Viewing Fisheries from a Decision-Analytic Perspective

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Goals for Talk

- Think about fisheries management as a decision problem (where future is uncertain)

- Consider variability and uncertainty as important areas for decision making

- Setup (later) example of quantifying changing variability in fish catches
Framing the Problem

“Many wildlife management decisions are difficult because the objectives are contentious, the possible management actions are limited, and the response of the resource is uncertain…”

Lyons et al. 2008

“We do not really know how many fish remain in the world’s oceans, lakes, and rivers today, nor do we know exactly how many fish we remove from them every year, nor the condition of their habitats.”

Kura et al. 2004
Potential Population Responses

- Changing distribution or phenology
  - Range contraction / expansion
  - Timing of important events & interactions (hatch dates, migration, match–mismatch of predator and prey)

- Demographic processes
  - Growth, mortality, recruitment

- Evolutionary processes
  - Natural selection, introgression

Lynch et al. 2016
Potential Needs

- Expanding taxonomic focus
  — Tend to study economically important species

- Confronting models (i.e., hypotheses) with data
  — Monitoring programs, analytical approaches

- Resilient ecological & management systems
  — Broader collaborations & coalition of stakeholders

- Decision support
  — Useful information
  — Approaches for changing systems

Also see Lynch et al. 2016, Paukert et al. 2016
Changing Conditions

Oneida Lake, NY

Summertime Water Temperature

Days of Complete Ice Cover

Jackson et al. 2017 CBFS Report
Figure 4. Comparison of abundance of adult Yellow Perch (age-3 and older) and adult Walleye (age-4 and older) given as the corrected gill net catch (equation (1) for Yellow Perch and corrected for catchability following Irwin et al. (2008) for Walleye), and as mark-recapture estimates. Bars are 95% confidence limits for the mark-recapture estimates.

Rudstam et al. 2016
Changing Conditions

Figure 5. Smallmouth Bass Micropterus dolomieu are finding that Ontario’s inland lakes more habitable with climate change. Photo credit: Gretchen J. A. Hansen, Minnesota Department of Natural Resources.

Lynch et al. 2016

Jackson et al. 2017 CBFS Report
Trend Uncertainty
(no additional variability)

0.02 year\(^{-1}\) increase

0.04 year\(^{-1}\) increase

Performance metric

Years into the future

Years into the future
Small Additive Deviation
(time-invariant variability)

0.02 year\(^{-1}\) increase

0.04 year\(^{-1}\) increase

Performance metric

Years into the future
Small Additive Deviation
(increasing variability)

0.02 year\(^{-1}\) increase

0.04 year\(^{-1}\) increase

Performance metric

Years into the future
Small Multiplicative Deviation

Years into the future

0.02 year\(^{-1}\) increase

0.04 year\(^{-1}\) increase

Performance metric

Years into the future
Summary Thoughts

Informing Decisions

- What do we hope to achieve?
  - Specify objectives

- What can we do about it?
  - Identify implementable options

- What are the likely consequences?
  - Make predictions (use models)

- What are the justifiable losses & gains?
  - Assess tradeoffs

- What are the risks?
  - Evaluate uncertainties

- What has been learned?
  - Update information

Our uncertainty should affect our decisions…

Irwin & Conroy 2013