

To Optimize or Not to Optimize: A Practitioner's Perspective

Forest Estate Modeling
Conference - Victoria
June 14, 2007

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Introduction

- From a BC consulting forester's perspective....
- Pros and cons of various solution generation techniques in the operational delivery of forest estate modeling services.
- My comments observe general trends – nothing is meant as absolute!
- A caveat:
 - “I only know what I know.”
- Feel free to expand my horizons! This talk should be considered an interactive dialogue.

Solution Techniques

- Forest estate models typically employ one of three solution generation techniques:
 - **Stepwise Simulation** (what if?)
 - Maps out the results for a single predefined solution.
 - For example: *ATLAS/FPS* or *CASH*
 - **Heuristics** (what's good?)
 - Iterative solutions generated and reviewed in an effort to find a good or near optimal solution.
 - For example: *Patchworks* or *FSOS*
 - **Optimization** (what's best?)
 - Mathematical techniques (i.e. linear programming) used to find true optimal solutions within defined solution spaces.
 - For example: *Woodstock* or *Spectrum*

Model Type Considerations

Depends on the objectives of the project and the resources available.....specifically:

- Costs
- Ability to Represent the Problem / Control the Solution
- Ability to Rationalize / Explain Results
- Ease of Sensitivity Analysis
- Number of Scenarios Required
- Desire to Support Tactical Planning

Costs



- Effort required to setup model and generate solutions.
 - Heuristics and optimization tend to be more complex and thus require more effort to setup and verify.
- Model run times and interpretation time.
 - For realistic size problems, heuristics and optimization take significantly more time to reach a solution and interpretation can be more difficult/time consuming.
- Model purchase and maintenance.
 - Heuristics and optimization more complex = ↑\$'s



Ability to Represent the Problem

- Can key indicators influence the solution?
 - Manage Costs/Revenue (Max NPV, Min costs, etc)
 - Limited to heuristics and optimization
 - Stand level spatial relationships (blk adj, patches)
 - Only simulation and heuristics for reasonable size problems. Only heuristics can work toward desired patch size distributions using soft targets.
 - Indicators requiring look ahead (i.e. max mid seral)
 - Only optimization and heuristics evaluate harvest decisions across all periods (look ahead to see impact of harvest decision today to objectives/constraints in the future).

Represent the Problem (2)

- Constraints/Objectives
 - Simulation limited to hard constraints (met/not met) with recruitment functions.
 - Optimization can offer hard or soft constraints.
 - Heuristics typically use soft constraints and priorities (targets and penalty functions).
 - Soft constraints offer flexibility needed to address issues such as:
 - Patch size distributions
 - ECA

Represent the Problem (3)

- Management options/choices
 - Simulation requires that a stand have a predefined single treatment pathway (Clearcut or partial cut, fertilization or not, etc)
 - Heuristics and Optimization allow options to be constructed to give the model treatment choices.

Ability to Rationalize / Explain Results

- Simulation results can be explained relative to the predefined scenario inputs (typically simpler models, broad patterns are followed).
- Heuristics and optimization are able to make a range of alternative decisions outside of broader patterns – making it more difficult to explain results (more complex models).

Sensitivity Analysis

- Ability to completely isolate impacts of a single variable is tough with heuristics that use a penalty function because change in harvest flow requests can cause differences as well.
- Optimization can provide shadow prices
- Simulation will allow a large number of sensitivities to be completed quickly.

Scenario Numbers \ Timelines

- Simulation can explore a large number of management scenarios quickly relative to optimization/heuristics.
- When timelines are short, it may not be possible to wait for optimization/heuristic based solutions.
- Links to costs.....

Desire to Support Tactical Planning

- If aiming to use the solution to guide tactical planning, then it can be worth the time to add detail to the model to help ensure a more 'realistic' solution.
- Heuristic models can directly incorporate the most detail critical to tactical planning:
 - road building costs
 - Haul costs
 - Financial targets
 - Species/product targets
 - Landscape and stand level spatial issues.

General Themes

- Simulation
 - Provides simple, fast, and transparent solutions when budgets or timelines are tight and/or landbases are large and complex.
- Heuristics
 - Allows the most detail to be integrated into the solution procedure so it can produce very detailed solutions (patches, road networks, financial considerations, etc).
 - A one stop shop.
- Optimization
 - Same traits as heuristics accept you lose some ability to deal with tactical planning issues to get an optimal answer and shadow prices.

Summary

- Costs and ability to adequately represent the problem are key drivers.
- Tendered work (lowest cost) will almost certainly use simulation approaches.
- In my opinion:
 - If looking to quickly understand the relative differences between numerous mgmt scenarios – simulation (especially on large or complex land bases).
 - If looking to explore alternative treatment options, use soft targets, and/or incorporate financial considerations into solution procedure – optimization or heuristics.
 - If looking to use modeling to also incorporate tactical planning issues – heuristics. Only heuristics can deliver it all in one package.

Take Home Messages

- A specific model's ability to address the problem at hand should drive choice, and solution technique is only one factor.
- A model's user interface, supporting tools, and inherent flexibility may well out weight solution generation methodology.
- And then there are always costs.....