Design of alternative management procedures for black grouper fisheries

An exploration of viability and data limitations

Vania Henriquez, Peyton Moore, Bill Harford

bill@natureanalytics.ca

August 15, 2024

NATURE ANALYTICS

CONTEXT

- This presentation (and report) serve as a proposed foundation for designing management procedure (MP) options for black grouper fisheries.
- In 2017, the Florida Fish and Wildlife Conservation Commission (FWC) suspended its stock assessment due to high uncertainty in landing records.
- Early 2024, FWC initiated a study to assess the viability and related challenges of designing management procedure(s).
- Today, we summarize a five-part information synthesis aimed at illuminating a pathway to designing and testing management procedure(s).

OUTLINE

Introductory notes

1) Key uncertainties affecting management

2) Review of management procedures (MPs)

3) Examples from other fisheries

4) A brief note on MSE

5) Viable pathways towards Black grouper MPs

Conclude with ideas for next steps

Introductory notes

INTRODUCTORY NOTES

Management regulations for the South Atlantic Fishery

- Permits for commercial fishers.
- Annual catch limits (ACL) and accountability measures (commercial and recreational).
- Gear types and usage regulations (commercial and recreational).
- Seasonal closure to protect spawners (commercial and recreational).
- Eight deep-water marine protected areas (MPAs) and five spawning special management zones (SMZs) to protect habitats (fishing prohibited year-round).
- Minimum size limits (24 inches in total length) (commercial and recreational).
- Bag limit, aggregate bag, and recreational vessel limits (recreational).

INTRODUCTORY NOTES

Management regulations for the Gulf of Mexico Fishery

- Individual Fishing Quota (IFQ) program and reef fish permit (commercial)
- Annual catch limits (ACL) and accountability measures (commercial and recreational).
- Gear types and usage regulations (commercial and recreational).
- Seasonal closure to protect spawners (commercial and recreational).
- Minimum size limits (24 inches in total length) (commercial and recreational).
- Bag Limit (recreational).

INTRODUCTORY NOTES

Current decision-making process

Landings:
misidentification of
black grouper and gag

SUSPENDED STOCK
ASSESSMENT

**Stock status
“unknown”**

MANAGEMENT
DECISION

INTRODUCTORY NOTES

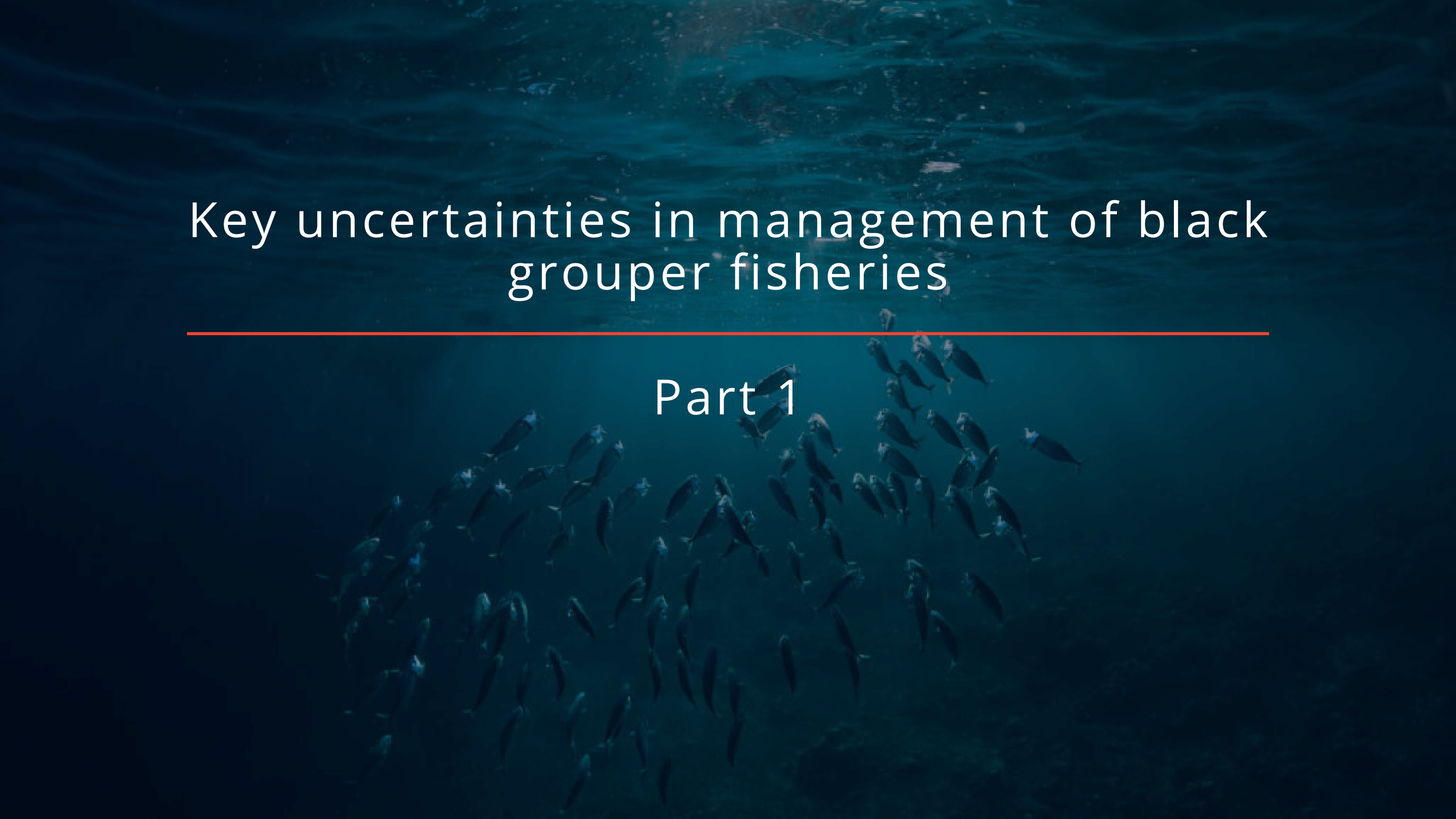
Current decision-making process

- **The South Atlantic Fishery Management Council**
  - Level 4 - No stock assessment ; “only reliable catch stocks” (ORCS).
  - ABC rule: Catch-based
  - ABC derived on case-by-case basis; guided by ORCS approach to determine catch statistic and scalar.

- **The Gulf of Mexico Management Council**
  - Tier 3a - No assessment, landings data available, expert opinion suggest recent landings sustainable.
  - ABC control rule: Catch-based
  - OFL = mean recent landings plus two standard deviations
  - ABC = mean of landings plus a determined number of SDs

Key uncertainties in management of black grouper fisheries

Part 1



KEY UNCERTAINTIES

- Summary of the established uncertainties in data inputs.
- Review life history, fishery-dependent and fishery-independent data to assess quality and limitations (e.g., sampling design, coverage, statistics, time gaps).
- Review based on report by SEDAR 48 working group (SEDAR 2017) and some additional considerations.
- Coarse ‘traffic light’ approach to guide discussions. Not strictly intended to exclude any data types or data sets.

Good quality

Medium quality

Low quality

KEY UNCERTAINTIES

Table 1. Categorization and reliability of the available data.

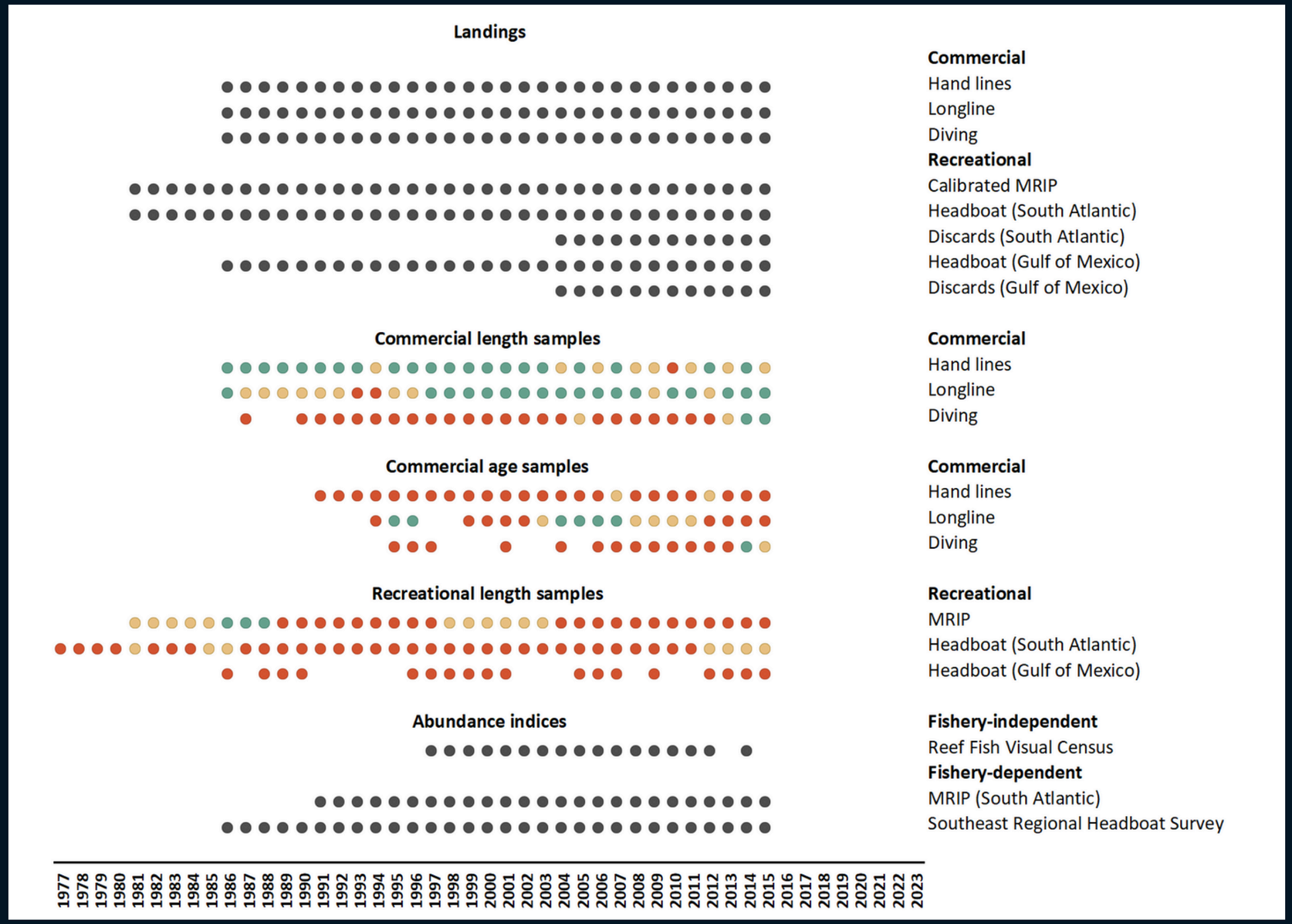
Data	Description	Data category	Data reliability
A50%	Age at 50% maturity	Life history	
L50%	Length at 50% maturity	Life history	
M	Natural mortality	Life history	
Linf	Asymptotic length in VBGF	Life history	
K	Growth parameter in VBGF	Life history	
t0	Age at zero length in VBGF	Life history	
a	Parameter *a* in weight–length relationship	Life history	
b	Parameter *b* in weight–length relationship	Life history	
A50% transition	Age at 50% of transition	Life history	
L50% transition	Length at 50% of transition	Life history	
Ct	Commercial landings	Catch	
Crt	Recreational landings	Catch	
CAL	Commercial length samples	Catch composition	
Reef Fish Visual Census (RVC)	Fishery independent survey (sub-adults)	Population indices	
MRIP (South Atlantic)	Fishery dependent survey	Population indices	
Southeast Regional Headboat Survey (SRHS)	Fishery dependent survey	Population indices	

Good quality

Medium quality

Low quality

KEY UNCERTAINTIES



Availability

Available

Length or age sample size (n)

n > 100

n > 50

n < 50

KEY UNCERTAINTIES

Life History

Growth, length-weight, and maturity parameters generally reliable for use in MP design

Some limitations:

- **Growth Parameters:** Limited number of age samples.
- **Age Determination:** Accuracy for older age groups is unknown.
- **Maturity Parameters:** Based on data from 1994-1996; no recent updates.
- **Age at 50% Transition (Female to Male):** Uncertainties due to low sample size and potential under representation of males.
- **Natural Mortality (M):** Derived from empirical approaches. No experimental estimates (e.g., mark-recapture) conducted for black grouper in the southeastern US.

KEY UNCERTAINTIES

Population Indices

Generally reliable for use in MP design

Fishery - independent

1. **Reef Fish Visual Census (RVC) Survey:**

- Utility: Can serve as an abundance indicator.
- Limitations: Sub-adult survey in distribution center; hyperstability unclear.

Fishery - dependent

1. **Marine Recreational Fisheries Statistics Survey of South Florida (MRFSS/MRIP)**
2. **Southeast Regional Headboat Survey (SRHS)**

- Utility: Can serve as an an abundance index (both).
- Catch rates are standardized (both).
- Limitations:
  - MRFSS/MRIP: Data before 1991 may contain more uncertainty. Post-1991 improvements in data collection and field sampler training.
  - SRHS: Based on trips landing black grouper in the distribution center; potential hyperstability.

KEY UNCERTAINTIES

Length Composition

Generally reliable for use in MP design

Length composition data from commercial fishery

- Useful as length-based indicators (e.g., mean length in catches).
- Small annual sample sizes; exploration of representativeness required.
- Handline and longline length composition may provide information about:
  - Selectivity information.
  - Changes in length-frequency related to fishing mortality.
  - Potential identification of recruitment pulses.

KEY UNCERTAINTIES

Commercial and Recreational Landings

Concern about use in MP design

- Commercial and recreational landings: misidentification with gag.

- Correction Methods:
  - Model-Based Methods: Used to correct species misidentification but may introduce estimation errors.
  - Recreational Landings Adjustments (calibrations): Applied to improve accuracy and consistency of MRIP estimates and correct species misidentification.

- Species misidentification introduces considerable uncertainty to the stock assessment model (not updated since 2010 due to species misidentification).

KEY UNCERTAINTIES

How can we overcome data limitations and improve management recommendations?

DATA LIMITATIONS

SUSPENDED STOCK ASSESSMENT

?

MANAGEMENT DECISION?

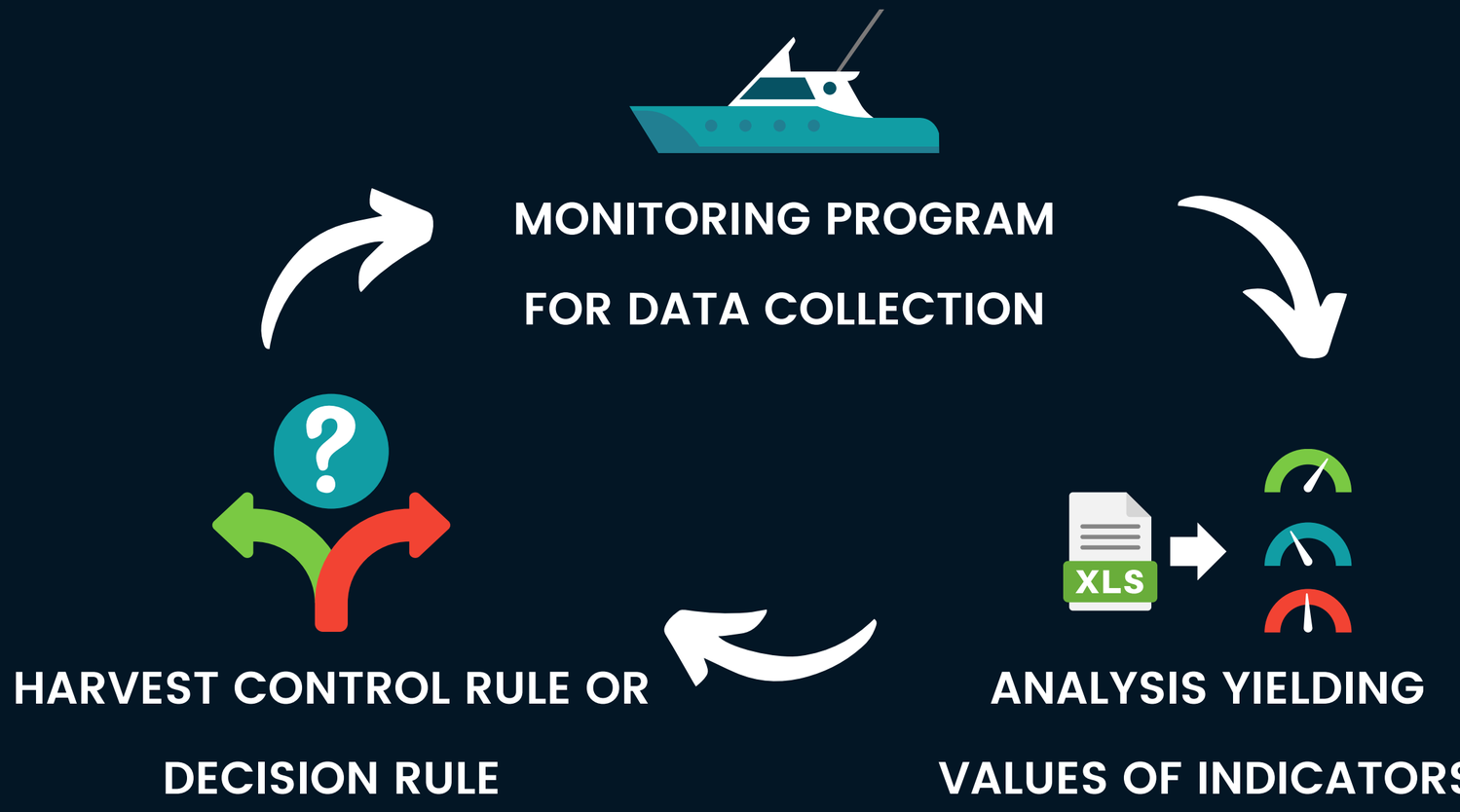
How can we design a process for addressing these limitations?

Review of management procedures (MPs)

Part 2

REVIEW OF MANAGEMENT PROCEDURES

Components of a Management Procedure (MP):



MPs are a procedural paradigm focused on how data collection, analysis, and decision rules work holistically to achieve fishery management objectives

REVIEW OF MANAGEMENT PROCEDURES

MPs exist along a spectrum of complexity
Data limitation is likely to form the basis of proposed solutions

DATA-LESS

Fisheries lacking data may implement ‘data-less’ management and/or establish a monitoring program that could become the basis on an MP.

INTERMEDIATE

MPs of intermediate complexity can be based on qualitative data, derived from raw data, or based on simple demographic models.

DATA-RICH

Where sufficient information exists, an MP can be centered around conventional, fully integrated stock assessment.

REVIEW OF MANAGEMENT PROCEDURES

Indicator-based MPs

INTERMEDIATE

MPs of intermediate complexity can be based on qualitative data, derived from raw data, or based on simple demographic models.

REVIEW OF MANAGEMENT PROCEDURES

Indicator-based MPs

Fishery management without complex stock assessment.

Indicators are observations or estimates of the state of the fishery resource that are proxies for variables of interest.

*Not dismissing stock assessment (will return to this later).

INTERMEDIATE

MPs of intermediate complexity can be based on qualitative data, derived from raw data, or based on simple demographic models.

REVIEW OF MANAGEMENT PROCEDURES

Indicator-based MPs

Fishery management without complex stock assessment.

Indicators are observations or estimates of the state of the fishery resource that are proxies for variables of interest.

*Not dismissing stock assessment (will return to this later).

INTERMEDIATE

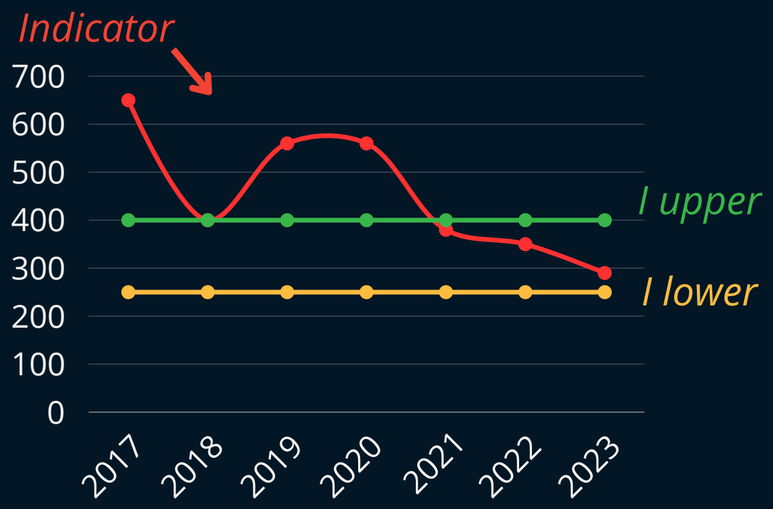
MPs of intermediate complexity can be based on qualitative data, derived from raw data, or based on simple demographic models.

Practical definition: Indicator-based MPs are used to support decision-making in the absence of biomass estimates

REVIEW OF MANAGEMENT PROCEDURES

Indicators (e.g., survey, CPUE, average length) used to modify catch advice.

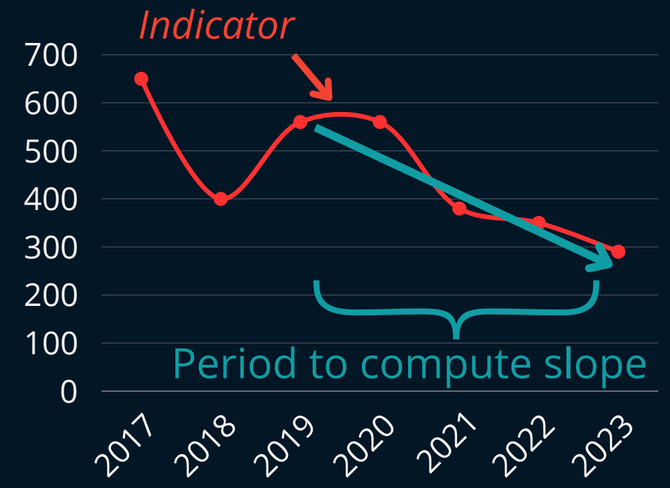
MP: Stepwise adjustment



HCR: catch advice is "stepped" up or down when outside reference range

Objective: Keep indicator stable between range

MP: Indicator trend



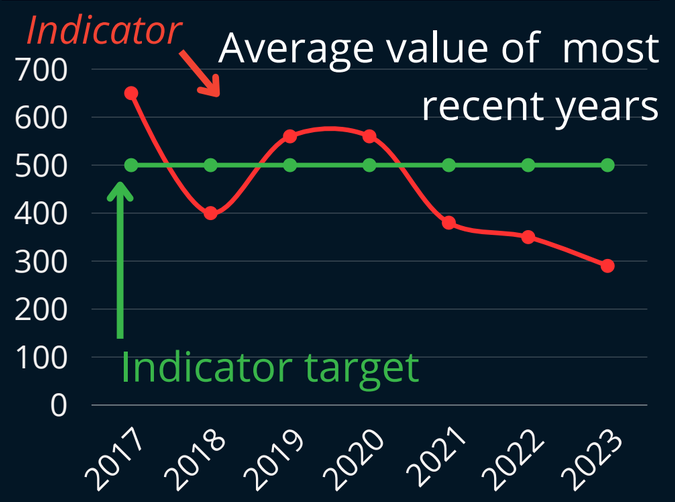
HCR: catch advice adjusted relative to magnitude of slope.

Objective: Keep indicator stable based on current trend

REVIEW OF MANAGEMENT PROCEDURES

Indicators (e.g., survey, CPUE, average length) used to modify catch advice.

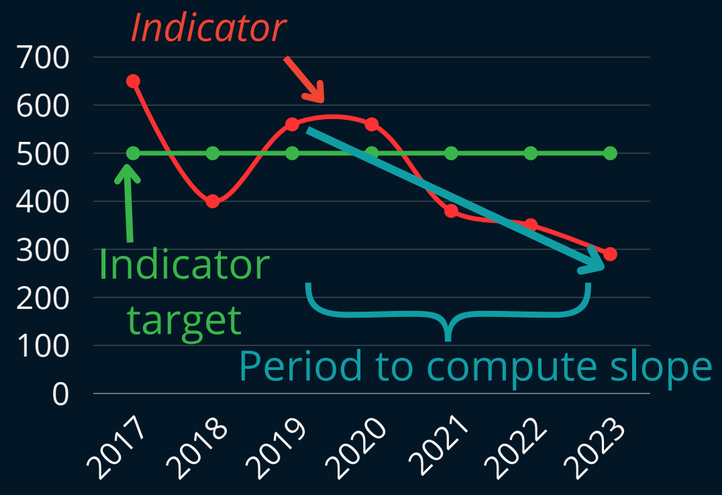
MP: Indicator target



HCR: catch advice adjusted based on the distance to the the target value.

Objective: Keep indicator stable relative to target.

MP: trend + target



HCR: catch advice is adjusted relative to both slope and distance to target value.

Objective: Keep indicator stable relative to target.

Examples from other fisheries

Part 3

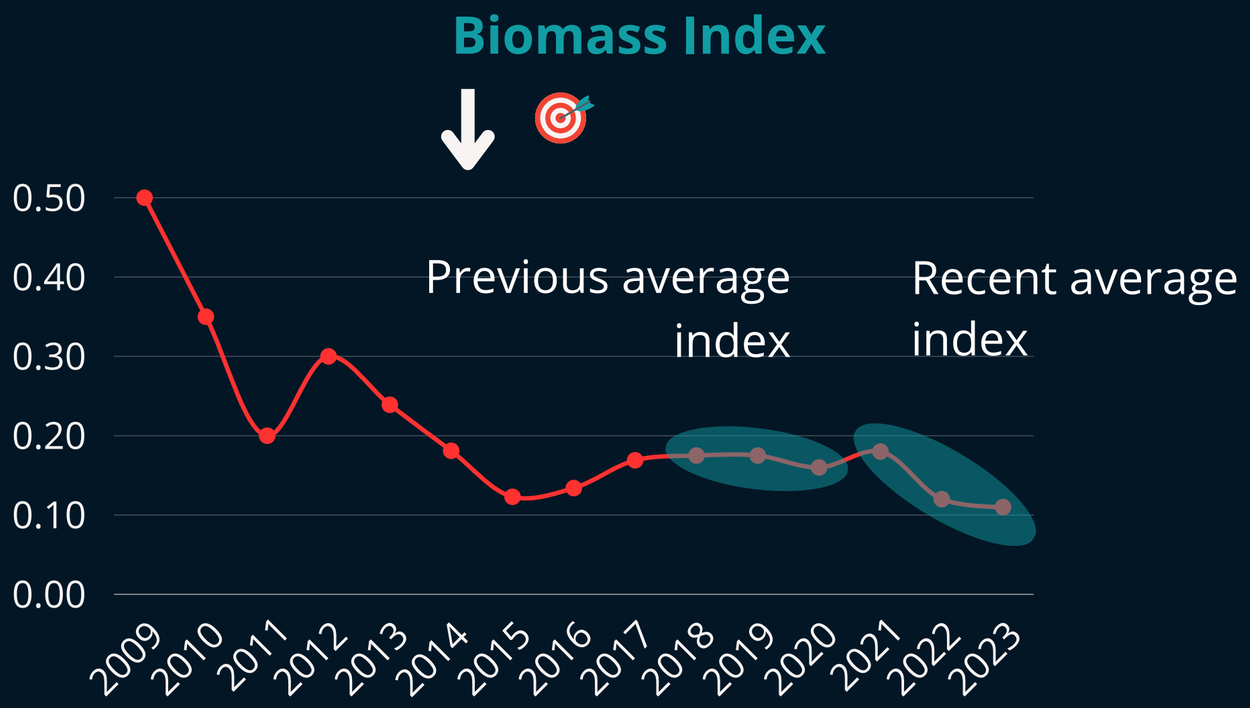
EXAMPLES

- Summaries are provided for three fisheries that faced similar data limitations as the black grouper fishery and used indicator-based management procedures.
- In each example, catch advice is adjusted based on indicators such as biomass indices, catch per unit effort (CPUE), and/or mean length in catches.
- These management procedures aim to provide evidence-based recommendations that accommodate different degrees of data availability.

THORNY SKATE

Amblyraja radiata | Location: Gulf of Maine, USA (New England Fishery Management Council)

Decision Rule Visualization



Catch advice calculation

ABC = median (Average catch / Average index) x Recent average index

ACL = ABC

Annual Catch Limit (ACL) = Aceptable Biological Catch (ABC)

ACT = ACL x 0.9

Annual Catch Target (ACT): mitigates uncertainties related to discards and landings

- ***Overfished status determination****: If the recent average index falls below biomass index threshold, the stock considered to be overfished.*
- ***Overfishing status determination****: If the recent average index falls below the previous average index by more than a pre-agreed percentage, overfishing is occurring.*

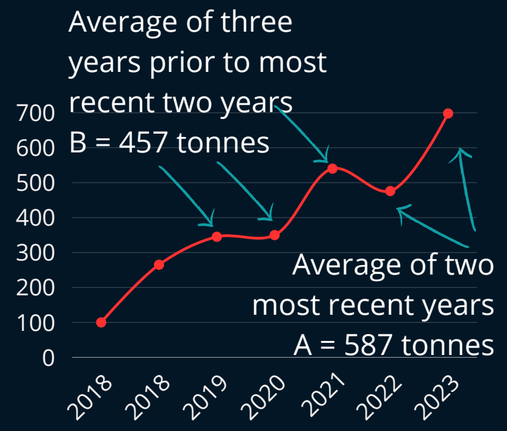
PLAICE

Pleuronectes platessa | Location: ICES divisions 7.h–k (Celtic Sea South, southwest of Ireland)

Decision Rule Visualization

Biomass index from most recent 5 years

Maintain stable biomass



m1: A/B =1.28

Biomass index from most recent 5 years

Avoid low biomass

Most recent year
I = 698 tonnes

Index trigger
Itrigger = 150 tonnes

m2: min{I/Itrigger,1} = 1

Mean length in catches

Move fishing pressure towards MSY

Most recent year
L= 29.7 cm

Target length
Ltarget=28.9 cm

m3: L/ Ltarget = 1.03

Previous catch advice

110 tonnes

Multi-indicator management procedure (Biomass index + mean length in catches)

Catch advice calculation

This year's catch advice = Previous catch advice x m1 x m2 x m3 = 137.7 tonnes

- *Catch shall be decreased by no more than 30% relative to previous advice (Reduce interannual catch variability).*
- *Catch shall be increased by no more than 20% relative to previous advice (Precautionary measure).*

SPANNER CRAB

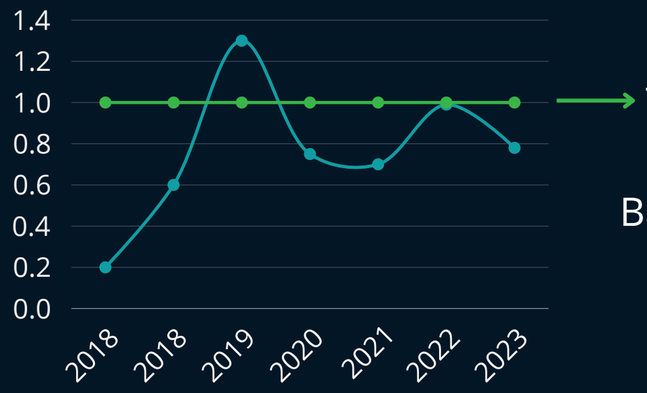
Ranina ranina | *Location: Queensland, Australia*

Decision Rule Visualization

Pooled biomass index (average of survey and CPUE)

↓🎯

Rebuild to target biomass



→ Target Reference Point (TRP)

Based on a period of high and stable catch rates

This management procedure has been assessed through Management Strategy Evaluation (MSE).

Catch advice calculation

Conditions for an increase

Pooled index (current year) > 1 ✅

Pooled index (current year) > Pooled index (previous year) ✅

Conditions for a decrease

Pooled index (current year) < 1 🔴

Pooled index (current year) < Pooled index (previous year) 🔴

*Fishery closure if CPUE < Limit Reference Point (LRP) ⚠️

% change in catch advice = % change of biomass index relative to the previous year

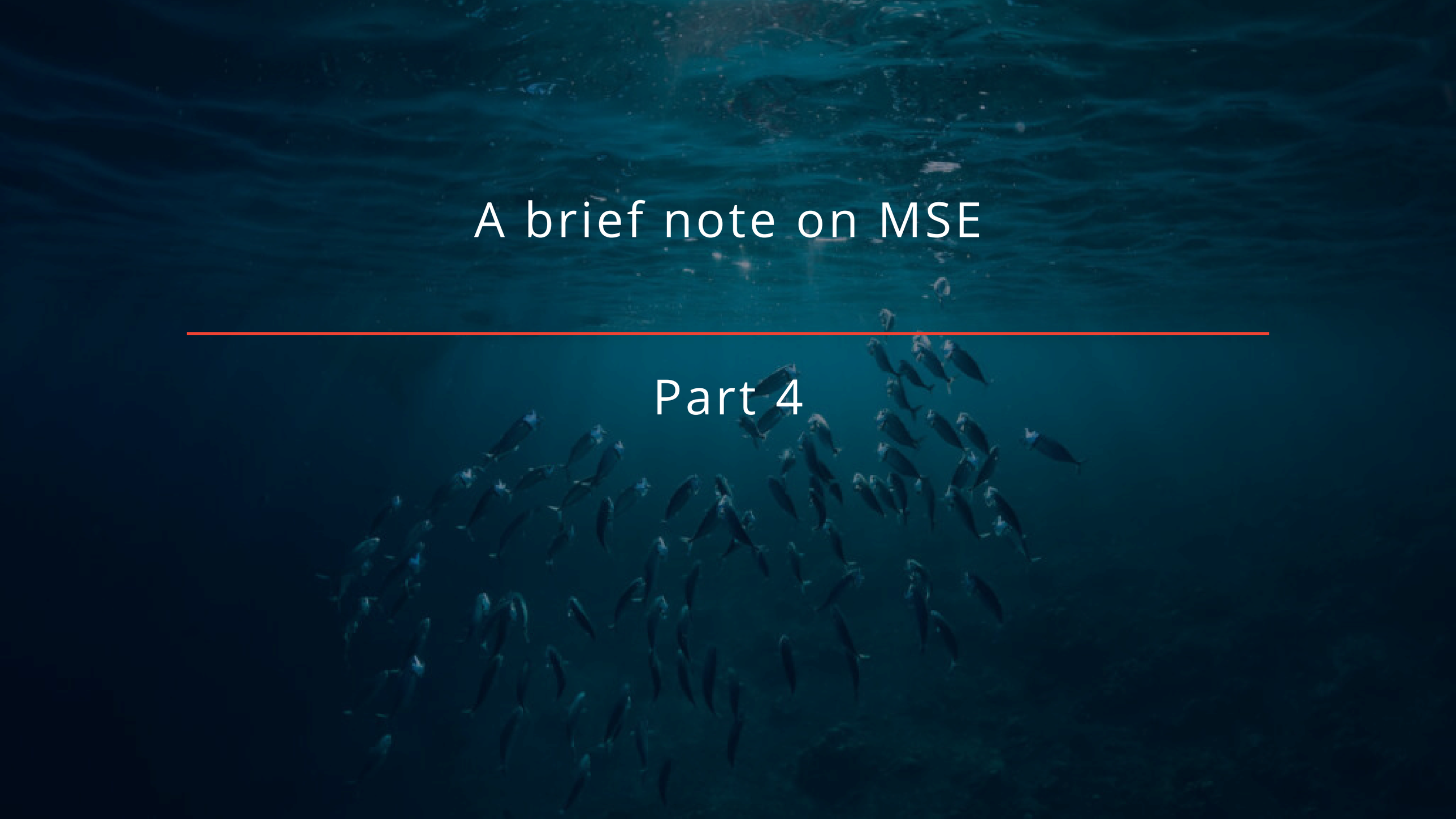
Additional clauses

No change in catch advice when neither set of conditions met

Annual change in catch advice capped at 200 t

Catch advice cannot exceed 1300 t

Catch advice cannot fall below 300 t



A brief note on MSE

Part 4

A BRIEF NOTE ON MSE

HOW THE MSE PROCESS COULD BE APPLIED TO BLACK GROUPER?

OPERATING MODEL

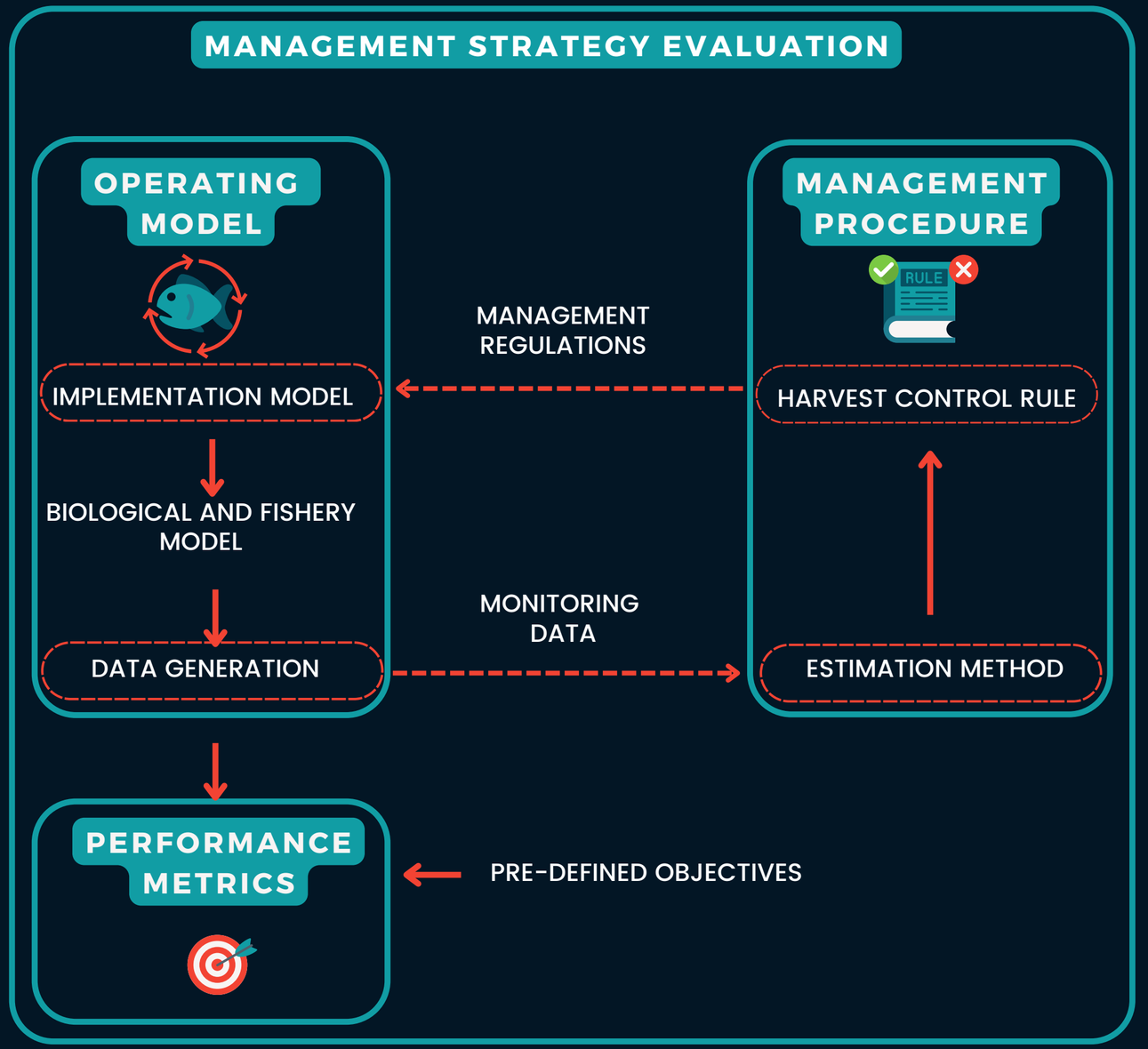
A mathematical-statistical model used to simulate a representation of the fishery system and its monitoring programs.

MANAGEMENT PROCEDURE (MP)

A management procedure is a pre-agreed process defining how a fishery will be managed, with the primary role being to take fishery information and return a management recommendation.

PERFORMANCE METRICS

Statistics that summarize different aspects of the results of MSE to illuminate how well an MP achieves some or all of the management objectives.



A BRIEF NOTE ON MSE

MSE offers an opportunity to improve decision-making, despite uncertainty, by testing the merits of management procedures (MPs) and examining the costs and benefits of improved data collection.

WHY CONDUCT MSE?

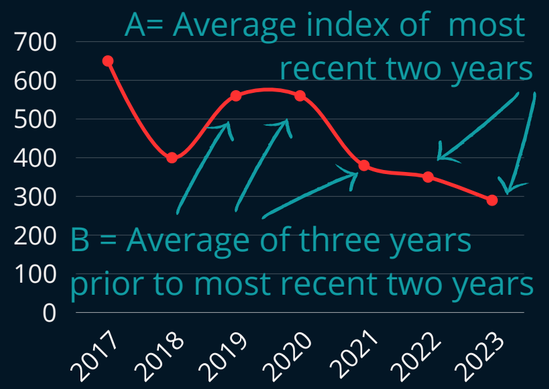
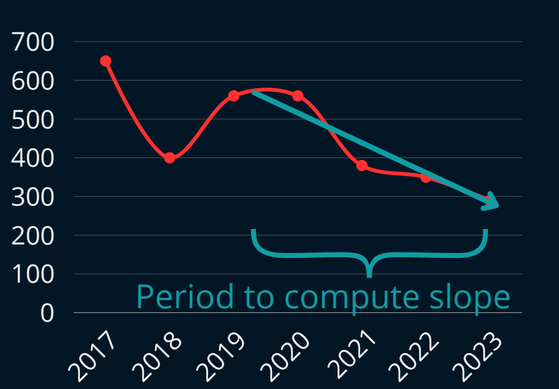
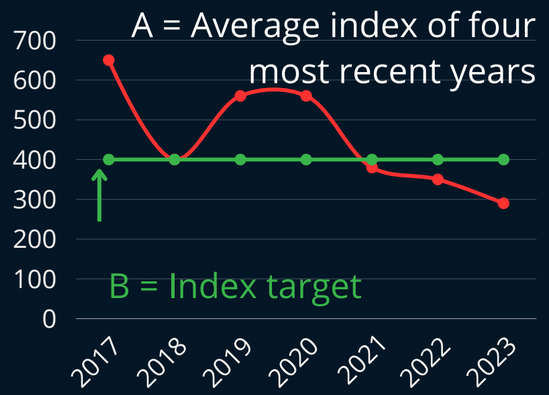
- Evaluate MPs relative to management objectives
- Identify MPs that are robust to uncertainty
- Trade-offs between MPs of different complexity
- Evaluate cost and benefits of data collection
- Promotes collaboration between parties
- Test MPs prior to real-world implementation

REX SOLE

Glyptocephalus zachirus | *Location: West Coast Vancouver Island groundfish management area*

Decision Rule Visualization

Biomass index

Maintain stable biomass	Maintain stable biomass	Achieve target biomass
MP: Index ratio	**MP:** Index slope	**MP:** Index target
		
a: Index ratio (A/B)	**sl**: Index slope	**Itar**: Index ratio (A/B)
This year's catch advice = Previous catch advice x a	**This year's catch advice = Previous catch advice x (1+c x sl)**	**This year's catch advice = Previous catch advice x Itar**

Tested using MSE

Catch advice calculation

c: is a control parameter (0-1) that adjusts how quickly this year catch is adjusted based on sl

Viable pathways towards black grouper MPs

Part 5

VIABLE PATHWAYS TOWARDS BLACK GROUPER MPS

- Current data limitations make traditional stock assessment challenging for the black grouper fishery.

- There is an opportunity to construct a pathway to overcome these current limitations by exploring and designing MPs and testing them using Management Strategy Evaluation (MSE).

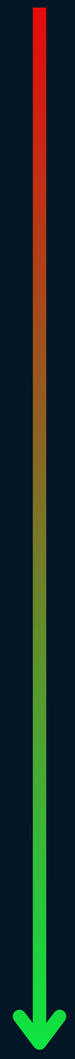
VIABLE PATHWAYS TOWARDS BLACK GROUPER MPS

Where Are We Now? (Status Quo)

What Can We Achieve With Current Data?

What Can We Achieve With Improved Catch and Indices Reliability?

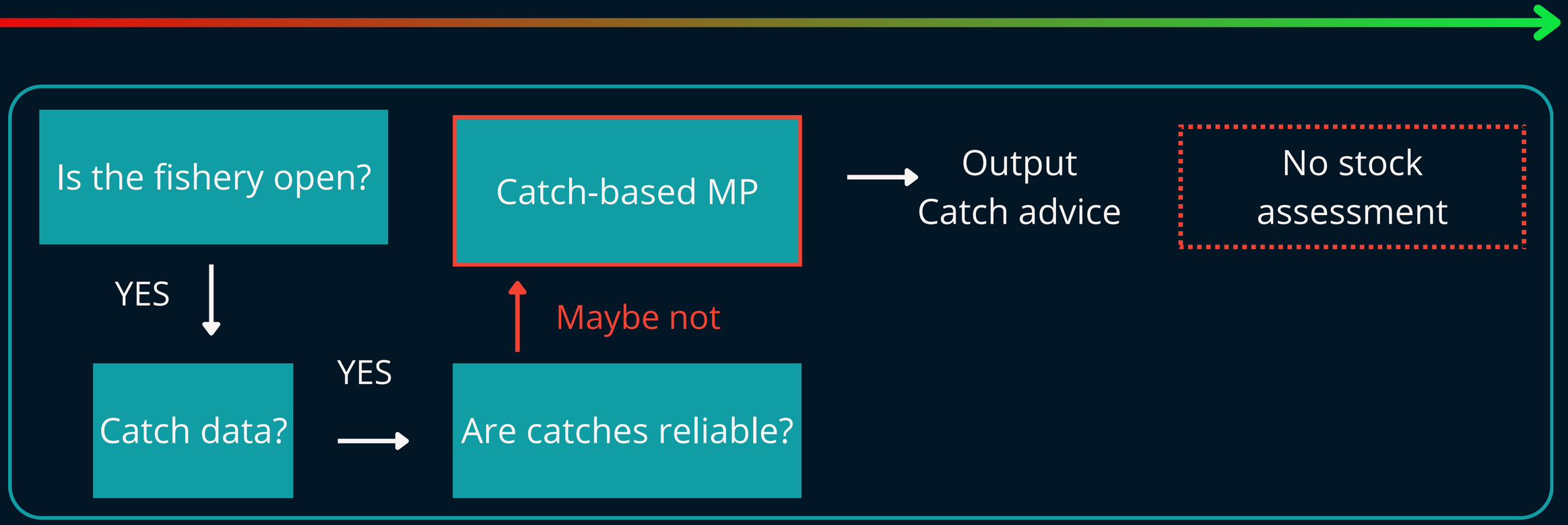
How Do We Design and Prioritize a Pathway Forward?



- Stepwise approach with four stages.
- Progresses from limited data to improved data.
- Emphasizes indicators that could be used to transition away from status quo catch-only methods.

VIABLE PATHWAYS TOWARDS BLACK GROUPER MPS

Where Are We Now? (Status Quo)



VIABLE PATHWAYS TOWARDS BLACK GROUPER MPS

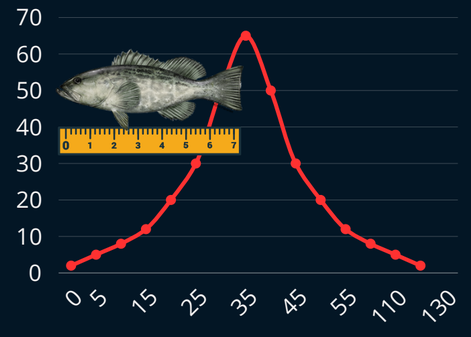
What Can We Achieve With Current Data?

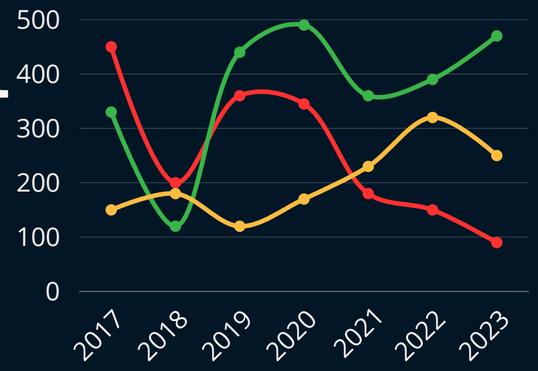
Length data

Index (SRHS)

Index (MRIP)

Index (RVC)

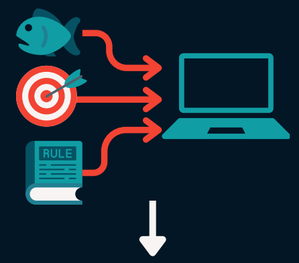




Indicator or multi-indicator management procedures

MP options:

1) Indicator or multi-indicator
2) Model-based MPs unlikely



Output
Catch advice

VIABLE PATHWAYS TOWARDS BLACK GROUPER MPS

What Can We Achieve With Improved Catch and Indices Reliability?

Indices

+

Catch data

Indicator or multi-indicator management procedures

MP options:

1) Indicator or multi-indicator adjusted catch MP
2) Model-based MP, including stock assessment

Model-based MPs included

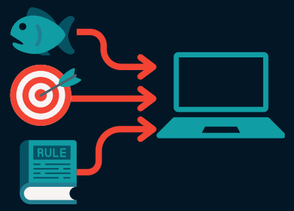
Output
Catch advice

VIABLE PATHWAYS TOWARDS BLACK GROUPER MPS

How Do We Design and Prioritize a Pathway Forward?

Improve data collection and reliability	→	Composition data Catch data Indices
Design and testing of MPs	→	Robustness of MPs Complexity of MPs
Assess the Value of Information (VOI)	→	Cost/benefit of new data Data prioritization Benefits of improving data

Simulation-tested MPs
(MSE approach)



Output
Catch advice

VIABLE PATHWAYS TOWARDS BLACK GROUPER MPS

Where Are We Now? (Status Quo)

Relies on previous catch advice and expert judgment.
Precautionary catch limits, size limits, and gear restrictions.

What Can We Achieve With Current Data?

Data-limited but potentially more robust than status quo.
Promotes enhancing MPs by better utilizing available data.

What Can We Achieve With Improved Catch and Indices Reliability?

Improved data reliability supports more sophisticated approaches.
Could evaluate demographic models and stock assessment.

How Do We Design and Prioritize a Pathway Forward?

Design and tests MPs prior to implementation.
Evaluate robustness of MPs under different scenarios.
Value of information (VoI).

Next steps

NEXT STEPS

- **Communicate this MP framework and process?**
  - Share-out of this discussion and related materials.
  - Not all MPs will achieve same outcomes, need stakeholder input

- **Construct a preferred pathway to design of MP options?**
  - Stages we discussed akin to entry points to MP design.
  - How do we prioritize and scope next step(s)?

- **Conduct testing of MPs using MSE?**
  - Begin with translating life history, fishery characteristics, and monitoring programs into a suitable simulation (e.g., operating model(s)).
  - Key uncertainties as alternative model configurations
  - Value of information