



# Right-Sizing Stock Assessment

Shannon L. Cass-Calay (Director, SEFSC-SFD)

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# Request from SEDAR Steering Committee

- *The Committee agreed that there is value in considering simpler approaches and making modeling decisions based on the data availability and time requirements.*
- *The SEFSC will produce a document to provide additional information on the costs and benefits of alternative approaches.*
  - *It would be useful to produce a summary of what the data needs, and time requirements are for different classes of models, so that the information may be considered when deciding what model options are appropriate.*
  - *Information on potential management options or constraints should be included.*



# Stock Assessment Model Complexity

- Source: <https://www.fisheries.noaa.gov/national/population-assessments/fish-stock-assessment-report>
- NOAA Fisheries uses a variety of approaches to conduct stock assessments. When stock assessment scientists conduct an assessment they identify and develop appropriate methods based upon the available data.
- Those approaches fit into one of six general categories based upon their data requirements and products:
  - [Index-based](#)
  - [Data-limited](#)
  - [Aggregate biomass dynamics](#)
  - [Virtual population dynamics](#)
  - [Statistical catch-at-length](#)
  - [Statistical catch-at-age](#)



# Index Based Approaches (IB)

- **Typical Data Requirements:** One or more indices of stock size
- **Resources Required:** Minimal to execute, benefit from MSE evaluation to ensure management objectives are met with sufficient probability
- Most often used in-between comprehensive stock assessments (Interim Assessment). Uses index trends to update management advice (e.g. ABC)
- Some IB methods evaluate the current index value against a critical threshold. If the stock index falls below the threshold it triggers management actions such as a reduction in catch
- Cannot provide estimates of MSST or determine whether a stock is overfished
- Cannot evaluate the risk associated with many harvest options (e.g. size limits, allocations)
- Examples include: AIM, I-target, I-slope, Gulf Interim Assessment...



# Data Limited Models (DLMs)

- **Typical Data Requirements:** Total catch of a stock over time or a survey-based index of total stock abundance
- **Resources Required:** Minimal to execute, benefits from MSE evaluation to ensure management objectives are met with sufficient probability
- DLMs typically provide management advice in relative terms (e.g. whether harvest level should increase or decrease compared to previous years)
- Cannot provide estimates of MSST or determine whether a stock is overfished
- Cannot evaluate the risk associated with many harvest options (e.g. size limits, allocations)
- Examples include: DBSRA, DCAC, MLE...



# Aggregate Biomass Dynamics

- **Typical Data Requirements:** Total catch over time and an abundance index for the stock; perform best when the input data have high levels of contrast, with periods of high and low abundance and catch
- **Resources Required:** Minimal to execute
- These represent the simplest stock assessment method able to provide the full suite of management advice
- Can provide estimates of stock status relative to management references, current stock size, harvest rates, etc.
- Cannot evaluate the risk associated with some harvest options (e.g. size limits, allocations)
- Examples include: ASPIC, BSP, JABBA



# Virtual Population Analysis

- **Typical Data Requirements:** Data-intensive. For each age class, VPAs require information on catch, body weights, and the assumed mortality rate due to natural causes. They also require at least one index of stock size.
- **Resources Required:** Moderate
- Can provide the full suite of management advice for a stock
- Can provide forecasts of catch and biomass that managers can use to evaluate the risk associated with a range of harvest options (e.g. size limits, allocations)
- Examples Include: ADAPT, VPA-2BOX





# Statistical Catch-at-Length

- **Typical Data Requirements:** Data-intensive. Require information on the number of fish caught at each size during annual surveys and by all relevant fisheries
- **Resources Required:** High
- Two notable weaknesses.
  - Less informative on stock growth rates than methods that incorporate age
  - Less precise regarding reproduction, growth, and death rates for animals approaching their maximum size
- Can provide the full suite of management advice
- Can provide forecasts of catch and biomass that managers can use to evaluate the risk associated with a range of harvest options (e.g. size limits, allocations)
- Examples include: SCALE, SS, MultifanCL...





# Statistical Catch-at-Age

- **Typical Data Requirements:** Data-intensive. Require at least one index of stock size, and records of the total catch from each fishery targeting a stock over time. Despite those requirements, catch-at-age models tolerate situations where some of those data are missing or incomplete
- **Resources Required:** High
- Can provide the full suite of management advice
- Can provide forecasts of catch and biomass that managers can use to evaluate the risk associated with a range of harvest options (e.g. size limits, allocations)
- Examples include: SS, ASAP, BAM, CASAL...



# Management strategy evaluation

- Management procedures, simulation tested through Management Strategy Evaluation provide an additional option in the toolbox, often integral to the above-mentioned applications.
- Management Procedures: A pre-agreed framework for setting catch limits, designed to achieve specific management objectives. Essentially the 'recipe' for setting and implementing the ACL
- Can be model-based (similar to a stock assessment) or empirical (index-based)
- Simulation tested to be robust to key uncertainties: non-stationarity, data limitations, climate change, biological assumptions- often provide a path forward for provision of advice when
- Can explicitly consider multiple competing management objectives such as social, economic or ecosystem considerations.

**May provide 'simpler' but not necessarily any less robust options to traditional stock assessments**

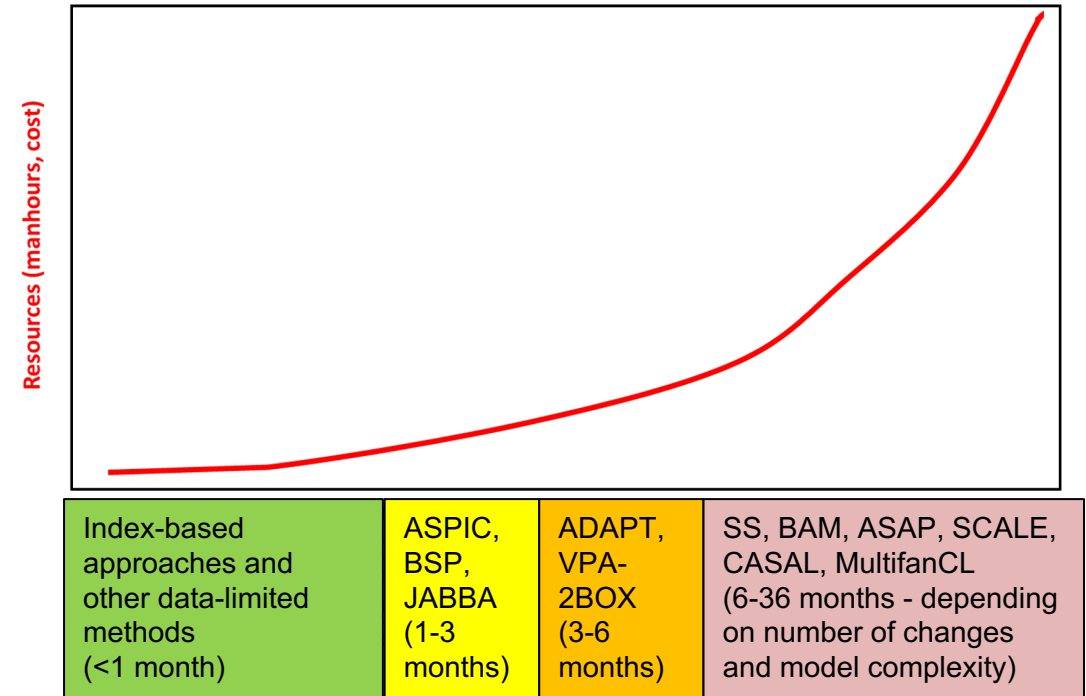
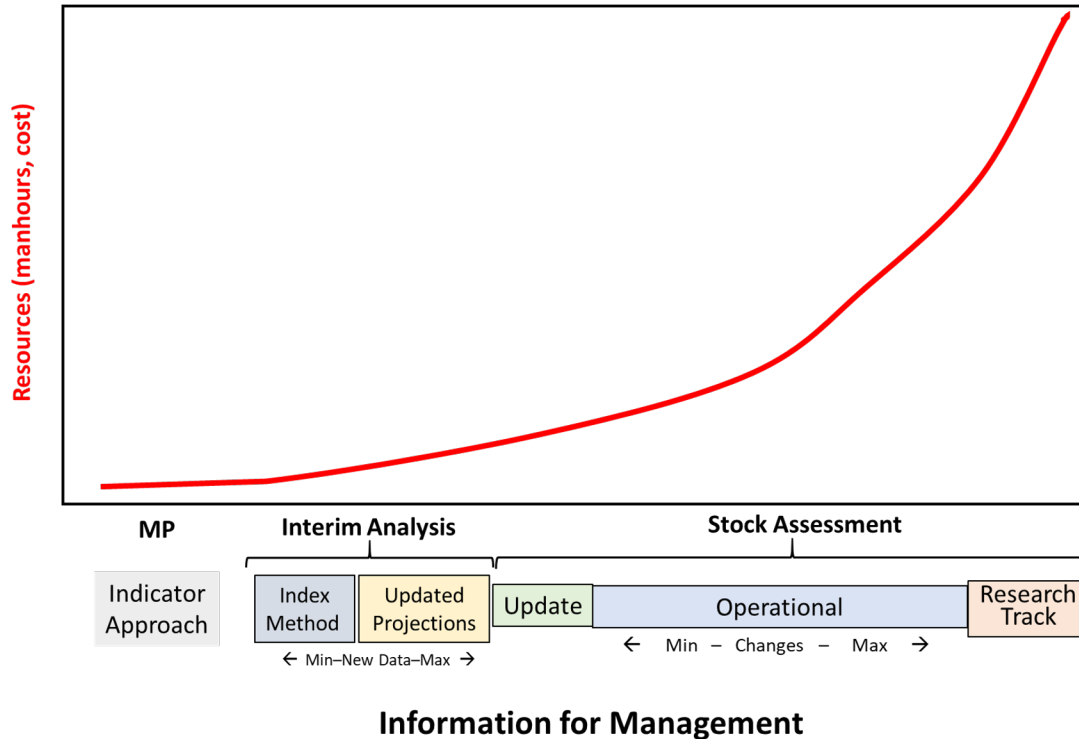
# Within management strategy evaluation there is a continuum of complexity



Full stakeholder MSE	Intermediate MSE	Desk MSE	Not MSE
<ul style="list-style-type: none"><li>• Full iterative stakeholder involvement</li><li>• MSE intended to result in management action</li><li>• Where management objectives are not fully developed</li><li>• Expensive and time consuming</li></ul>	<ul style="list-style-type: none"><li>• Spectrum between full stakeholder MSE and desk MSE</li><li>• Moderate resource requirements</li></ul>	<ul style="list-style-type: none"><li>• No stakeholder input</li><li>• General research questions</li><li>• management objectives are known</li><li>• Can be used to test Interim approaches</li></ul>	<ul style="list-style-type: none"><li>• Simulation exercises where the full feedback-loop characterizing the MSE is not necessary</li><li>• Consider other less resource-intensive approaches</li><li>• Risk analyses</li></ul>

Walter, Peterson, Marshall, Deroba, Gaichas, Williams, Stohs, Tommasi, Ahrens 2023. When to conduct management strategy evaluation. *ICES Journal of Marine Science*, fsad031, <https://doi.org/10.1093/icesjms/fsad031>

# There exists a spectrum of approaches: Both of these illustrations represent reality



\*\*\* Initially, index-based approaches and DLMs benefit from an MSE to ensure management objectives are met with sufficient probability \*\*\*



# Other key considerations for which tool apply

Unaccounted for management objectives: optimum yield- social, economic and ecosystem factors, recreational opportunity

non-stationarity: climate change, shifting distributions may challenge the stationarity assumptions of many models

life history and episodic factors- not all species fit the 'stock-assessment + projection' framework due to short-lived population dynamics or rapid changes.



# Conclusions: Choosing the appropriate tool

- NOAA Fisheries uses a variety of methods to conduct stock assessments and/or provide management advice
- Stock assessment scientists should identify and develop appropriate models based upon available data and resources
- ***To inform that decision, the Center recommends that Councils provide a prioritized list of species, desired improvements and/or research needs, and a preferred management approaches***
- ***The Center would initially propose an appropriate methodology and work with Council Staff to develop TORs and project schedules***