ACL Science Workshop: Quantifying Uncertainty in Forecasts

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Outline

• Role of uncertainty and forecasting in setting ACLs
  • Uncertainty
  • Forecasting
  • Uncertainty and Forecasting Improvements
  • Communicating the Science
  • Benefits of Improvements
Role of Uncertainty and Forecasting in determining ACL’s

OFL should not account for precaution, but does have uncertainty
— should correspond to long-term MSY

↑Uncertainty leads to ↑Precaution leads to ↑Buffer and ↓ACL/ACT
— Tolerance for risk is an important part of this

ABC accounts for scientific uncertainty in estimating the true OFL
ABC = OFL would imply no scientific uncertainty
ACT = ACL, or no ACT, would imply perfect control of catch
“OFL should not account for precaution”—What does this mean?

- In the context of assessments for which sufficient data exist to support statistical estimation, specification of OFL is based on a point estimate, which in turn is based on three choices:
  1. Choice of model
  2. Choice of data
  3. Choice of estimator

- The process of making each of these choices may involve many factors, some or all of which may have implications for the resulting point estimate of OFL.

- However, the likely impact on the resulting point estimate of OFL should not be included among these factors.

  - E.g., do not choose a model because of the resulting OFL estimate.

- The above choices, along with the final estimate of OFL, should be subject to an open and transparent scientific review process.
Some Major Sources of Uncertainty For Stock Assessment and Management Advice Processes

Determination of ABC

• Model Uncertainty/ Structural Complexity
• Estimation Error
• Sampling/ Observation Error
• Random Natural Variability/ Process Error

Determination of ACL/ ACT

• Implementation Uncertainty
• Inadequate Communication

“To know one’s ignorance is the best part of knowledge”
~ Lao Tzu, Tao-te Ching, no. 71
Stock Assessment and Management Strategy Evaluation Process

- Catch Data
- Abundance Indices
- Biological Data

- Population Model
- Forecast
- Stock Status

- Mgt. Strategy Evaluation
- AM/ABC/ACL/ACT

- Advanced Model
  - Habitat
  - Climate
  - Ecosystem

Socioeconomics
Uncertainty – current practices

Ex: SA red grouper
Uncertainty – current practices

Ex: Eastern Georges Bank Cod

- Probability $F_{2010}$ greater than $F_{ref} = 0.18$
- Probability $B_{2011}$ at age 4+ will not increase

Graphs showing probability distributions with different split M values for 2010 yield (000s mt).
ACLs and Uncertainty – current practices

- **P* analysis** is one way to formalize this, but it only focuses on a single metric, probability of overfishing
  - management may desire other metrics (e.g. bycatch, economic yield, ecosystem measures, etc.)

- Flat rates (e.g. ACL = 75% Fmsy)
  - implies a variable risk tolerance

- Use of decision theory, where ACL is set at a value that minimizes risk (= expected loss) under some positive level of risk aversion
Forecasting

Forecasts are processes by which hypothetical control rules are translated into practical regulations.

Considerations:
- Current state of the resource
- Desired goal or state of the resource
- Time frame
- Feasible control measures
- Model of resource dynamics
Forecasting – current practices

Common models/methods currently in use

• Stochastic short term and long term projections using a constant/variable fishing mortality rate or landings
  – Model stochasticity and complexity may be too limited

• Incorporating management feedback, implementation uncertainty
  – Need for increased communications to prevent management and models from diverging

• Technical interactions
  – Caps on aggregate TACs (ACTs) across species
  – Fishery closures due to incidental catch caps
  – Fishery closures due to incidental catches of another species

• Ecosystem dynamics
Forecasting

P* analysis

**Landings**

- **Fishing mortality rate**

- **P**

- **SSB**
Forecasting

• Setting catch levels for multiple years requires a projection model, because of feedback among catch levels and the stock.
• Second year and beyond ABCs should not be set without explicit consideration of ACTs.
Uncertainty and Forecasting Improvements

• Improved Data Collection (both timeliness and types)
  – Increase sample sizes of input data
  – New data sources
  – New surveys (e.g. fishery independent monitoring, recreational surveys)
  – More timely data could improve forecasting

• Improved Monitoring of the Fishery System
  – Realize unaccounted uncertainty
  – Better understanding of what works and what doesn’t
Uncertainty and Forecasting Improvements

Modeling Improvements

• Use model ensembles

• Improved predictive accuracy from more realistic models

• Improved use of environmental linkages

• Improved use of socio-economic linkages (e.g. fleet behavior)

• Improved accounting for interactions with other fisheries in the multi-species complex (e.g. bycatch quotas for other species)

• Improved treatment of uncertainty in parameter values
Incorporating Environmental Signals into Recruitment and Catch Forecasts
• Move beyond just probabilities
  • More explicit about consequences
  • Trade-offs

• Understanding the limits to reducing uncertainty

• Communicating uncertainty
Communicating the Science

- Time series plots with confidence intervals
- Probability density curves of current estimates
- Risk plots
- Multiple Models
- Multivariate benefit streams
Ex: Multivariate Benefit Streams for Forecasts - Hawaii Bottomfish

Status: Probability of Overfishing

Yield: Average Catch & Variability

Supply: Exploitable Biomass & Variability

Efficiency: Average CPUE & Variability
Communicating

- Our goal is to provide managers with a clear and complete description of all the “important” uncertainties and trade-offs involved in setting an ACL/ACT.

- “Important” is a relative term. Each region will have its own list of uncertainties and trade-offs to consider.

- This will require scientists, economists, and managers to communicate with each other in order to avoid miscommunications or decisions based on incomplete information.
Benefits of Improvements

• “Bang for the buck” analysis of data collection systems
  - Targeted data collection to reduce uncertainty which could lead to increased ACLs.

• Further monitoring of fishery system will help to reveal more effective management measures.

• Non-quantified sources of uncertainty may eventually be quantified, through long term monitoring.

• Better communications between managers and scientists will increase efficiency and timeliness.
Questions?