Spatial modelling of landscape pattern

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Outline

- Landscape planning in a forest management modelling context
- Spatial forest management models as landscape management planning tools
- Evolving practices for landscape planning
  - Policy analysis
  - Management planning

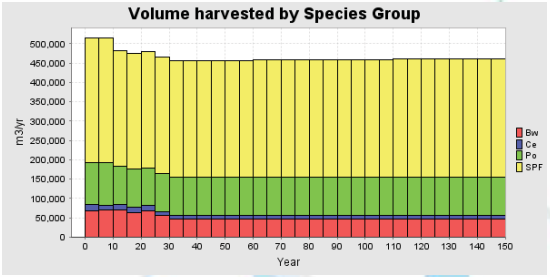
Decisions are choices between alternate futures

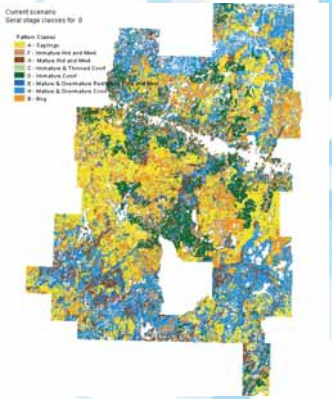
- When we choose one alternative over another, we are really selecting the short or long-term future outcome we prefer
- When we think about future benefits we are making predictions
- We cannot manage what we cannot predict
- “Active” management options revolve around timber operations

Wood supply modelling is all about forecasting future benefits

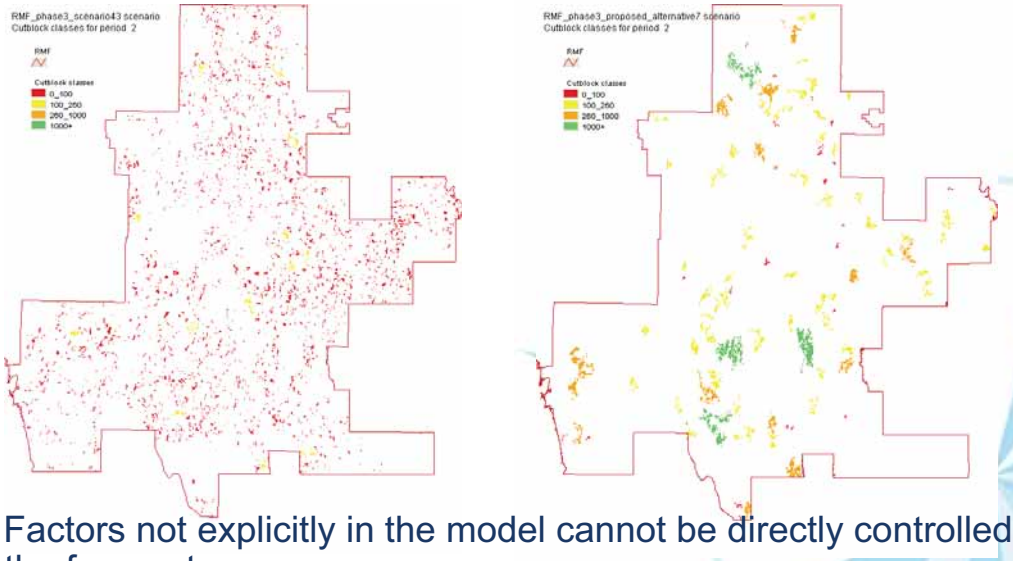
- Time-base forecasts of stand and forest development
  - Growth
  - Available harvest
  - Retained growing stock
  - Budgets

- What about changing pattern and location over time?





Aspatial models do not consider spatial arrangement

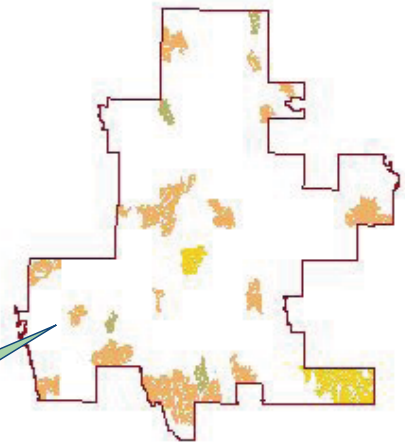


- Factors not explicitly in the model cannot be directly controlled in the forecasts
- Shotgun pattern on left is not reality (regulations and best practices would not allow the forest to develop in this manner).

Marten core area deferral

- *Suitable marten habitat should be arranged in "core habitat areas" between 30 and 50 km2 in size. A minimum of 75 percent of core habitat areas should be comprised of suitable stands.*

Identify areas to be deferred from harvest for up to 60 years.

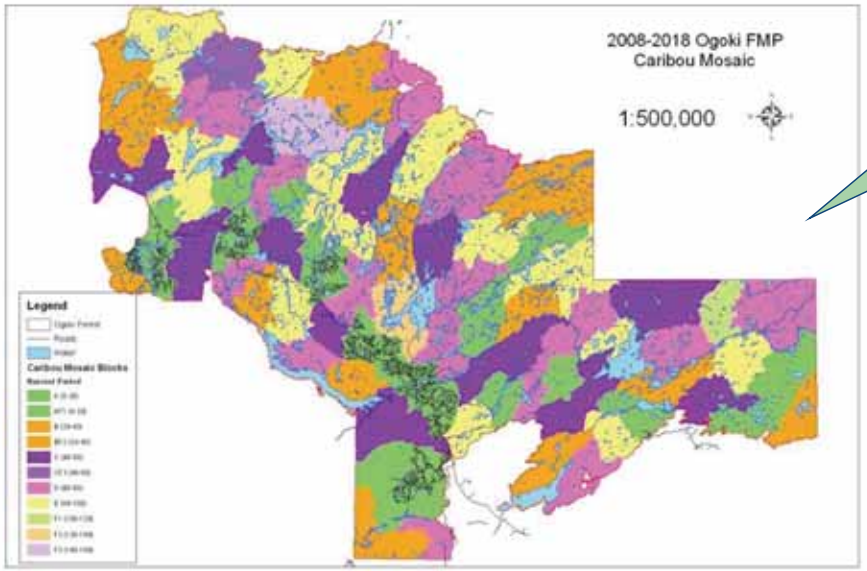


Where are the core areas after 60 years?

Operational Gridlock

- Operational policies will restrict current practices to follow spatial guidelines, but what about long-term impacts?
  - Is it possible to follow guidelines yet still end up with undesirable conditions (fragmentation)?
- Management should seek to prevent foreclosure of future management options
  - Means actively assess future conditions

Caribou mosaic



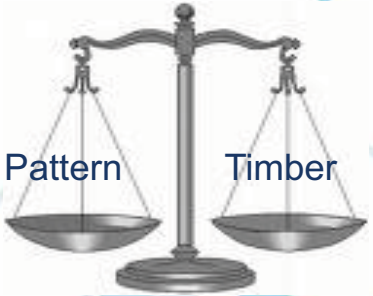
850,000 ha forest
Harvest in 5 ‘passes’

Manual design approaches to landscape planning

- Slow, painstaking
- Not necessarily coming up with ‘best’ design with respect to all management factors
- So expensive that it is difficult to compose and assess alternate designs

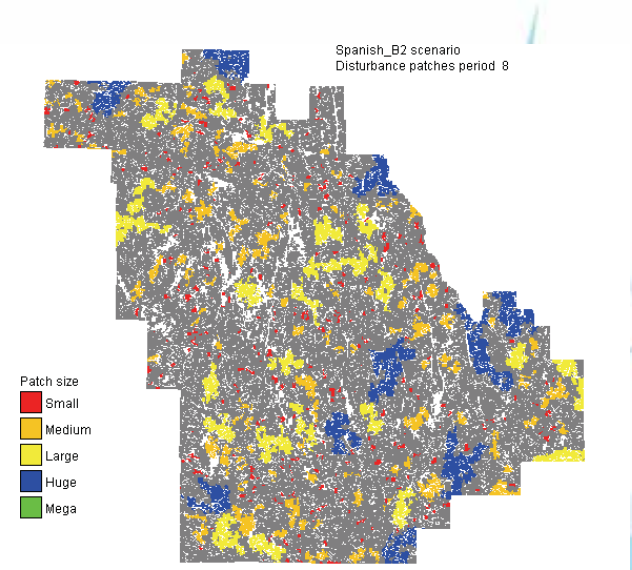
Need to combine spatial controls with traditional wood supply goals

- Non-timber objectives (including spatial arrangement) as goals, not constraints
  - Goal programming
- Automate the design process
- Explore trade-offs between mutually exclusive outcomes
  - What happens to wood supply when spatial pattern is enforced?
  - Can intensive forest management mitigate decreases in wood supply



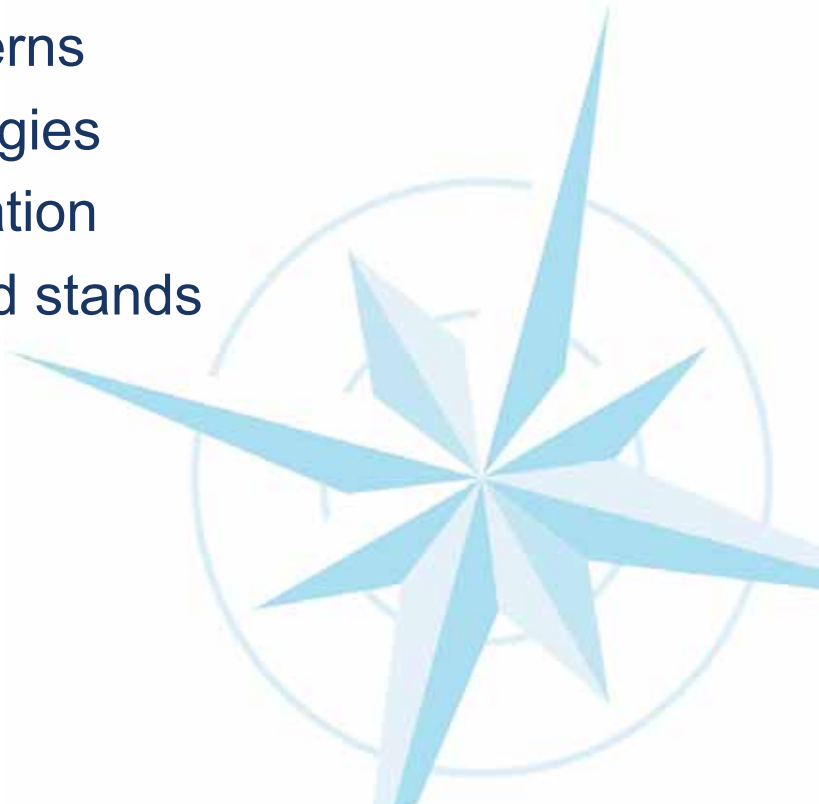
What types of spatial controls?

- Patches of contiguous similar forest condition
  - Based on common stand condition
  - Within a specified separation distance
- Targets set by patch size class
  - Frequency or area within size class
  - Changing over time



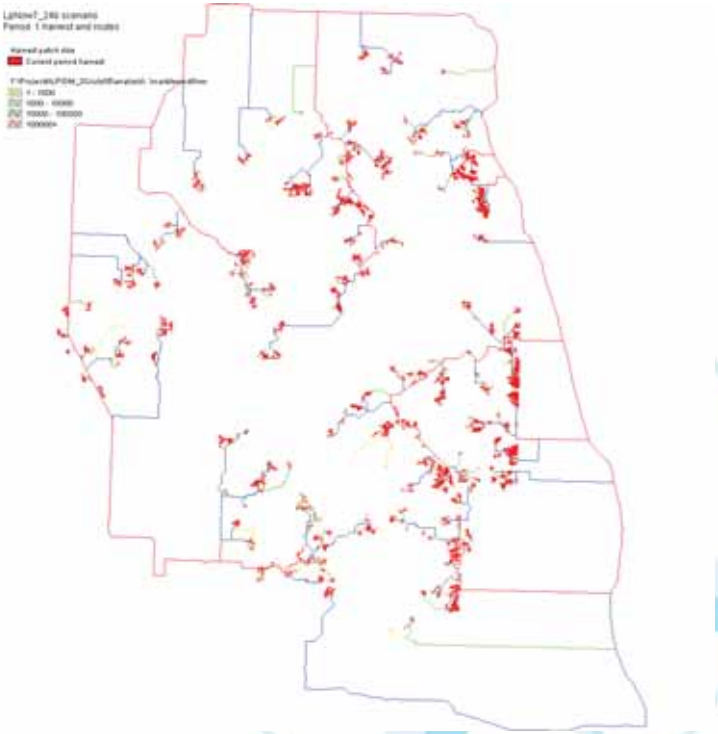
Spatial factors of practical importance

- Existing assess patterns
- Roadless area strategies
- Barriers to transportation
- Economically isolated stands



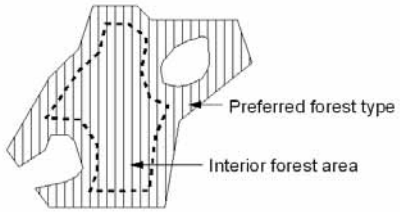
Transportation modelling

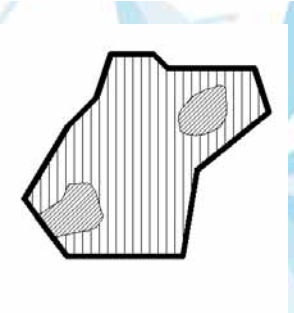
- Fully connected topological model of transportation of multiple products to multiple destinations
- Construction, maintenance and hauling costs vary by individual segment
- Accounts can track costs by category, and targets on accounts can participate in the goal programming formulation



Weaknesses of spatial controls in management models

- Poor treatment of interspersion
  - What types and how much are allowed to intersperse with core patches
- Interior core area vs. gross patch area
- Shape morphology
  - Do long skinny shapes provide the same ecological function as dense compact shapes?





Design vs Assessment models

Design

- Propose new arrangement
- Simplistic spatial arrangement
- Based on deterministic objectives
- Trade-off between objectives

Assessment

- Evaluate existing or proposed arrangement
- Complex and detailed spatial arrangements
- Based on biological hypothesis
- Evaluate objectives independently

Context for using spatial models

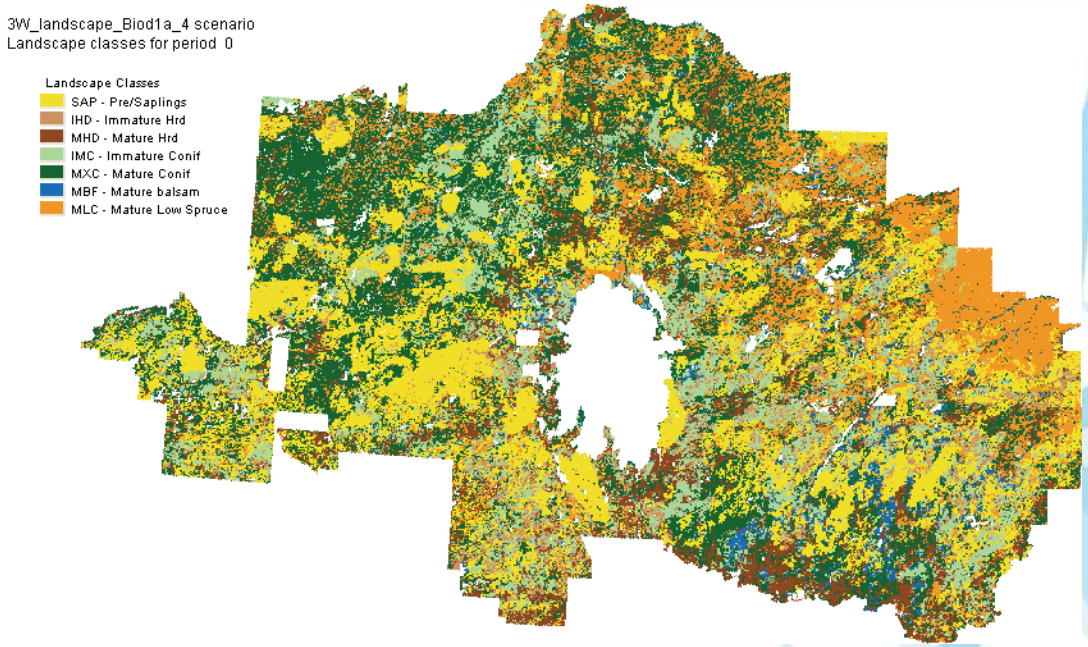
- Policy analysis
  - Determine effectiveness and impacts of alternate guidelines
- Management planning
  - Develop long-range strategic plan that is consistent with spatial guidelines

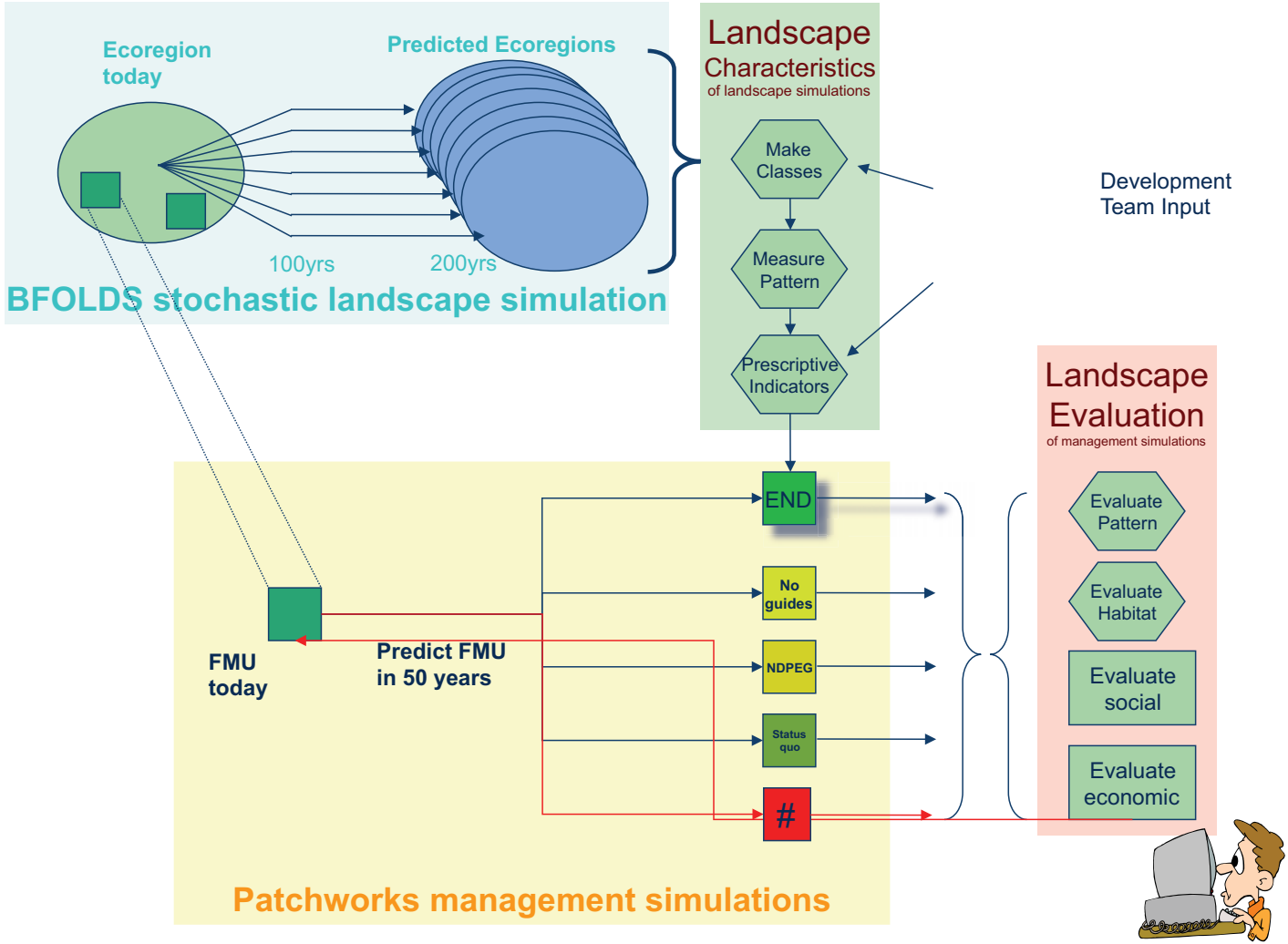
Policy analysis level modelling

- Explore impacts of proposed policy
  - Will this policy achieve the stated goals?
- Game with the system
  - What are the alternatives
- Feasibility of implementation
  - Test drive the planning and management tools
  - What problems will arise putting policy in to practice

3W case study

- 10 million ha eco-region in NW Ontario
- 11 sustainable forest license planning areas
- 10 processing facility destinations




Ecoregion today
Predicted Ecoregions
100yrs
200yrs
BFOLDS stochastic landscape simulation
Landscape Characteristics
of landscape simulations
Make Classes
Measure Pattern
Prescriptive Indicators
Development Team Input
Landscape Evaluation
of management simulations
Evaluate Pattern
Evaluate Habitat
Evaluate social
Evaluate economic
END
No guides
NDPEG
Status quo
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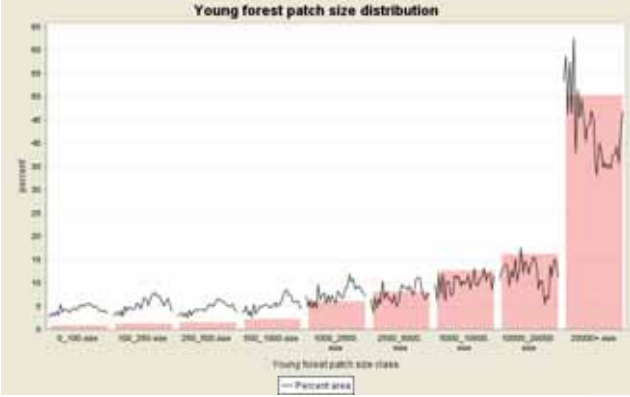
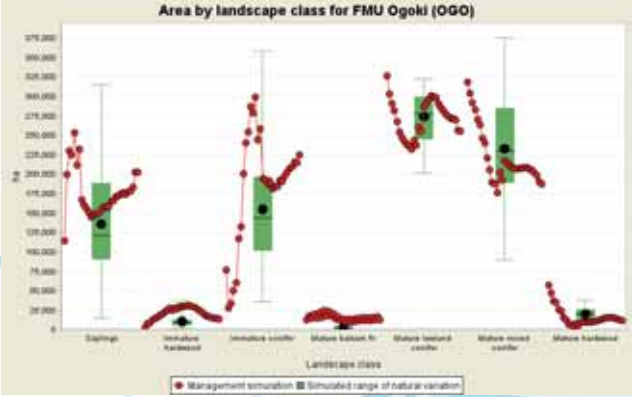
FMU today
Predict FMU in 50 years
Patchworks management simulations

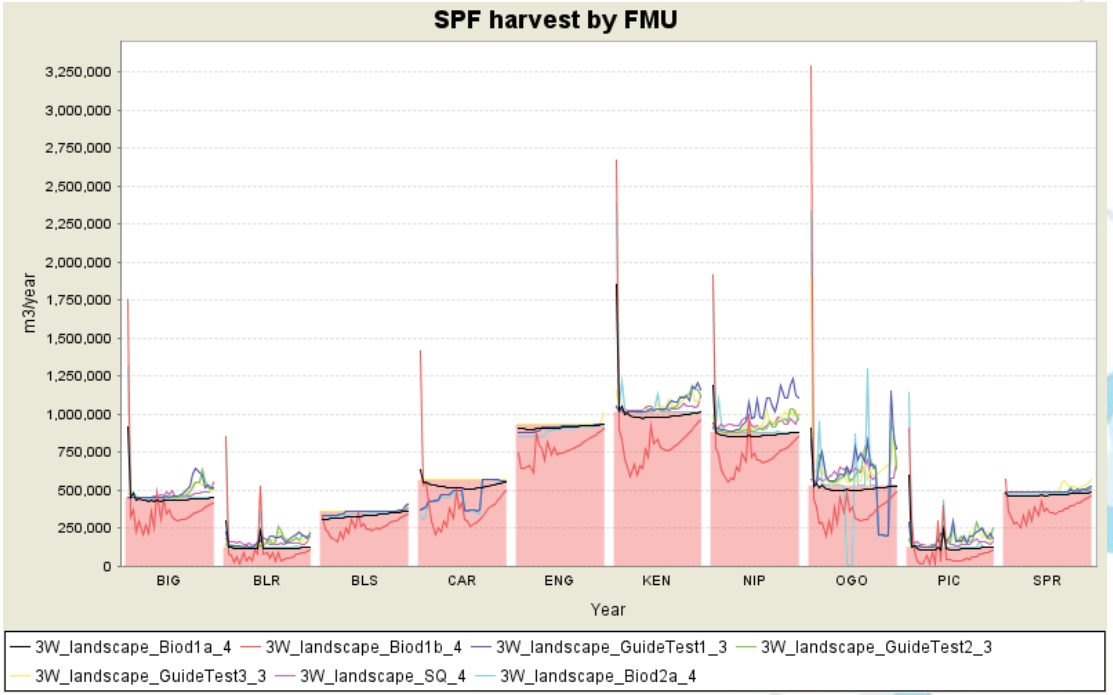
Simulated range of natural variability





Location of young forest through time

Economic indicators

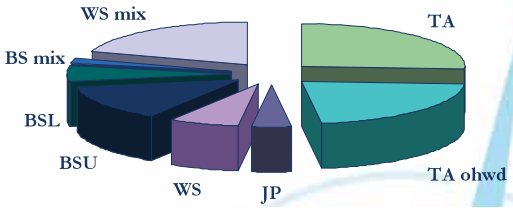


Management planning case study

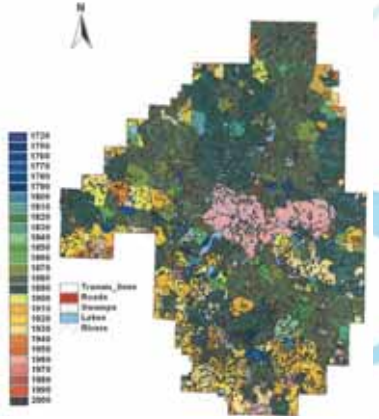
- Develop 200-year strategic plan that shows
  - Timing and location of all proposed treatments
  - Explicit forecast of future forest conditions
  - Evaluation of future conditions using detailed spatial assessment model

The Duck Mountain Forest - Management planning

Available forest	234,882 ha
Reserved forest	82,041 ha
Non forest	59,994 ha



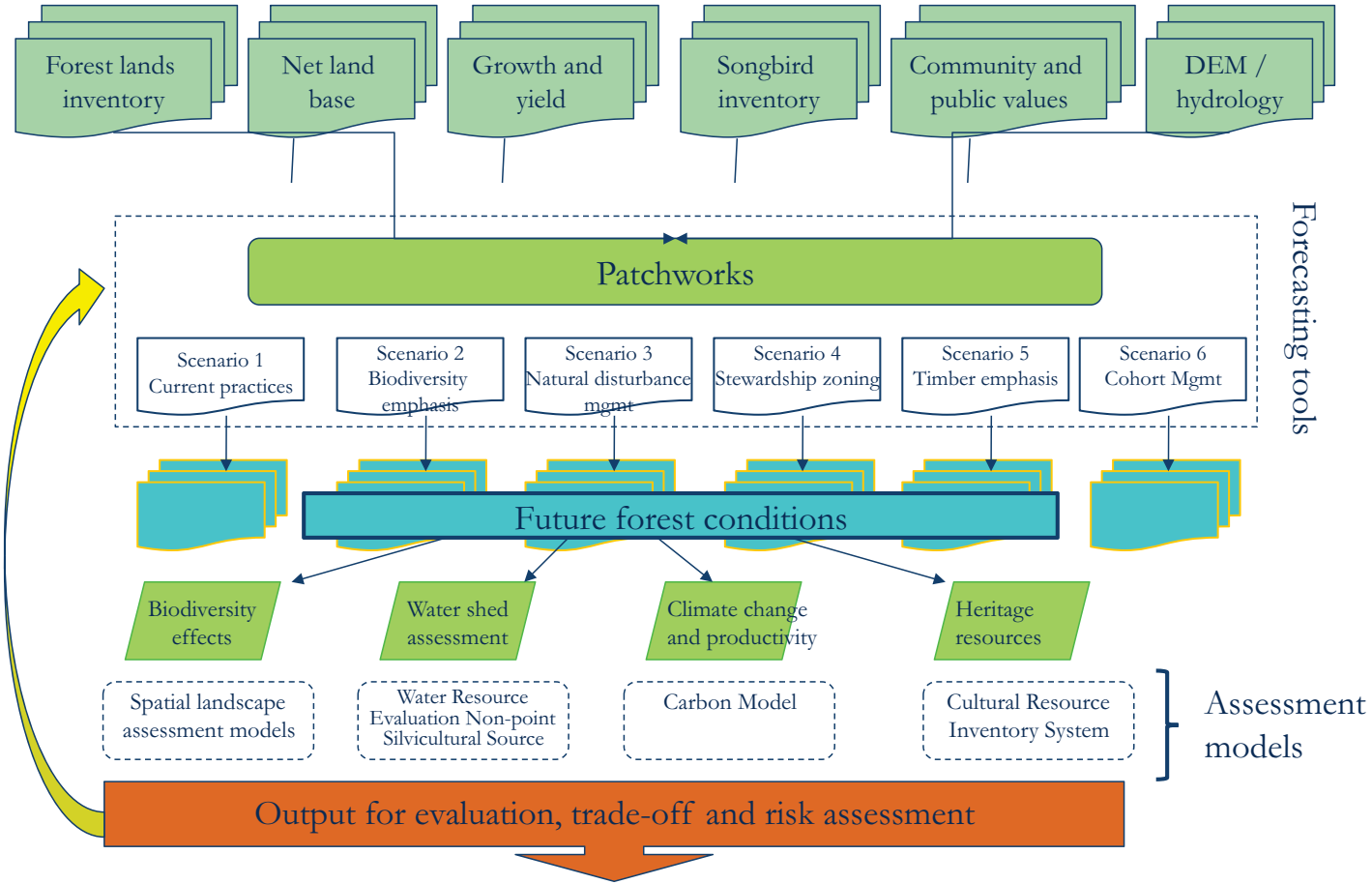
- 385,000 ha land base
- Aspen and mixedwood composition
- Older ages due to past fire history
- Surrounding agricultural land use



Time since Fire map (Tardif, 2004)

Management availability

LP's Scenario Planning Framework

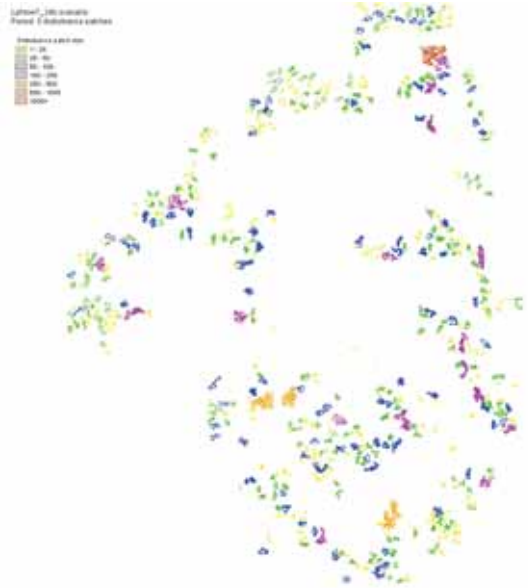


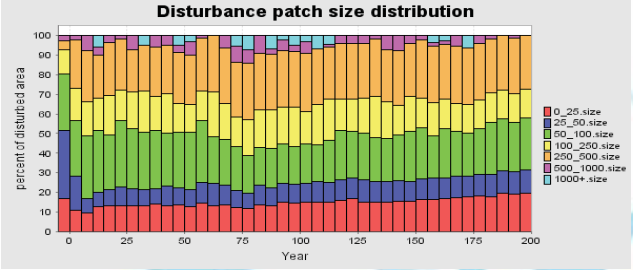
Disturbance patches

- Size of contiguous area of 'younger than free-to-grow' (10-15 years since harvest)
- Membership criteria based on species composition
- 'Narrow' (current practice) and 'broad' (biodiversity emphasis) ranges

Size	Narrow	Broad
0 - 25 ha	40%	25%
25 - 50 ha	40%	15%
50 - 100 ha	30%	15%
100 - 250 ha	0%	15%
250 - 500 ha	0%	30%
500+	0%	0%

Patch size reports

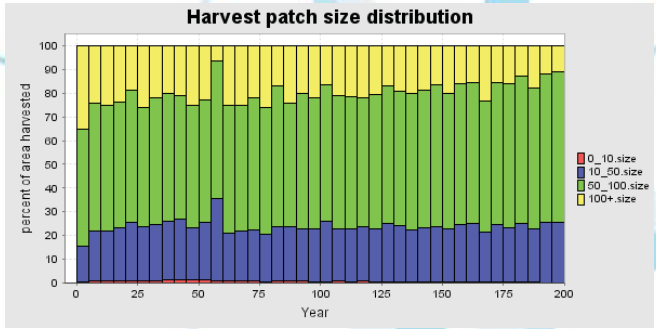




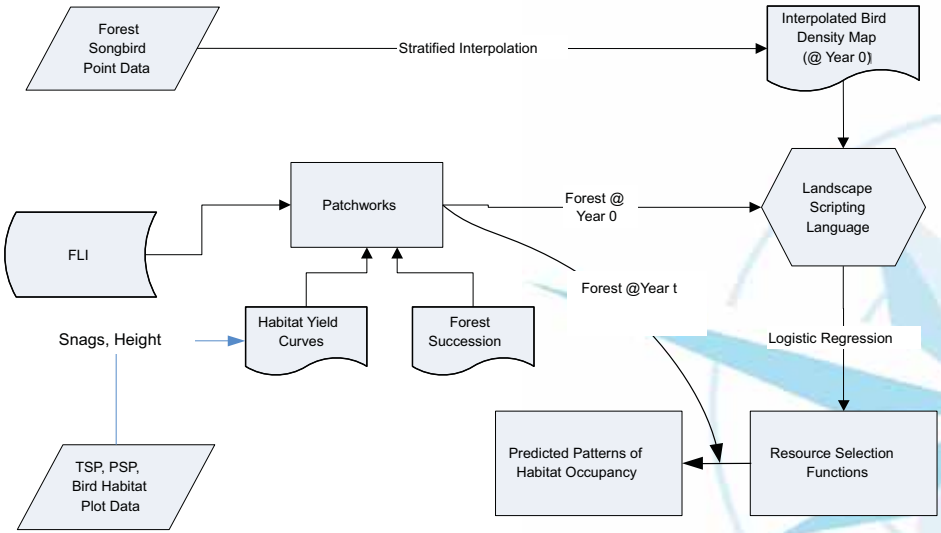
Harvest openings

- Similar to disturbance patch modeling, but looking at area harvested within each planning period.
- At the larger end of the scale, harvest openings must not exceed provincial regulations
- Small openings should be discouraged due to cost and fragmentation considerations
- Size targets based on current practice

0-10	0%
10-50	30%
50-100	70%

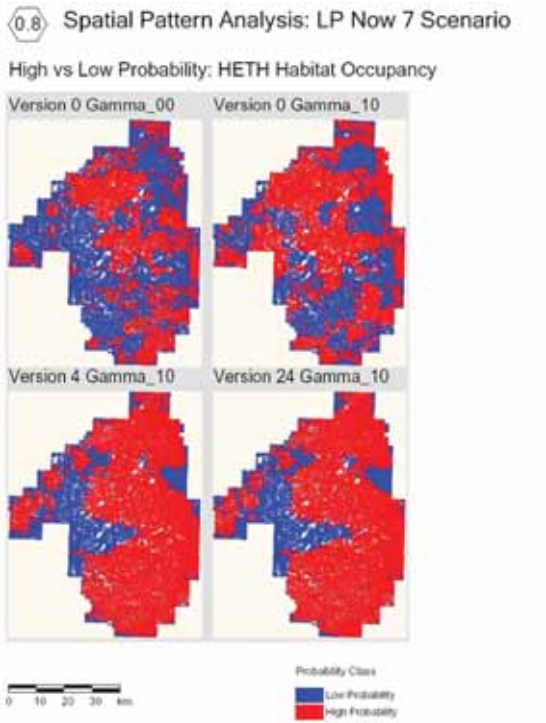


Assessment – Spatial Landscape Assessment Model



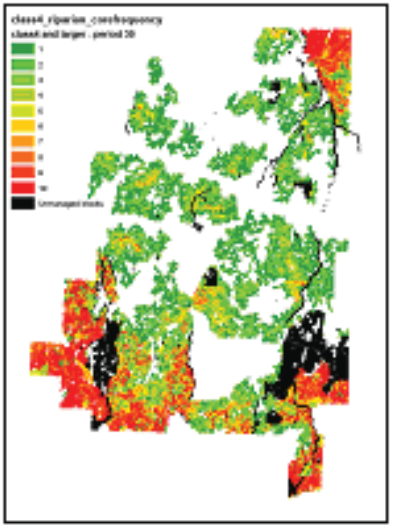
SLAM output

- Inventory forecasts exported by PW
  - Snapshots at 5, 10 15, 20,25, 40, 50, 100 years
- Landscape Scripting Language computed multi-scale summaries and applied RSF across surface



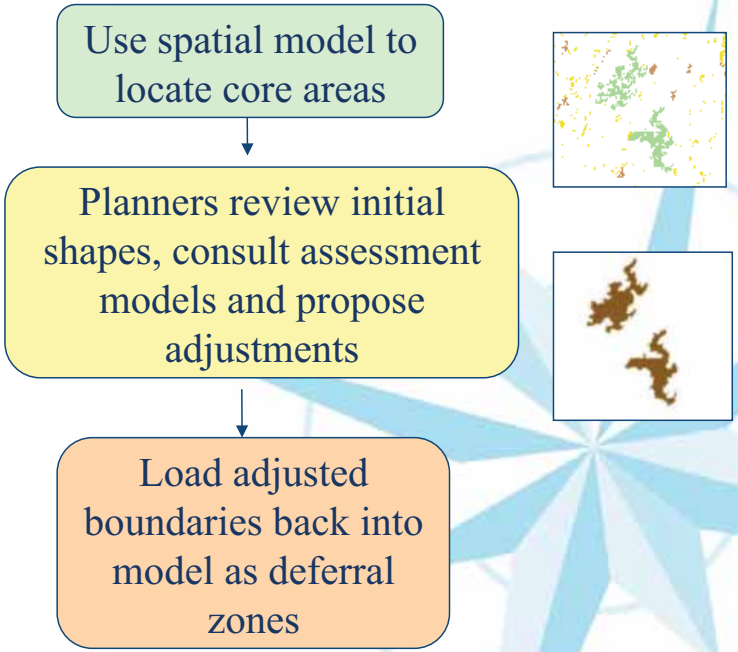
Repeatability

- How many different designs accomplish an equivalent outcome?
- Is there are single design that is optimal and therefore correct?



Semi-automated design

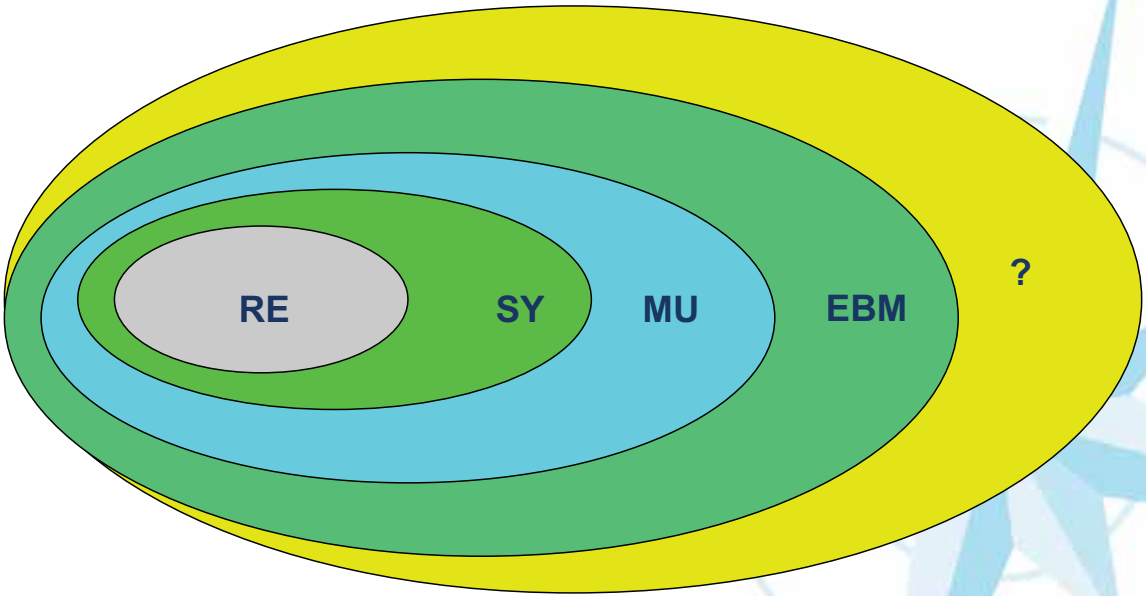
- Allow spatial model to conjecture a design
- Let planners use it as a starting point as they include other operational factors



Dealing with uncertainty

- Planning process repeats every 5 to 10 years
- Within this time frame many other changes occur
  - Public policy
  - Economy
  - Large catastrophic disturbance
  - Climate change
- No matter what long-term plan is developed, only the first 5-10 years really matter.
  - The rest is just to prove to ourselves that sustainability is possible

Repeating patterns...



Summary

- Decision making is a choice between alternate futures. Informed decisions are made when we can reasonably forecast the outcomes of our actions.
- Spatially explicit forest management models simultaneously consider pattern and other conventional wood supply goals, and are able to make long-range forecasts of various spatial management policy options.
- For policy development, spatial models can test impacts and evaluate if policies will help to achieve stated goals.
- For forest management planning, spatial models help ensure our short-term actions are consistent with long-term sustainability goals.
- Assessment models are used to evaluate and interpret spatial model outputs in greater detail (fine filter models).
- Models, data sets and assumptions are fraught with errors and uncertainties, and reality never works out as we plan. Replanning occurs every 5-10 years to provide mid-course corrections to a sustainable trajectory.