Dolphin Management Strategy Evaluation: Revision Phase

SAFMC
September 2025

Request for Council

- Provide feedback on
  - MSE timeline
  - Operating model structure and uncertainties
  - Management objectives and performance metrics
  - Management procedure structure

Dolphin MSE

Purpose: to develop an *empirical management procedure* for dolphin in the US Atlantic that is:

- Fully-specified 'recipe' for setting OFL/ABC/ACL along with additional management actions
- Simulation tested to be robust to uncertainty
- Meets stakeholder-defined management objectives

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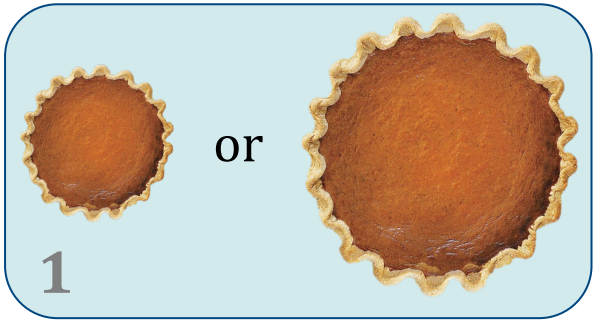
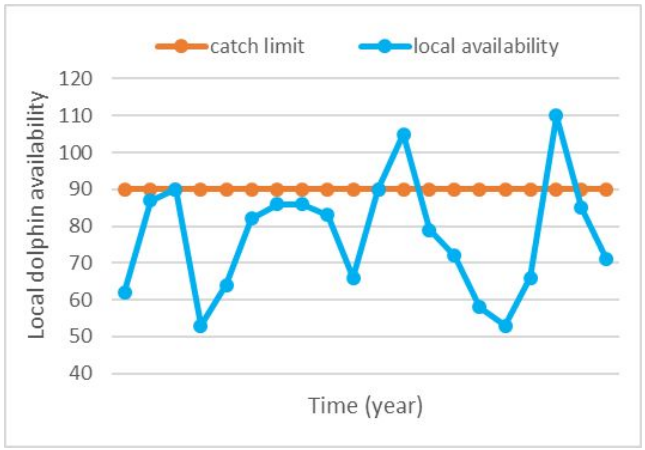
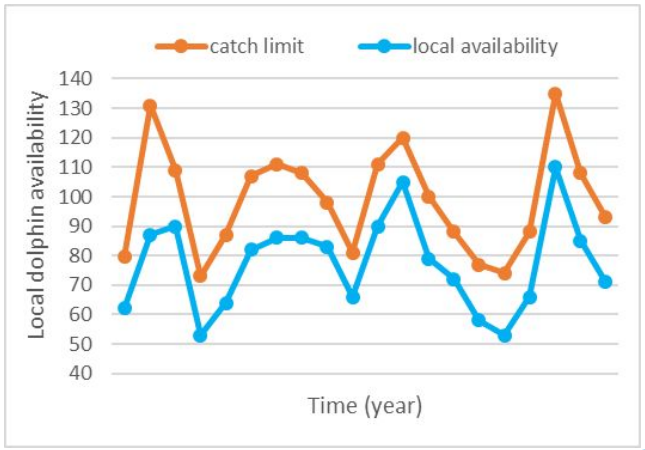
Management Procedure

With our MP, we want to:

1. predict the amount of dolphin the SAFMC will have each year
2. maximize the usage of those fish across sectors and region







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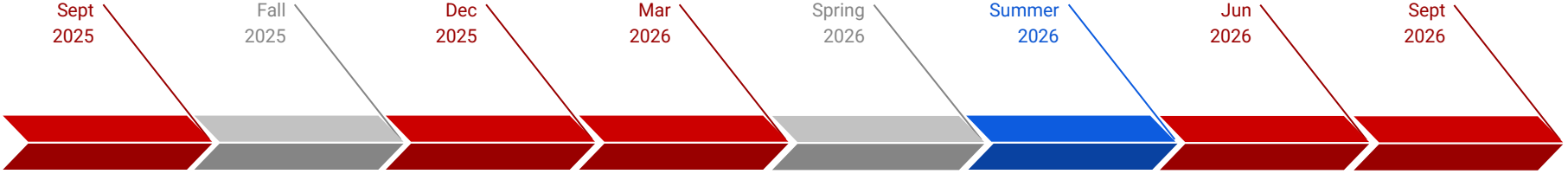
Draft Timeline & Schedule

* Timing of results will depend on ability to meet target timeline

Legend:
OM: operating models
PM: performance metrics
MP: panagement procedures

Council Meeting
SSC Meeting
CIE Review



September Council

Revision phase:

- PM review and refine
- MP advise and revise

Fall SSC

Revision + refinement phase:

- **OM review and adopt**
- "Must-pay" PMs advise
- *scientific sign-off of MSE framework*

December Council

Refinement phase:

- **PM adopt**
- MP refine
- *manager sign-off on MSE*

March Council

Identify MP options:

- **Identify MP** options

Spring SSC

Adoption phase:

- *Scientific sign-off on MSE and MP framework*
- Exceptional circumstances provisions
- MP / MSE review timeline

CIE Review

Review of MSE framework

[optional] June Council

Select preferred:

- **Choose preferred MP**

[optional] Sept Council

Final action:

- **Final action to adopt preferred MP**

https://www.iccat.int/Documents/CVSP/CV081_2024/n_6/CV08106103.pdf

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Operating model requirements

Capture the important population and fishery dynamics for dolphinfish, including stakeholder-identified considerations, that include:

- Historical exploitation patterns
- Current stock status
- High natural variability
- Rapid growth
- High fecundity
- Short-lived

- Seasonal-spatial distribution
- Availability that varies more in some areas
- Differing fleet behaviors and regulations
- Differing impacts of regulations on fishing groups
- Exploitation by poorly known high-seas fisheries

Be able to accommodate various ideas about possible dynamics (robustness tests):

- Changes in natural survival, future growth, condition factor and fecundity
- Alternative / changing spatial distribution and mixing

- Alternative levels of unreported catches
- Persistent or systematic changes in recruitment

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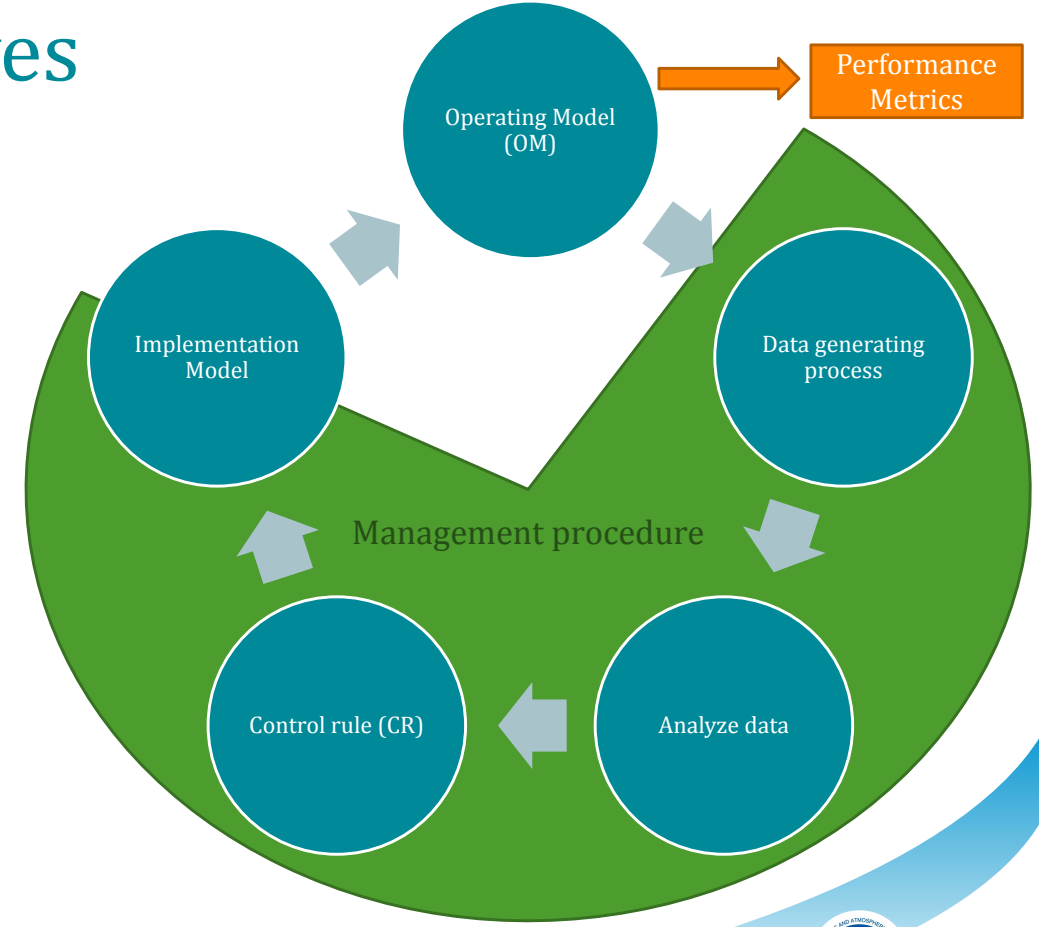
Management Objectives

Remember that management objectives:

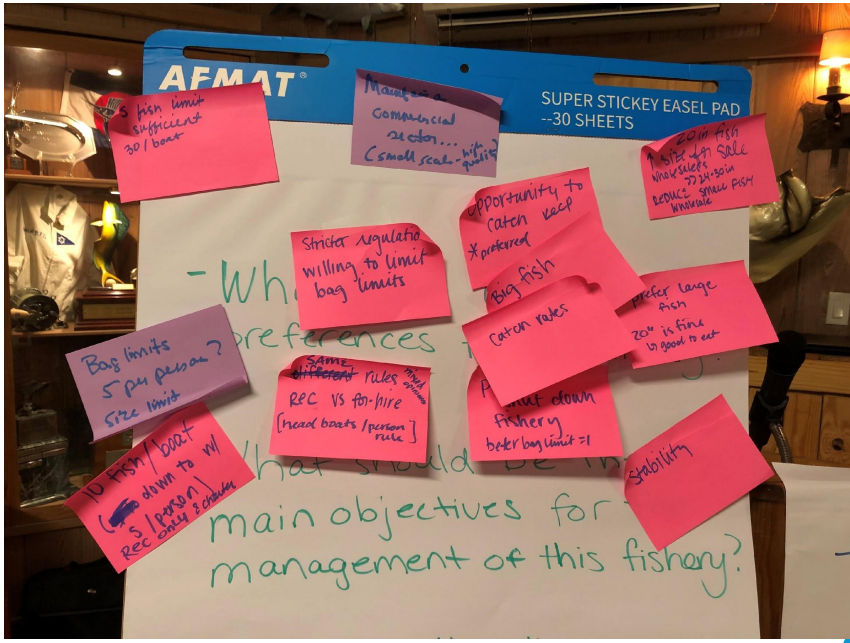
- reflect what we want to get out of the fishery now and in the future
- are used to define “good” or acceptable MP performance
- will be measured within the MSE through performance metrics

Conceptual management objectives will be quantified into *operational management objectives* once we can outline biological trade-offs inherent in managing dolphin



Stakeholder-defined objectives

- Ensure opportunity / access to fishery
- Prevent fishery closures
- Large sizes preferred
- Stability in regulations (though mixed)
- Regional & sector differences in fishery goals and objectives
  - Improve consistency and reliability of fishery
  - Area-based TACs or pay-back measures
  - Conserve stock vs. high landings
  - No size limits vs. open to size limits



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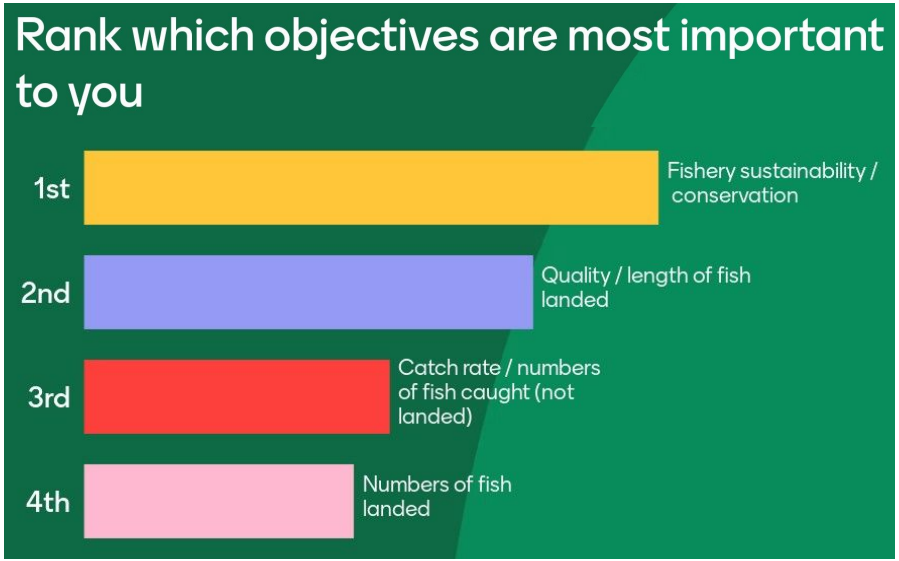
Proposed Conceptual Management Objectives

Generic*:

1. Status
2. Yield
3. Stability

Dolphin relevant*:

1. Catch rate
2. Fishing effort / opportunity
3. Size of fish caught



* Metrics calculated over short (2025-2034), medium (2035-2044), and long (2045-2055) time horizons

Decision Point:
Management Objectives & Performance Metrics

Generic*:

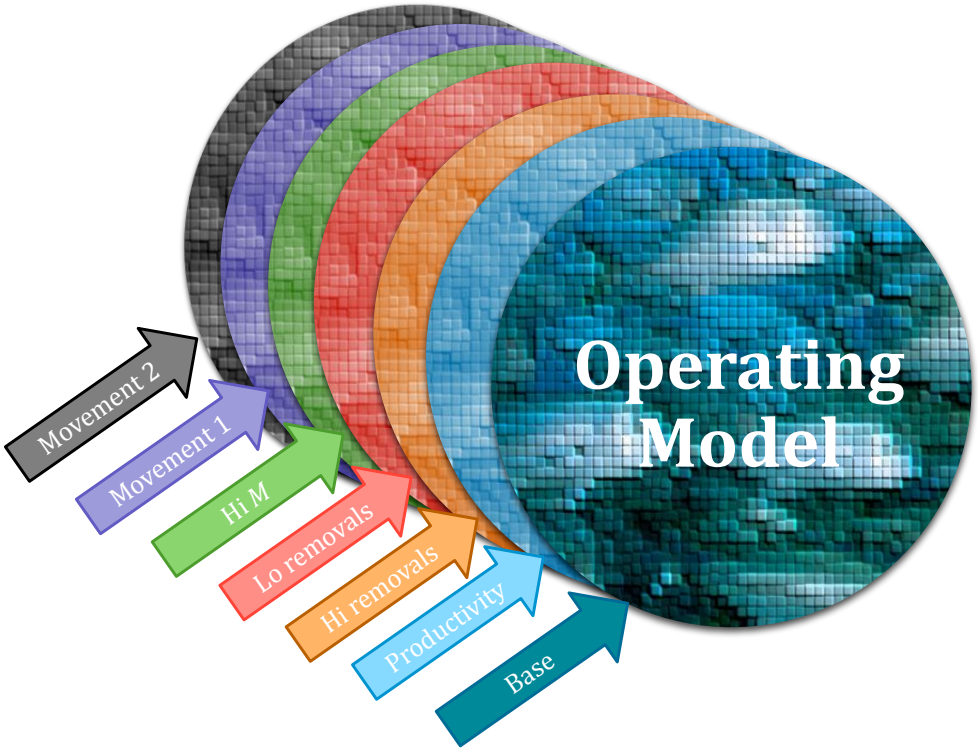
1. Status
2. Yield
3. Stability

Dolphin relevant*:

1. Catch rate
2. Fishing effort / opportunity
3. Size of fish caught

* Metrics calculated over short (2025-2034), medium (2035-2044), and long (2045-2055) time horizons

Uncertainties to Ensure Robust Management



Reference Set – set of operating models reflecting the most likely and key axes of uncertainty to which the MP must be robust

- used to tune or calibrate MPs

Robustness Set – set of operating models reflecting less understood uncertainties; what-if scenarios akin to sensitivity runs

- used to differentiate between top-performing MPs
- used to develop and inform exceptional circumstances protocols
- used to test for climate robustness

Carruthers (2024) SCRS/2024/104

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Stakeholder Uncertainties

- Removals (US recreational; International)
- Alternate movement patterns
- Enforcement challenges
- Changing availability & catchability
  - Biophysical (temp, Gulf Stream positioning, Sargassum)
  - Anthropogenic (ropeless lobster pots, offshore wind)
- Economic fishery drivers
- Post-release mortality & depredation

Proposed Uncertainties

Reference OMs

1. Natural Mortality
2. Recruitment
3. Productivity / steepness
4. Spatial distribution
5. Movement viscosity

Robustness OMs

1. Uncertainty in removals
   a. MRIP & International
2. Future nonstationary
   a. Future recruitment
   b. Distribution shifts
   c. Changes in availability / catchability
   d. Changes in life history parameters

Table 8. The factors and levels of the orthogonal grid of reference set operating models.

Uncertainty	Level 1	Level 2
Natural Mortality	Low (m): 1.0 per year	High (M): 2.0 per year
Recruitment Level	Low (r): as last 10 years	High (R): all years
Resilience (steepness)	Low (s): 0.7	High (S): 0.95
Spatial distribution	US obs (d)	With expert judgement (D)
Viscosity	Low (v): prob. stay. = 0.6	High(V) prob. stay. = 0.9

Proposed Uncertainties

Reference OMs

1. Natural Mortality
2. Recruitment
3. Productivity / steepness
4. Spatial distribution
5. Movement viscosity

Robustness OMs

1. Uncertainty in removals
   a. MRIP & International
2. Future nonstationary
   a. Future recruitment
   b. Distribution shifts
   c. Changes in availability / catchability
   d. Changes in life history parameters

Table 9. Robustness operating models. Single factor variants of the reference case operating model.

Code	Description
C1	Catch reconstruction consistent with the SAUP estimates
C2	Seasonal catch distribution of international, discard and unreported fleets matches the Rec and Hire fleets.
C3	IUU increases by 1% every year
R1	Future recruitment declines 1% per year
R2	Future recruitment reduces by 25% after 5 years
R3	Future recruitment reduces by 25% after 10 years
R4	Future recruitment is 50% more variable
S1	Two percent decline in CAR and SFL, 1 percent increase in SE, 2% increase in NC and NE
S2	50% greater variability in spatial / seasonal distribution
S3	1% pa. increase in catchability reflecting range contraction
P1	1% pa. decrease in somatic growth rate (k)
P2	1% pa. decrease in condition factor (weight at length)
P3	1% pa. increase in natural mortality rate (all ages)

Decision Point: OM Uncertainties

Reference OMs

1. Natural Mortality
2. Recruitment
3. Productivity / steepness
4. Spatial distribution
5. Movement viscosity

Robustness OMs

1. Uncertainty in removals
   a. MRIP & International
2. Future nonstationary
   a. Future recruitment
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Management Procedures

Empirical MP: a management recipe that uses the behavior of a population indicator (e.g., index of abundance) to adjust management recommendations

Table 12. Examples of candidate management procedure archetypes.

Archetype	Description
Index rate output	Catch limits are calculated as a constant fraction of the observed index (constant harvest rate)
Index rate input	Effort, size limits or bag limits are adjusted to obtain a target rate of catch per index level
Index target	Catches, effort, size limits or bag limits are adjusted to achieve a target index level
Index slope	Catch limits, effort, size limits or bag limits are adjusted to obtain a particular schedule of index slopes (e.g.rebuild then stable)

Amendment 3* Scoping:

- expanded / revised size limits
- recreational bag limits
- recreational vessel limits

* https://safmc.net/documents/dw_a2_regam-3decisiondocument_202412-pdf-2/

Demonstration of responsive, index-tracking MPs

Management procedures can be designed to respond to spatial and temporal fishing opportunities by setting catch limits according to observed indices (e.g. US commercial longline).

In this mahiMSE demonstration we show two example projections - two individual simulations that represent possible future scenarios. One is pessimistic, the other more optimistic. These show how observed indices respond to regional biomass, and catch limits can be calculated from those indices.

Note that these operating model outputs should be considered ‘for demonstration purposes only’ as revisions to spatial structure and catch reconstruction are currently being finalized.

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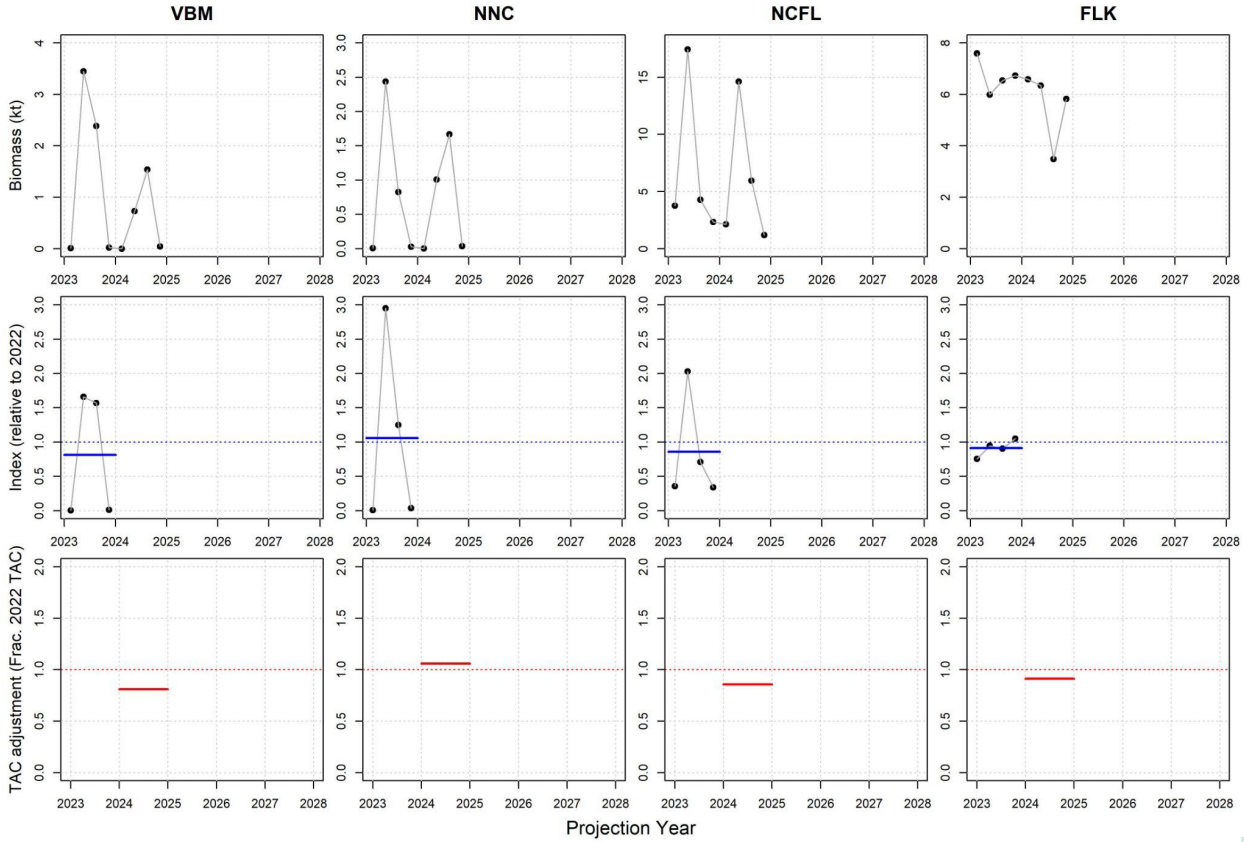
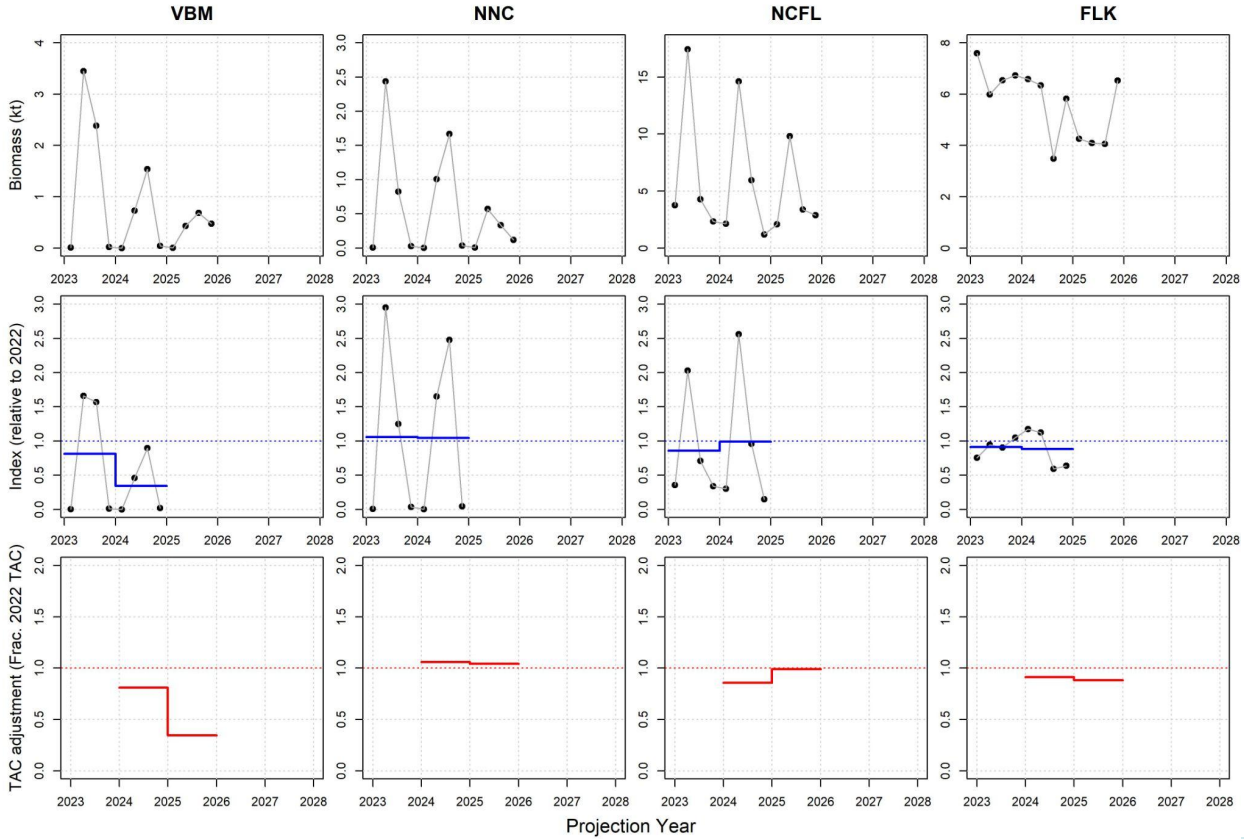
Responsive, index-tracking MPs

Pessimistic scenario
TAC changes in proportion to index



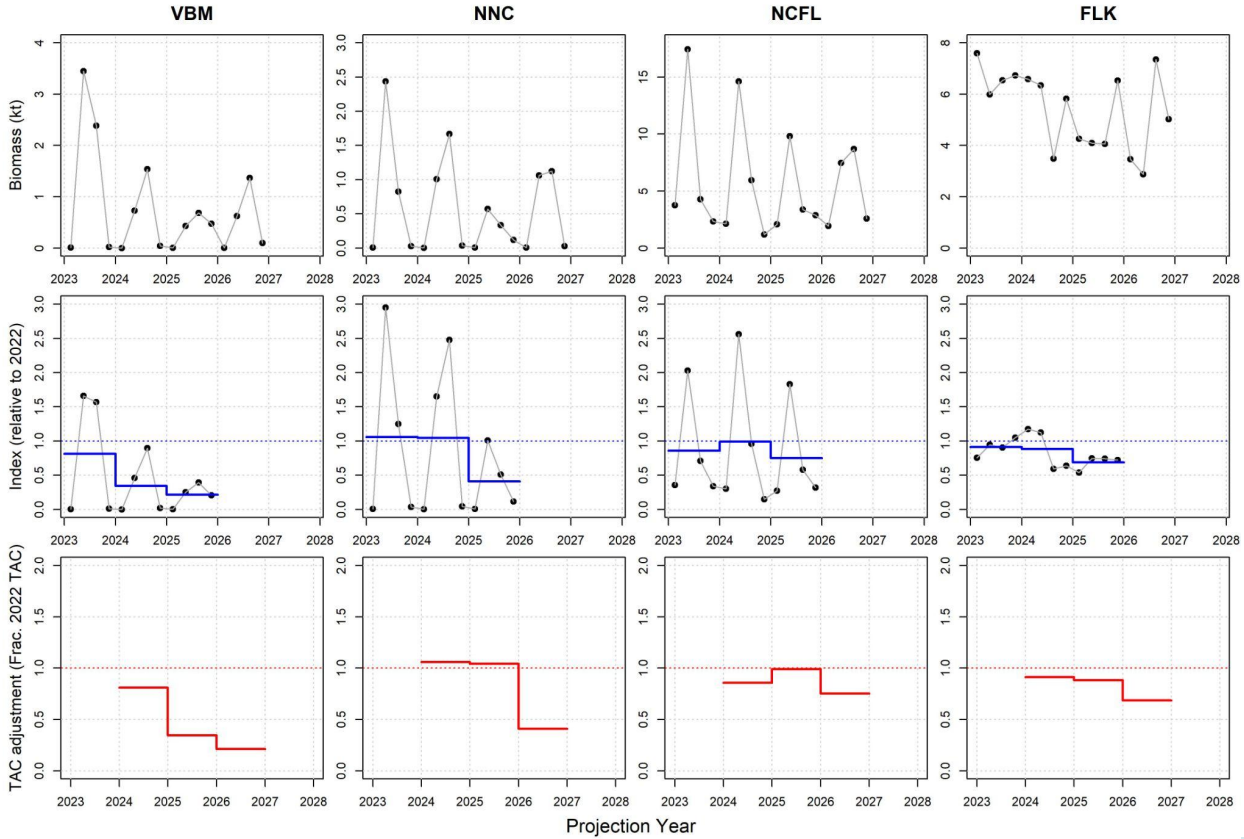
Responsive, index-tracking MPs

Pessimistic scenario
TAC changes in proportion to index



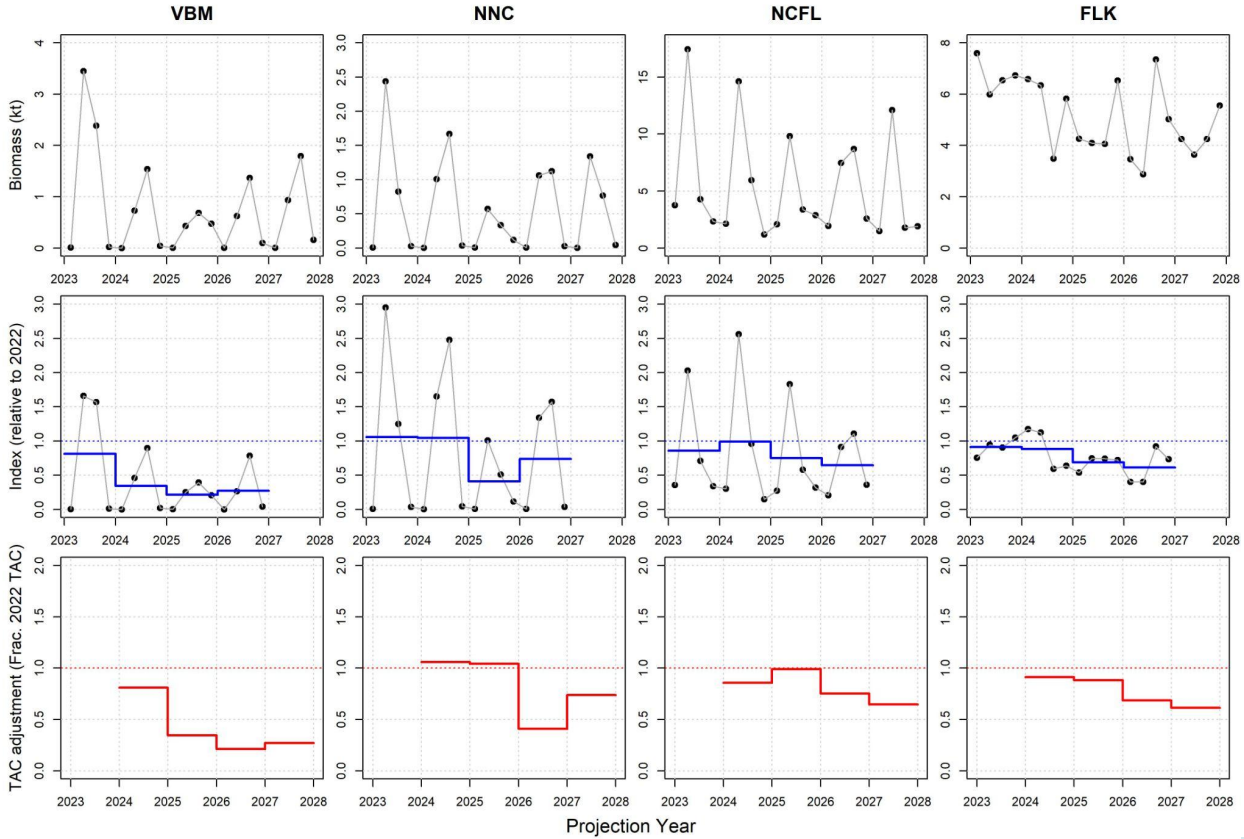
Responsive, index-tracking MPs

Pessimistic scenario
TAC changes in proportion to index



Responsive, index-tracking MPs

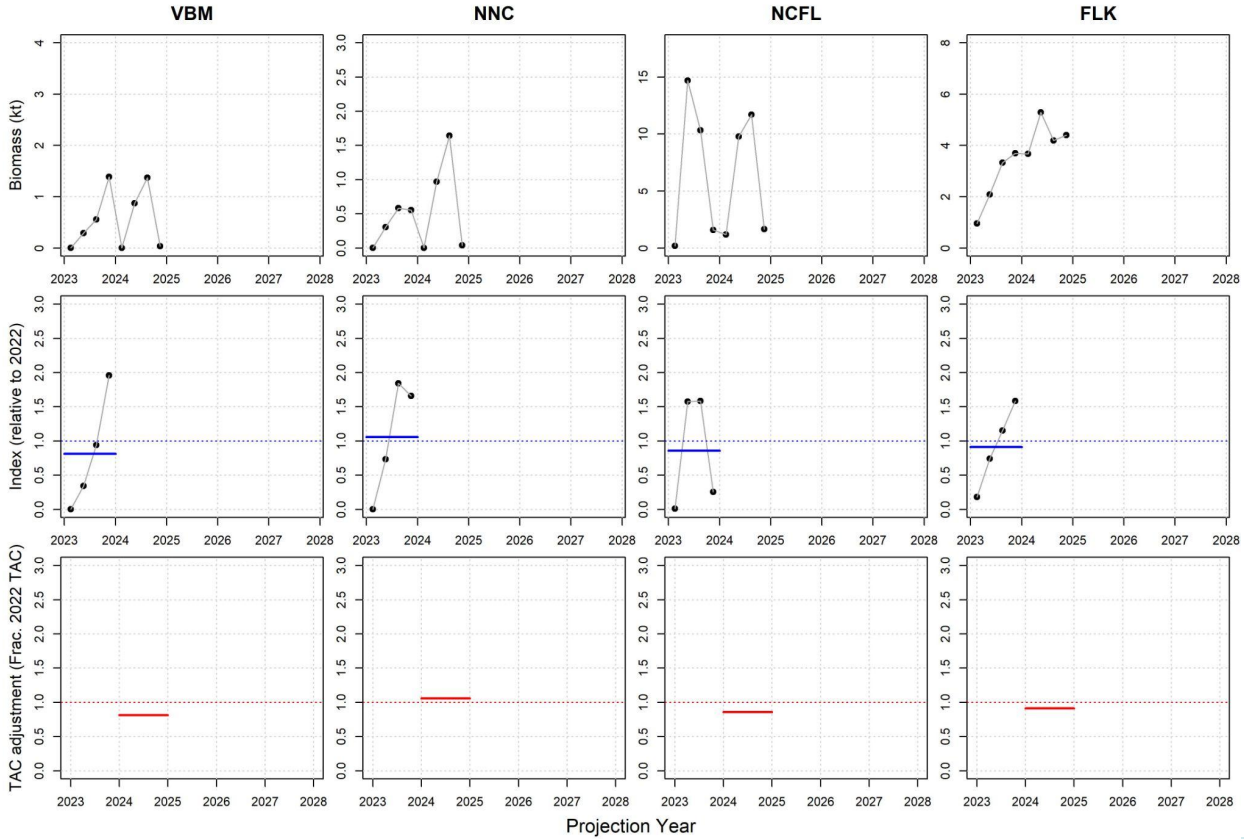
Pessimistic scenario
TAC changes in proportion to index



Responsive, index-tracking MPs

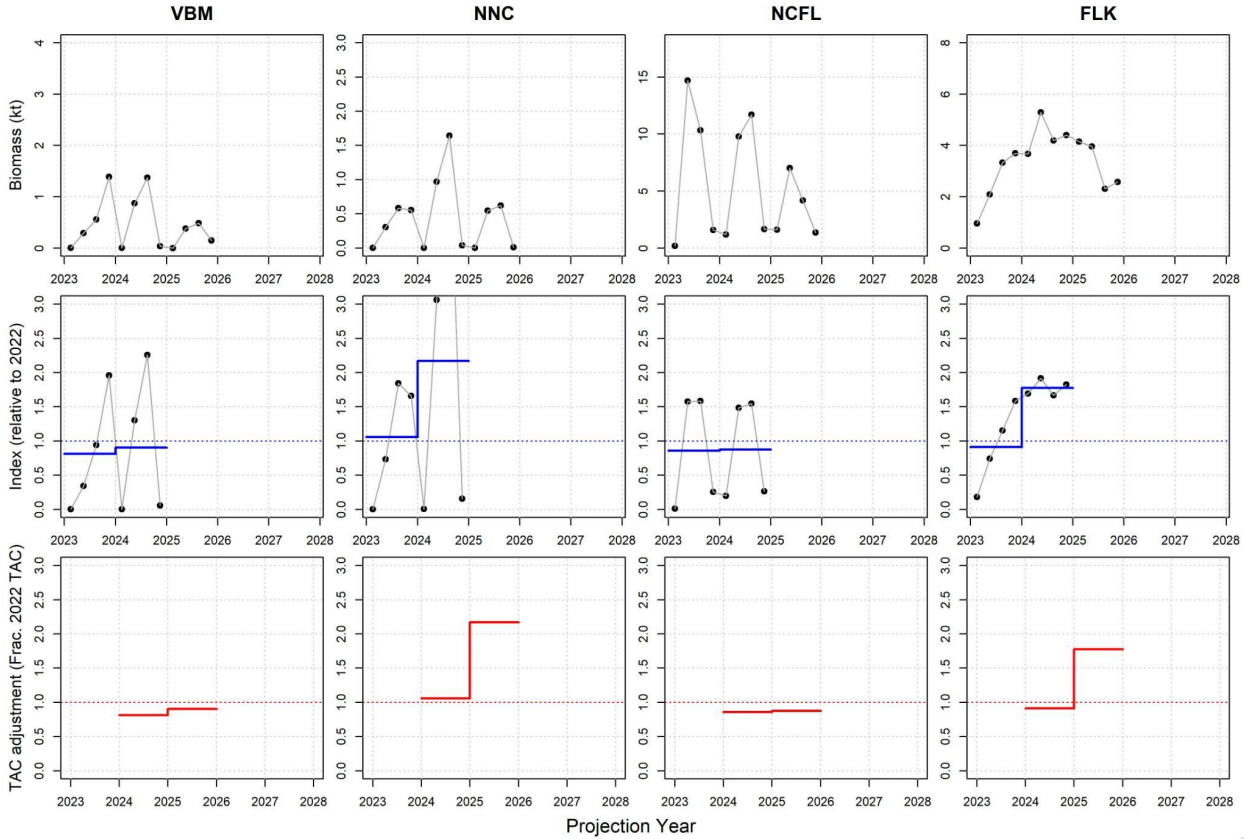
More optimistic scenario

TAC changes in proportion to index



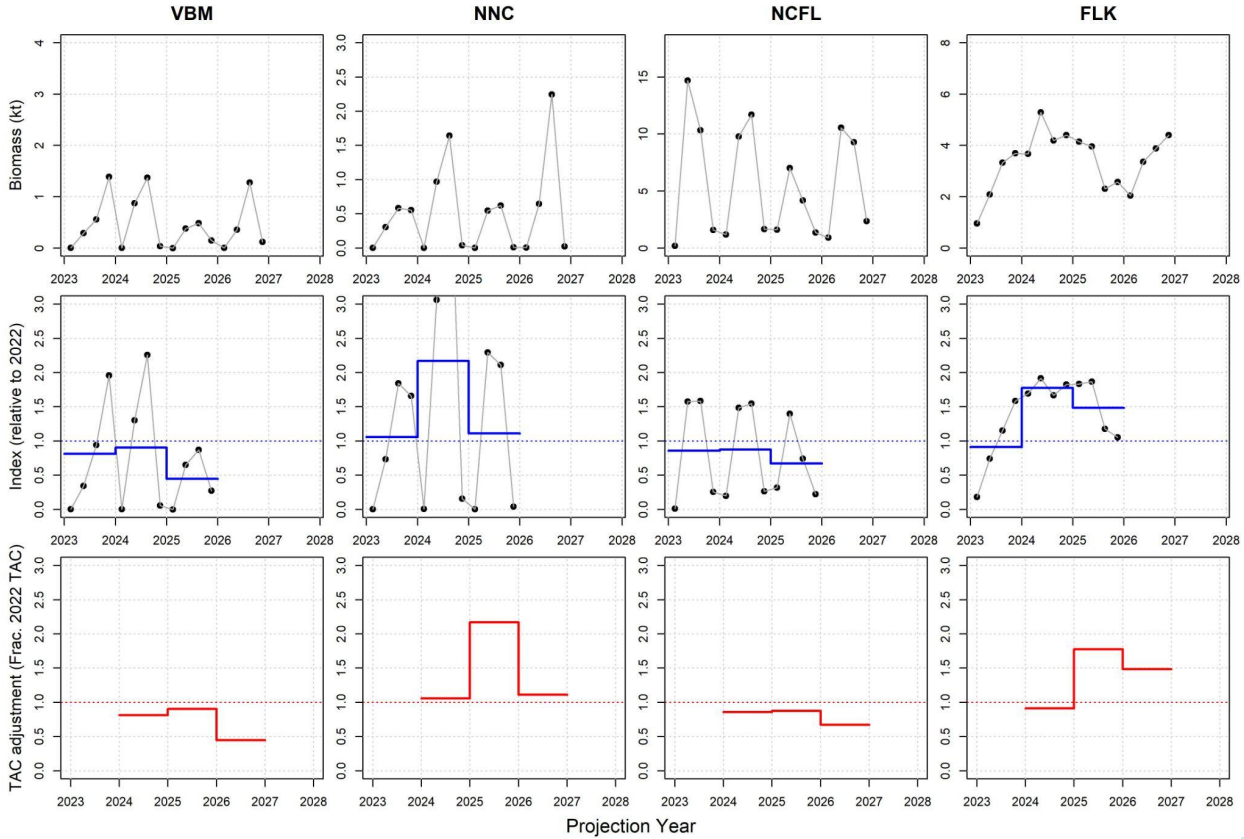
Responsive, index-tracking MPs

More optimistic scenario
TAC changes in proportion to index



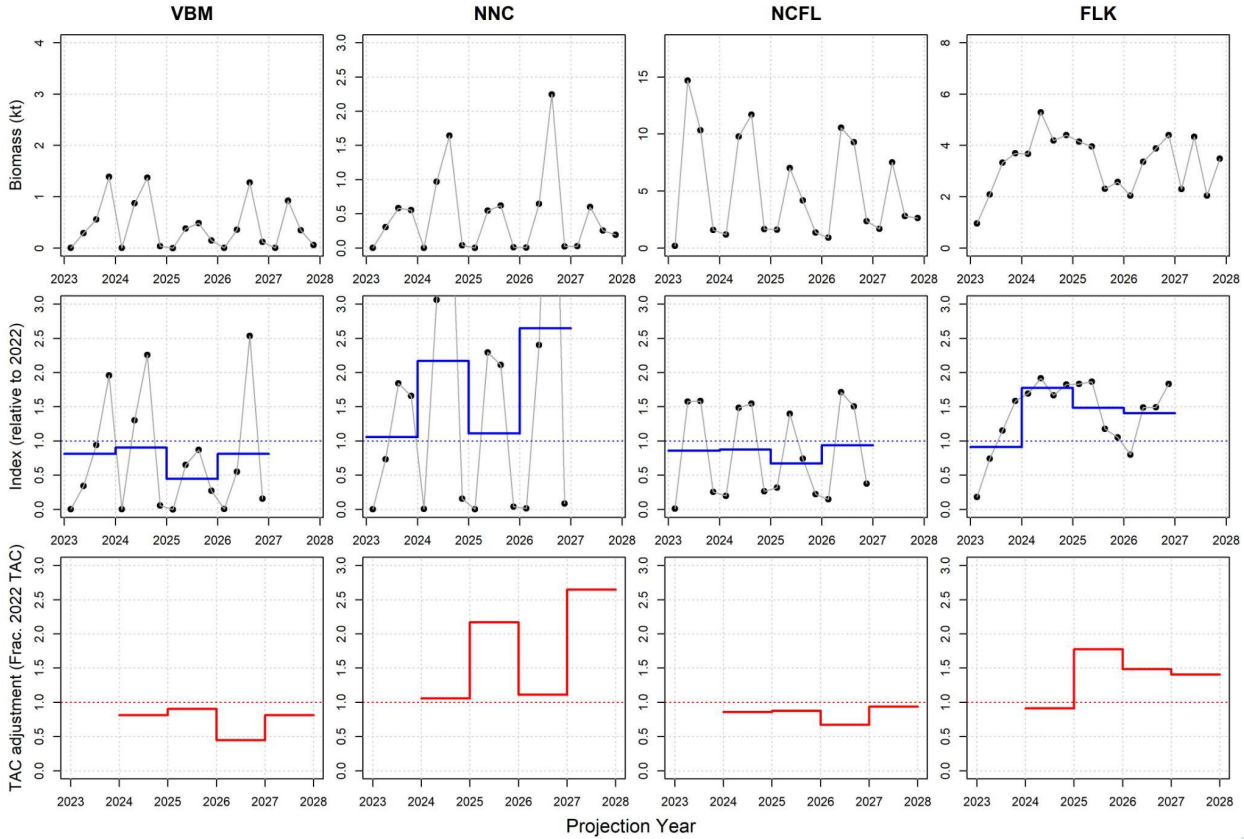
Responsive, index-tracking MPs

More optimistic scenario
TAC changes in proportion to index



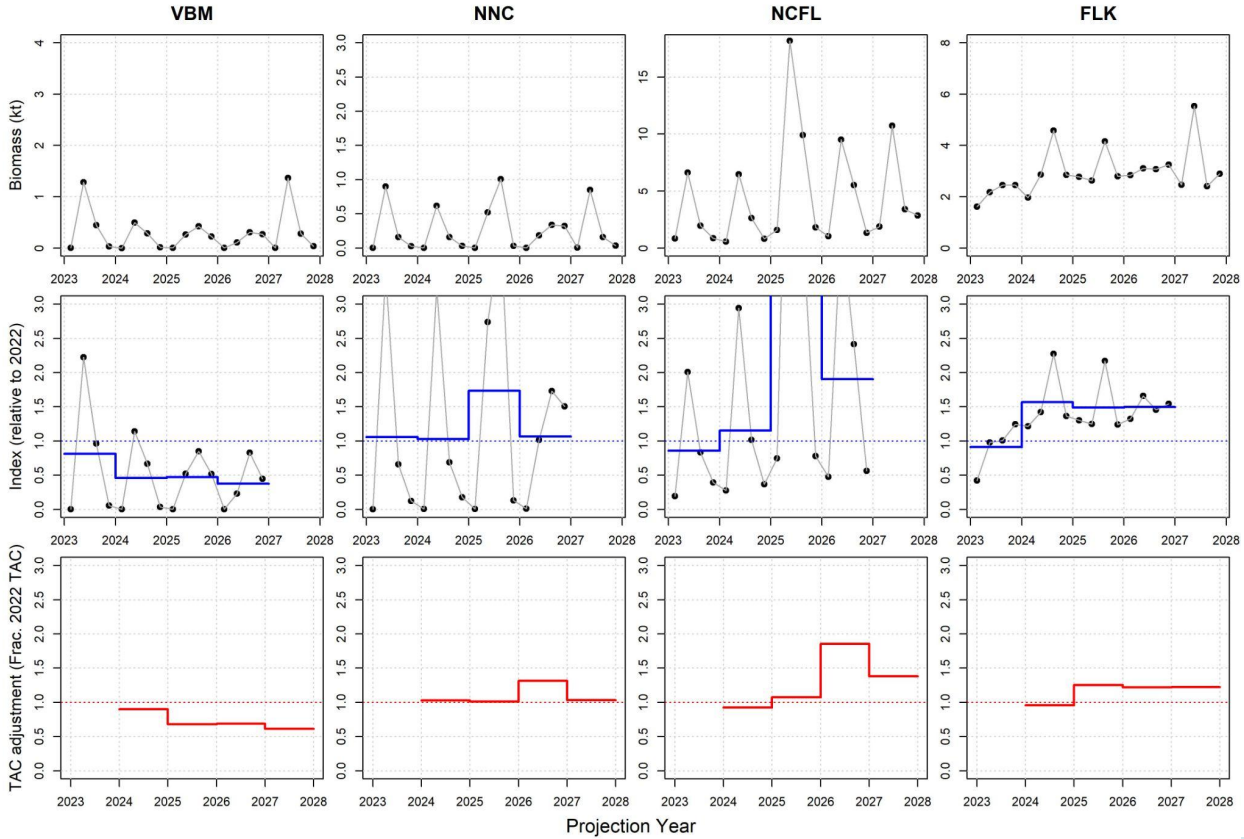
Responsive, index-tracking MPs

More optimistic scenario
TAC changes in proportion to index



Responsive, index-tracking MPs

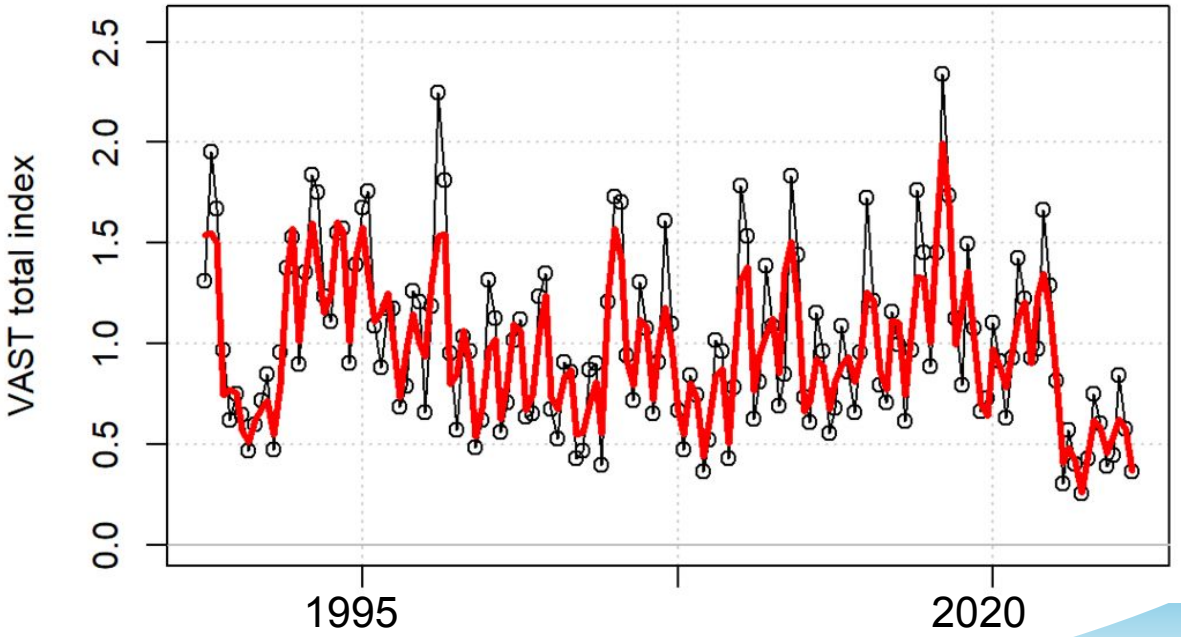
New MP / Scenario
TAC changes are reduced by 50%



Responsive, index-tracking MPs

Model fitting managed to track the total (all areas combined)VAST index reasonably well.

Empirical MPs could use just the overall index in projections or alternatively…



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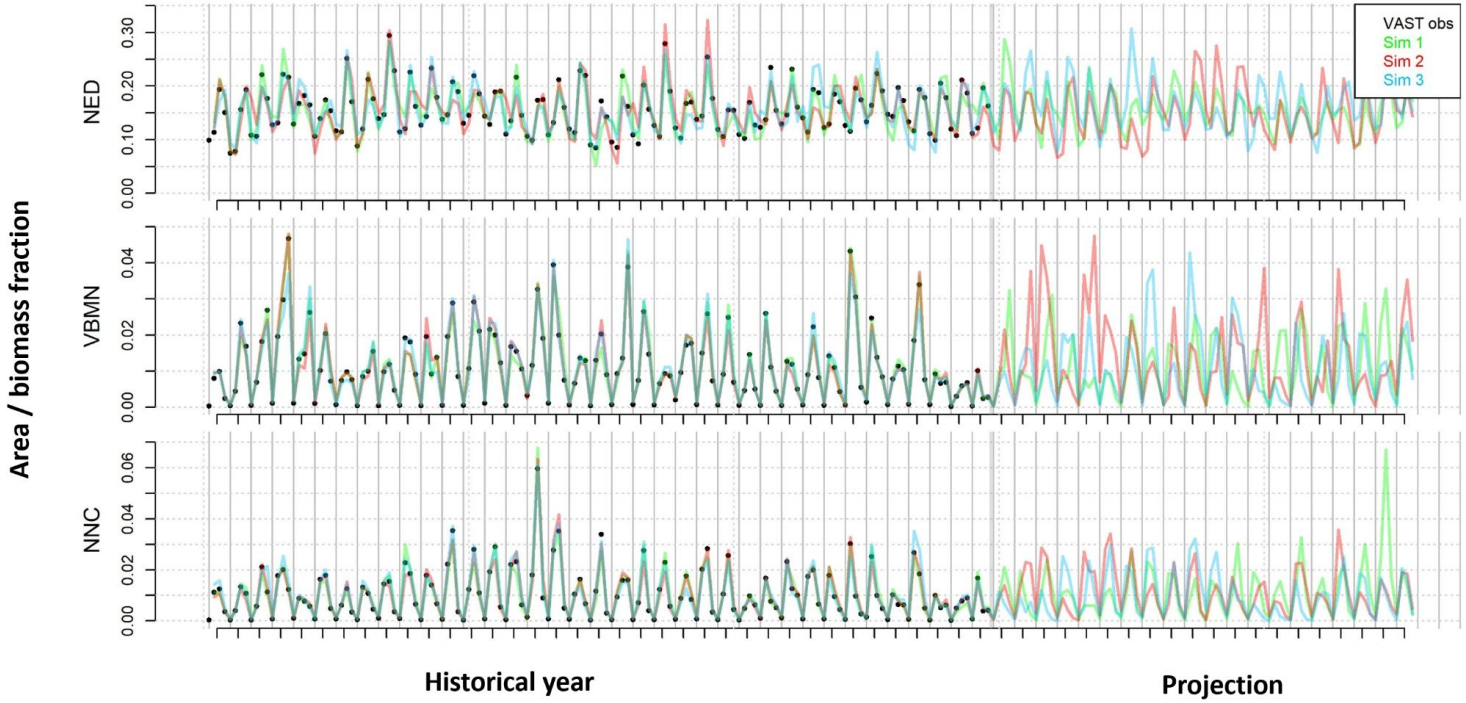
Responsive, index-tracking MPs

As shown above, MPs could use regional VAST indices or a combination of these with the total index.



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Responsive, index-tracking MPs

There are many opportunities in the design of index-based empirical MPs such as:

- Smoothing of index data
- Weighting of multiple indices
- Setting max / min catch changes
- Setting max / min regional catch
- Including other empirical inputs such as mean length in catch
- And many more.

Possible to also have dynamic regulations (e.g. size limits) in response to data also.

Next

- Updated spatial definitions for catch and VAST indices
- Include a missing catch (scale) uncertainty axis
- Robustness OMs
- Suite of responsive empirical management procedures
- mahiMetrics
- Shiny App results

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Acknowledgements

Stakeholder Science Team:

SEFSC: Mandy Karnauskas, Matt McPherson, Suzana Blake, Cassidy Peterson
SAFMC: Julia Byrd, John Hadley
SERO: Nikhil Mehta
Beyond Our Shores Foundation: Wess Merten
Avangrid: Lela Schlenker

MSE Modeling Technical Team:

Blue Matter Science: Tom Carruthers, Adrian Hordyk, Quang Huynh
SEFSC: Matt Damiano, Kyle Shertzer, John Walter, Cassidy Peterson
NCSU: Jie Cao

Stakeholder participants

Thanks

https://github.com/Blue-Matter/DolphinMSE | cassidy.peterson@noaa.gov | tom@bluematterscience.com
https://www.fisheries.noaa.gov/southeast/science-data/dolphinfish-management-strategy-evaluation-us-atlantic

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Project Splash Page

https://blue-matter.github.io/mahiMSE/

- Project info
- Progress
- Background docs
- TSD
- Links to software
- mahiMSE manual
- Installation guide
- Other resources

Management Strategy Evaluation for Atlantic Dolphinfish

Tom Carruthers tom@bluematterscience.com

19 August, 2025

bluematter openMSE

Disclaimer

The following work is preliminary and intended only as tool for eliciting feedback on data, modelling and other aspects of this fishery.

None of these results are final.

These analyses do not necessarily reflect the point of view of NOAA and in no way anticipate NOAA future policy.

Objective

Develop an MSE framework for the Atlantic Dolphinfish (mahi mahi) fishery to test candidate management procedures and inform other management decision making including research prioritization, assessment methodology, specification of fishing regulations and enforcement.

Project details

'Lead Analyst for the Dolphin Management Strategy Evaluation Project IAW the Tasks included in the Statement of Work'

Term	June 2024 - May 2025, June 2025 - May 2026
Funding body	U.S. National Oceanic and Atmospheric Administration
Funding stream	Sam.gov
Solicitation No.	# 1305M324Q0309, NA
Contract No.	1305M324P0270, NA
Project Partners	Blue Matter Science Ltd.
Blue Matter Team	Tom Carruthers, Adrian Hordyk, Quang Huynh
NOAA Collaborators	Cassidy Peterson, Matt Damiano

Progress

The Prerequisite phase has been completed. MSE framework development is current in the Foundation and Initial phases (Figure 1). Rapid progress is expected toward

Dolphin Management Strategy Evaluation: Amendment 3 Scoping

SAFMC
September 2025

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Amendment 3

Framework amendment to implement changes to the minimum size limit and recreational retention limits for dolphin

1. Extend 20-inch FL minimum size northward
2. Modify daily bag limit (2-10) for private, chater, or headboat
3. Modify vessel limit (12 - 54) for private, chater, or headboat in FL or entire Atlantic
4. Remove for-hire captain and crew bag limits in FL or entire Atlantic

https://safmc.net/documents/dwap_a3_regam3discussiondocument_202504-pdf/

Amendment 3 scoping

Proposed Action Plan:

- Use MSE to compare performance of status quo management (SQM) with management actions proposed in Amendment 3
- Apply to base OM or narrow set of reference OMs (e.g., OMs with most important axes of uncertainty)
- Status quo management:
  - 20” minimum size limit for commercial and recreational sectors off FL, GA, SC
  - Daily recreational bag limit 10 dolphin / person onboard private, charter, and headboat vessels
  - Recreational vessel limit of 54 dolphin / vessel onboard private and charter vessels
  - Captain and crew may retain daily recreational bag limit to not exceed vessel limit
- Alternate static management actions should include:
  - Expanded minimum size limit: state-by-state expansion of 20” FL minimum size limit for both commercial and private sectors from FL through ME
  - Modified daily recreational bag limit: across private, charter, and headboat vessels, modified daily bag limits from 2-8 fish
  - Modified daily recreational vessel limit: across private, charter, headboat vessels, modified from 12 - 48 fish

Adding amendment 3 capabilities to MSE software

- Trip limits, bag limits and size limits (min, max, slot) have been incorporated into mahiMP and we have these working in mahiMSE.
- Size limits are relatively simple to implement and are a standard feature in openMSE.
- Trip and bag limits require trip-level data to characterize the distribution of catch rates.

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Incorporating Trip Limit regulations

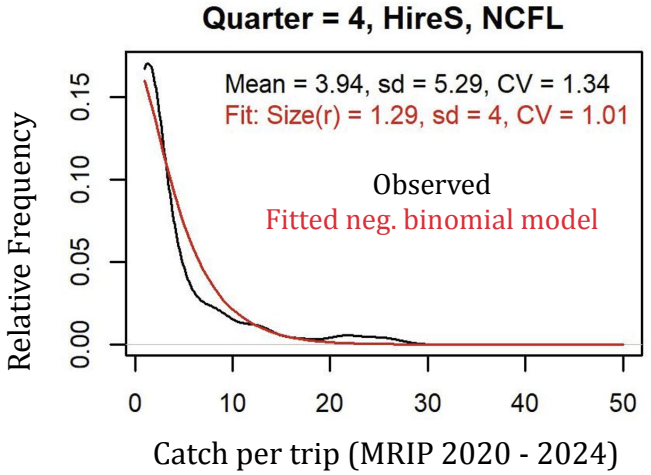
Step 1: Obtain trip level data for rec and hire fisheries (MRIP).

Step 2: Characterize the distribution of catch per trip for each fleet / area / quarter.

Step 3: Predict the distribution of catch per trip when stocks are at varying levels.

Step 4: For any stock level and specified trip limit, predict the fraction of fish released due to the trip limit.

Step 5: Provide this information, along with expected post release mortality rate to openMSE as part of the MP.



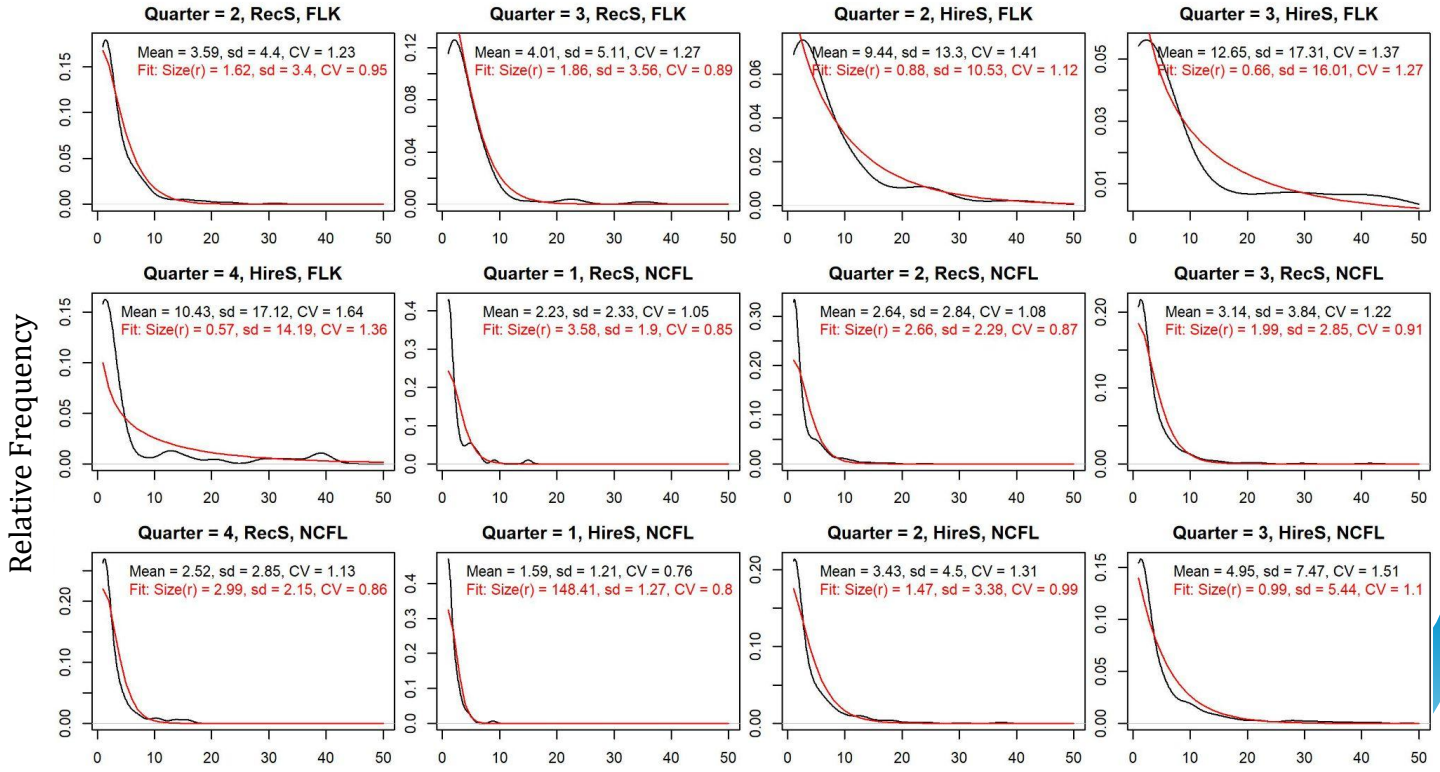
Bag limits (recS, hireS in FLK and NCFL)

Observed
Fitted neg. binomial model

According to MRIP records, catch per trip has rarely exceeded nominal maximum of 54 fish

Given a post release mortality rate of ~85% (Rudershausen et al. 2019) bag-limits and size limits are expected to have limited impact on fishing mortality given constant fishing effort.

Restrictive size limit and/or bag limit regulations could lead to very high fishing mortality given catch controls.



Next

- Updated spatial definitions for catch and VAST indices
- Include a missing catch (scale) uncertainty axis
- Simulate Amendment 3 scoping scenarios

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More to come

https://github.com/Blue-Matter/DolphinMSE | cassidy.peterson@noaa.gov | tom@bluematterscience.com
https://www.fisheries.noaa.gov/southeast/science-data/dolphinfish-management-strategy-evaluation-us-atlantic

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