Management Strategy Evaluation for the SAFMC Snapper-Grouper Fishery

Gulf of Mexico Fishery Management Council
Scientific and Statistical Committee

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Adrian Hordyk
adrian@bluematterscience.com

Key Questions of an MSE

1. What do we ***know***?

2. What do we ***want***?

3. What ***can*** we do?

4. What ***should*** we do?

Operating Model: What do we know?

Stock Dynamics

- Growth and natural mortality rates
- Reproductive behavior
- Spatial distribution
- Absolute magnitude
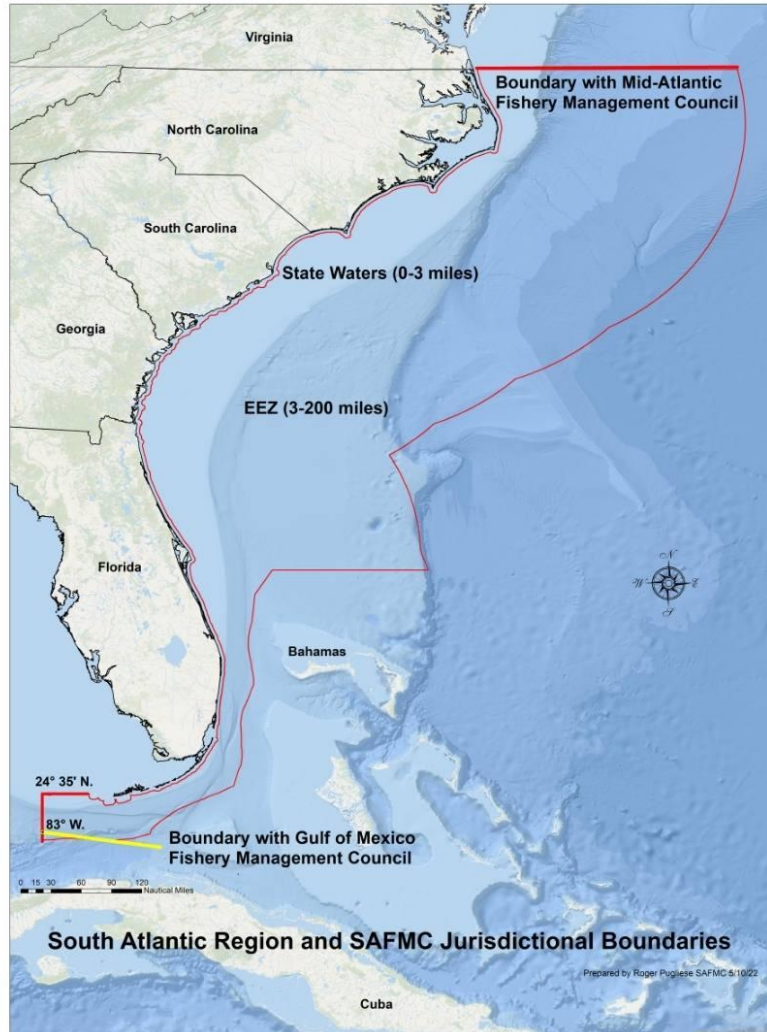- Current stock status

Fleet Dynamics

- Selectivity of gear
- Historical exploitation pattern
- Spatial distribution

Operating Model: What do we know?

Multispecies Fishery

- Biological interactions between stocks
- Preferential targeting behavior of the fleets

Snapper-Grouper Fishery

South Atlantic Region and SAFMC Jurisdictional Boundaries

50+ Species

Snapper Grouper managed species list

Amberjack, Greater

Amberjack, Lesser

Atlantic Spadefish

Grouper, Black

Grouper, Coney

Grouper, Gag

Grouper, Goliath

Grouper, Graysby

Grouper, Misty

Grouper, Nassau

Grouper, Red

Grouper, Red Hind

Grouper, Rock Hind

Grouper, Scamp

Grouper, Snowy

Fleets

1. Commercial
2. Recreational Headboats
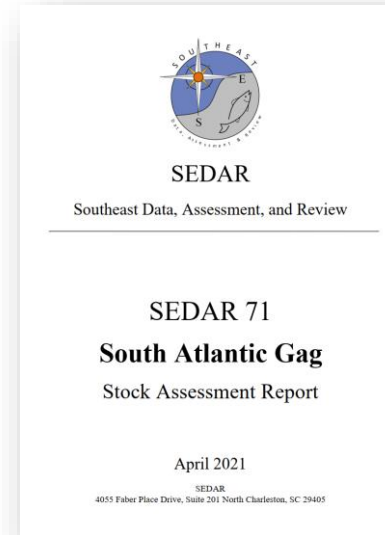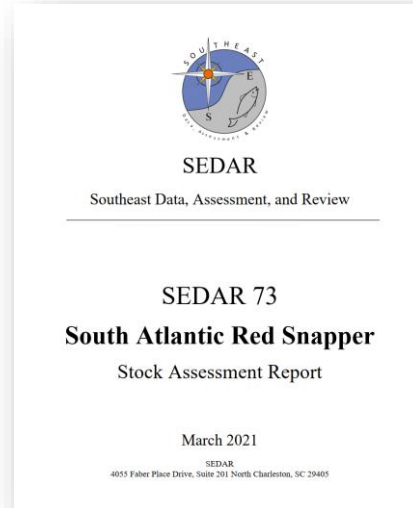3. Private Recreational

Snapper-Grouper Fishery

Red Snapper

Lutjanus campechanus

Gag Grouper

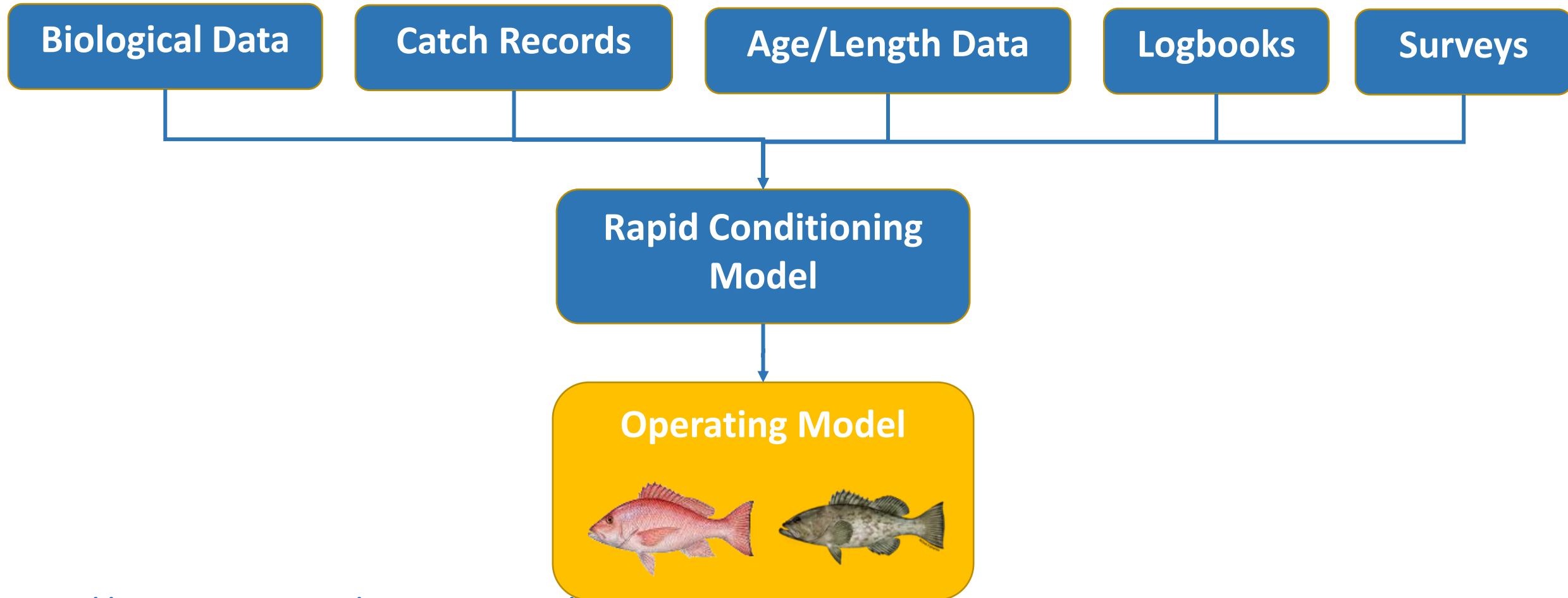*Mycteroperca microlepis*

Building the Operating Models

Building the Operating Models

Structure of Operating Model depends on the management questions being asked

Building the Operating Models: Rapid Conditioning Model (RCM)

Commercial, Recreational Headboats, Private Recreational Fleets:
On-Season and Off-Season

Biological Data	Catch Records	Age/Length Data	Logbooks	Surveys

Rapid Conditioning Model

Operating Model

https://openmse.com/tutorial-rcm/

Building the Operating Models: Spatial Component

Area
- North and South Carolina
- Georgia - Cape Canaveral
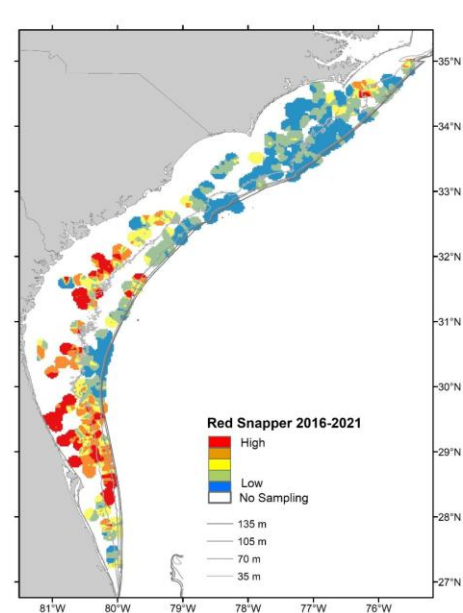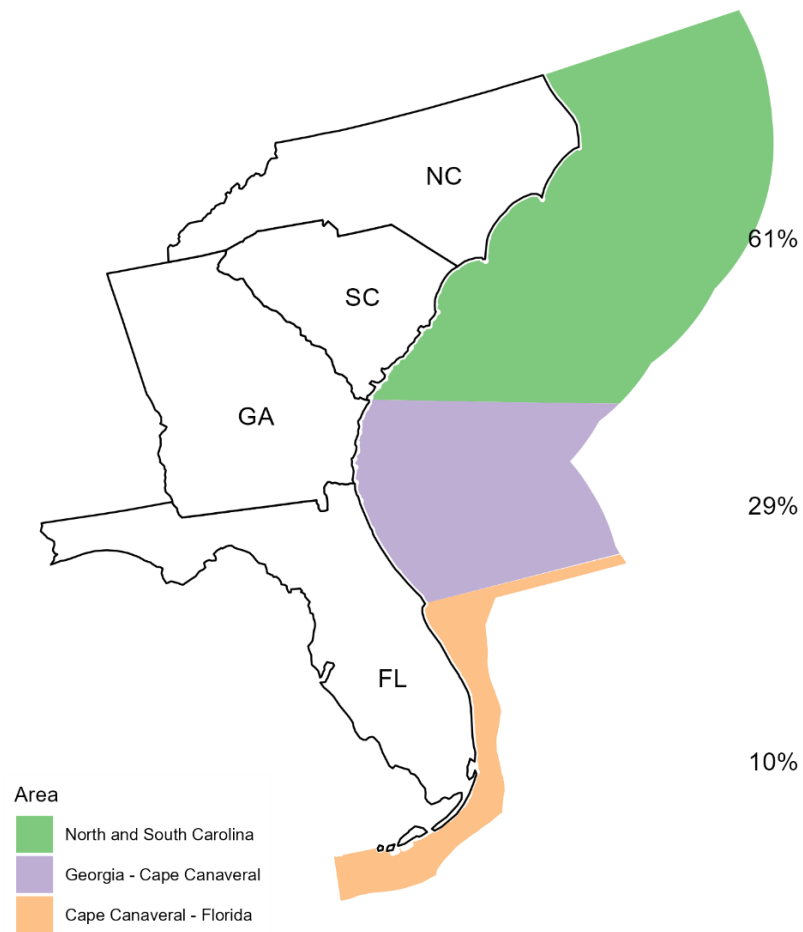- Cape Canaveral - Florida

61%

29%

10%

Figure 18. Distribution map of Red Snapper catch by SERFS from CHV in 2016-2021. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.

Figure 32. Distribution map of Gag catch by SERFS from CVT in 2016-2021. Colors indicate quartiles by catch per trap hour and white indicates areas not sampled by SERFS. The map smoothing was accomplished with inverse distance weighting.
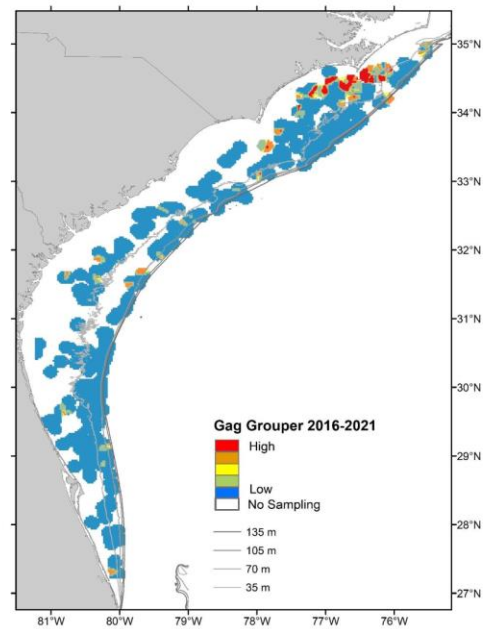
Building the Operating Models: Incorporating Uncertainty

System uncertainties: uncertainties in our knowledge of the system

Projection uncertainties: unavoidable uncertainty about future conditions

Building the Operating Models: System Uncertainty

Axes of Uncertainty

- Life history parameters (natural mortality)

- Discard mortality

- Uncertainty in landings data

Model 1	Model 1
Model 2	Model 2
Model 3	Model 3

Plausible hypotheses of system dynamics

Operating Models

| Model 1 | Model 2 |
| Model 3 | ... |

Building the Operating Models: Projection Uncertainty

Projection Scenarios

- Recruitment scenarios (higher than average vs revert to mean)

- Estuarine/habitat issues & habitat restoration

- Increases in number of recreational fishers

Performance Metrics: What do we want?

Biological

   a. Sustainability

   b. Probability of low biomass

   c. Probability of overfishing

Social & Economic

   a. Catch

   b. Stability of catches

   c. Size composition of catch

   d. Opportunity

Quantitative measures of management outcomes

Performance Metrics: What do we want?

Biological

Management Objective

1. Avoid stock being in an overfished state

Quantitative Metric

1. Probability SSB > MSST (min. stock size threshold)

$$MSST = 0.75\ SSB_{MSY}$$

Performance Metrics: What do we want?

Biological

Management Objective

1. Avoid stock being in an overfished state

2. Avoid overfishing the stock

Quantitative Metric

1. Probability SSB > MSST (min. stock size threshold)

2. Probability F < MFMT (max. fishing mortality threshold)

   MFMT = F30% (red snapper) F_{MSY} (gag)

Performance Metrics: What do we want?

Biological

Management Objective

1. Avoid stock being in an overfished state
2. Avoid overfishing the stock
3. If overfished, rebuild stock to target within desired time-frame

Quantitative Metric

1. Probability SSB > MSST (min. stock size threshold)
2. Probability F < MFMT (max. fishing mortality threshold)
3. Probability SSB > $SSB_{F30\%}$ or SSB > SSB_{MSY} (rebuilding target) by 2044 (red snapper) 2040 (gag)

Performance Metrics: What do we want?

Recreational and Commercial Objectives

Performance Metrics: What do we want?

Recreational

Management Objective

1. Catch a lot of fish, keep enough to make the trip worthwhile; 'Enough' fish = one *trophy* fish to keep and some to take home

Quantitative Metric

1. Average catch rate (relative to current); Probability of catching *trophy* size fish

Performance Metrics: What do we want?

Recreational

Management Objective

1. Catch a lot of fish, keep enough to make the trip worthwhile; 'Enough' fish = one *trophy* fish to keep and some to take home

2. Maximize fishing opportunity; opportunity to go fishing when it best suits the angler

Quantitative Metric

1. Average catch rate (relative to current); Probability of catching *trophy* size fish

2. Season length and average catch

Performance Metrics: What do we want?

Recreational

Management Objective

1. Catch a lot of fish, keep enough to make the trip worthwhile; 'Enough' fish = one *trophy* fish to keep and some to take home

2. Maximize fishing opportunity; opportunity to go fishing when it best suits the angler

3. Reduce discards compared to kept fish

Quantitative Metric

1. Average catch rate (relative to current); Probability of catching *trophy* size fish

2. Season length and average catch

3. Calculate ratio of discards : kept fish

Performance Metrics: What do we want?
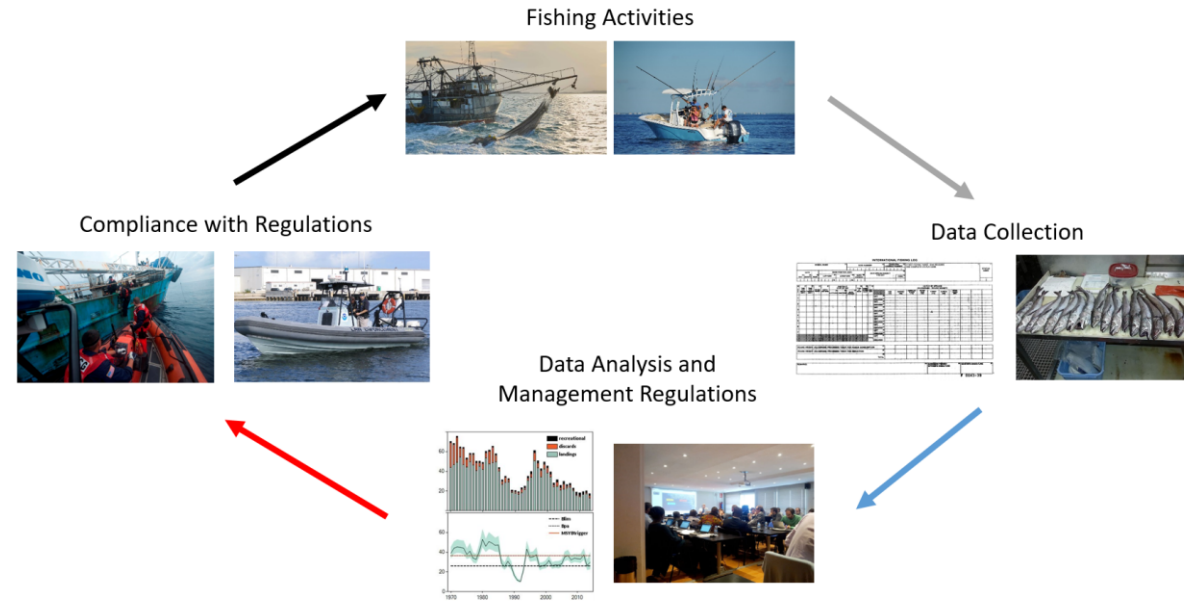
Commercial

Management Objective

1. Stability in catch

2. Maximize yield

3. Reduce discards compared to kept fish

Quantitative Metric

1. Average inter-annual variability in catch

2. Average yield

3. Calculate ratio of discards : kept fish

Management Strategies: What can we do?

Data Collection → Analysis → Regulations → Compliance = **Management Strategy**

Management Strategies: What can we do?

Static Controls
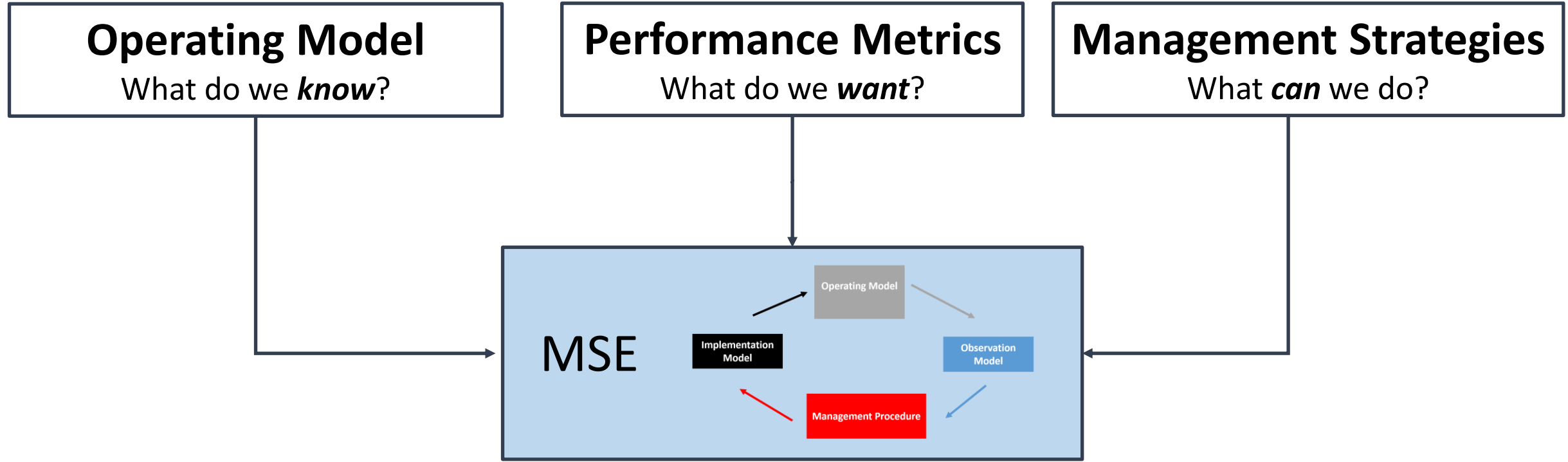
Fixed regulations that don't change

1. Seasonal closures

2. Bag/retention limits

3. Size limits

4. Total allowable catch

5. Regional management

Dynamic Controls

Regulations change in response to data

1. Size frequency of catch

2. Trends in catch-rate

3. Indices of abundance (surveys)

MSE: Calculate Performance

Operating Model What do we ***know***?	**Performance Metrics** What do we ***want***?	**Management Strategies** What ***can*** we do?

MSE

Operating Model

Implementation Model

Observation Model

Management Procedure

MSE: *Evaluation* of different *Management Strategies*

MSE: Calculate Performance

Operating Model	**Performance Metrics**	**Management Strategies**
What do we *know*?	What do we *want*?	What *can* we do?

openMSE

https://www.openmse.com/

MSE: Calculate Performance

Operating Model	Performance Metrics	Management Strategies
Operating Model	**Performance Metrics**	**Management Strategies**
What do we *know*?	What do we *want*?	What *can* we do?

openMSE
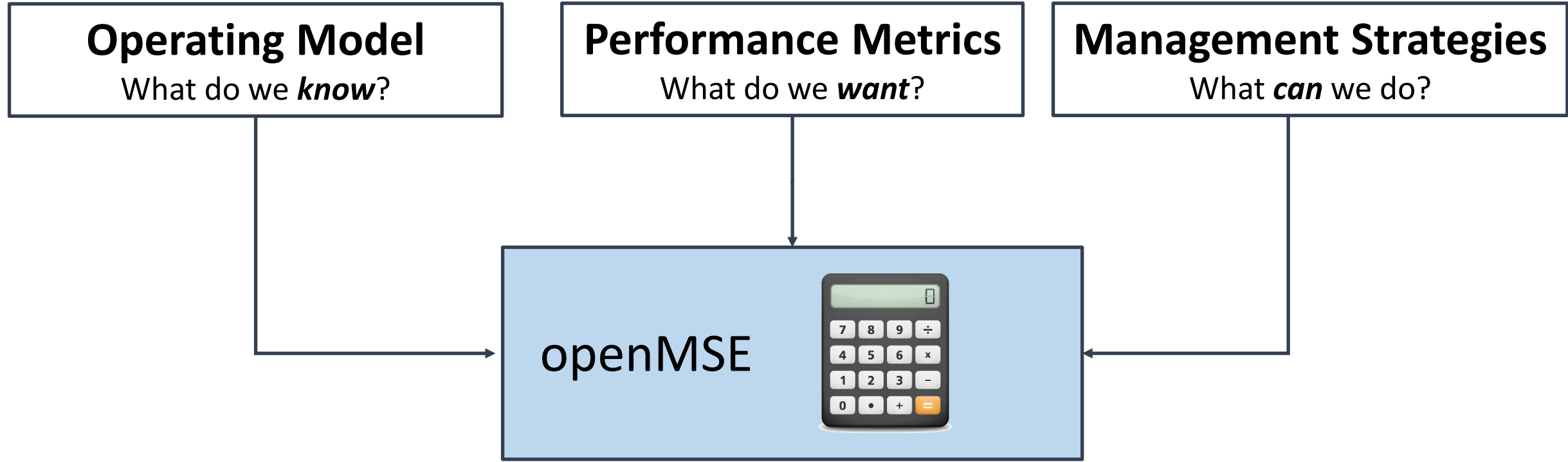
Results
What *should* we do?
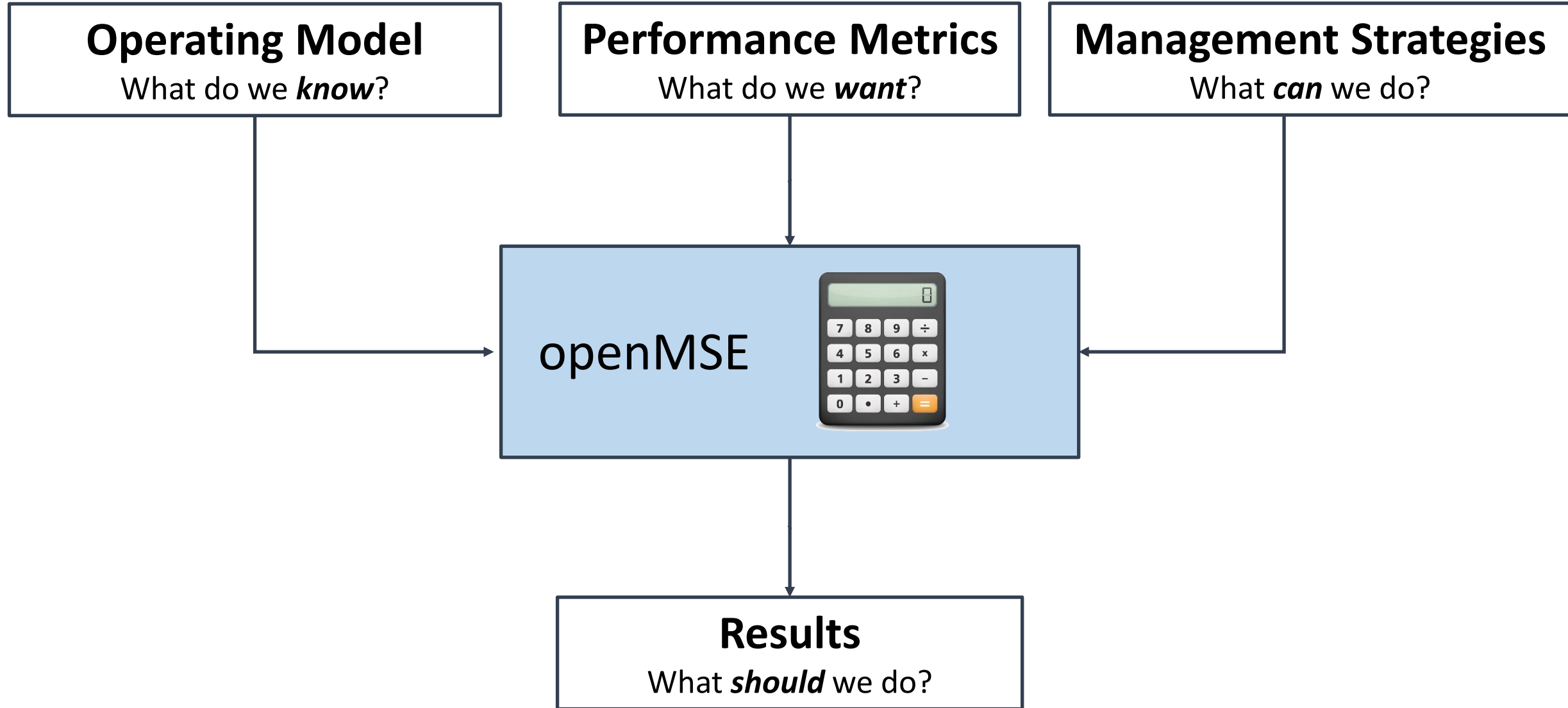
Results: Identification of a Robust Management Strategy

Management Strategy:

- Collect these data

- Analyze data in way

- Adjust management regulations with this set of rules

Trade-Offs:

- Quantify trade-offs among competing objectives

Results: Other Outcomes

Operating Models
What do we *know*?

- Collection of documented hypotheses describing the system dynamics

- Cost of Current Uncertainties: quantify how uncertainty in knowledge of system impacts management decision

- Value of Information: prioritize scientific research; identify improvements which will lead to largest gains in management outcomes

Performance Metrics
What do we *want*?

- Formally stated quantitative management measure

Summary

> **MSE**: A framework for ***reproducible***, ***transparent***, ***defensible*** decision-making for a system with high uncertainty

Reproducible: analysis can be repeated by others and gets the same result

Transparent: all steps in the decision-making process are explained

Defensible: decisions are based on data, with clearly explained rationale

Summary

- Concept is relatively straightforward, but new ideas take time to digest

- Software and computing barriers largely removed, but building defensible operating models takes time

- Collaborative process with stakeholders; presently linear but iterative in practice

- Potential for enormous number of questions: start small and stay focused

- Consider value of each component of the MSE process

Thank You