Forest Management Planning Models: An Overview

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What is a forest planning model?

- **Decision support**
  - **What to do?**
  - **When to do it**
  - **Where to do it?**
- **Suggestions not prescriptions**

- **Components**
  - **Objectives**
  - **Constraints**
  - **Input**
  - **Assumptions**
  - **Output**

A simple forest planning model

$$AAC_{area} = \frac{A}{R}$$

- **Objective**
  - **Create a “normal forest” in one rotation**
- **Input**
  - **Total forest area and rotation age**
- **Assumptions**
  - **Equal productivity**
- **Output**
  - **How much area should be cut annually**

Another simple forest planning model

$$AAC_{volume} = \frac{V_m}{R} + I$$

- **Objectives**
  - **Liquidate overmature timber and harvest growth**
- **Input**
  - **Volume of mature timber, rotation age, annual increment**
- **Assumptions**
  - **Known volume, known growth rate**
- **Output**
  - **How much volume should be cut annually**

Modern Forest Planning Models

- Computer programs
- Planning horizons
  - 100-250 years in 5 or 10 year periods
- Objectives
  - Optimize/Track NPV, or volume, or costs, or habitat, or water quality/quantity etc., or some weighted combination of indicators
- Constraints
  - Volume flow constraints, cover type area constraints, spatial constraints
- Activities
  - e.g. harvesting timber, silvicultural treatments, road building, land zonation, etc.
- Input
  - Starting inventory, yield tables, transition rules
- Output
  - Level of indicators at different periods of time

Simulation vs. optimization

Simulation

- **If I was to do these sets of actions, at these locations, and at these points of time, what would happen to the forest values of interest to me?**

Optimization

- **What should I do, where should I do it, and when should I do it in order to best meet my objectives for the forest?**

Simulation

- Tracks development of forest in response to transition rules
  - e.g. two-period old pine becomes three-period old pine next period
- Actions based on decision rules and operability limits
  - Harvest until harvest request is met, harvesting slowest-growing stands (with more than 50 m^3/ha) first
- User searches decision space by changing rules

Optimization

Automated search for best decision rules

- **Linear programming**
  - **A single objective**
  - **Constraints and objective function must be expressed as linear equations**
  - **Activities are expressed as continuous variables**
- **Goal programming**
  - **CCFM Criteria and Indicators (2003)**
    - **6 criteria and 46 indicators**
- **Mixed integer programming**
- **Non-linear programming**
- **Heuristic optimization**

Non-Spatial vs. spatial

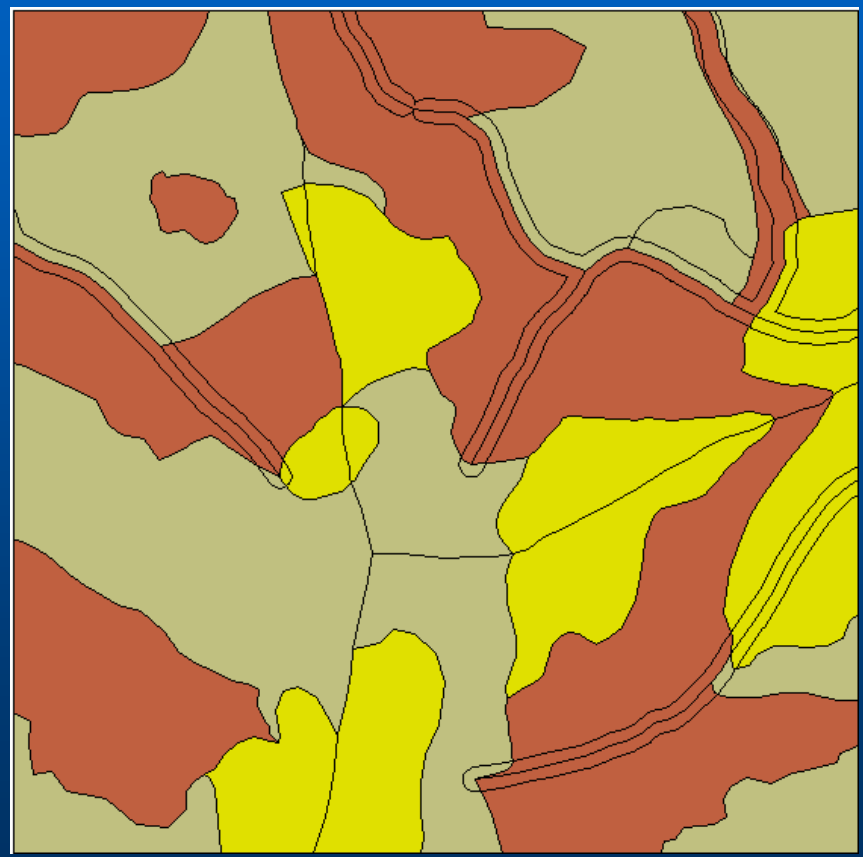
- **What level of spatial detail needed for question at hand?**
- **What level of spatial detail can be supported by available data?**

Spatial detail

- **Relevant to**
  - **Access development**
  - **Harvesting / haul cost**
  - **Visual quality concerns**
  - **Wildlife habitat**
  - **Inter-stand policy constraints (e.g. green-up requirements)**
  - ***etc.***

Levels of Aggregation

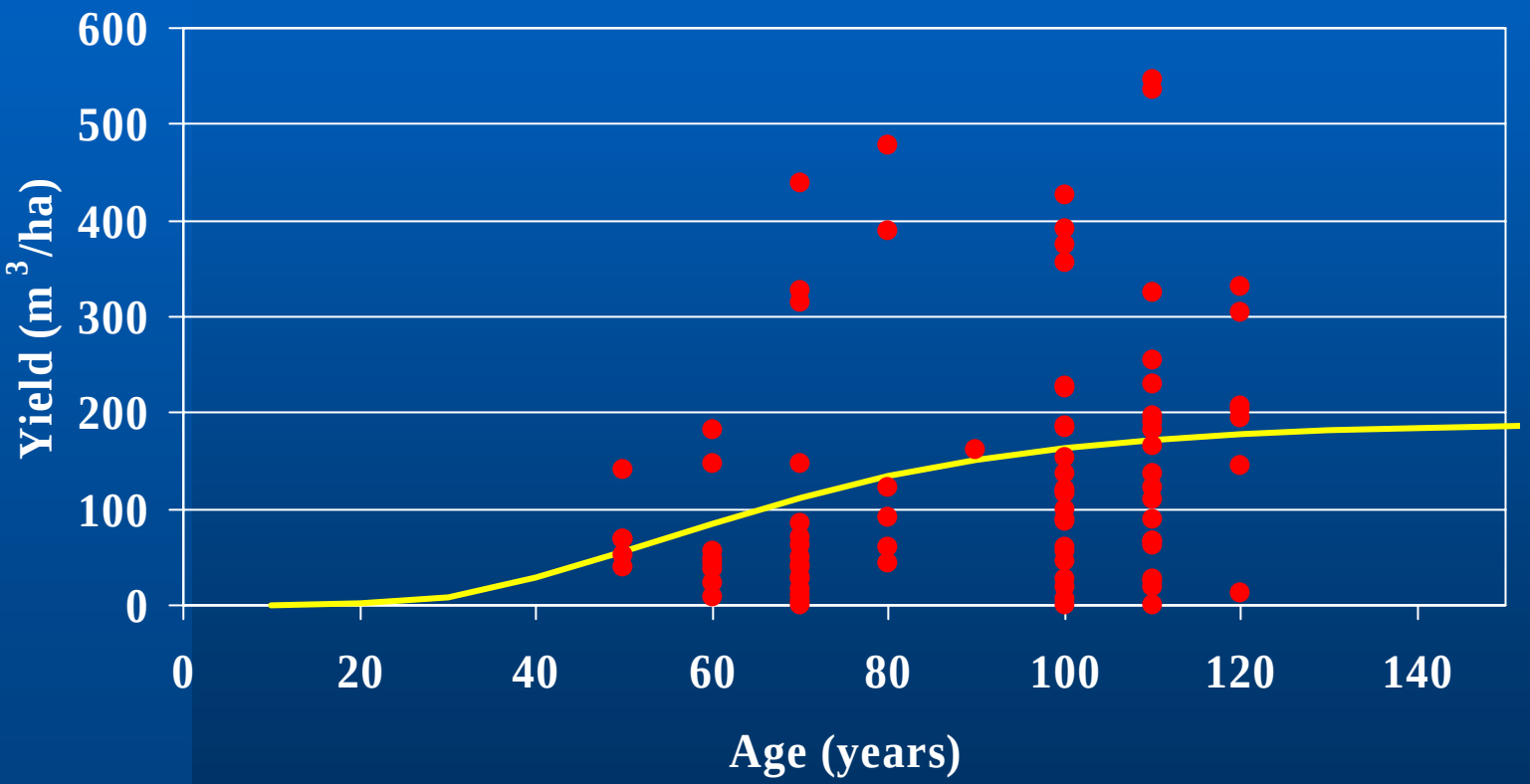
- 3 watersheds
- 3 stand conditions
- 2 riparian classes
- =
- 18 possible land classes
- 39 homogenous polygons



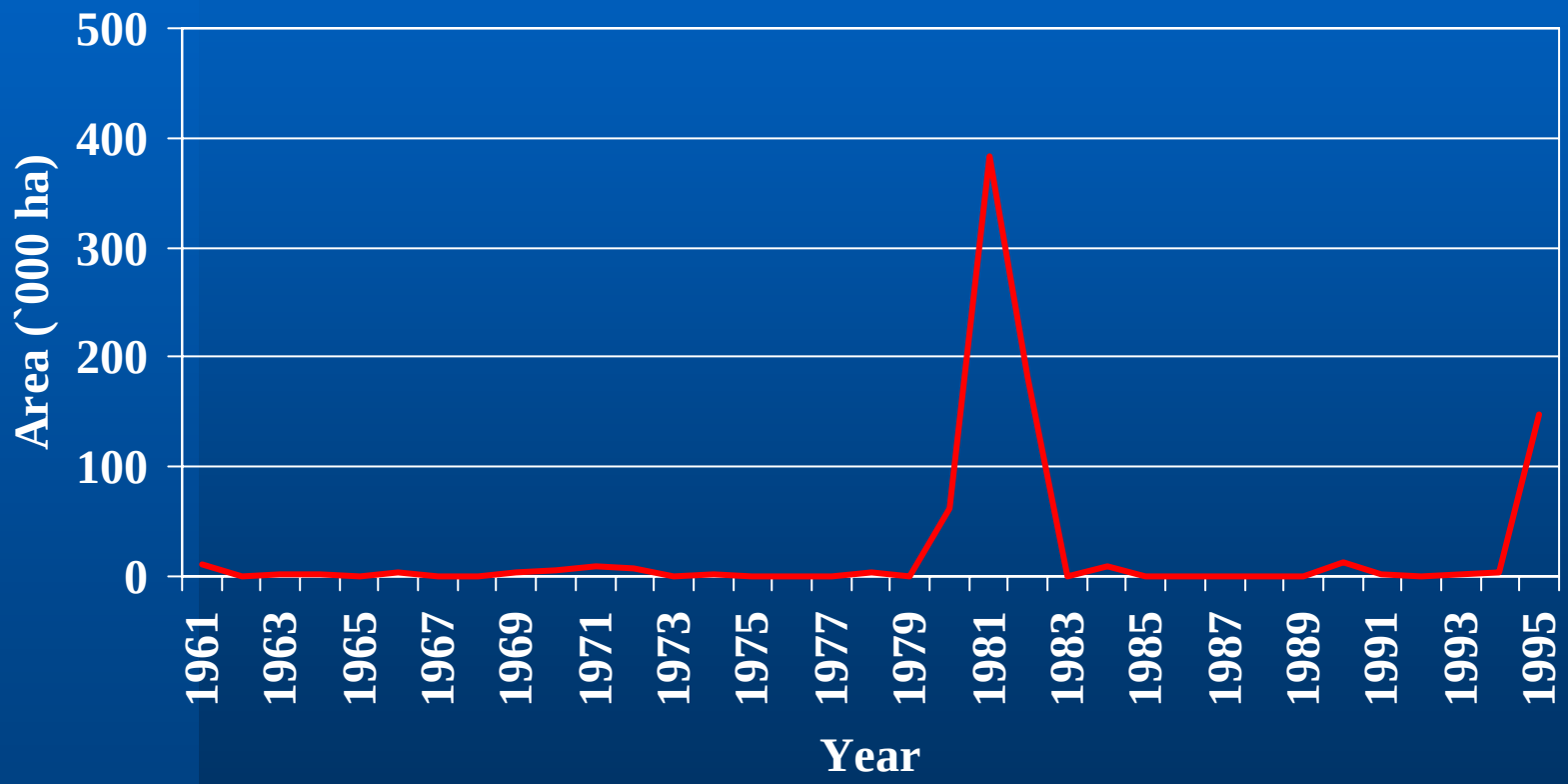
Deterministic vs. stochastic

- **Important random variables**
  - **Fire/insects/disease**
  - **Prices**
  - **Growth**
- **Is understanding variability of projections important?**
- **Does risk matter?**

An Alberta yield curve

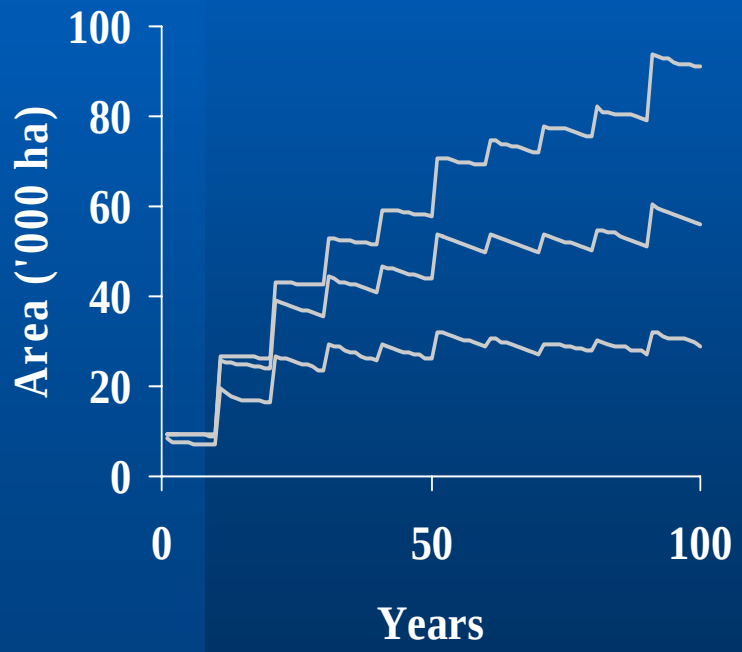


Annual Area Burned

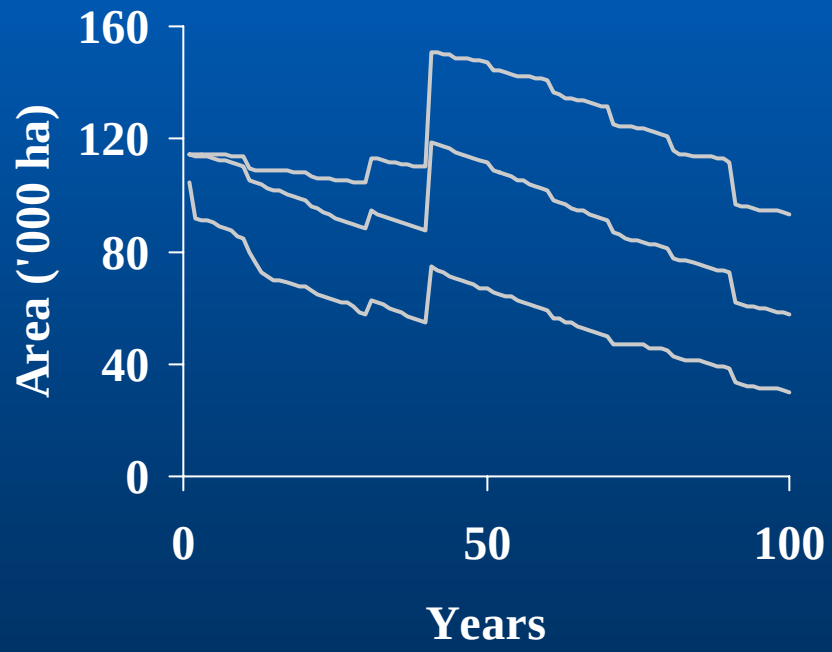


Simulated Habitat Projections

Pine Marten Habitat (5+)



BTGW Habitat (5+)



Trends

- More indicators
- Increased spatial detail
- Increased stochasticity?
- More complicated models
- More “disconnect” between analysts and users

Ramblings and reflections

- Need for “secure, stable, and known” supply of wood fibre (Dave West)
- Management must “instill public confidence” (Dave West)
- Sustained wood supply helps “maintain communities” (Riet Verheggen)
- “modeling toolkit is growing faster than our knowledge base” (Tim Bogle)
- “diminished role of thinking” and “complexity without understanding” (Dirk Kloss)

Everything should be made as simple as possible, but no simpler.

--Albert Einstein (?)