Adaptive Management at PWRC: Past, Present and Future

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USGS

Common 2-Step Approach to Management/Conservation

- (1) Scientist collects information or conducts science and provides results to managers
- (2) Manager uses these results to make wise management decisions
- Interaction between scientist and manager largely restricted to this transfer of results

Common 2-Step Approach to Management/Conservation

- Inefficiency is likely
- Intellectual displacement behavior is common
  - Instead of identifying critical information needs, claim that “more information is needed” or “establish a monitoring program”
- Worst case (most cynical):
  - “Collect more information” becomes a political delaying tactic
- Approach fuels public perception of science as a never-ending story with little practical utility

Integrated Approach to Management/Conservation

- Scientist and manager work together in the decision-making process (may involve optimization methods)
- Information collection is focused on precisely the information most useful to management decisions
- Science focuses on hypotheses about how the managed system responds to potential management actions
- Approach has support and agreement from high levels of USGS, FWS and DOI management

Most of Us Lack Training in Decision Processes, Optimal Control

- Surprising because:
  - Management/conservation necessarily involves decisions and subsequent actions
  - Life is a sequential decision process

> "All we have to decide is what to do with the time that is given to us."- *Gandalf to Frodo, in the Mines of Moria* (Tolkien 1954)

On Decisions and Uncertainty

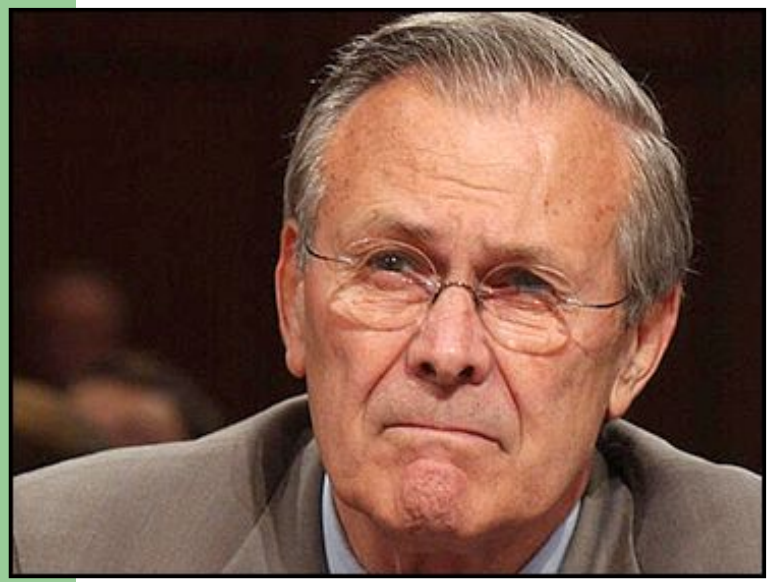
- Decisions are made difficult by uncertainty
- Uncertainty is pervasive and must be accommodated in informed decision processes

"The future's uncertain (and the end is always near)."

Roadhouse Blues (J. Morrison 1970)

What is uncertainty?

"…as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns -- the ones we don't know we don't know…"



Sources of Uncertainty in Natural Resource Management

- Ecological (Structural) Uncertainty
  - nature of system dynamics is not completely known
  - competing ideas about system response to management actions
- Environmental Variation
- Partial Controllability
  - management decision is applied to system indirectly
  - immediate effects of management actions are characterized by uncertainty
- Partial Observability
  - the state of nature is rarely seen perfectly (estimation)

Elements of an Informed Decision Process

- Objective(s): what do you want to achieve
- Management alternatives: stuff you can do
- Model(s) of system response to management actions (for prediction)
- Measures of model credibility
- Monitoring program to estimate system state and other relevant variables

Adaptive Management: Process

- Use dynamic optimization to select management action based on:
  - (1) objectives
  - (2) available actions
  - (3) estimated state of system
  - (4) models and their measures of credibility
- Selected action drives system to new state, identified via monitoring program
- Compare estimated and predicted system state to update measures of model credibility
- Return to first step

Quantitative Methods Used in Adaptive Resource Management

- Modeling (system dynamics, for prediction)
- Estimation (state variables and dynamic rate parameters)
- Optimization (conditional on model(s) and estimated system state)

Methods Development at PWRC: Dynamic Modeling

- Late 1960s-early 1970's: Anderson, Burnham, Pospahala
- Late 1970s-1980s: Conroy, Hines, Nichols, Noon, Williams
- 1990s-present: Boomer, Hatfield, Hunter, Johnson, Kendall, Moore, Runge, Sauer, most folks in PWRC quantitative group and FWS group

Methods Development at PWRC: Estimation

- Late 1960s-early 1970's: Anderson, Burnham
- Late 1970s-1980s: Conroy, Geissler, Hensler, Hines, Krementz, Nichols, Stokes, Williams
- 1990s-present: Bailey, Barker, Boomer, Boulinier, Cam, Garrettson, Geissler, Hatfield, Hestbeck, Hines, Kendall, Link, MacKenzie, Moore, Nichols, Otto, Pradel, Royle, Runge, Sauer, Wilkins, most folks in quantitative group and FWS group

Methods Development at PWRC: Optimization and Optimal Control

- Late 1960s-early 1970's: Anderson
- Late 1970s-1980s: Williams
- 1990s-present: Hunter, Johnson, Kendall, Moore, Runge

Adaptive Management at PWRC

- Advocacy:
  - Late 1960s-early 1970's: Anderson
  - Late 1970s-1980s: Conroy, Nichols, Williams
- Implementation:
  - 1990s-present: Boomer, Johnson, Kendall, Koneff, Moore, Nichols, Runge

Adaptive Management at PWRC, 2006: Endangered Species

- Adaptive management of warm-water sites used by manatees
  - Runge, Converse
- Establishment of a non-migratory flock of whooping cranes in Florida through adaptive releases of birds
  - Moore, Runge, Hatfield, Link
- Adaptive Management of Bull Trout in the Lemni Basin, Idaho
  - Jim Peterson (GA Coop), Kendall, Runge, et al.
- Adaptive Management of Mead's Milkweed
  - Moore, Runge, et al.
- Adaptive Habitat Management for Florida Scrub-jays at Merritt Island NWR
  - Johnson, Nichols, Runge, et al.

Adaptive Management at PWRC, 2006: Continental Waterfowl Management

- Adaptive harvest management for N.A. waterfowl
  - Runge, Boomer, Kendall
- Adaptive harvest management of northern pintails
  - Runge, Boomer
- Joint Task Group: integrating adaptive harvest management and the North American Waterfowl Management Plan
  - Runge, Koneff, et al.

Adaptive Management at PWRC, 2006: FWS Refuges

- Shorebird use of impounded wetlands within USFWS Region 5
  - Kendall, Runge
- Grassland bird breeding use of managed grasslands on NWRs within USFWS Region 5
  - Runge, Kendall
- Timing of impoundment drawdowns and impact on waterbird, invertebrate, and vegetation communities within managed wetlands
  - Runge, Kendall, Lyons
- Adaptive management on units of the FWS National Wildlife Refuge System (consultancy)
  - Moore

Adaptive Management at PWRC, 2006: Miscellaneous

- Developing capacity for structured decision making and adaptive management within USFWS and USGS
  - Runge
- Adaptive harvest management for Rocky Mountain sandhill cranes
  - Kendall
- Adaptive approaches to conduct of science
  - Kendall, Nichols
- Adaptive monitoring of resources managed under uncertainty
  - Moore, Kendall
- Adaptive management within Missouri DOC
  - Runge, Nichols

Adaptive Management at PWRC: Thinking About the Future

- Premise 1: few people worldwide think seriously about application of formal decision processes in natural resource management
- Premise 2: a fair fraction of those people currently work at PWRC or are PWRC graduates and affiliates
- Premise 3: few natural resource schools or research facilities offer training in structured decision processes
- Premise 4: more implementation of structured decision making would be useful to conservation and management

Adaptive Management at PWRC: Vision for the Future

- PWRC as Center of Excellence in structured decision making for natural resources
  - Increased consulting with organizations ranging from states to DOI agencies
  - Increased research in methods development
  - Training/education
    - short courses
    - postdoctoral research and management positions
    - primer for structured decision making in natural resources
    - edited volume of example implementations, successful and unsuccessful
- Current limitation is time and people
  - Solution: modest funding for postdoctoral folks