Structured Decision Making Examples: Small Scale

I. Managing Disturbance of Golden Eagle Nest Sites at a National Park

Problem I: Statement

- Setting: Large Alaskan National Park
- 100 potential golden eagle nesting sites
  - About 60 (average) sites are used for nesting each year
- Park visitors and potential disturbance
  - Visitors hiking into nest sites may disturb nesting eagles, thus reducing nest success
- Want to permit visitor access while maintaining viable eagle population

Objective Function

- Minimize restriction of hiker access, subject to constraint (eagle status)
- Constraint: predicted proportion of potential nesting sites with successful eagle reproduction must be at least 0.4

Management Action(s)

- Actions:
  - (1) Prohibit hiking near potential nest sites for the spring-summer season
  - (2) No restriction of hiking
- Decision timing and basis:
  - Annually, in late winter, just before the breeding season
  - Based on eagle monitoring information from previous spring-summer

2 Models: Shared Basic Bookkeeping

- Both models, 2 key transition parameters for potential nesting sites:
  - Probability of successful reproduction next year, given
    - (1) successful reproduction this year
    - (2) no successful reproduction this year
- Proportion of sites with successful reproduction this year is determined by:
  - Proportion of sites with successful reproduction last year
  - Parameters 1 and 2 above

2 Models: Differences

- Model 1:
  - Transition parameters (probabilities of successful reproduction next year) do not vary with management decision:
    - Disturbance does not influence eagle reproduction
- Model 2:
  - Transition parameters are influenced by management decision
  - This year's reproduction influenced by mgmt:
    - Larger when hiking is restricted
    - Smaller when hiking is not restricted

Monitoring Program

- Survey of all potential nest sites
- Repeated visits during spring-summer season
- Estimation using occupancy models that account for detection probabilities <1
- Yields estimates of proportion of sites at which successful reproduction occurs

Decision Step

- Decide (e.g., using optimization) whether or not to restrict hiking based on:
  - Objective function
  - Models
  - Current system state (proportion sites with successful reproduction the previous season)

Decision Table: Result of Optimization

Prop. Successful Last Year	Decision This Year
0.1	Restrict
0.2	Restrict
0.3	Restrict
0.4	Restrict
0.5	Restrict
0.6	No Restrict
0.7	No Restrict
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Learning to Make Better Decisions

- Each winter, management decision uses weighted (based on faith in model predictions) average of the 2 models
- Each model makes prediction for the next season
- Monitoring the next season provides an estimate of "truth"
- Degree of faith in each model is modified based on how well it predicts

Structured Decision Making Examples: Small Scale

II. Fish Hatchery Management: Stocking

Problem II: Statement

- Setting: eastern state(s) streams and lakes
- Population fluctuations of a salmonid species cause difficulties in maintaining a viable fishery

Problem II: Statement

- Hatchery provides ability to stock a fixed number (based on hatchery capacity) of either:
  - age 0 fish (greater number, smaller cost, stock this year), or
  - age 1 fish (smaller number, greater cost, stock next year)
- Want to stock fish of appropriate age, when needed to maintain fishery
- Want to minimize stocking costs

Objective Function

- Minimize stocking costs
  - Cost per released fish is fixed
  - Cost is larger for release at age 1 than for release at age 0
- Constraint: predicted abundance of adults (age 2+ breeding size) must be at least as large as some threshold value

Management Action(s)

- Actions:
  - (1) No stocking
  - (2) Stock age 0 fish (fingerlings) this year
  - (3) Stock age 1 fish (subadults) next year
- Decision timing:
  - Annually, winter or early spring
  - Decision based on abundance estimates of adult fish from previous spring-summer

2 Models: Shared Basic Bookkeeping

- Both models predict adult population size in subsequent years based on:
  - (1) Adult population size last year,
  - (2) Number of age 0 and age 1 fish stocked last year, plus this year's decision:
    - number age 0 stocked this year, or
    - number age 1 to be stocked next year
  - (3) Survival rates of age 0 and age 1 stocked fish

2 Models: Differences

- Model 1:
  - Relatively small difference between annual survival rate of age 0 releases and age 1 releases
- Model 2:
  - Relatively large difference between annual survival rate of age 0 releases and age 1 releases

Monitoring Program

- Survey managed streams and lakes
- Stratified random sampling of specific sites within water bodies
- Use 3-pass removal sampling (electrofishing or nets)
- Estimation using removal models (deal with nondetection)
- Yields estimates of abundance of adult fish for the managed water bodies

Decision Step

- Decide (e.g., using optimization) to:
  - Not stock
  - Stock age 0 fish this year
  - Rear age 0 fish and release as age 1 next year
- Decision based on:
  - Objective function
  - Models
  - Current system state (estimated adult abundance the previous season)

Learning to Make Better Decisions

- Each spring-summer, management decision uses weighted average of the 2 models
- Each model makes predictions for the subsequent spring-summer seasons
- Monitoring the each spring-summer provides an estimate of “truth”
- Degree of faith in the models is modified based on how well they predict