Landscape Ecosystems and Native Plant Communities

Where we’ve been and where we’re going
## Early efforts for the 1\textsuperscript{st} NE Landscape Plan

<table>
<thead>
<tr>
<th>Report</th>
<th>Author</th>
<th>Date</th>
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<tbody>
<tr>
<td>Range of Natural Variability in Forest Structure for the NSU</td>
<td>Lee Frelich, UM, for FRC</td>
<td>Sept 1999</td>
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<tr>
<td>Native Plant Communities of the Northern Superior Uplands (Draft)</td>
<td>Kurt Rusterholst, DNR Natural Heritage Program</td>
<td>Nov 1999</td>
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<tr>
<td>Landscape Ecosystems for the NSU: Draft Map &amp; Methods</td>
<td>Mark White &amp; George Host, NRRI</td>
<td>Aug 2000</td>
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<tr>
<td>NSU 10 Year Growth Stages</td>
<td>Terry Brown &amp; Mark White</td>
<td>2000</td>
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<td>Northeast Landscape RNV Analysis</td>
<td>White, Brown, Host</td>
<td>Jan 2001</td>
</tr>
<tr>
<td>1990-2002 Trend Assessment</td>
<td>Brown &amp; Host</td>
<td>2006</td>
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</table>
Premises

• Understanding how different forest ecosystems respond to past disturbance is a key to understanding how they’ll behave in the future

• NSU contains communities that respond differently to disturbance
  – Northern Hardwoods
  – Red & White Pine
  – Aspen-birch-spruce-fir
  – Lowland Conifers
Landscape Ecosystems (Frelich)

- Identified late successional forest communities
  - Similar to but predates MN DNR Native Plant Community Classification
- Focus of Lee Frelich’s forest disturbance history work
  - Tree ring
  - Air photo
  - Canopy gap assessment
- Understand role of fire and wind in structuring different forest communities
- Based on Vegetation Growth Stages (VGS)
Vegetation Growth Stage

- An integration of forest development and forest successional stages

**Developmental stages:**

- stand age 0–10: initiation
- stand age 11–50: stem exclusion
- stand age 51–80: demographic transition
- stand age ≥81: multi-aged

**Successional stages:**

- stand age 0–40: aspen
- stand age 41–80: aspen with fir understory
- stand age 81–100: mixed aspen and fir
- stand age ≥101: fir
Vegetation Growth Stage

Vegetation growth stages:

- stand age 0–10: aspen-dominated initiation
- stand age 11–40: aspen-dominated stem exclusion
- stand age 41–50: aspen–fir stem exclusion
- stand age 51–80: aspen–fir demographic transition
- stand age 81–100: multi-aged aspen–fir
- stand age ≥101: multi-aged fir
NSU_4 Northern Superior Uplands
Lowland Conifer
NSU_2 Northern Superior Uplands
Mesic white and red pine

Sapling-pole spruce-fir
8: 1-50

Birch-SF-pine
10: 1-10

Sapling-pole pine
7: 1-50

Sapling birch
1: 1-10

Birch-SF-pine
11: 11-50

Pole-mature birch
2: 11-50

Mature birch-pine
3: 51-80

Mature white pine
4: 81-120

Multi-aged white pine
9: 121-161

Multi-aged pine-spruce-fir
5: 121-200

Multi-aged spruce-fir
6: 201-9999

Simple succession

Stand replacing wind

Stand replacing fire

Clear cut type management
Use of VGS models

• Understanding stand development and forest succession by landscape ecosystem can guide forest management
  – Manage for best use of a particular site
• Combined with ownership, allows an assessment of ‘who owns what?”
• But - need a map...
Mapping Landscape Ecosystem of the Northern Superior Uplands

• Approach: develop relationships between important GIS layers (soil, landform, climate) and forest inventory data

• Predict dominant late successional communities across the landscape

White and Host 2000
# Environmental drivers influencing forest composition

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Attributes</th>
<th>Minimum mapping unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minnesota Soil Atlas</td>
<td>Drainage, Texture, pH</td>
<td>16ha</td>
</tr>
<tr>
<td></td>
<td>Depth of rooting zone</td>
<td></td>
</tr>
<tr>
<td>Cummings-Grigal Soil Associations</td>
<td>Texture+material</td>
<td>5km²</td>
</tr>
<tr>
<td>Geomorphology of MN Associations</td>
<td>Geomorphic and sedimentary Associations</td>
<td>16ha</td>
</tr>
<tr>
<td>Land Type Associations</td>
<td>Soil-landform units</td>
<td>5km²</td>
</tr>
<tr>
<td>Zedex Climate data</td>
<td>Mean growing season minimum, maximum temperature,</td>
<td>5km²</td>
</tr>
<tr>
<td></td>
<td>Precipitation</td>
<td></td>
</tr>
<tr>
<td>USGS digital elevation</td>
<td>elevation, slope, aspect,</td>
<td>1ha</td>
</tr>
</tbody>
</table>
Growing Season Maximum Temperature (F *10)

Mean Maximum Temperature
- 681 - 693
- 694 - 699
- 700 - 705
- 706 - 711
- 712 - 716
- 717 - 721
- 722 - 727
- 728 - 735
- 736 - 745

Scale: 0 - 100 Kilometers
Spatial Modeling

1. Principal Component/Cluster Analysis to identify combinations of soil, landform & climate that recur in characteristic landscape positions

2. Identify statistical associations between landscape units and forest inventory plots
<table>
<thead>
<tr>
<th>Forest Inventory Data Sources</th>
<th>Attributes Used To Classify Inventory into Landscape Ecosystems</th>
<th>Data Criteria</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN DNR Phase2 Inventory</td>
<td>Relative Volume by Species&lt;br&gt;Cover type&lt;br&gt;Shrub/ground layer data</td>
<td>Natural Regeneration Field Inventory&lt;br&gt;Age &gt;= 40</td>
<td>6400</td>
</tr>
<tr>
<td>FIA Remeasurement plots</td>
<td>Relative Basal Area by species&lt;br&gt;Cover type</td>
<td>Natural Regeneration Field Inventory&lt;br&gt;Age &gt;= 40</td>
<td>1245</td>
</tr>
<tr>
<td>Superior National Forest Inventory</td>
<td>Primary–secondary cover type&lt;br&gt;Primary–secondary species</td>
<td>Natural Regeneration Field Inventory&lt;br&gt;Age &gt;= 40</td>
<td>13900</td>
</tr>
<tr>
<td>Natural Heritage Program Releve plots</td>
<td>Native Plant Community classification</td>
<td>None</td>
<td>298</td>
</tr>
<tr>
<td>GLO Bearing Tree Database</td>
<td>Tree species</td>
<td>Section corners &gt; 2 bearing trees</td>
<td></td>
</tr>
</tbody>
</table>
Classified FIA Points (n = 1245)

FIA Points
- N. hardwood
- Mesic Wp-RP
- Dry-,mesic Wp-Rp
- Lowland Conifer
- White cedar-black ash
- Mesic spruce-fir/hwd
- Jack pine-B. spruce
- Jack pine-hardwood
Classified Superior National Forest Inventory (n = 13900)

SNF Inventory
- Dry-mesic Wp-Rp
- Jack pine-black spruce
- Jack pine-hwd
- Lowland conifer
- Mesic Spruce-fir/hwd
- Mesic Wp-Rp
- Northern hardwood
- White Cedar-black ash
Spatial Modeling

• Use cluster analysis to identify unique combinations of soil, landform, climate for the Northern Superior Uplands – \( \rightarrow \) Landscape Ecosystems

• Identify statistical associations between the Landscape Ecosystems and \( \sim \)20000 Forest Inventory plots – \( \rightarrow \) Electivity

• Use these relationships to map potential Landscape Ecosystems entire landscape
  – Landscape Ecosystems – term used for Native Plant Communities prior to development of formal classification
  – Potential – map covers all lands, including those currently in urban, agricultural or other land use
MN DNR Native Plant Community Classification (2003)

- NPC: “A group of native plants that interact with each other and their environment”
  - Form recognizable units that repeat over space and time
  - Classified considering vegetation, hydrology, landforms, soils and natural disturbance regimes
Native Plant Community has six hierarchical levels

<table>
<thead>
<tr>
<th>Classification Level</th>
<th>Dominant Factors</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Group</td>
<td>Vegetation structure &amp; geology</td>
<td>Upland Forest &amp; Woodland Systems</td>
</tr>
<tr>
<td>Ecological System</td>
<td>Ecological processes</td>
<td>Fire-Dependent Forest/Woodland</td>
</tr>
<tr>
<td>Floristic Region</td>
<td>Climate &amp; paleohistory</td>
<td>Central</td>
</tr>
<tr>
<td>NPC Class</td>
<td>Local environmental conditions</td>
<td>Central Dry Pine Woodland</td>
</tr>
<tr>
<td>NPC Type</td>
<td>Canopy dominants, substrate, or finer environmental conditions</td>
<td>Jack Pine-(Yarrow) Woodland</td>
</tr>
<tr>
<td>NPC Subtype</td>
<td>Finer distinctions in canopy dominants, substrate, or environmental conditions</td>
<td>Ericaceous Shrub</td>
</tr>
</tbody>
</table>

Group of NPCs unified by a strong influence from major ecological processes

Uniform soil texture, moisture, topography, disturbance regimes

Dominant canopy trees, Substrate, fine-scale differences in moisture and nutrients
NPC System level

- Defined by
  - Plant indicators
  - Landform affinity
  - Soil & hydrology
  - Field characteristics

- Useful for landscape (30,000 foot) planning
NPC Class level

- Defined by fine scale soil and moisture variables
- Higher resolution than System level
- Useful for local scale forest management planning
Landscape Ecosystems & Native Plant Communities

- Are they compatible?
  - Yes, with concerted group effort

- Mapping
  - same fundamental environmental data used in both systems
  - Map units of similar size to Minnesota-Ontario Peatlands effort

- Classification
  - Landscape Ecosystems roughly between System and Class level
  - Class-level assignments to LE map units can be made by incorporating GIS information or use of expert panels (or both!)
Current NPC efforts

• The Drift and Lake Plains NPC map is at a coarser spatial resolution than the NSU or MOP

• Effort underway to map DLP and Western Superior Uplands with the same data sets and methods
  – Goal – a synoptic NPC map for the Laurentian Mixed Forest
    • Same spatial resolution
    • Same classification units
Questions & Comments?
Trends in Forest Composition & Spatial Pattern
Trends in Forest Composition

• 2006 – FRC (Dave Miller) requests a comparison of 1990 and 2002 forest inventory
• Which way are we heading?
• Conducted for DLP and NSU Sections
Northern Superior Uplands: Mesic birch-aspen-spruce-fir

FIA condition 0 years from 2002
SW condition 0 years from 2002
RNV

Percent of ecosystem

VGS (num.: min. yr - max. yr)
Update Highlights

• Many growth stages showed little change between the two inventories
  – 10 years relatively short time span
  – Smaller interval than most Vegetation Growth Stages
• Few FIA plots in old or multi-aged VGS categories
• FIA change of methods between 1990 -2003 confounds interpretation of data
Trends in Forest Disturbance

- Study
  - Quantify trends in disturbance frequency and size
  - Based on GLO survey and interpreted aerial photography from 1930s, 1970s, 1990s
  - Covers 8 subsections in NSU and DLP

Trends in Forest Disturbance

• Results

  – Fire was the dominant disturbance 1860 - 1890
  – 0.3-0.6% Annually
  – Border Lakes & Tamarack Lowlands highest frequencies
  – North Shore and Moraines low frequencies

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Trends in Forest Disturbance

• Results
  – Harvest has replaced fire as the dominant form of forest disturbance
  – 1910-1940
    • Large events in post settlement
    • Even-aged management
    • Smaller and more uniform patch sizes
    • High edge density favors some wildlife species, reduces habitat for others

Segue to Lindberg & NLCD based change analysis
Applying Model Predictions to the Forest Landscape

• Run model at min and max estimates of disturbance frequencies to calculate the range of conditions (e.g. 10-20% of the ecosystem should be in pole size birch)