Science, Service, Stewardship

Using Optimization Models to Evaluate Bio-economic Impacts of Management Plans

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Role of Economics in PR Science & Management

1. Regulatory Support
   - Regulatory Impact Review / Regulatory Flexibility Act analyses
   - Critical Habitat Designation analyses

2. Value of PR Science (VOI framework)

3. Making PR management “better” (PR species valuation, benefit-cost analysis, cost-effectiveness analysis)

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Policy Instruments
used to manage fish & protected species

1. Input Controls
    - Fishing Effort Reductions
        - Closures (Year-round or Seasonal)
        - DAS Restriction
        - Net Caps on Both Day and Trip Gillnet Vessels
    - Bycatch Rate Reductions
        - Gear Modifications
            - Pingers
            - Mesh size restrictions
2. Output Controls
    - Trip Limits
    - Annual Catch Limit (ACLs)

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Evaluating Area Closures

- Large amount of work over last several years looking at welfare losses associated with closed areas:
  - Dupont, 1993
  - Hicks 1997
  - Curtis 1999, 2000
  - Holland and Sutinen, 1999
  - Hicks, Kirkley and Strand, 2004.

- Most used Random Utility models

- Work in the Northeast to date has tended to focus on Math Programming (Optimization) Models

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Closed Area Model (CAM)

- Closures was one of the policy instruments analyzed (thus the name “CAM”)
- Developed by John Walden to assess economic impacts of groundfish regulations
- Expanded to include non-groundfish vessels (Maine to North Carolina)
- Modeling approach allows us to evaluate simultaneously several policy instruments in one model

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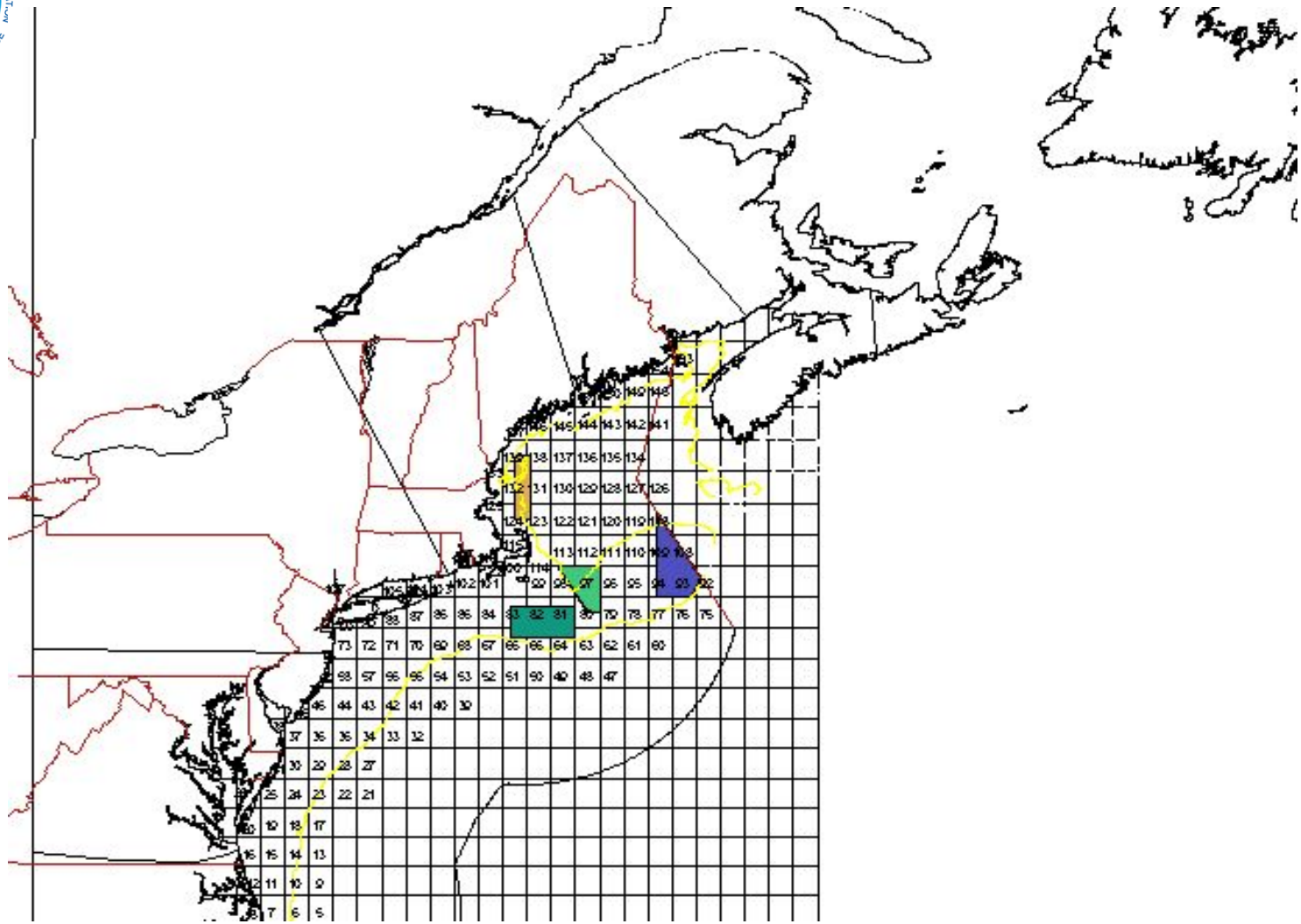
NE Region Grid Numbering System



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Estimating Changes in Harvest Under Each Management Option

- Desirable features:
  - A focus on 30 minute square blocks, and monthly time periods.
  - Estimate changes in harvest by species and area
  - The ability to incorporate several policy instruments (days at sea limits, trip limit changes and area closures, gear modifications) simultaneously.
  - A focus on the individual vessel level and profit changes.

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Modeling Approach

- Originally Published in AJAE (1995)
- Approach uses a model, calibrated to observed conditions in a base year, to examine policy changes
- Models are widely used in Agriculture, particularly by the USDA.

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Optimization

- Done at individual vessel level

- The model assumes an individual vessel will seek to maximize profit:

$$\text{Profit} = (\text{Price}*\text{Harvest}) - \text{Cost}(\text{Effort})$$

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Optimization

$$\text{Max Profits}_{\text{a}} = \sum_{ijs} P_{is} * (\beta_{ijs} - \delta_{ijs} * E_{ij}) * E_{ij} - c(E_{ij})$$

$s.t.$

$E_i \leq 30$ monthly effort

$\sum_i \sum_j E_{ij} \leq EFF$ annual effort

$E_{ij} \geq 0$

$\text{i} = 1 \text{ to } 12 \text{ months}$

$\text{j} = 1 \text{ to } 138 \text{ blocks}$

$\text{s} = 1 \text{ to } 20 \text{ species}$

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Data

- Logbook (VTR) and commercial dealer data in 2006 to determine:
  - landings
  - days at sea
  - CPUE (catch per unit effort) per block
- Logbook and commercial dealer trip data merged by serial number
- Vessel trip data were aggregated to a monthly level in each block
- Monthly price data were based on dealer records.
- NERO DAS database used to determine allocated and leased DAS for the vessel.

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Model Limitations

- Model only allows vessel effort to shift into areas or times where the vessel of the same size within port has previously fished. Landing reductions and profit losses may be overestimated.

- Non-linear programming model assumes “perfect” planning and foresight; the model assumes each vessel will make choices so that profit is maximized.

- Latent effort is not incorporated into the model.

- Provides an ordinal ranking of alternatives, not precise point estimates of impacts.

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Model Result Process

- Run Model with the
  - status-quo management options
  - proposed new management options

- Compare profits and landings under proposed management options with status quo to determine change in exploitation.

- Changes in profits and distributional impacts were also provided.

- Model results should be interpreted as an ordinal ranking of alternatives. Information from the model helps managers choose an alternative.

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Future Directions

- CAM model evaluates individual vessel responses. Need fleet models as well to evaluate alternative policy instruments (Bisack and Sutinen 2006).
- Need to consider models that incorporate
  - uncertainty
  - behavioral responses such as decision choice models
  - compliance behavior
- Need models that can assess commercial fishery targets and PR targets simultaneously (Bisack 2008).
- Other ideas?

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Published Literature

Bisack, Kathryn and Jon Sutinen. 2006.Harbor Porpoise Bycatch: ITQs or Time/Area Closures in the New England Gillnet Fishery. *Land Economics* . February 2006 . 82 (1): 85–102

Bisack, Kathryn. 2008. Integrating Porpoise and Cod Management: A Comparison of Days-at-sea, ITQs and Closures*. Marine Resource Economics.* Volume 23, pp. 359–376

Additional Questions?

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