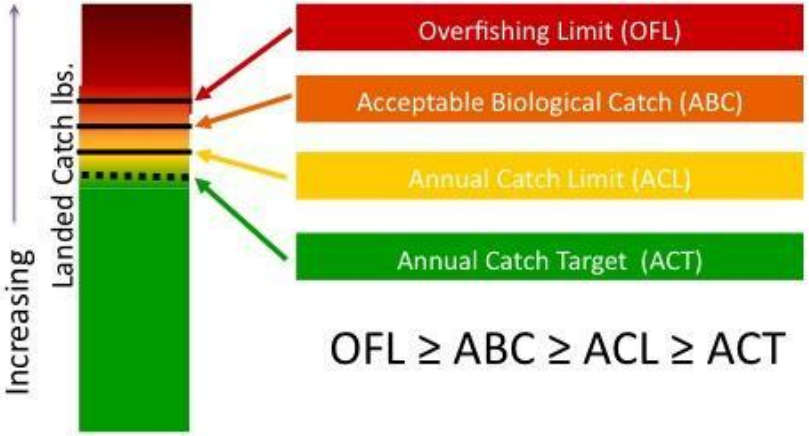
Typically summarized by MP across all OMs

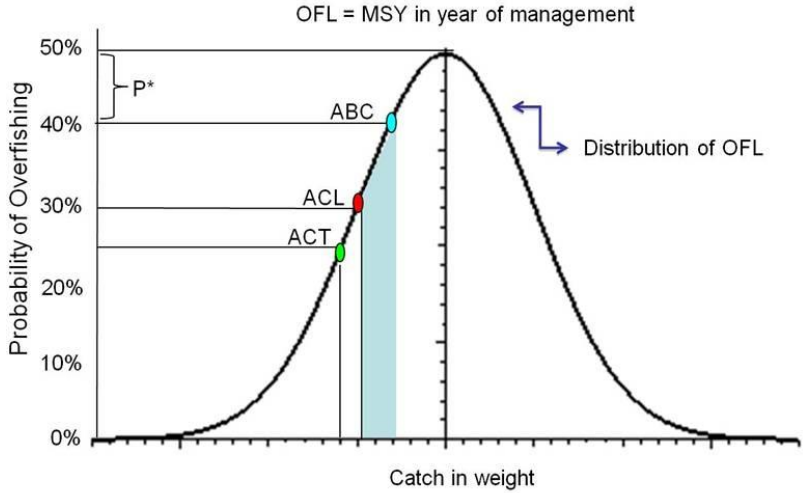


Management procedures & ABC control rules

Management procedures (MP) - pre-defined recipe for how management recommendations should be adaptively adjusted following the response of the stock

- Include description of data-collection, data analysis, ABC control rule, and translation into management advice
- **ABC control rule** – pre-defined decision rules that convert OFL to ABC based on perceived stock size or stock behavior



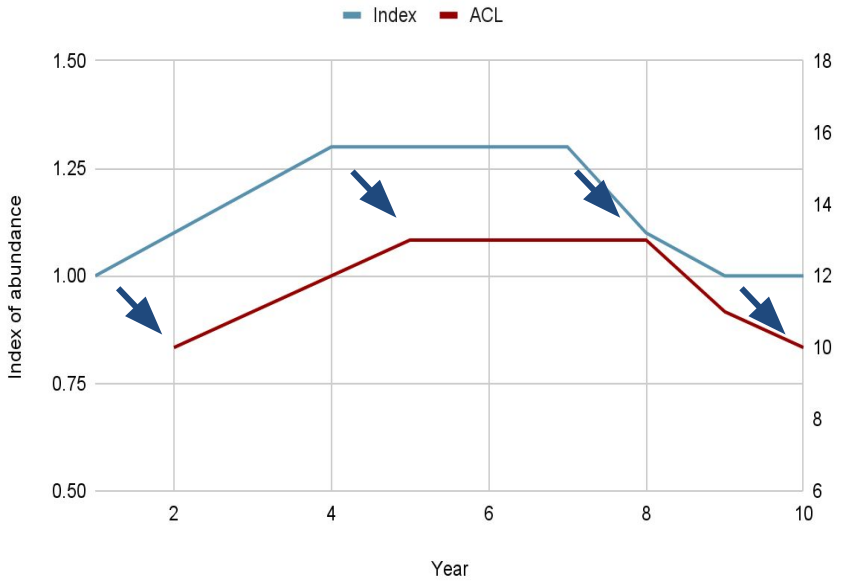


MSE: Management procedure

Empirical MP – management recommendation (ABC or ACL) follows the behavior of an indicator of relative abundance (e.g., survey index)

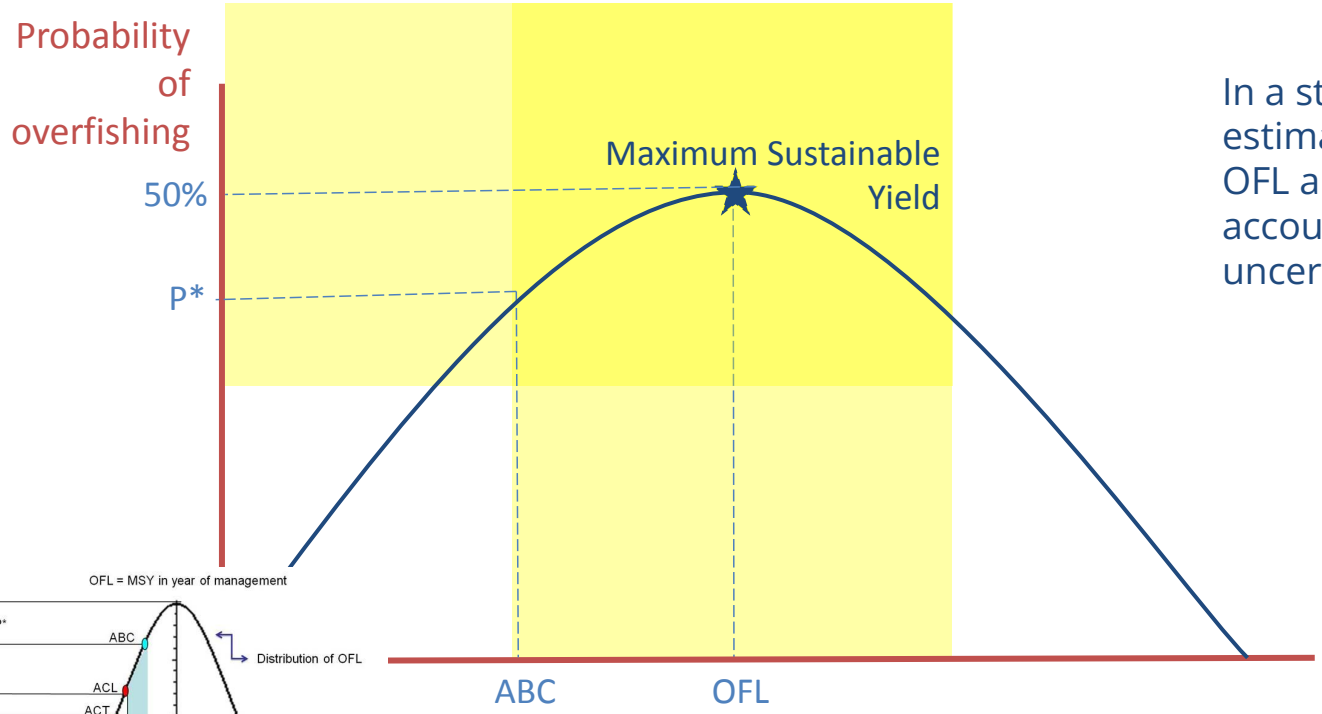
- empirical MPs do not implement stock assessment models at each application
- A good indicator (survey index) is one that is directly proportional to stock abundance; where proportionality is constant over time

MP 'tuning' - parameterizing the MP to meet key management performance targets (e.g., achieve target biomass by the end of the rebuilding period)

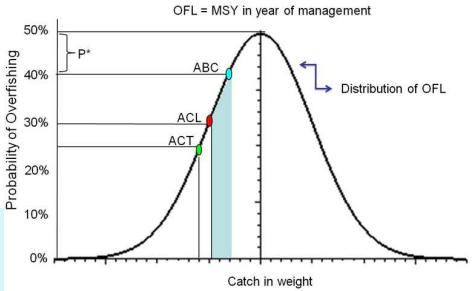


* simplified example

Stock Assessment: uncertainty in status

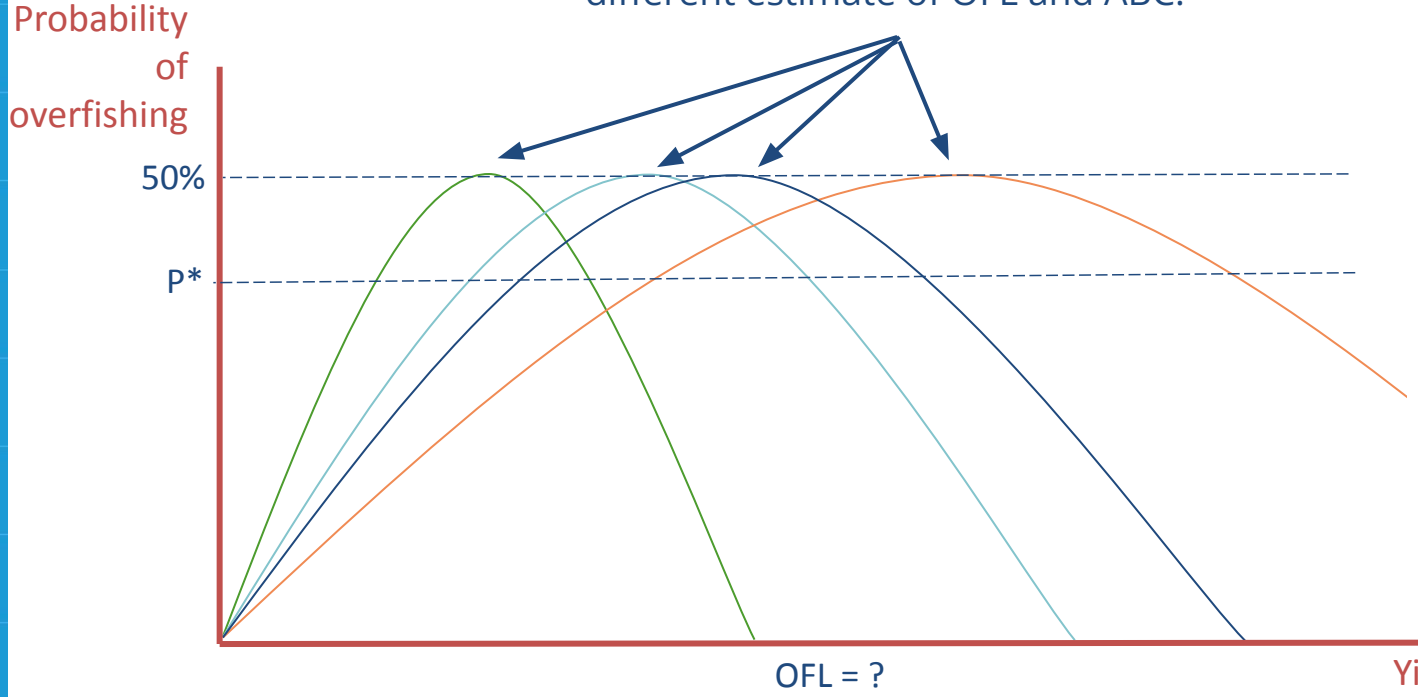


In a stock assessment (best estimate), we can define OFL and reduce to ABC to account for scientific uncertainty.



MSE: Unknown status, Known POF

In MSE, each Operating Model will produce a different estimate of OFL and ABC.



In MSE, we do not determine which OFL is 'correct'.

Rather, the probability of exceeding the unknown OFL (and $B<B_{MSY}$) is an emergent property of the MSE simulation.

This POF may become our OFL proxy.

Theory

An MP tuned to POF = 0.5 will provide OFL.

An MP tuned to P* will provide ABC.

Conceptual Demonstration

Using openMSE software:

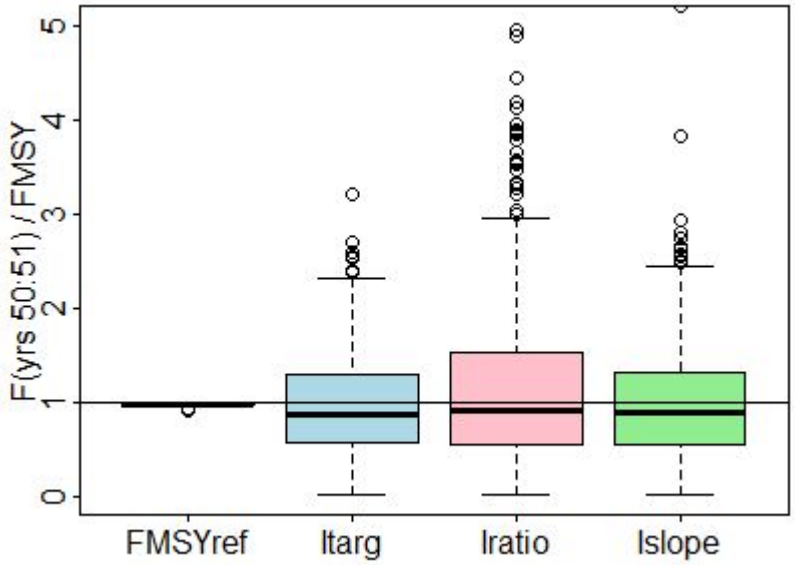
1. Define a generic, reef fish OM (built-in “Porgy” stock) with generic fleet, no observation error, and perfect implementation
2. Tune example empirical MPs to achieve P* ~ 0.5 and P* ~0.4, targeting constant F/F_{MSY}
3. Run MSE simulation with F_{MSY} reference MP and tuned empirical MPs (ITarget, IRatio, ISlope)
   a. 100 year projection period; 250 iterations / scenario

ITarget – maintain index at target level
IRatio – maintain constant index
ISlope – maintain constant index

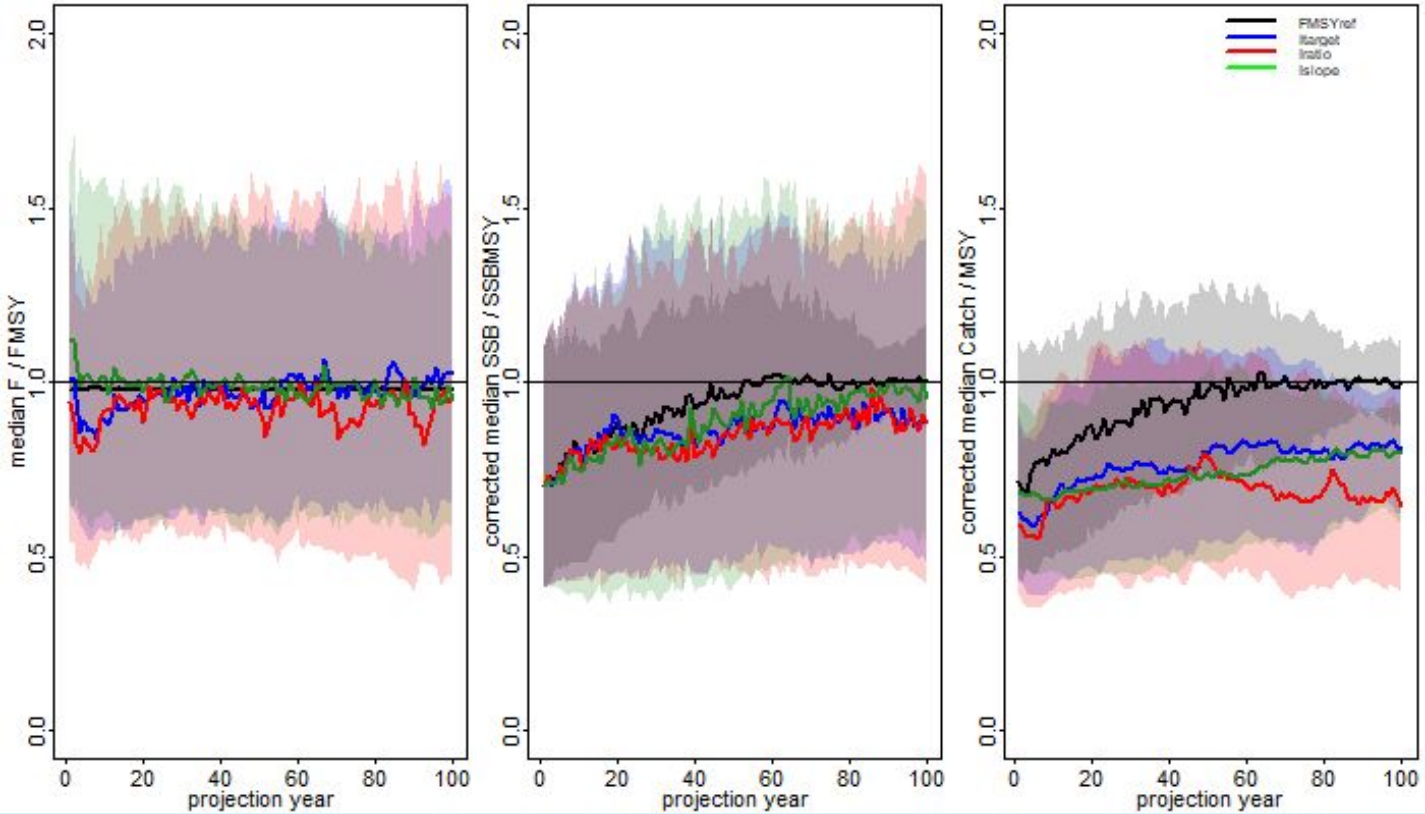
Demo Results

Tuned MPs generally behave comparably to F_{MSY} reference in terms of preventing overfishing and overfished stock status

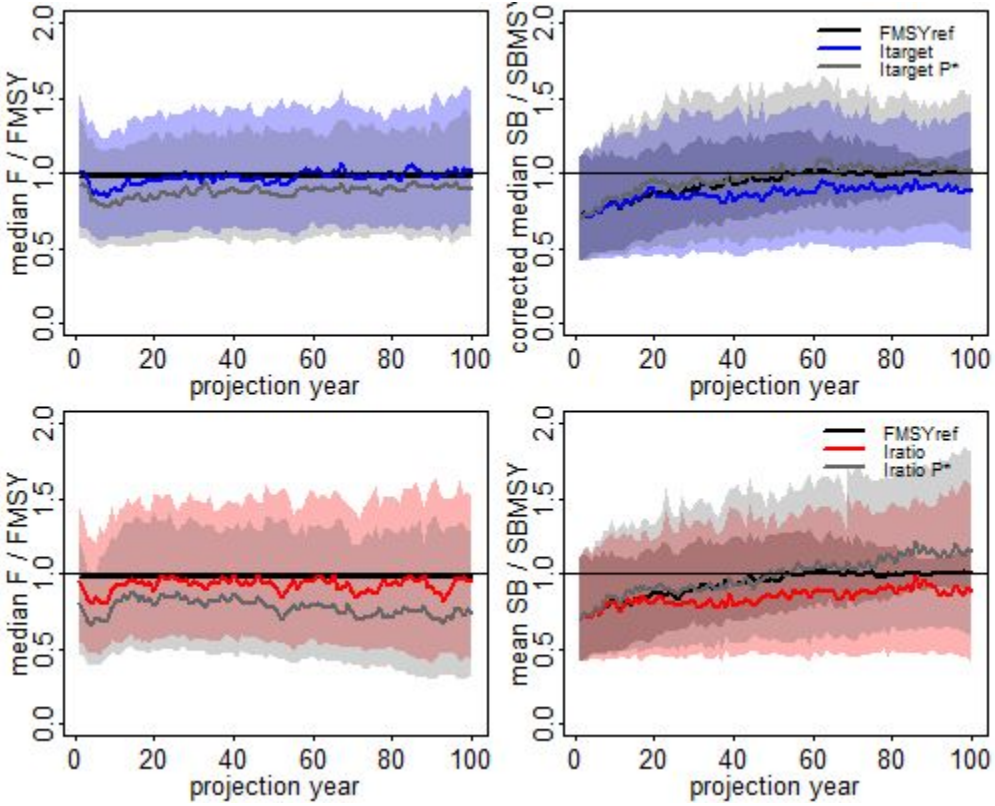
	FMSYref	ITarget	IRatio	ISlope
PNOF (yrs 50-51)	1.0	0.53	0.53	0.52
mean SB/SBMSY (yrs 50-51)	0.96	0.97	0.93	0.99



Demo Results



Consider P*= 40%



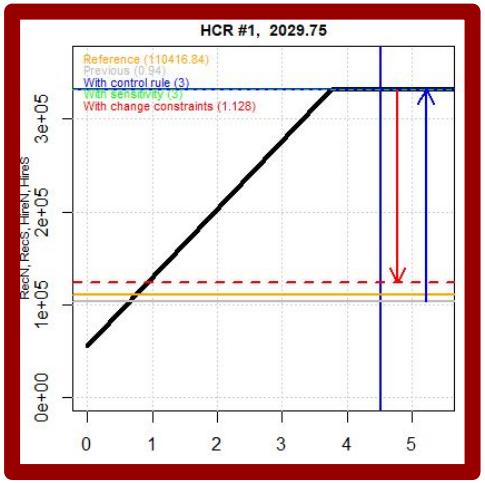
	FMSYref	ITarget	ITarget P*
PNOF (yrs 50-51)	1.0	0.52	0.59
mean SB/SBMSY (yrs 50-51)	0.96	0.97	0.93

	FMSYref	IRatio	IRatio P*
PNOF (yrs 50-51)	1.0	0.54	0.62
mean SB/SBMSY (yrs 50-51)	0.96	0.93	1.05

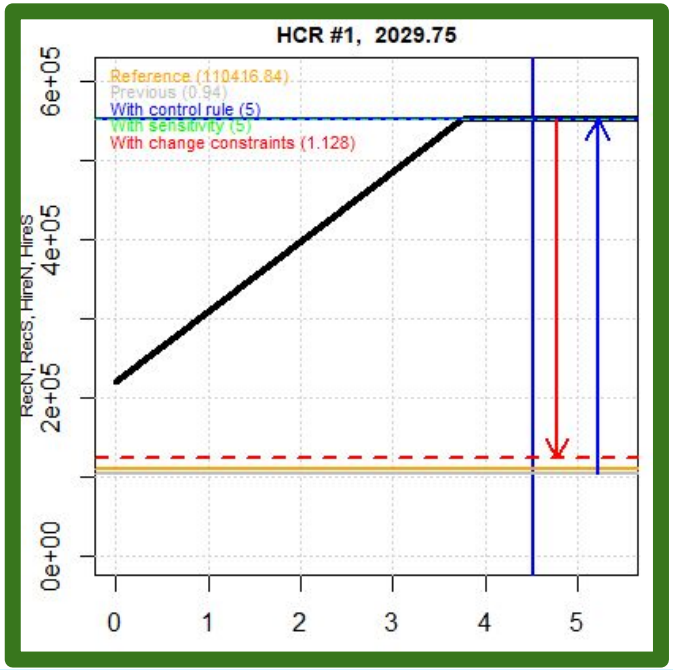
Theory applied to dolphin

Example – mahiMP tuned to 10 iterations of base OM_29; MP applied to US fleets

LCP = 0.5, 3.0

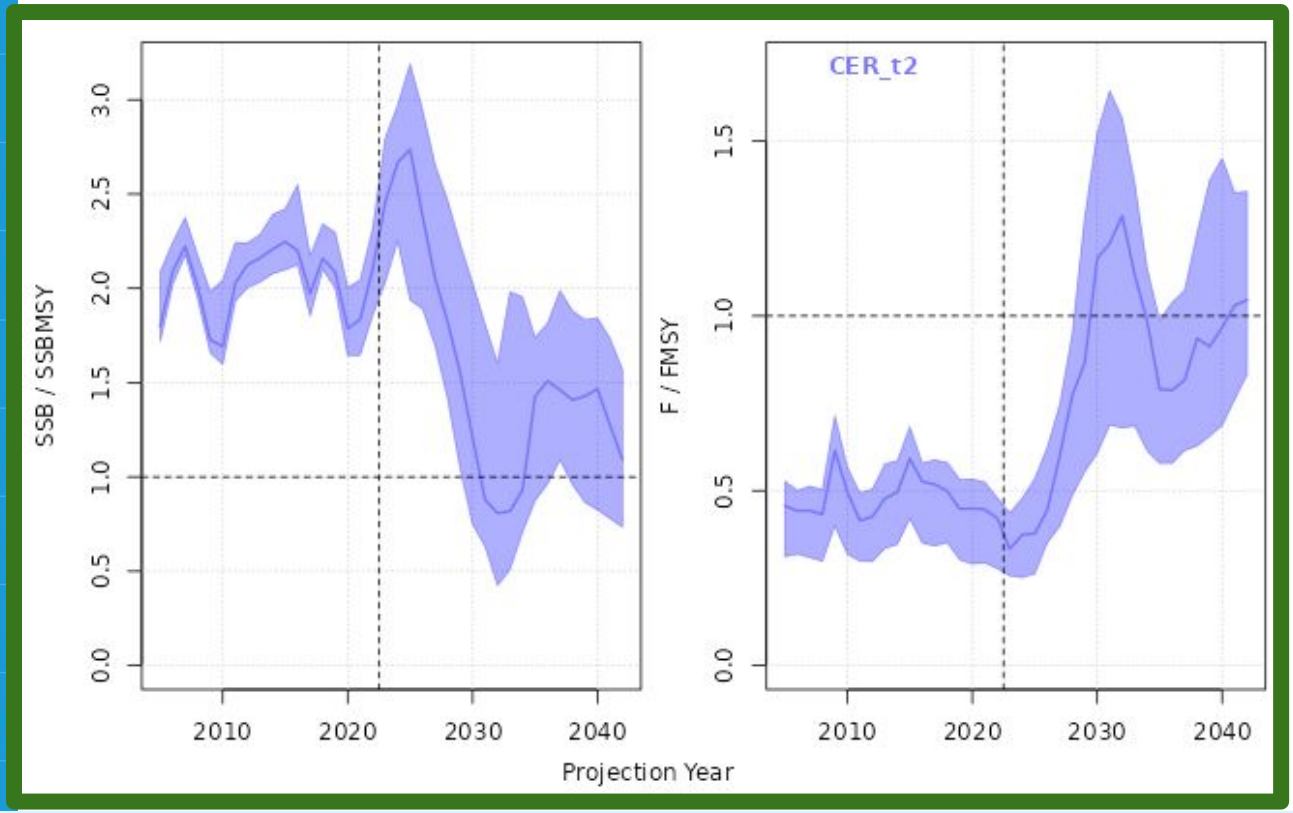


LCP = 2.0, 5.0

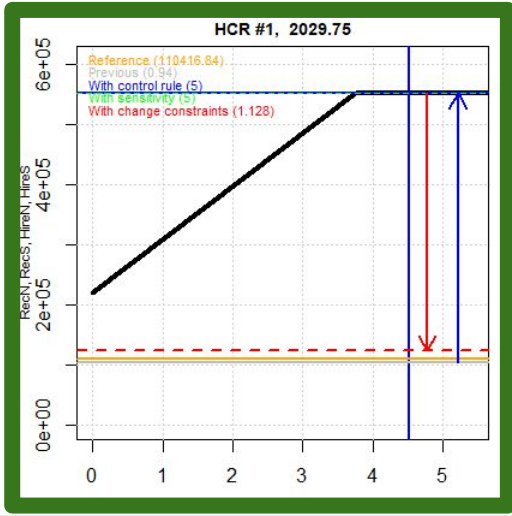


	CER	CER_A	CER_B	CER_C	CER_S	CER_tune
Mean F_FMSY (yrs 19-20)	0.53	**0.63**	0.39	0.29	0.52	**1.06**

Theory applied to dolphin



Example – mahiMP tuned to 10 iterations of base OM_29



Demo Conclusions

Experimental simulation generally supports our theory that:

- we can use empirical MPs tuned to POF=0.5 to provide OFL advice
- empirical MPs tuned to P* (following Council / SSC risk tolerance) can provide ABC.

Recognizing that MSE includes due diligence to allow for management uncertainty to be zero (ABC - ACL)

ACTION ITEM:

- SSC to advise on use of tuned MPs to provide OFL and ABC

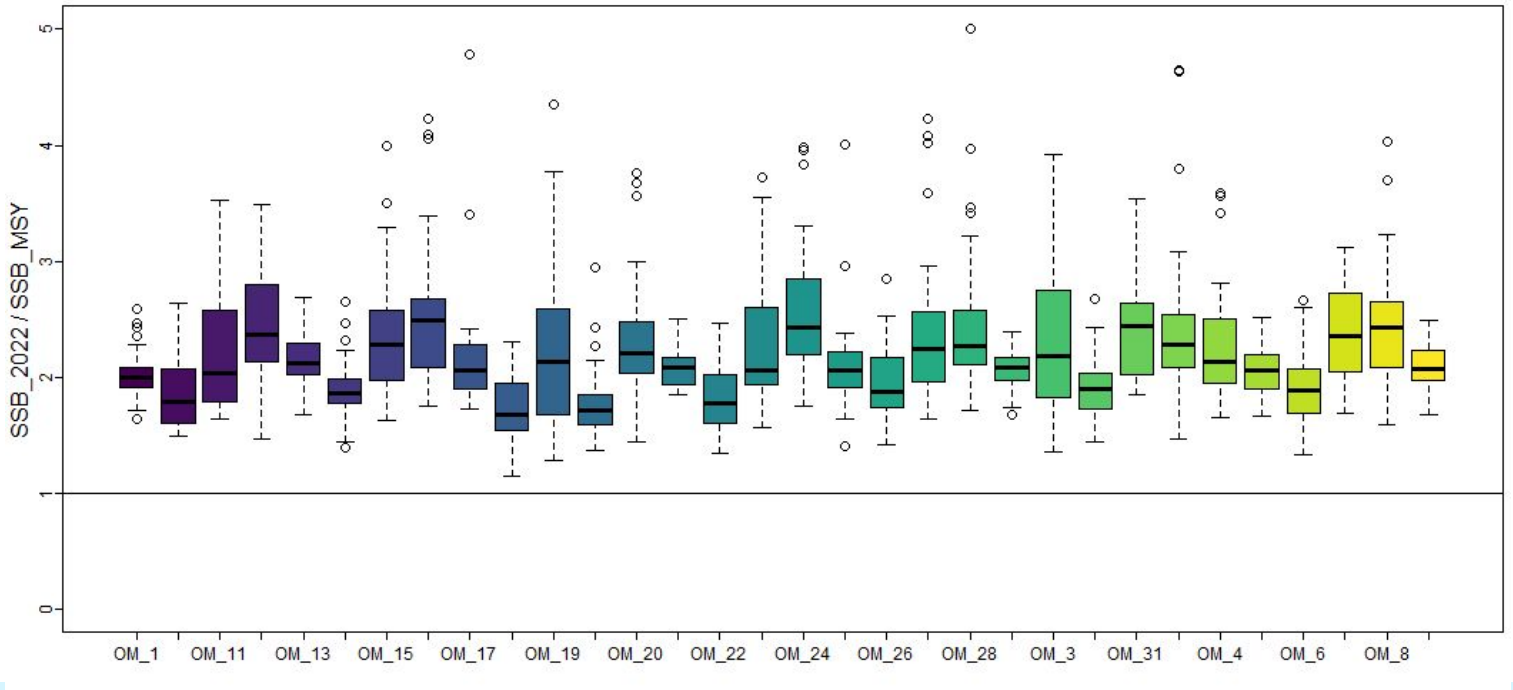
MSEs for stock status: Discussion

Empirical MPs do not provide stock status information. Potential solutions:

- **Create status barometer:**
  - Following the assumption that our MP indicator is proportional to stock biomass, can we use the MP as barometer for status? (e.g., define indicator value that corresponds to SSBMSY)
- **Periodically run data-limited model-based MPs to provide status:**
  - Run simple biomass dynamic or DLMs to estimate status, dependent on data availability
- **Extract status from MSE OM grid:**
  - Define most likely (“base case”) OM
  - Treat OM grid as ensemble, requiring discussion of OM weighting
  - Assume worst-case OM as lower bound

Status applied to dolphin

- Appears likely that we can categorically determine stock status for dolphin.



MSEs for stock status: Discussion

Empirical MPs do not provide stock status information. Potential solutions.

- Create status barometer
- Periodically run data-limited model-based MPs to provide status
- Extract status from MSE OM grid

Need: to balance status update frequency with operational difficulty

ACTION ITEM:

- SSC to advise on approaches to determine status

MSE Roles and Responsibilities

	Modeling team	**Stakeholders** (and Council-associated advisory bodies)	**SSC**	**Council**
Management objectives & Performance metrics	*Clarify* operational management objectives, and *Quantify* associated performance metrics	*Advise* on and articulate secondary management performance	*Advise* on biological minimum performance criteria (e.g. not overfishing and rebuilding) and risk tolerance	*Adopt* operational management objectives, performance metrics, and risk tolerance; *Advise* on desired performance outcomes
Operating models (OMs)	*Construct* and *refine* models based on best scientific information available and participant feedback	*Advise* on OM structure, alternative scenarios, and key uncertainties	*Recommend* as consistent with best scientific information available	*Advise* on OM structure, alternative scenarios, and key uncertainties
Management procedures	*Test* and *refine* MPs based on participant feedback	*Advise* on MP features and alternative management options	*Advise* on MP structure and parameterization	*Adopt* and *implement* management procedures based on performance relative to objectives
Exceptional circumstances provisions (ECPs)	*Develop* ECPs based on scientific foundation and regularly test for exceptional circumstances	*Advise* on unacceptable MP performance	*Advise* on unacceptable MP performance	*Adopt* and *implement* ECPs

SSC Role

Ensure MSE framework / OMs and resulting MP are consistent with BSIA

Input on management objectives and risk, MP design and performance is provided during MSE analyses

- MSE front-loads contributions

Regularly check for Exceptional Circumstances to ensure MP should remain basis for management advice

Acknowledgements

Many thanks to the hard work of our project collaborators

Blue Matter Science

Tom Carruthers, Adrian Hordyk, Quang Huynh

MSE Modelling Technical Team

Cassidy Peterson, Mandy Karnauskas, Matt Damiano, Kyle Shertzer, Jie Cao, John Walter

Stakeholder Science Team

Matt McPherson, Suzana Blake, Julia Byrd, John Hadley, Nikhil Mehta, Wess Merten, Lela Schlenker

Stakeholder Small Group

CIE Review Team

Daniel Howell, Ernesto Jardim, Gary Melvin, Jeff Buckel, Kelsey Roberts, Matt Damiano

cassidy.peterson@noaa.gov
tom@bluematterscience.com

Extra slides

Reference Operating Model Grid

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

Robustness Set

1-factor modification of the Reference Case OM (OM_29)

Catches increasingly exceed TAC of MP

Mean of Rec. Devs

Discrete ‘step-down’ in mean of Rec. Devs.

Same Rec. devs. but 50% ‘wider’

Mov. matrices calculated from spatial VAST index subject to these changes

New spatial fractions are exp(1.5 x log(D))

Asymptotic weight

(All yrs) Sel. curve translation: (new age = old age * 1.5)

(Proj. yrs) Gradual transition in future selectivity to smaller fish

Code	Type	Description
ROM_C1	Catches	IUU increases by 1% every year
ROM_C2	Catches	Catches halved for non-US fleets in area 1 (Florida and Caribbean)
ROM_R1	Recruitment	Future recruitment declines 1% per year
ROM_R2	Recruitment	Future recruitment reduces by 25% after 5 years
ROM_R3	Recruitment	Future recruitment reduces by 25% after 10 years
ROM_R4	Recruitment	Future recruitment is 50% more variable
ROM_S1	Spatial	Two percent decline in CAR and SFL, 1 percent increase in SE, 2% increase in NC and NE
ROM_S2	Spatial	50% greater variability in spatial / seasonal distribution
ROM_S3	Spatial	1% pa. increase in catchability reflecting range contraction
ROM_S4	Spatial	20% target probability of staying
ROM_S5	Spatial	80% target probability of staying
ROM_P1	Productivity	1% pa. decrease in somatic growth rate (k)
ROM_P2	Productivity	1% pa. decrease in condition factor (weight at length)
ROM_P3	Productivity	1% pa. increase in natural mortality rate (all ages)
ROM_F1	Fishery	33% shorter selectivity of all fleets (inflection point)
ROM_F2	Fishery	Projected shift towards 33% younger selectivity of all fleets (inflection point)