Biological Modeling to Support Edwards Aquifer Recovery Planning

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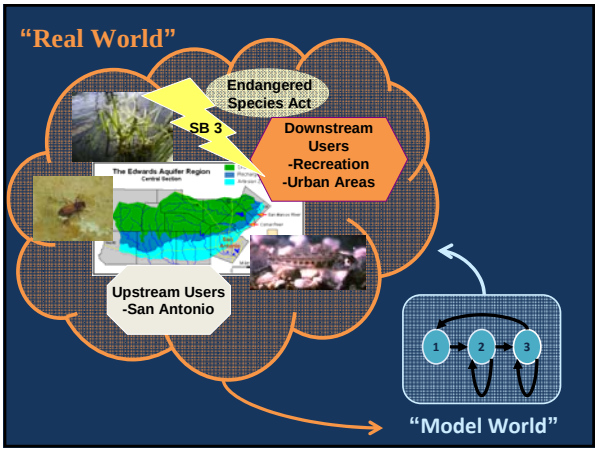
USGS science for a changing world

What is a Model?

- "Purposeful representation" of a problem
- Integrates complex information
- Simplifies reality
- Tool for assessing potential consequences



Why Model?

- Help guide direction and goals
  - Provide greater understanding and new insights
  - Indicate 'robust' management solutions
  - Identify critical data gaps and research priorities
- For "if-then" assessment of management options
  - Testing alternative scenarios in a virtual laboratory

Principles of Modeling for Management Decision Support

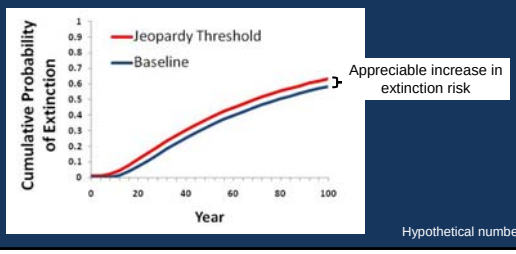
- Focused on the decision problem
- "Requisite model" – all the important information, but *no more*
- *Not* 'cookie cutter'
- Transparent
- Address uncertainty frankly
- Iterative process; start simple!
- Collaborative

Modeling for Jeopardy Analysis

- Jeopardy means…
  …to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. [50 CFR §402.02]
- So to assess jeopardy, we have to calculate (model) the "likelihood of survival & recovery," both with and without the proposed action(s)

Jeopardy "Threshold"

- May be determined as an "appreciable" increase in probability of extinction/time
  - *Relative* to the baseline



Hypothetical numbers

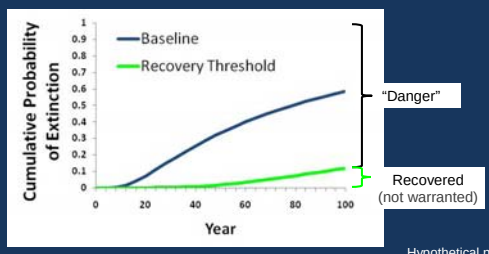
Modeling for Recovery Planning

- Recovery means the species no longer warrants ESA protection

  …no longer "likely to become in danger of extinction in all or a significant portion of its range in the foreseeable future."
- Again, need to calculate (model) the "likelihood extinction" over foreseeable future

Recovery "Threshold"

- Likelihood of extinction drops below "Danger"
  - In the foreseeable future

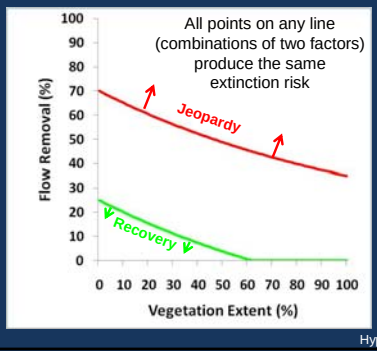


Hypothetical numbers

Modeling for Recovery Planning

- Use modeling to explore *combinations* of management actions (factors or threat management) that:
  - Achieve recovery
  - Avoid jeopardy

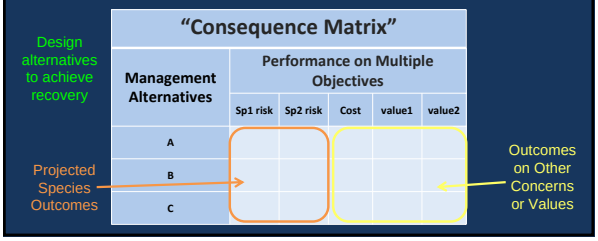
Hypothetical Two-Factor Illustration



Hypothetical numbers

Structured Decision Making

- Development of a recovery plan also considers other concerns and trade-offs (e.g., cost, efficiency, different water uses)

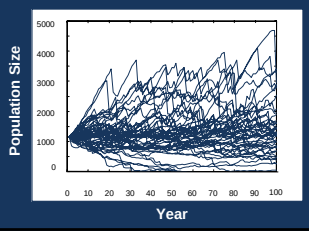


Extinction Risk Modeling

- Outcome of interest is chance (probability) of 'extinction'
- Must be a 'stochastic' model
- Include all important variables
  - Still only 'requisite'
- Time frame for *projecting forward* depends upon the decision requirements (policy) and ecological processes (foreseeable future)
- *Not* off-the-shelf "PVA"

Extinction Risk Modeling

- Results integrate natural variability, future trends in limiting factors (threats), and uncertainty about parameters (science)



100 simulations of one scenario

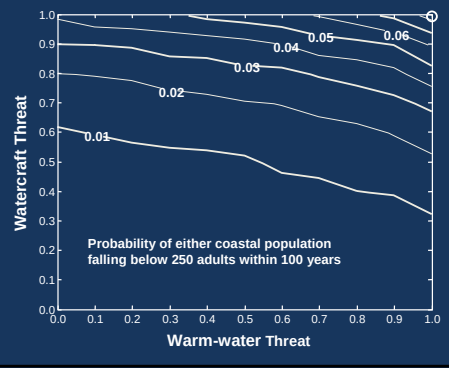
6 of 100 runs extinct

~6% probability

Florida Manatee Example

- Quantitative threats analysis, for recovery planning
- Projecting extinction risk over 100 yrs
  - With natural variability and scientific uncertainty
  - With different threat scenarios (trends)
    - ESA "5-factors" considered
    - Evaluated effects of five *major* threats
- "Demographic" model (birth-death processes)
  - Relatively data-rich example

Manatee threats analysis



Keys Elements for Edwards Aquifer?

- Focus on extinction risk
  - Jeopardy analysis
  - Recovery strategies
- "Stochastic"
- May count 'area occupied' rather than individual animals/plants
- Spatial (GIS) components key
- Integrate empirical data and expertise
- Handle scientific uncertainty with 'scenarios'

Edwards Aquifer Modeling Process

- Start simply: single species/spring system?
- Iterative, ongoing process
- Support adaptive recovery management in long-term
- Interdisciplinary collaboration
  - USGS "Team"
    - Texas Water Science Center
    - Patuxent Wildlife Research Center
  - FWS
  - RIP etc.