Projecting impacts of management alternatives

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Background

- Many ecological problems can only be understood and managed at landscape scales
  - Managing in the presence of broad-scale disturbance such as fire and insects
  - Understanding natural variability
  - Assessing management plans in light of global changes

Background

- Forested landscapes are characterized by:
  - a mosaic of diverse ecological conditions
  - multiple disturbance regimes
  - anthropogenic use and management
  - multiple global changes impinging upon them
  - complex interactions among all these factors

Background

- It is difficult for managers to:
  - understand the effects of proposed management actions in the presence of complex interactions
  - assess the range of natural variability of ecosystem properties
  - objectively predict the landscape consequences of management alternatives
- Dynamic landscape simulation models can be useful tools in such situations

Landscape Disturbance-Succession Models

- Landscape models are computational formalisms of state-of-the-art scientific knowledge
  - How to interpret model output: IF the state-of-the-art knowledge is correct, then this is how the system will behave
  - Well-verified models are as good as the science they reflect
- Landscape models are generalizations
  - At a fine level of detail, they will not duplicate the specifics of past or future history (which has a random component)
- Provide relative comparisons of system trends rather than absolute answers of system state (events, local conditions)
- Integrate ecological and forestry issues for research and planning purposes
- Support an ecosystem approach to management

Landscape Disturbance-Succession Models

- Account for spatial processes and spatial dynamics
- Consider long temporal scales and large spatial scales
- Account for complex interactions among ecological and management processes
- Make predictions about the *expected range* of future forest ecosystem states – composition, pattern, biomass
- Do not accurately predict individual events, but do accurately simulate regimes

Major LDSMs in use today

- Pathway (transition) based succession
  - VDDT/TELSA
  - LANDSUM
  - SIMMPPLE
  - RMLANDS
  - Fire-BGC
  - FETM
  - HARVEST
  - Disturbance simulation may be process-based
- Many western ecosystems have fairly predictable succession trajectories, and are well-simulated with this approach

Major LDSMs in use today

- Process-based succession (and disturbance)
  - LANDIS (v 4.0 and Landis-Pro)
  - LANDIS-II
- Eastern ecosystems tend to have less predictable successional trajectories, so a process-based approach may be required
- Predicting ecosystem behavior under novel conditions (e.g., climate change) may require a process-based approach

Validation issues

Validation usually refers to the quantitative comparison of model predictions against observations

- Impossible to validate predictions made over large areas and very long time scales

- Validate independent model components that are as simple and discrete as possible
- Verify component interactions
- Compare model behavior with known ecosystem behavior
  - Historical time series data
  - Expert opinion of expected ecosystem behavior
  - Consistency of model behavior with the model design (which is based on current ecological literature)
- Conduct sensitivity and uncertainty analyses
- Open source – many eyes are likely to spot problems

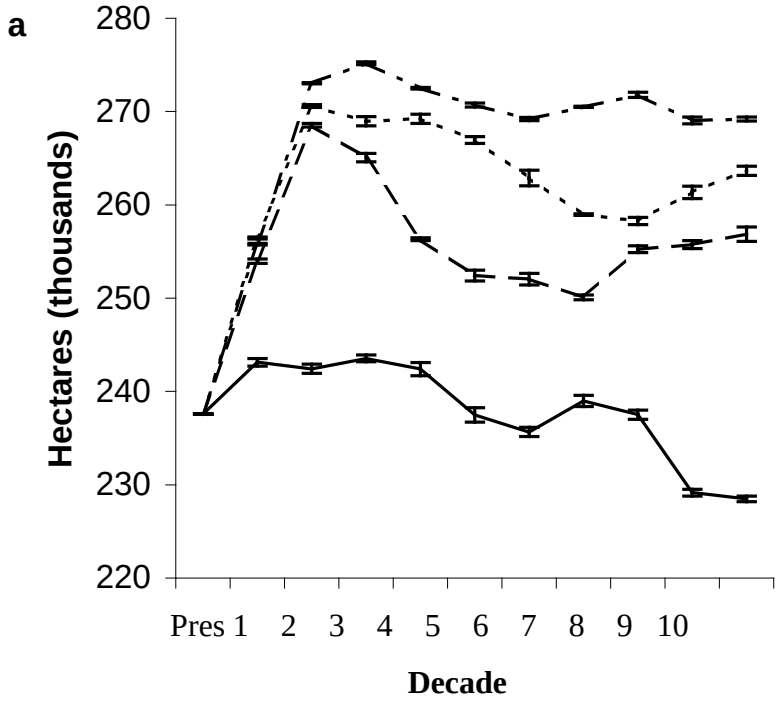
Primary use of LDSMs for Forest Management

- Compare outcomes of management alternatives
  - Management alternatives in the planning process
  - Forest Plan implementation strategies. For example:
    - Fuel reduction treatments
    - Habitat improvement strategies
- Compute effects of proposed management
  - Species and age class composition, biomass
  - Spatial pattern (patch size, connectivity, interior, juxtaposition, etc.)
  - Habitat for specific species of interest

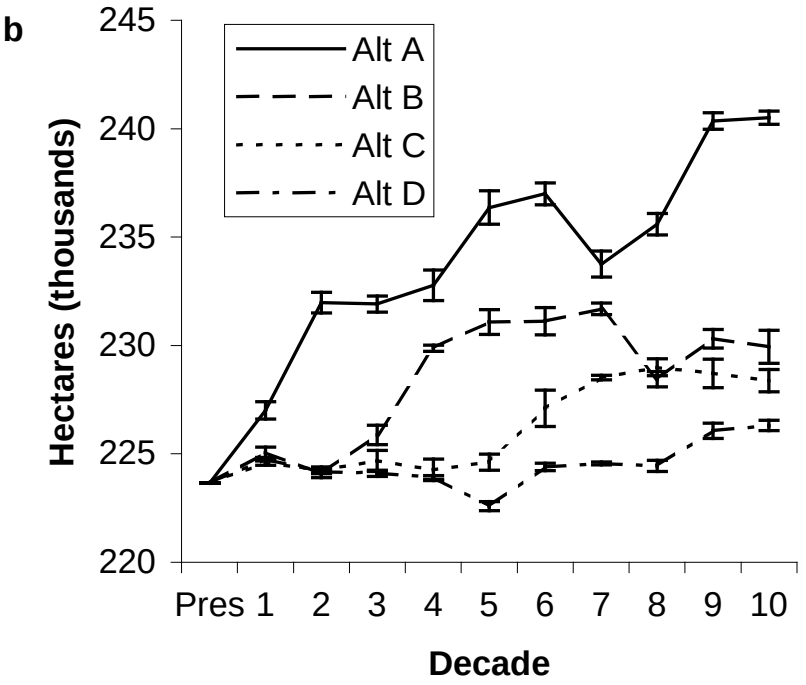
Some examples: Chequamegon-Nicolet National Forest

Harvest/Spectrum Alternative comparisons

Interior habitat

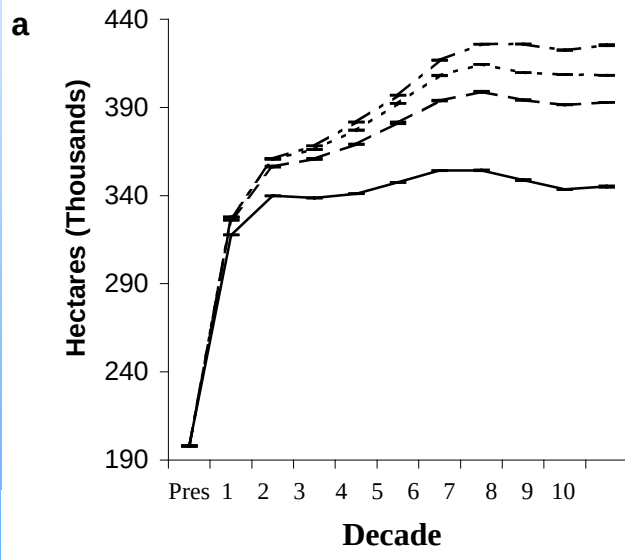


Edge habitat

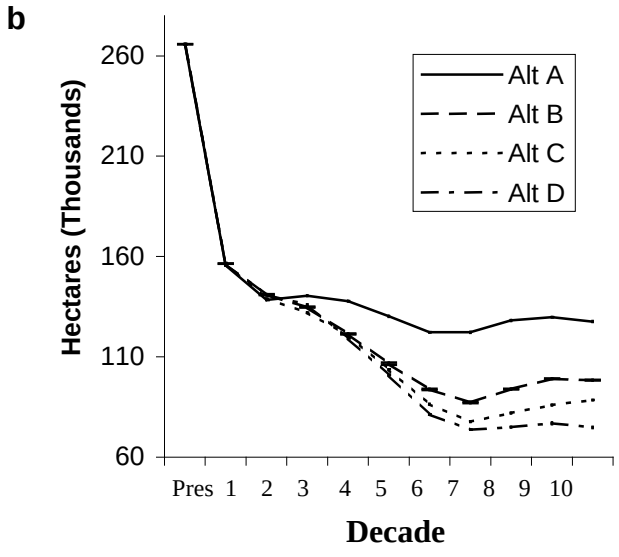


Harvest/Spectrum Alternative comparisons

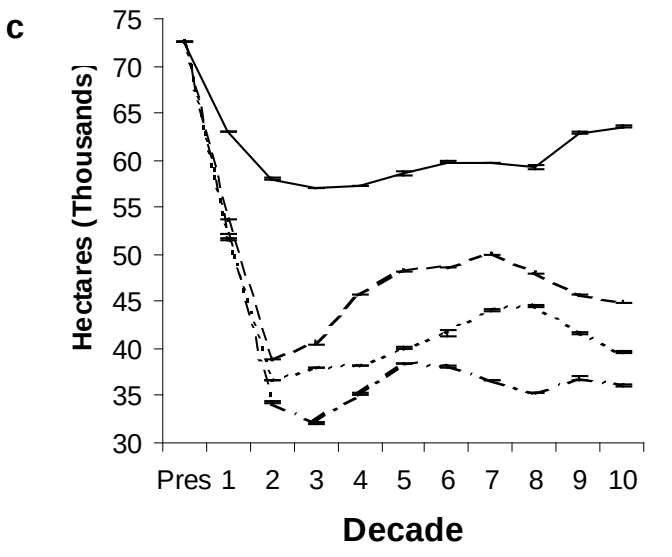
Area of mature forest



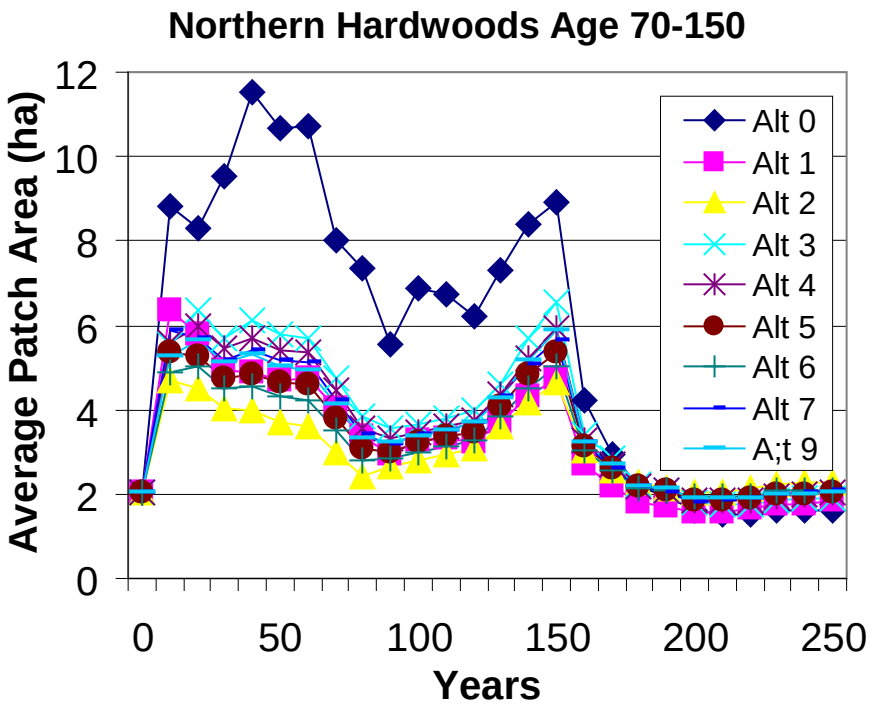
Area of young forest

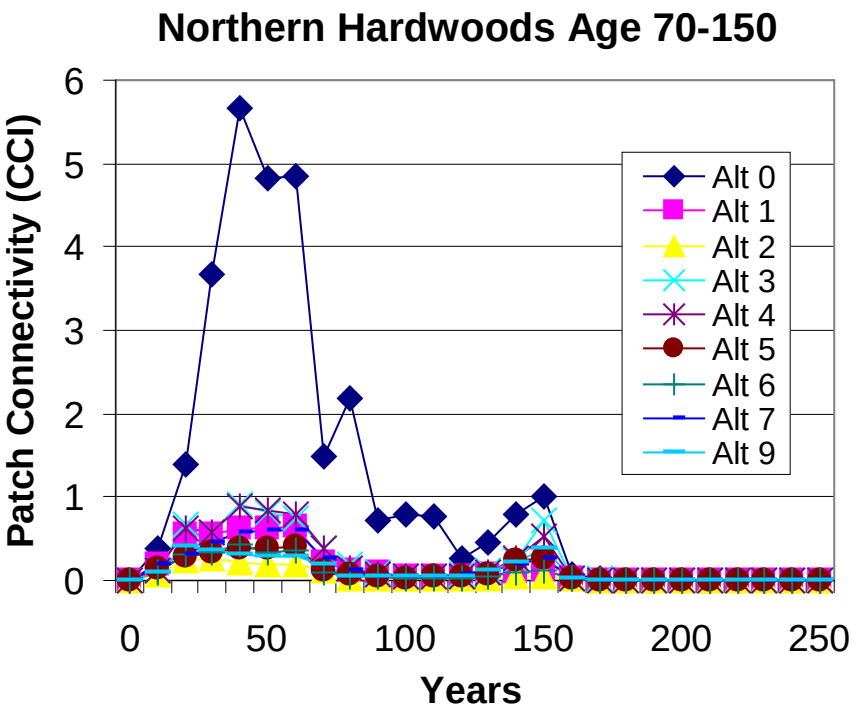


Area of regenerating forest



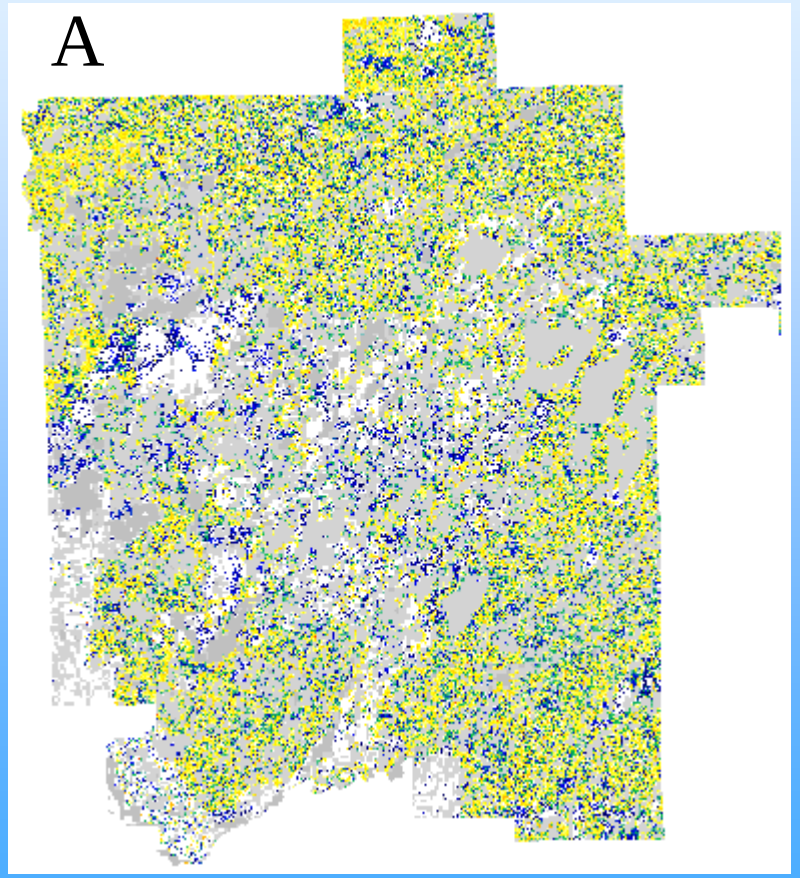
LANDIS
Alternative comparisons

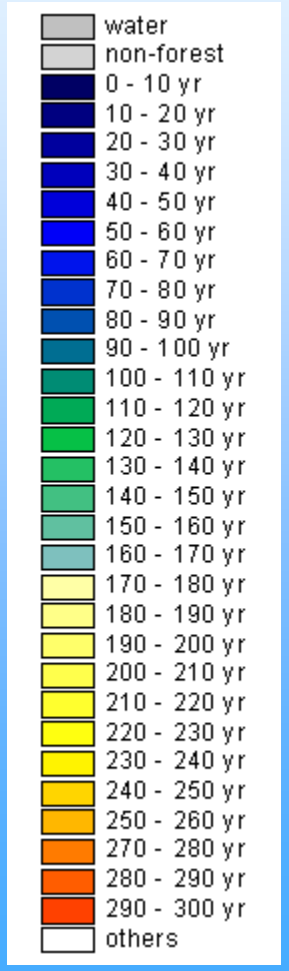


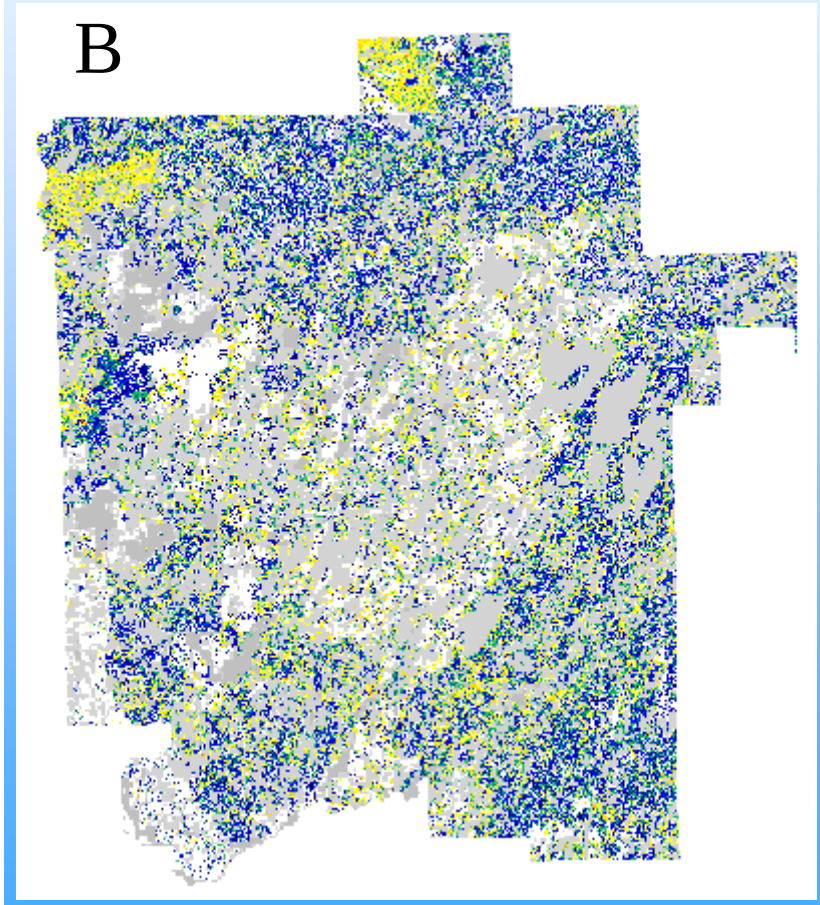


LANDIS
Alternative comparisons

Age of Northern Hardwoods Year 250

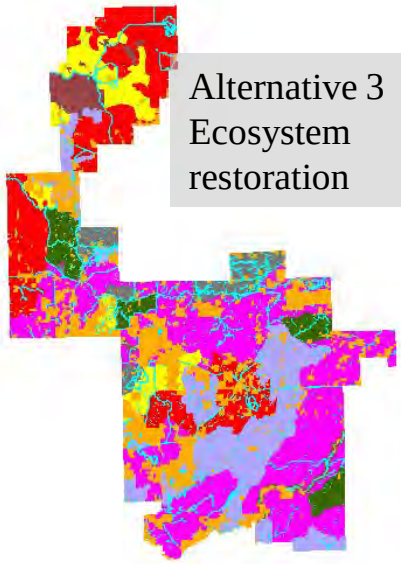




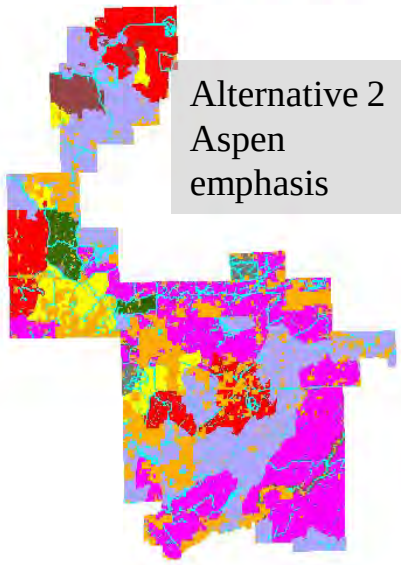


LANDIS
Habitat Projections for Alternatives

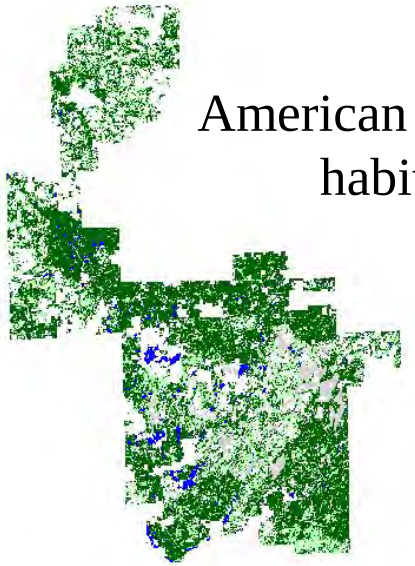
Management Areas and objectives



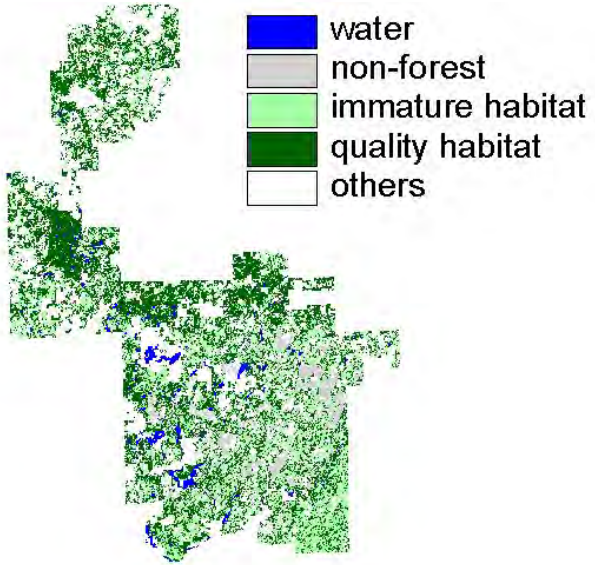
Alternative 3 Ecosystem restoration



Alternative 2 Aspen emphasis

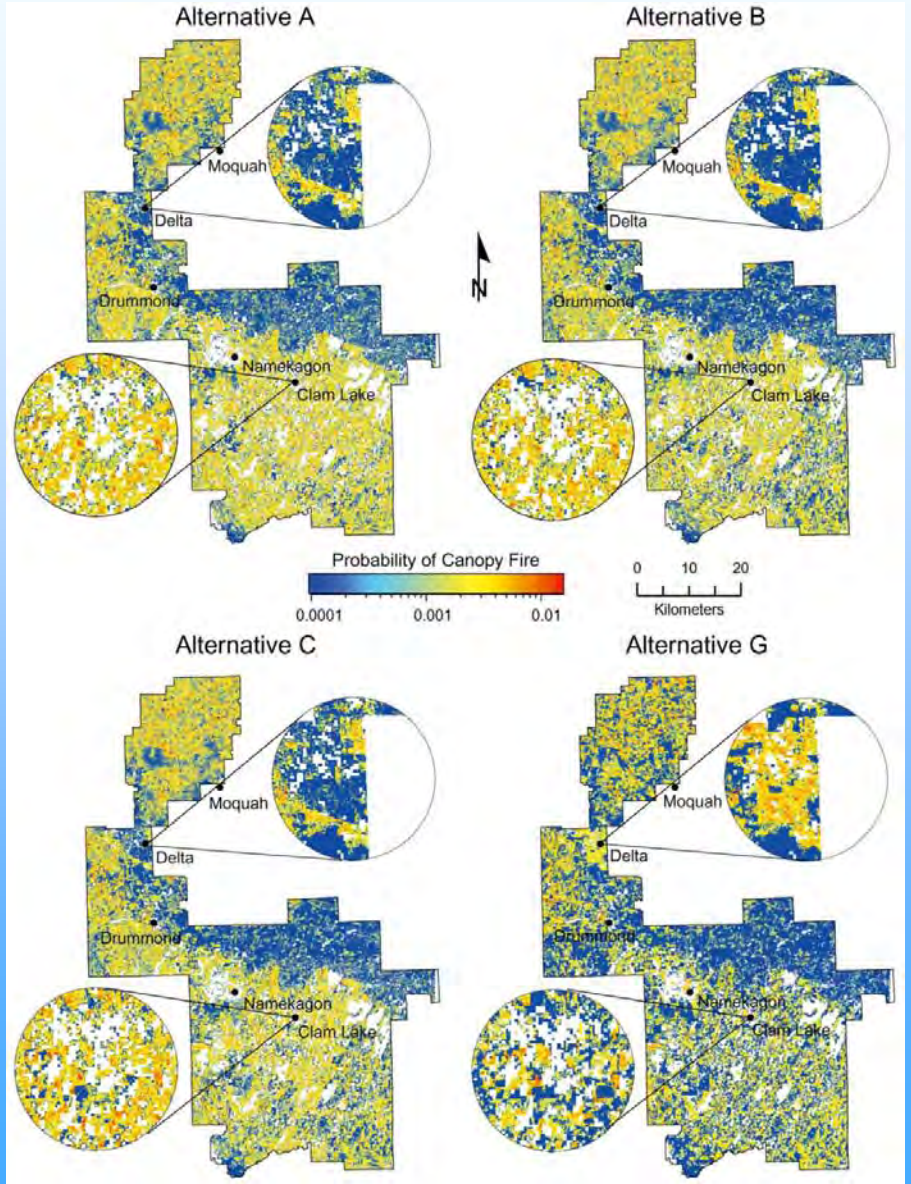


American Marten habitat



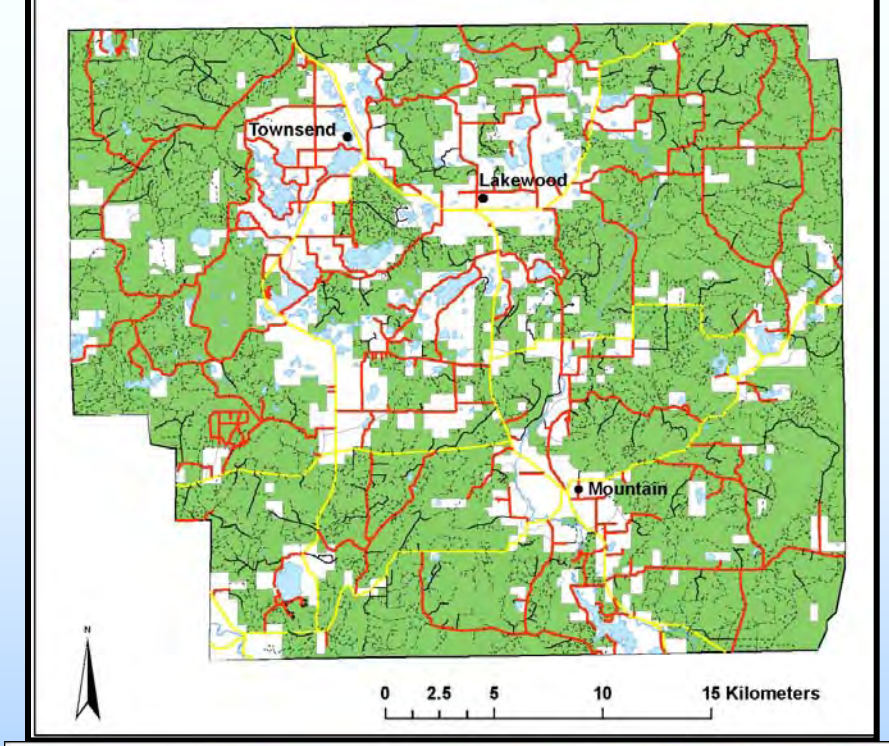
LANDIS

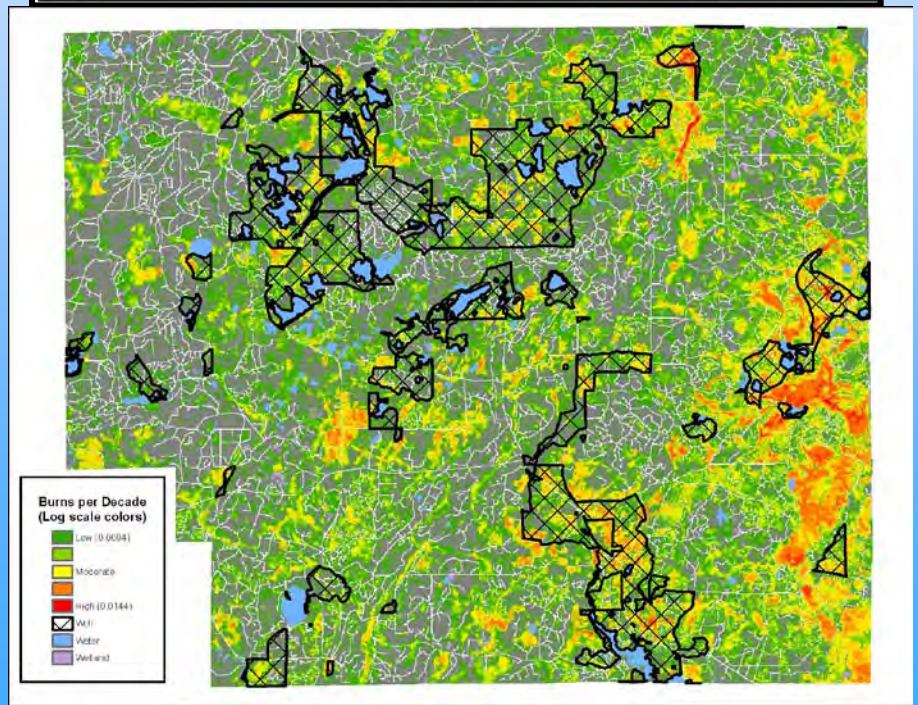
Alternative comparisons – fire risk



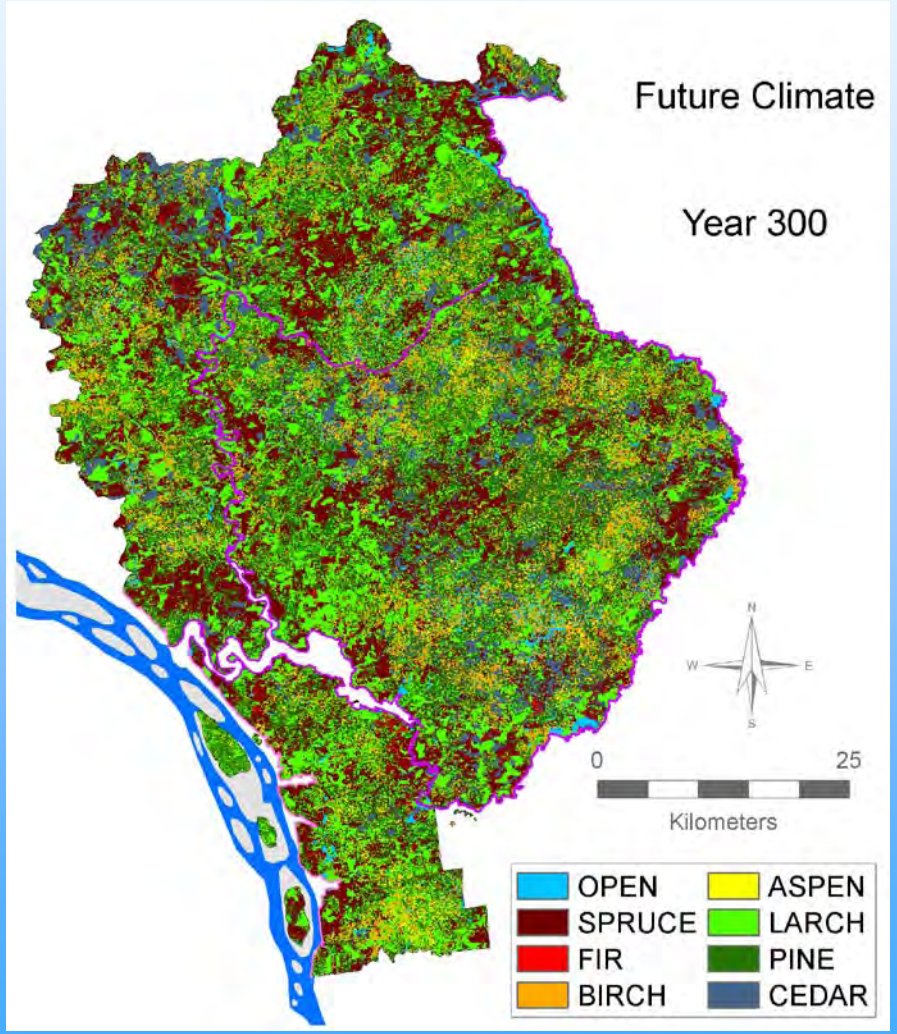
LANDIS: Assessing fire risk across all lands

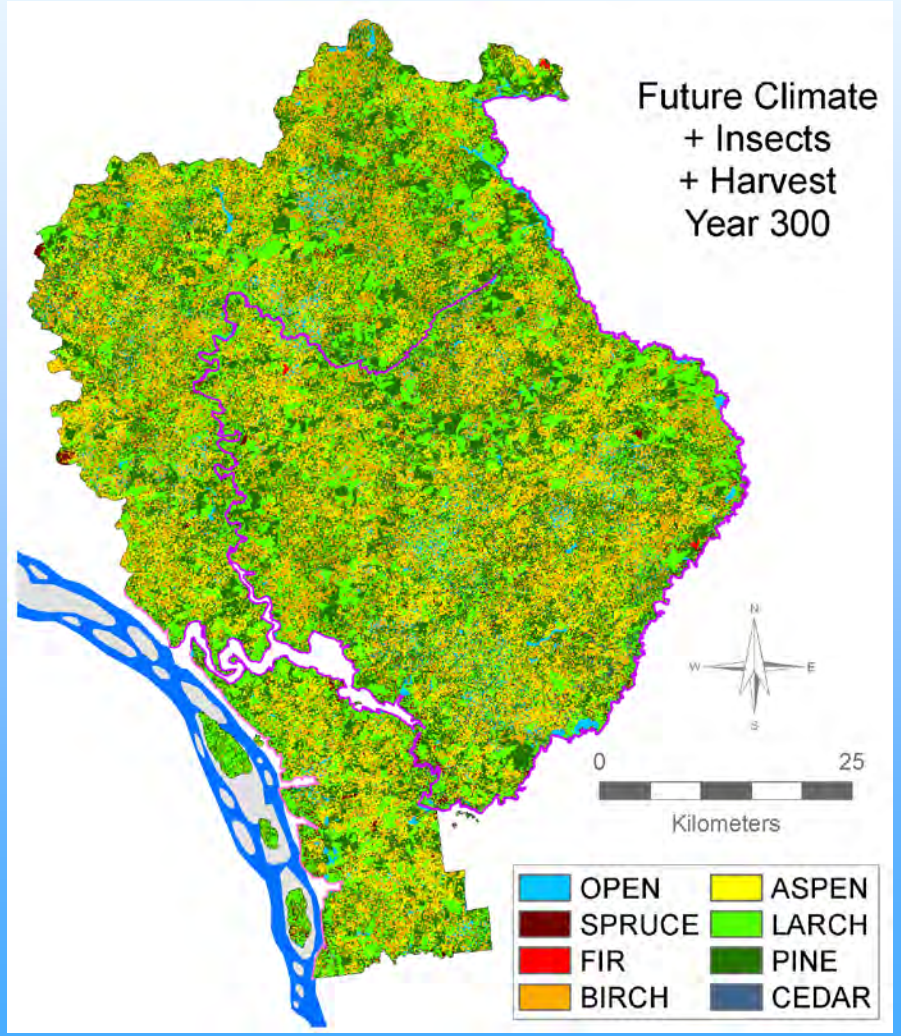
- Parts of the Chequamegon-Nicolet NF are fire-prone and have rapidly developing privately-owned inholdings
- Tested fire risk mitigation strategies accounting for behavior on non-FS land





LANDIS
Global change effects in Siberia





Elements to Incorporate into the Planning Rule

- When projecting the impacts of alternatives:
  - Focus on appropriately large spatial and temporal scales for evaluating ecosystem drivers and responses
  - Account for any important spatial dynamics of forest regenerative and degenerative processes
    - Seed dispersal, establishment, succession, productivity
    - Disturbance, disease, drought, harvest
  - Account for interactions among the drivers of ecosystem dynamics and condition
    - Establishment, competition and succession
    - Natural disturbances and stressors
    - Human disturbance and use (including adjacent lands)
    - Global changes (climate, novel disturbances such as insects, invasives)

Elements to Incorporate into the Planning Rule

- Explicitly allow planners to rely on state-of-the-art landscape models for effects analysis
  - Peer-reviewed, widely cited models represent the best available science
  - Favor comparisons rather than absolute projections
  - Avoid a one-size-fits-all prescription of models to use, or approaches to take
    - Ecosystems, processes, sustainability issues vary widely
- Consider how spatial pattern affects ecological process (landscape ecology)
  - Model outputs can be used to predict effects on many forest-related benefits such as wildlife, water yield, C sequestration

Elements to Incorporate into the Planning Rule

- Acknowledge uncertainty, and clearly define its role in the decision-making process
  - Uncertainty can be estimated by variability of replicates, estimation error of model inputs, and sensitivity analysis
  - Uncertainty can be quantified as the range of possible ecosystem conditions under a given management alternative
  - Uncertainty can be reduced with adequately replicated results
  - Uncertainty of comparisons is generally less than for absolute projections
  - Must not let uncertainty unduly handcuff decision-making
    - The best available science often has substantial uncertainty
    - Mitigate uncertainty through adaptive management strategies

Notice-of-Intent Comments

- Not sure why there is a restoration emphasis in the NOI
  - Presumes that NF lands are typically degraded?
  - The questions raised about restoration are valid ones
  - Climate change may preclude restoration of any previous condition
  - I recommend a sustainability or resiliency emphasis
    - This may require restoration in cases of degradation
  - Shift focus from preserving existing species and communities to promoting a diversity of sustainable species and communities in the face of uncertain future conditions
- Watersheds may not be the best planning unit in regions with low topographic relief. Use ecological units?