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An introduction to Harvest Strategies

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Abstract	
Presentation of the introduction to harvest strategies by Dr Geoff Tingley	

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An introduction to Harvest Strategies

A presentation to the SIOFA Joint MoP-SC Workshop on Harvest Strategy Pre-assessment (WS2023-HSPA)

17 March 2023

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This presentation covers:

- What is a Harvest Strategy?
- What is Management Strategy Evaluation (MSE)?
- Why bother with MSE?
- MSE – a refresher
- Performance evaluation
- Monitoring
- HCR
- Roles of scientists and managers
- Questions from the floor

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Harvest Strategy and Management Strategy Evaluation:

A Harvest Strategy is a pre-agreed framework for making fisheries management decisions. Different forums define or describe the approach slightly differently but all include the same core elements:

- A monitoring programme.
- An approach to estimate stock status (e.g. a biomass survey, a stock assessment).
- Reference points, and
- A Harvest Control Rule.

A Management Strategy Evaluation (MSE):

- Is a tool or procedure that uses simulation models to help compare the expected performance of different Harvest Strategies
- Guides the process of Harvest Strategy development.

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Purpose of MSE and Harvest Control Rules

- Highly effective approach to managing with uncertainty
    - MSE explicitly includes addressing selected, important uncertainties
- Enables pre-agreement of decisions to change catch or effort limits (up or down)
- Does not impact decisions on allocation of catching opportunity to different users (e.g. Members, gear-types)
- Cost effectiveness
    - Operate for a number of years before having to revisit them (~5 - 10 year review)
- Improved risk management (by design)
- Includes change protocols in case of unforeseen events
    - Breakout rules

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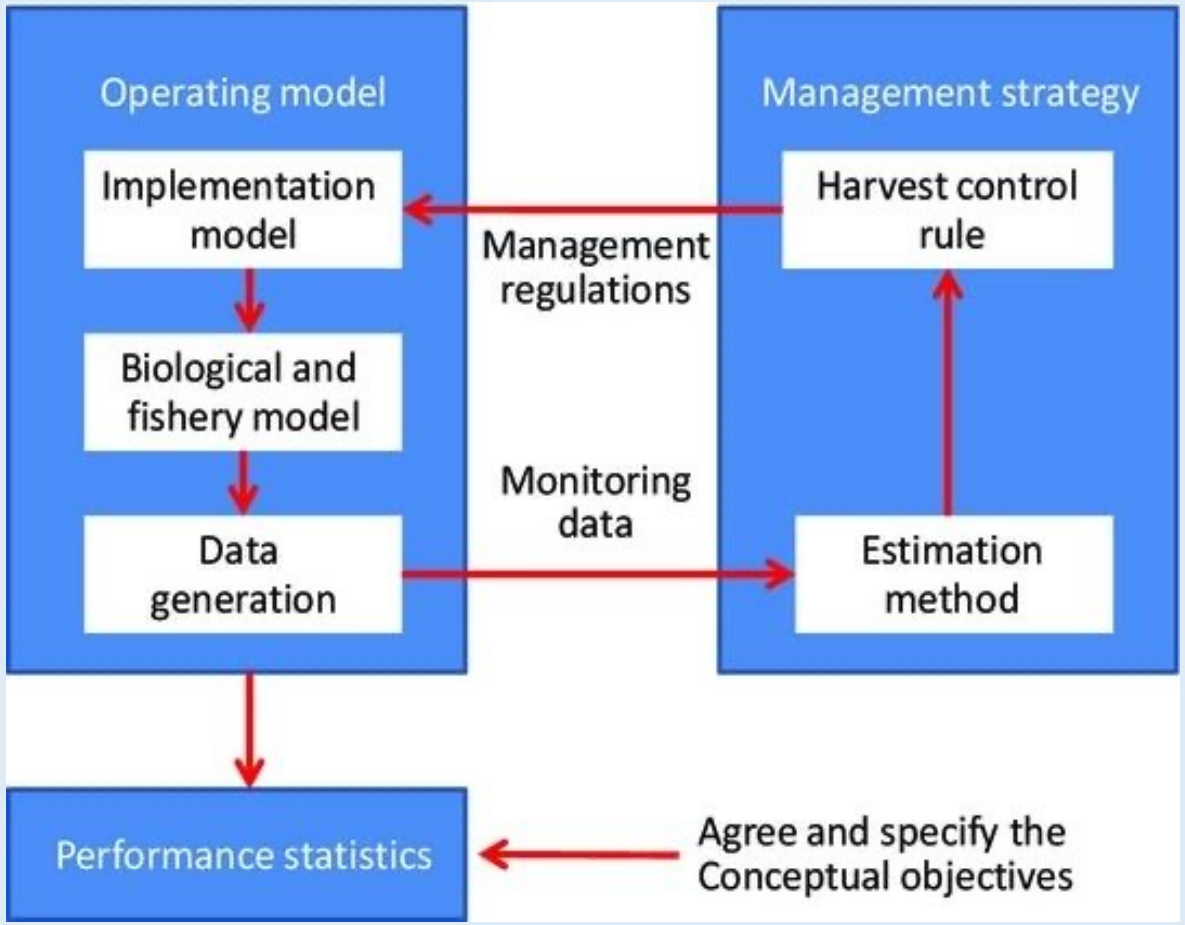
MSE Conceptual Framework



Adam Langley, with permission, after Punt et al. (2014)

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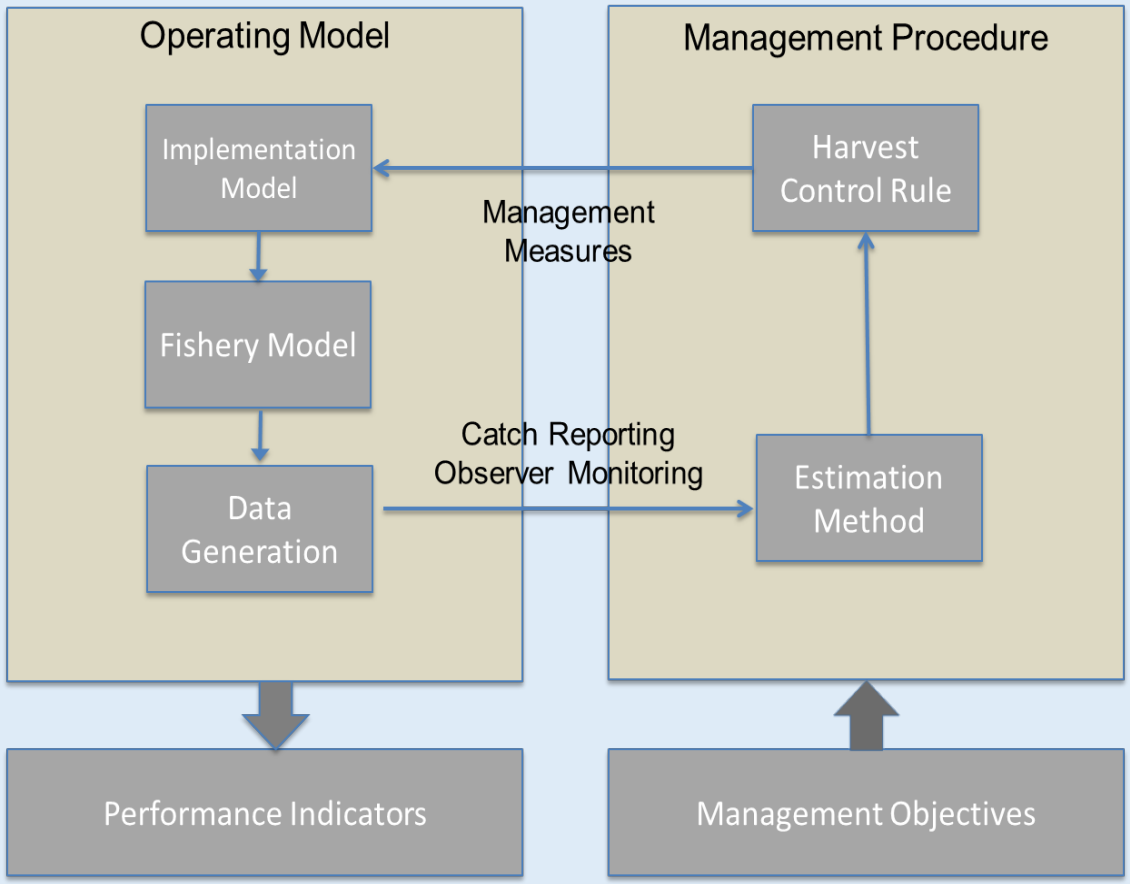
MSE Conceptual Framework



Scott et al. (2017), after Punt et al. (2014)

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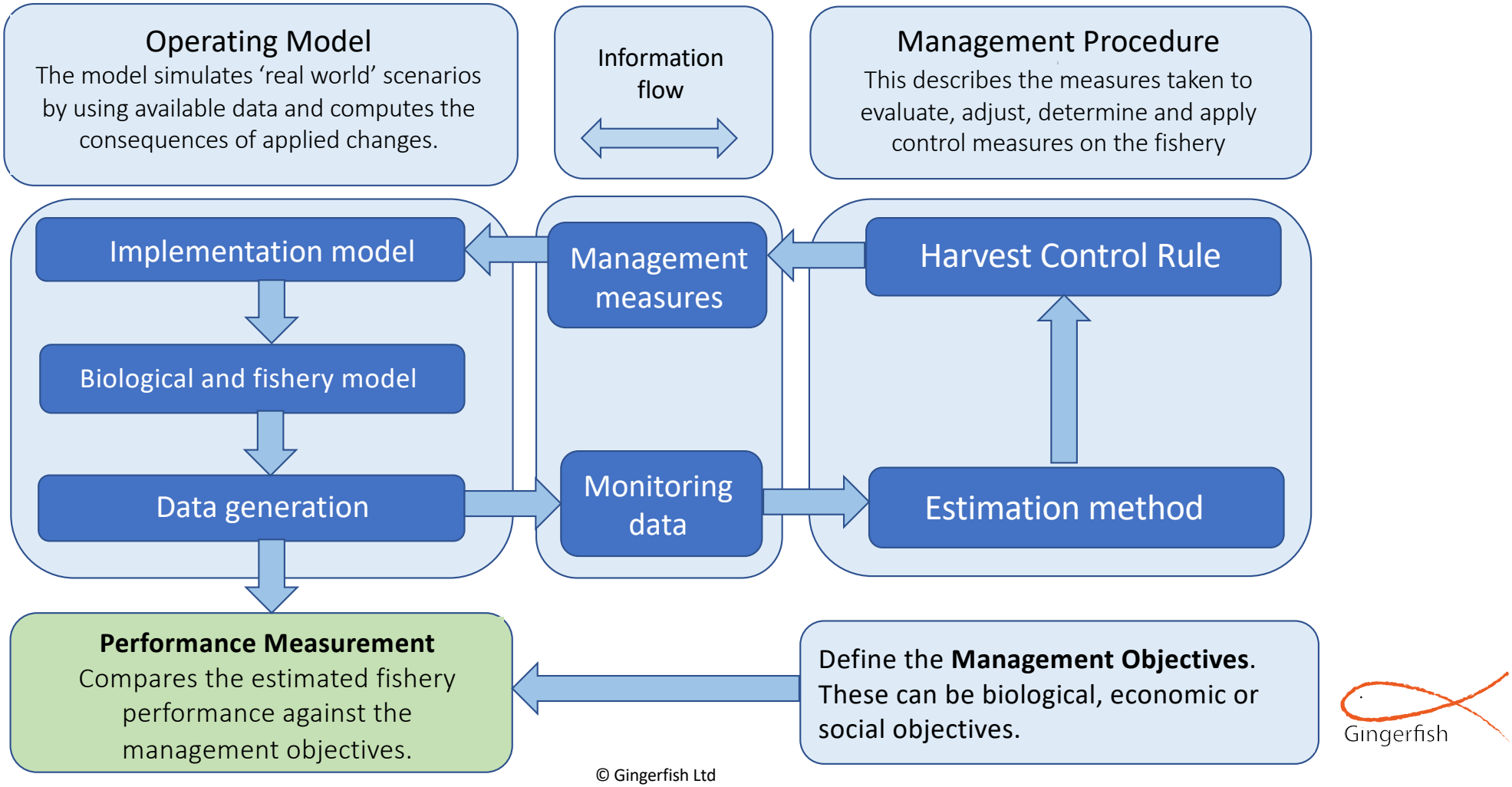
MSE Conceptual Framework



The Operating Model (OM)

- The OM simulates the real world. This becomes the reality against which the Management Procedure (MP) is tested.
- Each run of the OM is typically one model year.
- Duration of OM runs depend on the biology of the stock. Maybe 100 years for many species, but could be thousands of years for very long-lived species such as orange roughy.
- Used to explicitly test the sensitivity of the MP to uncertainty in (for example):
  - Stock structure
  - Biological parameters (e.g. natural mortality, *M; s*teepness in the stock-recruit relationship, *h*)
  - Catch misreporting (IUU, unobserved discards, conversion factor errors)
  - Bias in principle monitoring indices
- Used to evaluate the robustness of alternative MPs

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The Management Procedure (MP)

- The MP is informed by the monitoring data produced by the OM.
- The MP responds to the speed (scale) and direction of change in the monitoring data.
- The HCR then recalculates the management measure to be responsive to the state of the stock with the aim of redirecting future monitoring data to come into line with the objectives.
- The changed management measure is submitted to the OM, the OM runs, and the cycle repeats.
- For each cycle, performance data are recorded.

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The path to develop an MSE

STEP 1: Define your management objectives

Approach

- Conduct stakeholder dialogue with **ALL** interested parties (recommended best practice) or
- Conduct dialogue involving managers and fishers

Determine biological objectives

- Stock status with regard to specific biological reference points (around the TRP, above the LRP with a 95% probability)

Determine economic objectives

- Maximise total catch (TAC); frequency and size of TAC change
- Maximise economic yield
- Catch rates - minimum or average
- Fish size - minimum or average
- Fleet stability
- Wider ecosystem considerations (protected species, associated species)

Consider trade-offs between objectives

All objectives must be measurable [cost]

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The path to develop an MSE

STEP 2: Develop candidate Harvest Control Rules (HCRs)

- The HCR changes the catch level in response to a change in the monitored fisheries indices.
- The most appropriate HCR is selected following evaluation against performance criteria.
- Use the HCR to deliver and measure trade-offs between objectives.

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The path to develop an MSE

STEP 3: Determine appropriate fisheries monitoring regime

- What to monitor that will adequately inform the selected HCR (SSB from stock assessments, SSB directly from surveys, commercial CPUE, fish sizes/ages)?
- How to monitor (practicality, effectiveness, timeliness, cost)?
- How frequently to monitor (annually, or more/less frequently)?

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Iteration

- The path [to developing and implementing MSE and HCR-based fisheries management] is not straight.
- Iteration is needed.
- At key points, elements will need to be changed and the outcome revaluated before proceeding further.
- Sometimes it becomes apparent that not all objectives can be met. This requires reconsideration of the objectives through a trade-off process to reset objectives that are deliverable – e.g. maximising catch and having infrequent or only small changes in TACs are usually incompatible. There is a need to be flexible!

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Performance evaluation

A key part of MSE is the evaluation of the performance of the system against the objectives.

This is done using data generated by the OM

The OM generates performance data that can be compared against the agreed management objectives

Example:

Objective: stock to be at or above the LRP 99% of the time.
Run the MSE for 1,000 years.
Record the stock status compared to the LRP at the end of each year.
Compare the performance in terms of the % of years the stock was above the LRP against the Objective of ≥ 99%.
If the performance measure (objective) is not met, especially if by large margin, consider rejecting that part of the MP being tested (i.e. rejecting the HCR).

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Monitoring Fishery Performance

Examples:

Biomass indices (spawning stock biomass, total biomass, vulnerable biomass, recruitment index)

- Randomised bottom trawl (swept area) surveys
- Acoustic surveys of fish aggregations
- Standardised commercial CPUE timeseries
- Plankton survey (fish egg numbers, fish larval numbers)

Fish size (length, weight) or age

- Average size (age)
- Proportion below a threshold (potential recruitment indicator)
- Proportion above a threshold (potential overfishing indicator)

Frequency

Range of possible frequencies determined by (i) the biology of fish and (ii) the scale of the fishery

Practicality of using on-board observers

Cost

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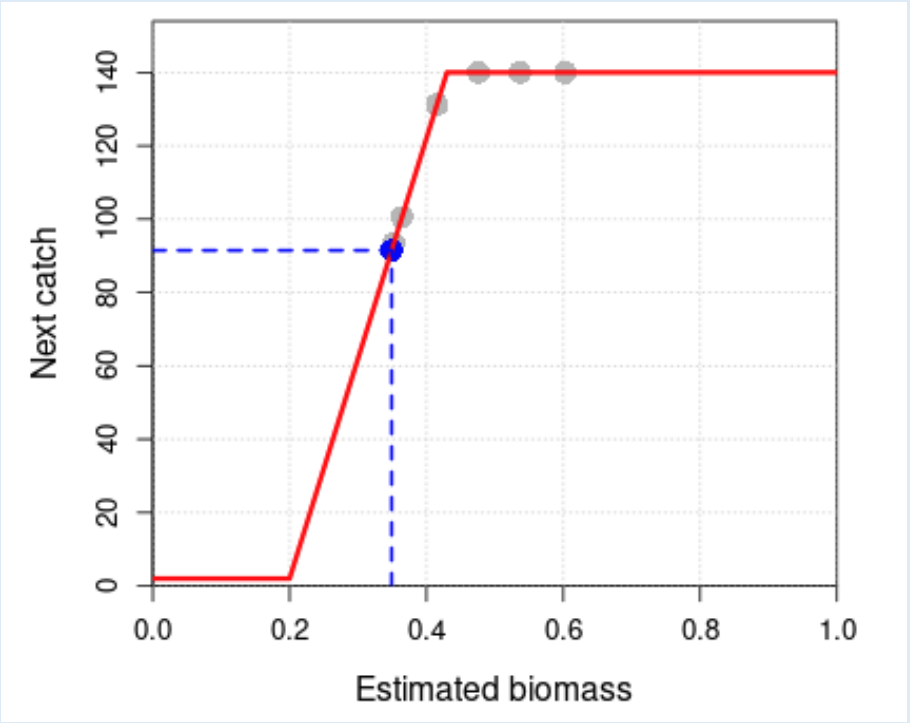
The key output: an effective HCR

- An HCR is a pre-agreed decision rule that is used to set fishing opportunity in the near future.
- An HCR is usually a rule agreed by the fishery stakeholders and managers.
- Operates using a simple feedback between changes in what is monitored (e.g. spawning stock biomass) and catch limit (e.g. TAC).

Scott (2021)

https://ofp-sam.shinyapps.io/AMPLE-intro-hcr/



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Some general advice

- Base both the OM and MP on existing software developed for broad application or that has been specifically developed to evaluate management strategies (Punt et al., (2014)).
- Some bespoke work and coding will likely be needed to be developed. Ensure that this is adequately tested.
- Develop an MSE for one stock initially, and use the knowledge and experience gained to develop a template for addressing other stocks over time.
- You do not have to reinvent the wheel. There are some fantastic resources available, much developed for other RFMOs, e.g. for Western and Central Pacific Tuna Commission (WCPFC) developed by the Pacific Community (SPC).

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The roles of managers and scientists

Managers (collectively)

- Decide on management objectives (biological and economic)
- Decide on the Harvest Strategy
- Decide biological reference points (target and limit reference points)
- Decide on the monitoring strategy
- Decide on the trade-offs they wish to make
- Decide on affordability

Scientists (through the SC)

- Advise on management objectives
- Advise on Harvest Strategies
- Advise on reference points
- Advise on implementing monitoring strategies
- Advise on costs, uncertainty, and the trade-offs between options for harvest strategies
- Run the MSEs for candidate harvest strategies

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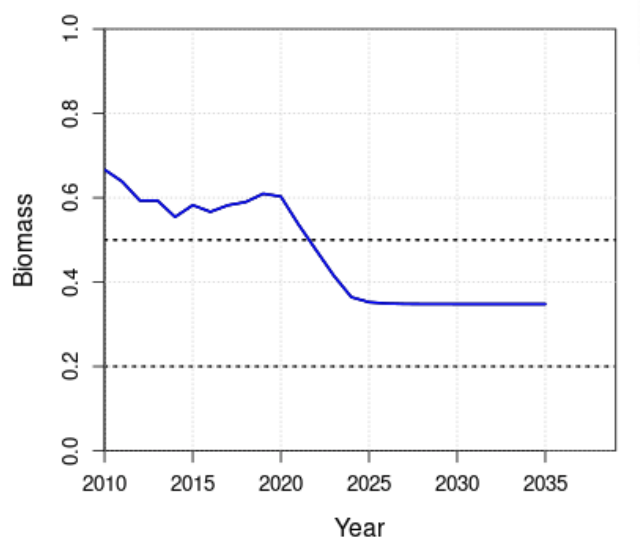
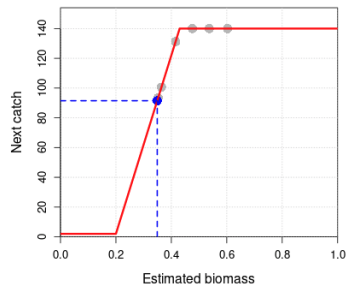
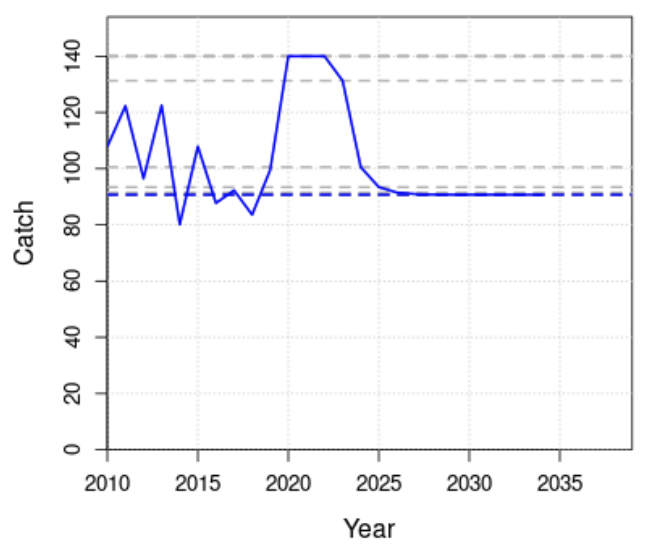
Questions?







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