Life cycle models, decision making, and resolving scientific uncertainty

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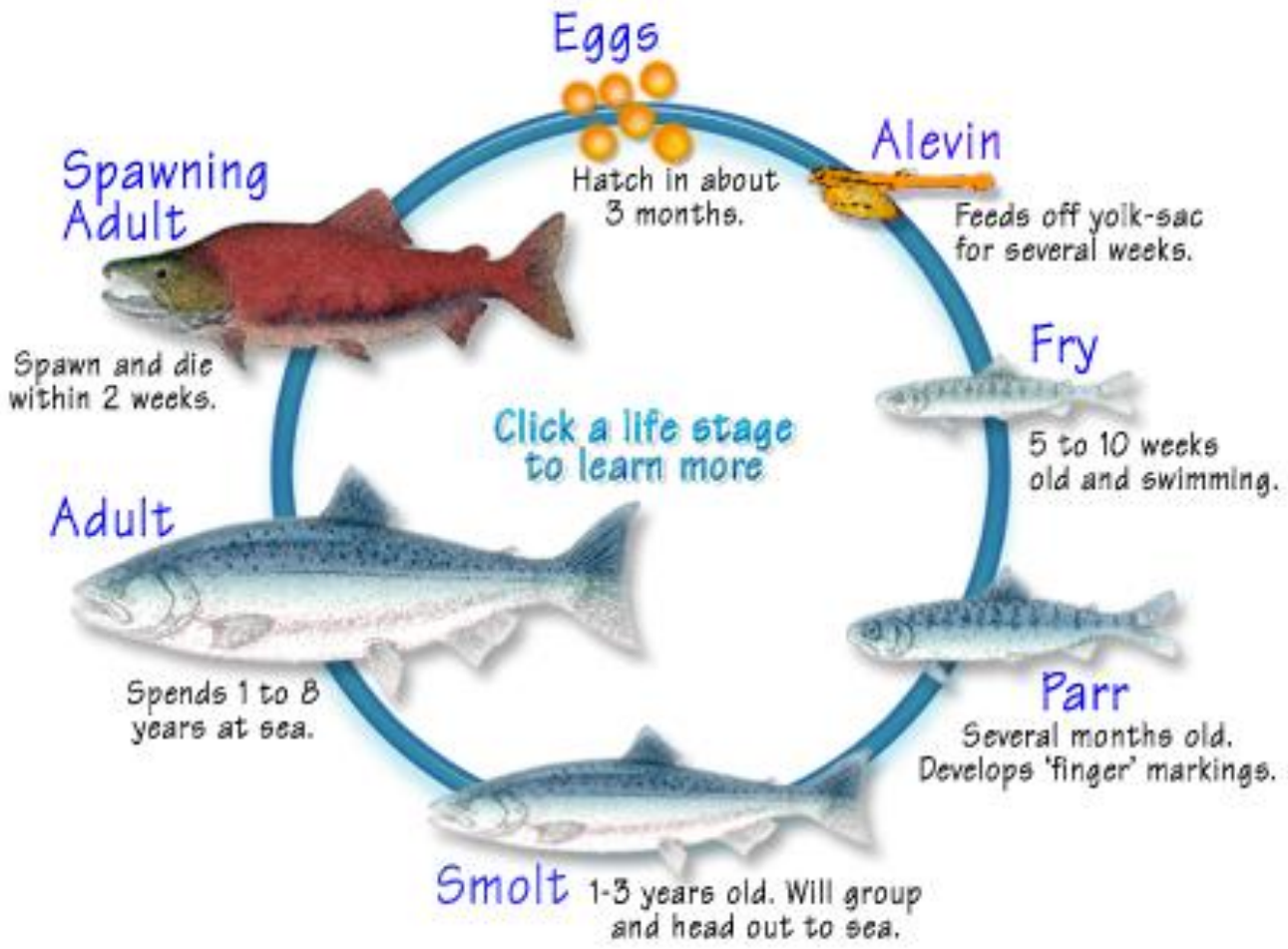
Adaptive management: more than window dressing?

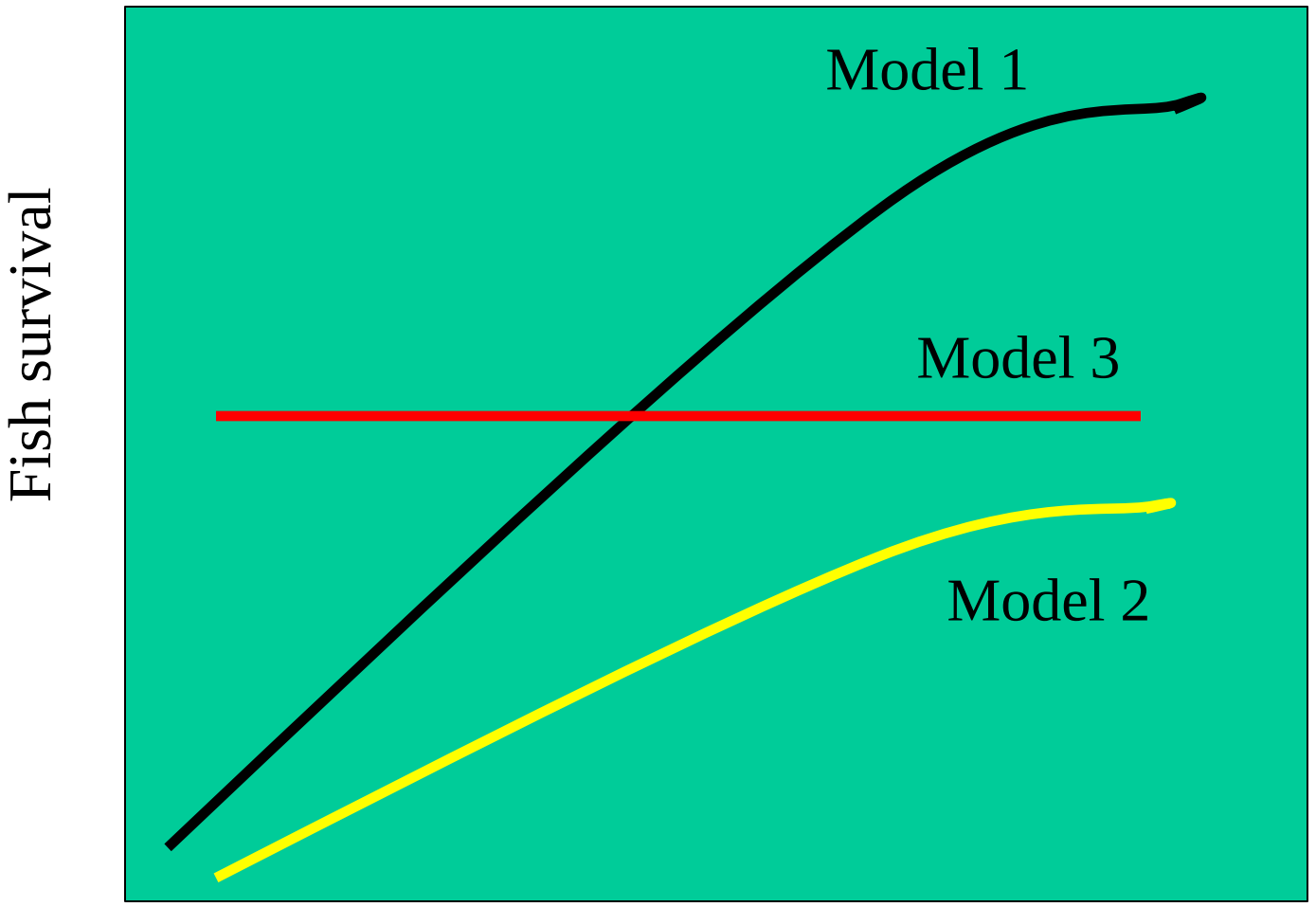
- The core of decision theory is evaluating the support data provide for competing models and evaluating alternative actions across the range of competing models
- In active adaptive management you experimentally manipulate the system to inform models
- In passive adaptive management you update the models as data accumulate over time and your decisions depend on data that have been collected
- In non-adaptive management you chose a policy based on your best knowledge at the time of the decision and you assume no information collected in the future will alter your decisions

The core of any policy evaluation must be life cycle models



Life cycle models

- Move fish through their life history
- Survival from one stage to the next depends on environmental conditions
  - and human actions such as flow regulation, harvest, etc.
- The uncertainties are primarily associated with how different factors affect survival and the intensity of that effect


Model 1
Model 3
Model 2
Fish survival
Environmental factor

Role of life cycle models: Measuring uncertainty

- A range of alternative models is considered
- At any point in time, the support the data provide for alternative models is measured
- Result is the degree of belief in each competing hypothesis

Control Rules are central to decision making

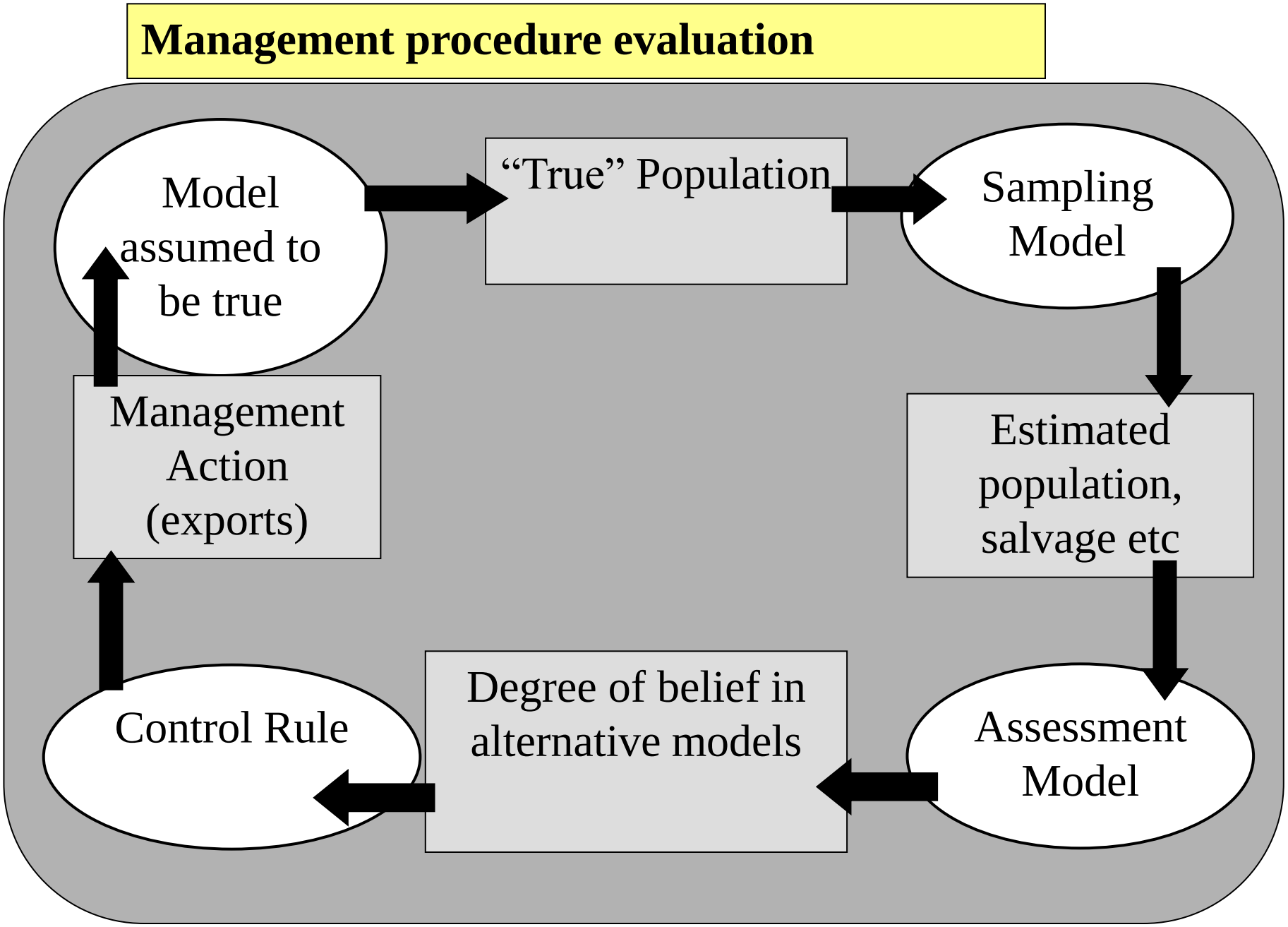
- Management actions are taken in relation to data collected such as fish surveys or environmental conditions

Role of life cycle models: designing control rules

- A range of alternative models (hypotheses) are formulated
- Potential control rules are evaluated and consequences under each alternative model is calculated
- The output of such evaluation is a range of indicators that reflect the multi-objective nature of the management problem
- The choice of which control rule to use is not a scientific issue: it is a political one

Management procedure evaluation

- How would the total system would behave if different hypotheses are true?
- These hypotheses are different life history models
- Elements of the system are
  - control rules,
  - data collection systems, and
  - evaluation methods


Management procedure evaluation
Model assumed to be true
"True" Population
Sampling Model
Management Action (exports)
Estimated population, salvage etc
Control Rule
Degree of belief in alternative models
Assessment Model

Questions to ask about proposed management actions: adaptive or non-adaptive

- Has their outcome been evaluated quantitatively using models?
- Has their outcome been evaluated across a range of life history models that represent the uncertainty?
- Has a range of alternative control rules been evaluated?
- Even if you are not adaptive, you have to use models to evaluate alternative policies

Finding common ground among scientists

NCEAS working group: **Finding common ground in marine conservation and management**

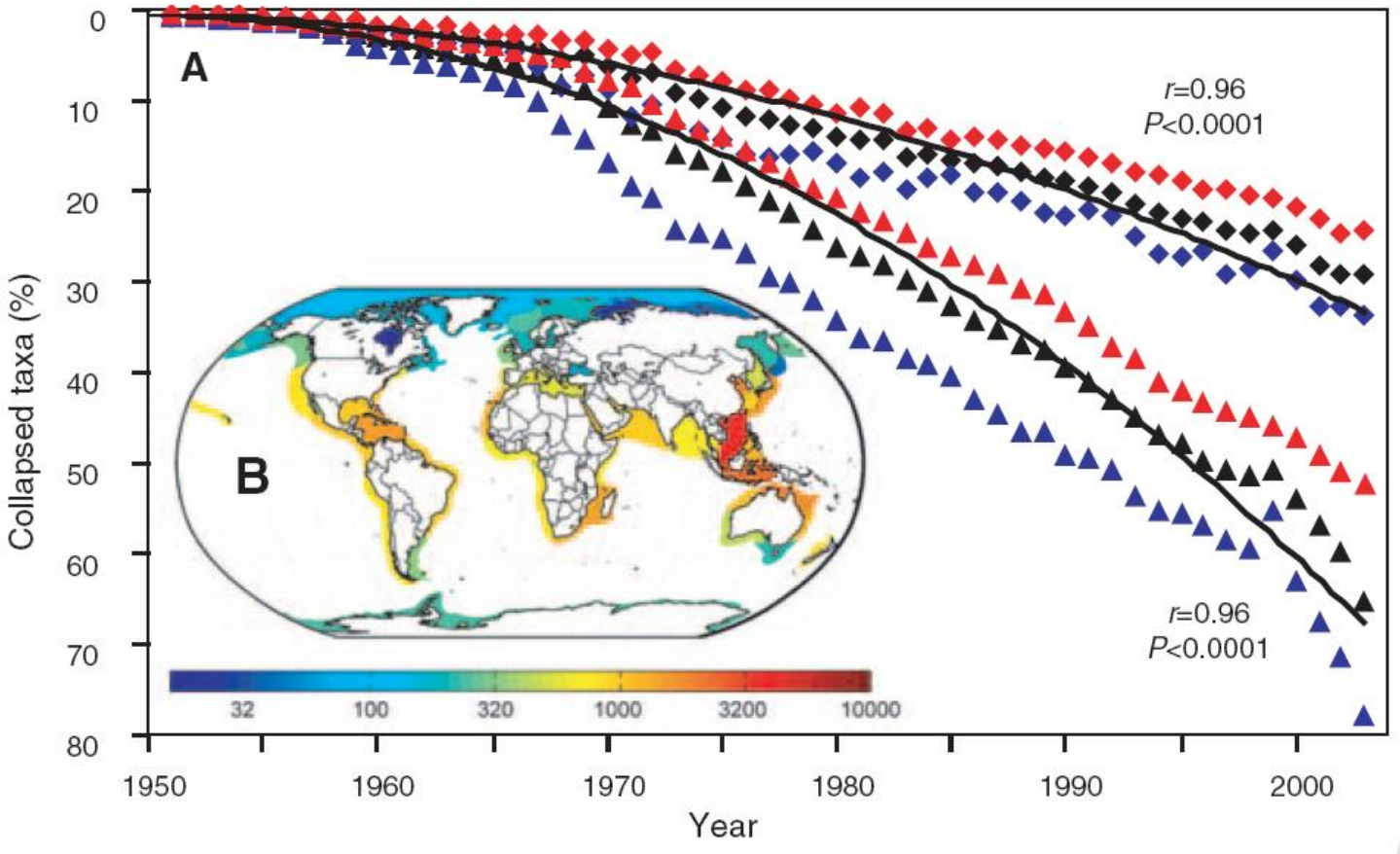
Rebuilding Global Fisheries

Boris Worm,[1]* Ray Hilborn,[2]* Julia K. Baum,[3] Trevor A. Branch,[2] Jeremy S. Collie,[4] Christopher Costello,[5] Michael J. Fogarty,[6] Elizabeth A. Fulton,[7] Jeffrey A. Hutchings,[1] Simon Jennings,[8,9] Olaf P. Jensen,[2] Heike K. Lotze,[1] Pamela M. Mace,[10] Tim R. McClanahan,[11] Cóilín Minto,[1] Stephen R. Palumbi,[12] Ana M. Parma,[13] Daniel Ricard,[1] Andrew A. Rosenberg,[14] Reg Watson,[15] Dirk Zeller[15]

Impacts of Biodiversity Loss on Ocean Ecosystem Services

Boris Worm,[1*] Edward B. Barbier,[2] Nicola Beaumont,[3] J. Emmett Duffy,[4] Carl Folke,[5,6] Benjamin S. Halpern,[7] Jeremy B. C. Jackson,[8,9] Heike K. Lotze,[1] Fiorenza Micheli,[10] Stephen R. Palumbi,[10] Enric Sala,[8] Kimberley A. Selkoe,[7] John J. Stachowicz,[11] Reg Watson[12]

All fish gone by 2048



Biodiversity Loss in the Ocean: How Bad Is It?

THE RESEARCH ARTICLE "IMPACTS OF BIODIVERSITY LOSS ON OCEAN ECOSYSTEM SERVICES" BY B. Worm *et al.* (3 Nov. 2006, p. 787) projects that 100% of seafood-producing species stocks will collapse by 2048. The projection is inaccurate and overly pessimistic.

Critiques by Hilborn, Methot Murawski and Tromble, Branch, and many others

"Mind boggling stupid"

Steps taken

- Conversation between Hilborn and Worm
- Identify objective “understand what abundance data tell us about trends in abundance and status”
- Assemble a team representing a range of perspectives
- Identify data that will be used

Lessons: Objectives

- Must be scientific, not policy
- Relatively specific focus, and carefully identified

Lessons: participants

- Be representative of different perspectives
- Do not include “dominant personalities”
- Large contingent of young post-docs who will actually do the work and are not closely identified with past publication

Lessons: data

- Data must be the focus of the work
- Assembly of a public data base available for everyone to explore
- Make this data base available for all members of the team to explore

Summary

- Models are essential components of management under uncertainty
- Achieving scientific consensus is possible if the structure of the process is properly defined.