Equilibrium Delay-Difference Optimization Model

Designing, evaluating, and comparing proposals under the MLPA

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Objectives

- How will we know if a given MPA network achieves goals of MLPA?
- Would also like to know (a) extent to which goals are being achieved and possibly (b) indirect consequences of a network.
- MLPA process requires a "model" – use best available science to:
  - Inform MPA network design
  - Evaluate and help improve on stakeholder proposals
  - Inform tradeoffs inherent in a given MPA proposal
  - Inform monitoring

What would be useful?

- For any given MPA network proposal:
  - Spatial distribution of stocks, many species/life-history traits
  - Coast-wide larval connectivity
  - Spatial distribution of commercial and recreational effort, harvest, and economic returns – before & after reserves

- This tool could be useful:
  - Take input from stakeholders (e.g. high value from keeping a patch open) seed "good" reserve networks as a starting point
  - Evaluate the spatial biological and economic impacts of given proposal
  - Compare across proposals
  - Illuminate obviously inferior proposals

Absent modeling predictions…

- "Model" would make biological and economic predictions across space.
- Without a "model" we could use habitat as proxy for biology and current effort/harvest as proxy for economics.
  - Problem is that these are dynamically and spatially connected – they respond in complicated ways to closures
    - Larvae and adults disperse
    - Fish population dynamics in response to closures
    - Fishermen move in response to closures
- These are poor proxies for assessing ultimate consequences of reserves.

Equilibrium Delay-Difference Optimization Model

- We seek to develop a model to achieve the aforementioned objectives
- Based on state-of-the-art spatial and dynamic biology and economics
- Rest of this talk
  1. Model basics and outputs
  2. Model inputs and other considerations
  3. Use EDOM to compare MLPA proposals
  4. Demonstrate graphical user interface

Model Basics

- Spatially explicit biological model – species are harvested, grow, disperse, etc.
- "Equilibrium" model
- Multiple non-interacting species are harvested simultaneously
- Reads in spatial data on habitat, dispersal, home ranges, biological parameters for species of interest, economics of fleet.
- Harvest outside: (1) constant fishing pressure everywhere, (2) fleet movement depending on harvest density, (3) bionomic equilibrium (rent dissipation), and (4) optimal spatial harvest
- Output: (1) spatial biomass, effort, harvest, economic returns for all species under consideration, (2) Larval connectivity, (3) Economic impacts by port separately for recreational and commercial fleets

Scientific Considerations

- Age structure – Fully accounted for (Deriso-Schnute delay difference model)
- Larval dispersal – without oceanographic model, we use normal distribution
- Adult dispersal – Home range, radius from literature
- Habitat – Beverton-Hold recruitment is habitat (therefore spatially) explicit, different for each species
- Post recruitment survival – Ford Brody growth, age independent survival, egg production proportional to fish weight (for older fish)
- Multi-species – species coexisting in a patch are harvested simultaneously without selection, no interspecies population dynamics
- Recreational and Commercial fleets considered, vulnerability of each species differs across sectors
- Fishing costs and revenue – constant price per kg, constant cost per unit of effort (though different across recreational and commercial)
- Harvest rate outside reserves – *critically drives impacts of reserves on biology and economics*
    1. Constant fishing mortality rate
    2. Fleet model – fishermen search for good fishing locations
    3. Bionomic equilibrium – fish down patches until revenue equals cost
    4. Optimized spatial harvest – each patch harvested differently to maximize economic value of fishery

EDOM User Interface

- I'll show the user interface & 3 kinds of uses:

1. The basic inputs, outputs, and features
2. Evaluating and improving a given reserve network proposal
3. Comparing a suite of reserve network proposals.

Edom.exe