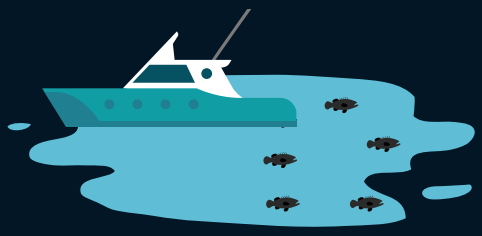
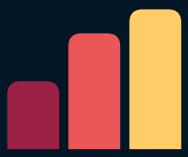
DESIGN OF ALTERNATIVE MANAGEMENT PROCEDURES FOR BLACK GROUPER FISHERIES



MONITORING DATA



INDICATORS OF STOCK STATUS

HARVEST CONTROL RULE

ADJUSTMENT OF MANAGEMENT MEASURE

NATURE ANALYTICS

Report prepared for: State of Florida Florida Fish and Wildlife Conservation Commission

MANAGEMENT PROCEDURE (MP)

MP DESIGN EXISTS 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

EXAMPLE MANAGEMENT PROCEDURES FROM OTHER FISHERIES

Summaries are provided for four 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)

- Managed by the New England Fishery Management Council (NEFMC), the skate complex is data-limited with high uncertainty in catches and discards, which precludes formal stock assessment.
- Because stock assessment is lacking, MSY, OFL and OY are not calculated. Instead, overfished status and overfishing status are determined using proxies derived from a biomass index.
- An empirical control rule is used to adjust catch advice. This approach produces Acceptable Biological Catch (ABC) and is considered an interim policy until OFL can be estimated.

Decision Rule Visualization

Biomass index

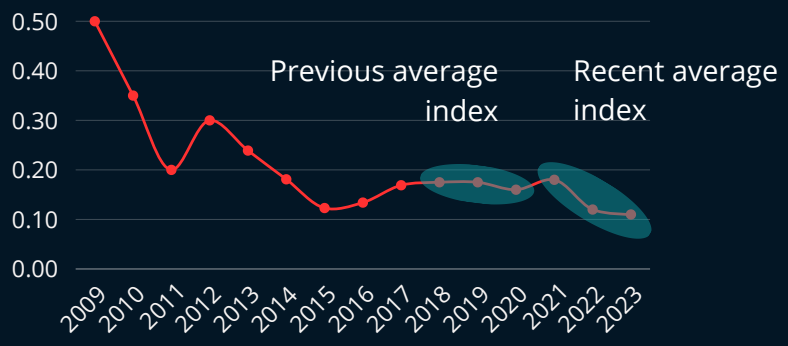
↓ 🎯

Overfished status determination

If the recent average index falls below biomass index threshold, the stock is 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



Catch advice calculation

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

ACL = ABC — *Acceptable Biological Catch (ABC); Annual Catch Limit (ACL)*

ACT = ACL x 0.9 — *Annual Catch Target (ACT)*
mitigates uncertainties related to discards and landings

This example illustrates how data-limited fisheries can be managed with an interim indicator-based management procedure until more precise benchmarks are derived from a stock assessment.

TECHNICAL DETAILS

Data-Limited Management
Data-limited stock with no quantitative stock assessment.

Uncertainties in Historical Data
Historical data is characterized by high uncertainties, particularly in recorded catches and discards.

Management Proxies
Biomass target: As a proxy for BMSY, this target is calculated as the 75th percentile of the biomass index time series from 1963 to 2007 (e.g., 4.13 kg/tow for thorny skate).
Biomass threshold: As a proxy for determining overfished status is calculated as 1/2 of the biomass target (e.g., 2.06 kg/tow for thorny skate).

Decision Rule
Status determination is based on a three-year moving average of the biomass index.

Catch Advice Process

- The ABC (= ACL) is calculated using an empirical rule, based on the median ratio of catch to biomass index, adjusted by a three-year moving average.
- An annual Catch Target (ACT) is set to 90% of the ACL to incorporate a buffer for management uncertainties.
- This basic MP employs dynamic adjustments based on a biomass index (only indicator), facilitating responsive management.

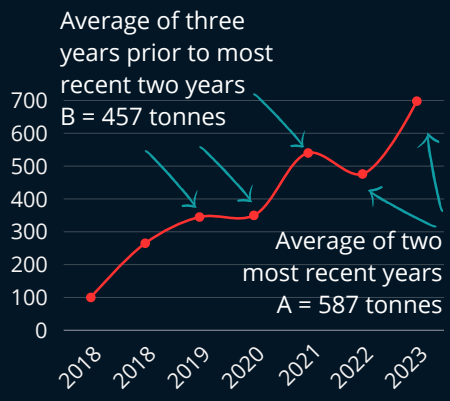
Modified from: Northeast skate complex fishery management plan. Annual Monitoring Report for Fishing Year 2021. Prepared by the New England Fishery Management Council In consultation with the National Marine Fisheries Service.
Free, C. M., Mangin, T., Wiedenmann, J., Smith, C., McVeigh, H., & Gaines, S. D. (2023). Harvest control rules used in US federal fisheries management and implications for climate resilience. Fish and Fisheries, 24(2), 248-262.

PLAICE

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

- This is a data-limited stock with insufficient information to conduct a formal stock assessment.
- There is high uncertainty in catches prior to 2004 where removals due to discards are unknown.
- Multi-indicator management procedure that provides MSY-based catch advice.

Decision Rule Visualization

Biomass index from most recent 5 years		Mean length in catches	Previous catch advice
Maintain stable biomass	Avoid low biomass	Move fishing pressure towards MSY	
	Most recent year I = 698 tonnes	Most recent year L= 29.7 cm	
	Index trigger Itrigger = 150 tonnes	Target length Ltarget=28.9 cm	
m1: A/B =1.28	**m2**: min{I/Itrigger,1} = 1	**m3**: L/ Ltarget = 1.03	110 tonnes

Catch advice calculation

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

Stability clause
Catch shall be decreased by no more than 30% relative to previous advice
Reduce interannual catch variability

Stability clause
Catch shall be increased by no more than 20% relative to previous advice
Precautionary measure

Key indicators such as fishery-independent surveys and length data from catches can provide a snapshot of stock status and trends, allowing for responsive management decisions.

TECHNICAL DETAILS

Data-Limited Management
The stock falls into ICES category 3 for data-limited stocks, lacking sufficient data for a full analytical stock assessment, but where life history and length data provide a basis for MSY-based catch advice.

Uncertainties in Historical Data
There are high uncertainties in catch data before 2004, especially with unknown discard figures. Thus, the management procedure relies only on contemporary data.

Management Proxies
Itrigger (150 tonnes): Based on 1.4 times the lowest observed historical biomass index.
Ltarget (28.9 cm): Calculated as mean catch length expected in the long-term when fishing at FMSY.

Decision Rule
Indicator-adjusted catch rule that considers previous catch advice, biomass index ratio, a length based proxy for fishing pressure, and a biomass safeguard multiplier.

ICES harvest control rule 3, method 2.1: rfb rule.
r: biomass ratio
f: fishing proxy
b: biomass safeguard

Catch Advice Process
- Previous year's catch advice used as a baseline
- Adjustments are made using recent biomass indices to assess stock trends
- A safeguard multiplier is used to ensure biomass index doesn't fall below critical levels
- Adjustments are also made using recent average length to assess fishing pressure
- A stability clause is implemented to limit drastic changes in catch levels

Source: https://ices-library.figshare.com/articles/report/Plaice_Pleuronectes_platessa_in_divisions_7_h_k_Celtic_Sea_South_southwest_of_Ireland_/19453640

SPANNER CRAB

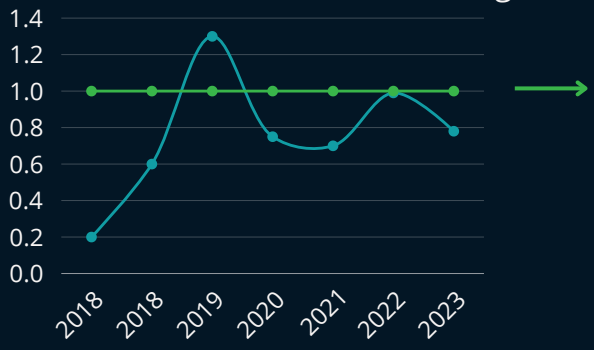
Ranina ranina | Location: Queensland, Australia

- Data-limited stock with insufficient data to conduct a stock assessment.
- A harvest control rule using two primary index-based indicators.
- This management procedure has been assessed through management strategy evaluation (MSE).

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

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

Despite data limitations, the fishery uses structured rules based on quantitative indicators to manage catch levels, aiming to rebuild the stock and minimize the risk of fishery closure.

TECHNICAL DETAILS

Data-Limited Management
There is insufficient data to assess the status of the spanner crab stock.

Uncertainties in Historical Data
Uncertainties in growth rates, age at maturity, longevity and recruitment.

Management Proxies
Limit Reference Point (LRP): 0.5 kg per dilly lift (CPUE), which represents a proxy for approximately 20% of biomass in the fishery. LRP based only on the CPUE index to provide greater decision-making certainty in a declining resource.

Target Reference Point (TRP): Pooled index standardized to a reference period that reflects strong commercial catch rates and stable survey catch rates.

Decision Rule
The allowable commercial catch is adjusted based on a pooled index from CPUE and survey data. Changes in allowable commercial catch are proportional to year-over-year index comparisons, with set upper and lower limits.

Catch Advice Process

- Increase allowable commercial catch: If the pooled index shows improvement.
- Decrease allowable commercial catch: If the pooled index declines.
- Close fishery if CPUE is critically low.
- No change in catch advice if none of the conditions for a change are met.
- Additional criteria trigger review of catch advice under certain circumstances.
- Catch advice process can be modified through regulatory and non-regulatory options to address issues related to fishery profitability, social and economic considerations.

Modified from: State of Queensland 2020. Spanner crab fishery harvest strategy: 2020–2025. Queensland Government.

REX SOLE

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

- Data-limited stock with insufficient data to perform traditional stock assessment.
- High uncertainty in historical catches prior to 1996, before the 100% at-sea observer program was implemented.
- In this example, several indicator-based MPs were proposed and tested using Management Strategy Evaluation (MSE). We summarize three of those MPs to illustrate the process of design and testing.
- Currently, DFO is in the process of recommending an MP to be implemented for several species of British Columbia groundfish. Thus, management planning is science-based with recommendations based on best available information and analyses.

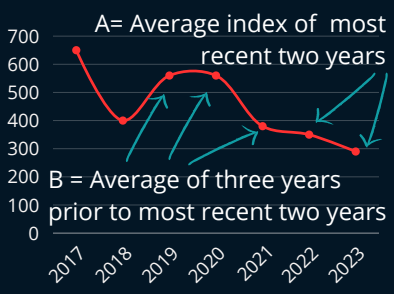
Decision Rule Visualization

Biomass index

Previous catch advice

Maintain stable biomass

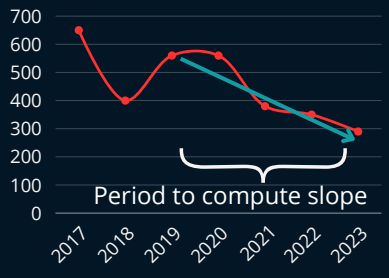
MP: Index ratio



a: Index ratio (A/B)

Maintain stable biomass

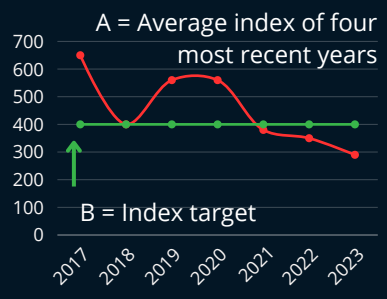
MP: Index slope



sl: Index slope

Achieve target biomass

MP: Index target



Itar: Index ratio (A/B)

Previous advice

Catch advice calculation

This year's catch advice = Previous catch advice x a

This year's catch advice = Previous catch advice x (1+c x sl)

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

This year's catch advice = Previous catch advice x Itar

These methods serve as an example where MSE can be used to address uncertainties and data limitations before implementing a management procedure in reality.

TECHNICAL DETAILS

Data-Limited Management
Several groundfish species in the British Columbia integrated groundfish fishery are managed with insufficient data to perform traditional assessment methods.

Uncertainties in Historical Data
Significant uncertainties in catch data exist before the implementation of the at-sea observer program.

Management Proxies
A Limit Reference Point (LRP) is defined to ensure sustainability, regardless of data limitations.

Decision Rule
Indicator-based MPs are used to guide management decisions:

- *Index-ratio MPs:* Recommend catches by comparing recent population indices to those from a recent period.
- *Index-slope MPs:* Recommend catch based on the trend of population indices during a recent period.
- *Index-target MPs:* Recommend catch by comparing recent indices to a historical benchmark.

Catch Advice Process

- Simulation tests and performance metrics help guide selection of the most reliable MPs for providing evidence-based catch advice, ensuring sustainable management despite data limitations.

Source: Anderson S., Forrest, R., Huynh Q., and Kepper, E. 2021. A management procedure framework for groundfish in British Columbia. Fisheries and Ocenas Canada.

WHAT IS MANAGMENT STRATEGY EVALUATION (MSE)?

MSE is a tool that scientists and managers can use to simulate the workings of a fisheries system and allow them to test whether management procedures can achieve management objectives

PERFORMANCE METRICS

OPERATING MODEL

MANAGEMENT PROCEDURE

MANAGEMENT STRATEGY EVALUATION

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.

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.

STEPS FOR MSE

1. IDENTIFY OBJECTIVES AND PERFORMANCE METRICS

2. IDENTIFY KEY UNCERTAINTIES

3. SPECIFY OPERATING MODELS

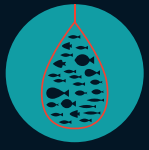
4. SELECT PARAMETERS

5. IDENTIFY CANDIDATE MANAGEMENT PROCEDURES

6. SIMULATE THE EFFECTS OF MANAGEMENT PROCEDURES ON THE FISHERY SYSTEM

7. SHARE RESULTS AND EVALUATE PERFORMANCE

8. SELECT OR REFINE MANAGEMENT PROCEDURES



9. IMPLEMENT A MANAGEMENT PROCEDURE

PATHWAYS FOR DESIGNING MPS FOR BLACK GROUPER FISHERIES

MSE offers an opportunity for the black grouper fishery to move forward in the face of uncertainty, by testing the merits of management procedures (MPs) and examining the costs and benefits of improved data collection.

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 through exploration and design of MPs.

WHY CONDUCT MSE?

Evaluate MPs relative to management objectives

Identify MPs that are robust to uncertainty

Highlight trade-offs between MPs

Understand stock responses to MPs

Illuminate cost/benefits of improved monitoring

Promotes collaboration between parties

Test MPs prior to real-world implementation

PATHWAYS FOR DESIGNING MPS FOR BLACK GROUPER FISHERIES

Where Are We Now? (Status Quo)

Is the fishery open?

YES

Catch data?

YES

Are catches reliable?

Maybe not

Catch-based MP

Output
Catch advice

No stock assessment

Need to be precautionary

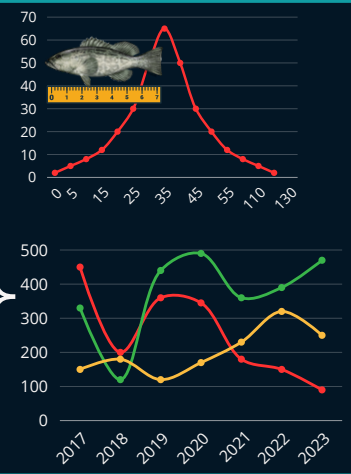
What Can We Achieve With Current Data?

Length data

Index (SRHS)

Index (MRIP)

Index (RVC)



Indicator or multi-indicator management procedures

MP options:
1) Stepwise adjustment
2) Indicator trend
3) Indicator target
4) Indicator trend + target

Model-based MPs mostly excluded

Output
Catch advice

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 based on a stock assessment

Model-based MPs included

Output
Catch advice

How Do We Design and Prioritize a Pathway Forward?

Improve data collection and reliability → Composition data, Catch data, Indices

Design and testing of MPs → Model -based MPs, Robustness of MPs, Stock assessment-based 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

Minimum size limit complement all appraoches