

# Potential Native Plant Communities for the Drift and Lake Plains, Western and Southern Superior Uplands

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# Motivating issues

- There have been many efforts over several decades to develop ecologically based vegetation classifications in Minnesota
  - Habitat Types (Kotar & Kerhohan)
  - Biophysical Land Units (Prettyman)
  - Landscape Ecosystems (Frelich, White, Brown, Host, others)
  - Native Plant Communities (Almendinger, Hansen, others)
- All have similar intents, differ in methods, mapping resolution and classification resolution
- Necessary information for cross-ownership land use planning and decision-making

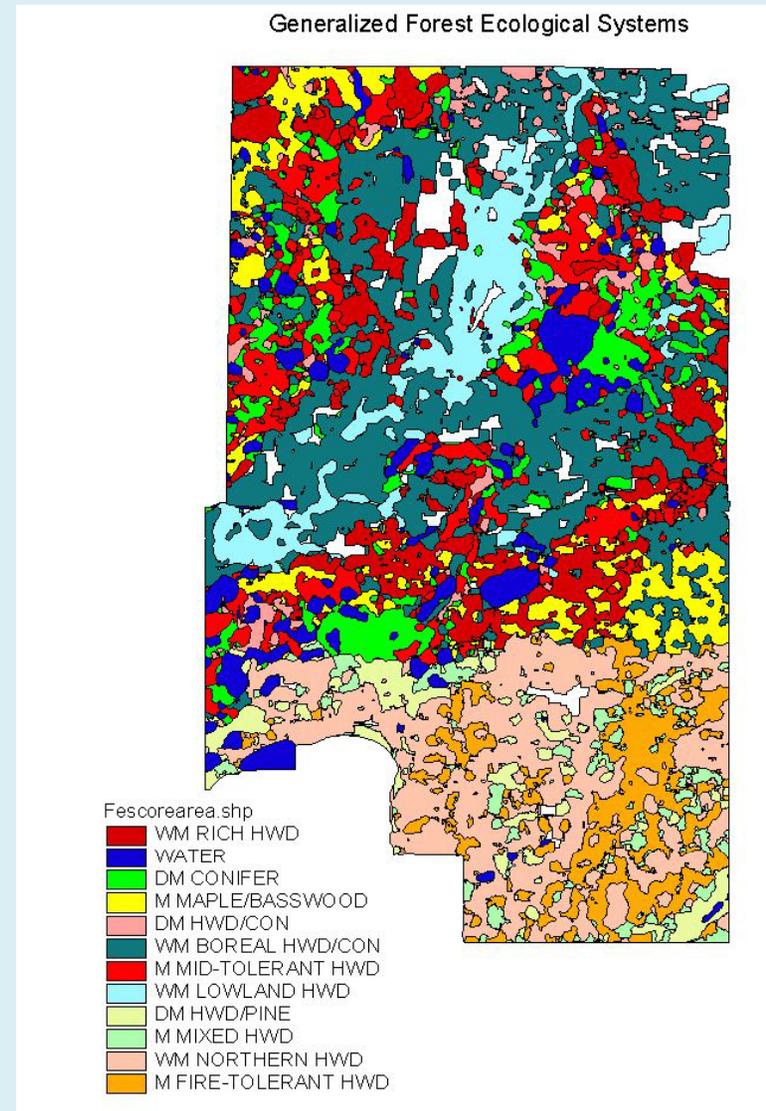
Chippewa National Forest ECS  
Shadis and Almendinger  
Late 1980 – early 1990s

- Ecological Landtype Phase (ELTP mapping)
  - Classification system based on relevee data
    - Ground flora indicators + soils
  - Acre-by-acre field mapping
  - “adaptive classification” - questions raised in mapping processes helped define classification scheme

# Aitkin Co. – Forest Ecological Systems

## 2000-2001

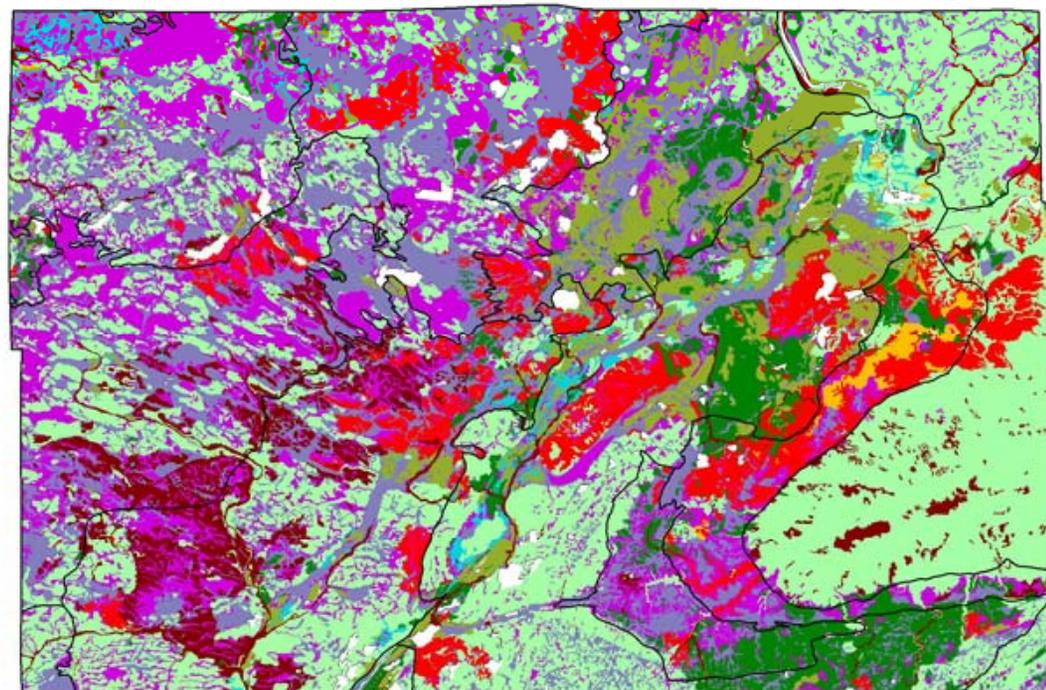
- Inputs
  - SSURGO-level soil
    - soil series
    - moisture and nutrient fields
  - GLO bearing trees, Marschner map
  - LTAs
- Classes (FES) – dominant cover x soil moisture
- Outputs
  - Distribution of types by ownership
  - Patch stats, large patch analysis, buffer analysis



# Carlton Co. – Forest Ecological Systems 2002-2003

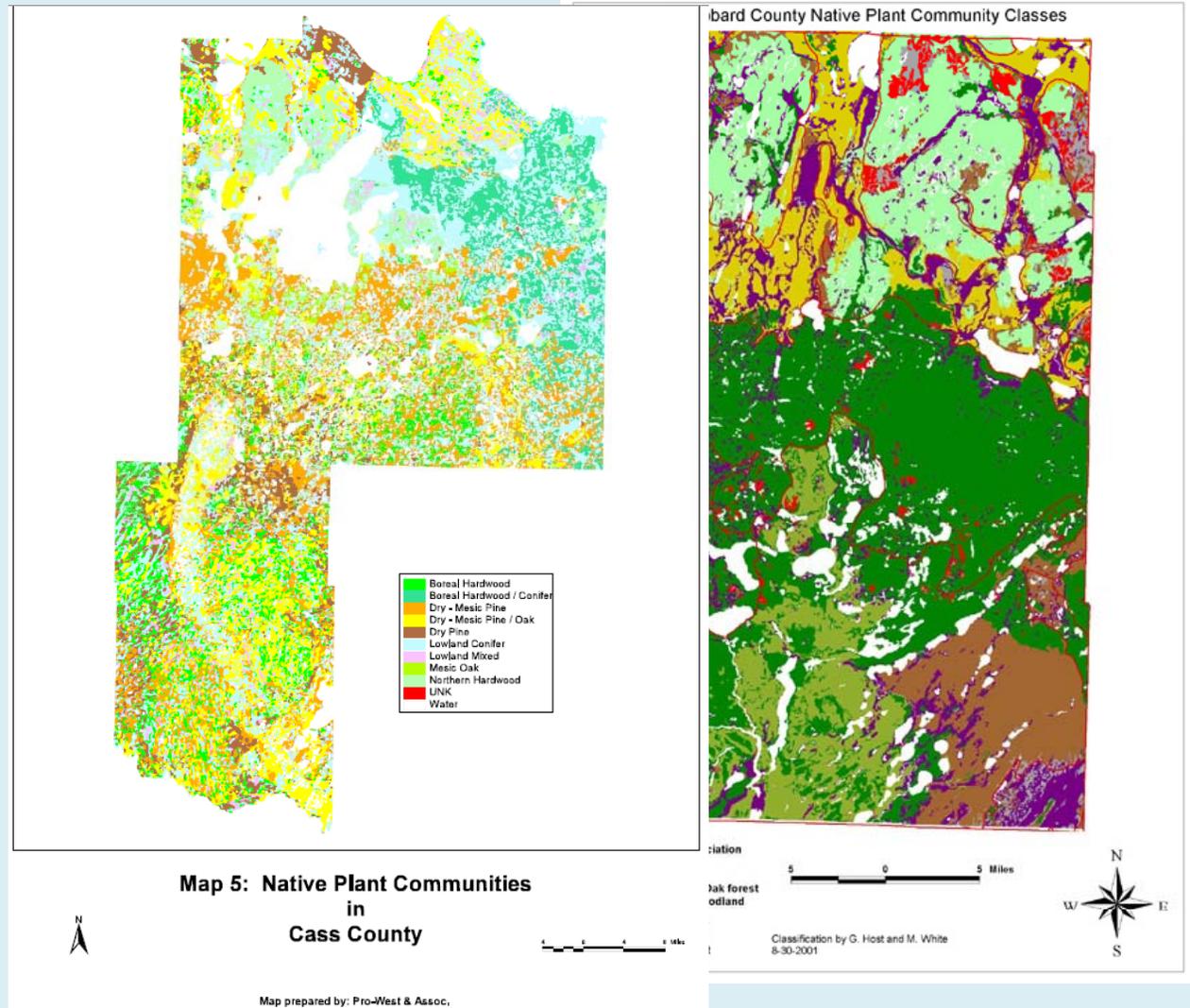
- Inputs
  - SSURGO
  - GLO Bearing trees – interpolated individual species
- Classes – pre field guide NPC types
- Outputs
  - Distribution of types by ownership

Carlton County FES Classification



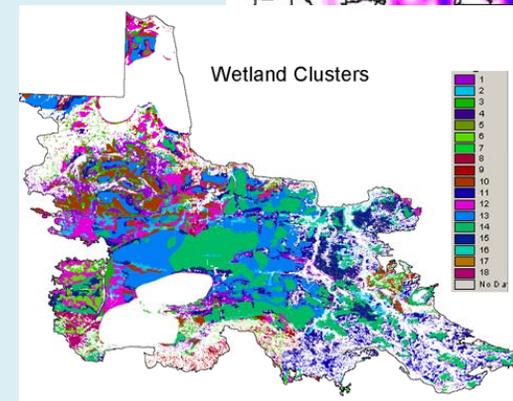
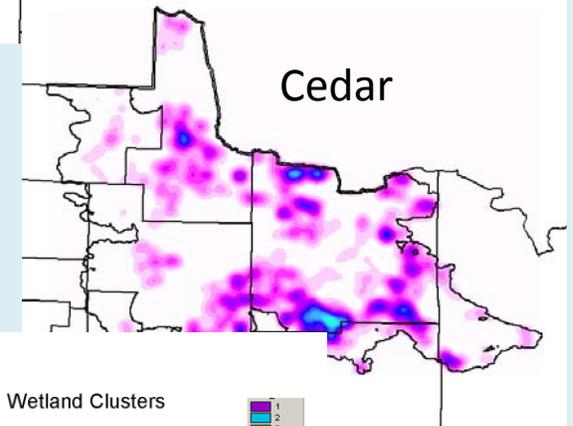
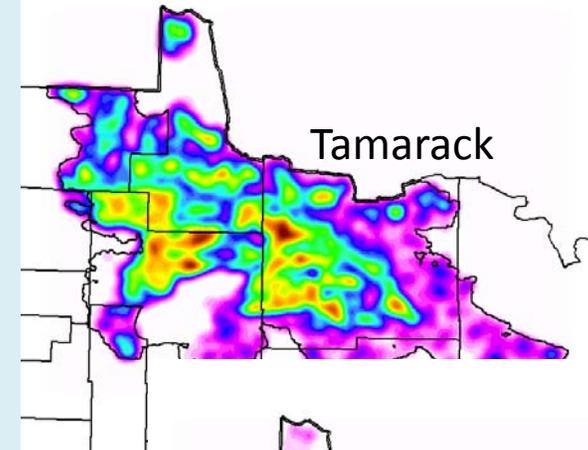
# Hubbard and Cass Counties 2001-2002

- Inputs
  - SSURGO-level soil – moisture and nutrient fields
  - Bearing trees summarized by SSURGO units
  - Bearing tree distance
  - LTAs
- Classes – pre Field Guide (Almendinger-Hansen ECS)
- Outputs
  - Distribution of types by ownership
  - Assess county land holdings
  - Silvicultural strategies
  - Landscape goals (dispersed recreation, large patch management)



# Koochiching Co. – Native Plant Communities 2006-2008

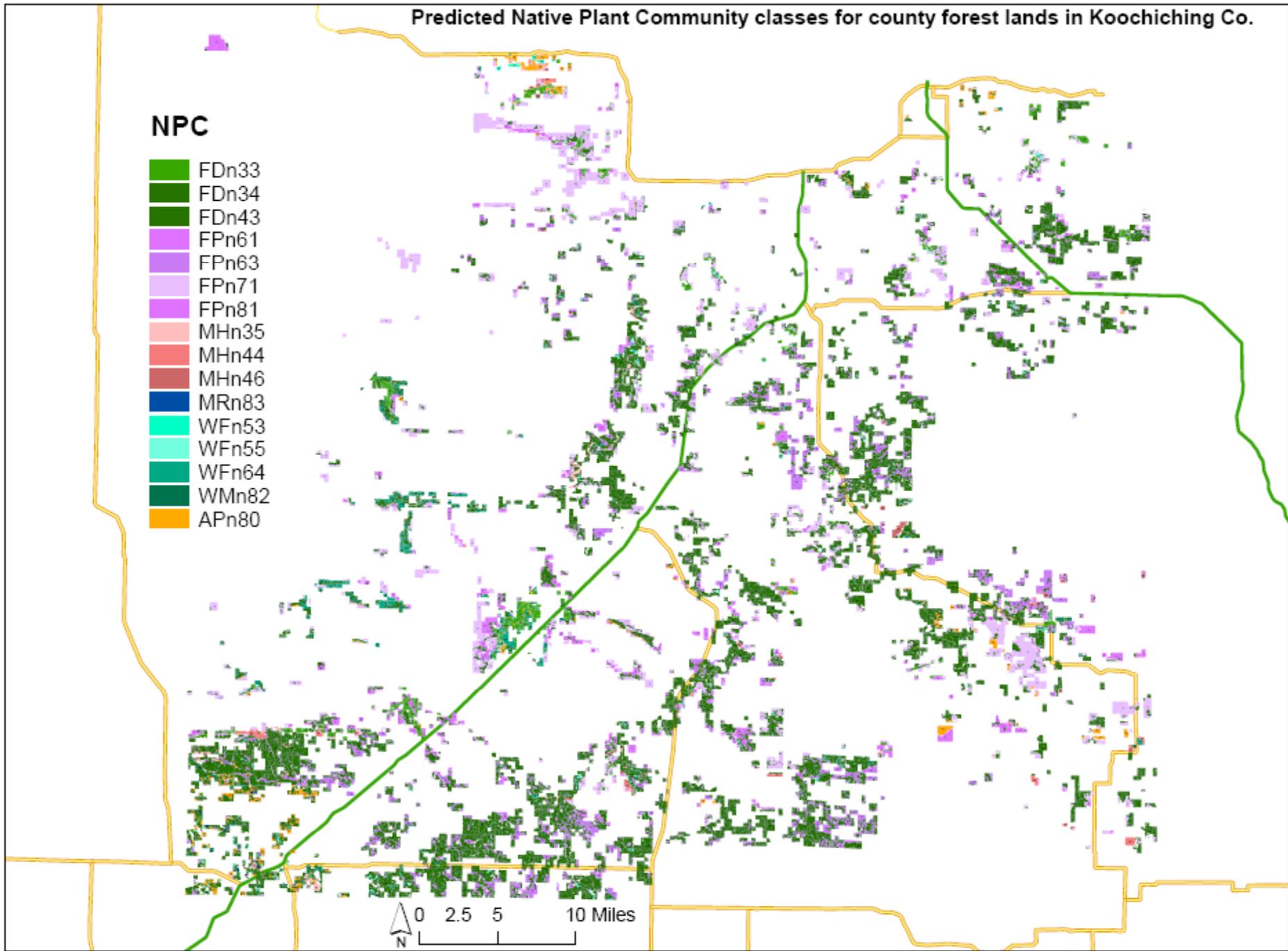
- Inputs
  - SSURGO not available
  - Cummins-Grigal soils map
  - STATSGO
  - Terrain analysis via Digital Elevation Models (slope, aspect, SD elevation, Topographic Moisture Index)
  - NWI (separate analysis for uplands & wetlands)
  - Bearing trees density maps
  - Subsections and LTAs
- Analysis
  - Data gridded to 30 m pixels
  - Isodata cluster analysis → 16 uplands & wetland classes
  - Summarize bearing trees within clusters – NPC indicators
- NPC Classes



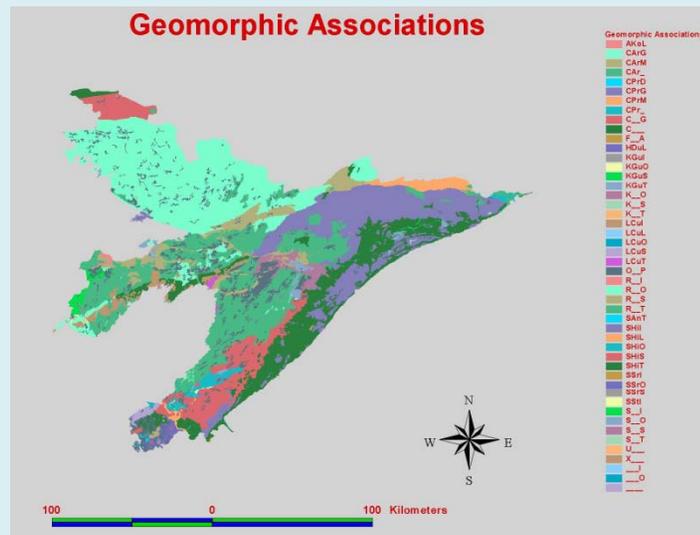
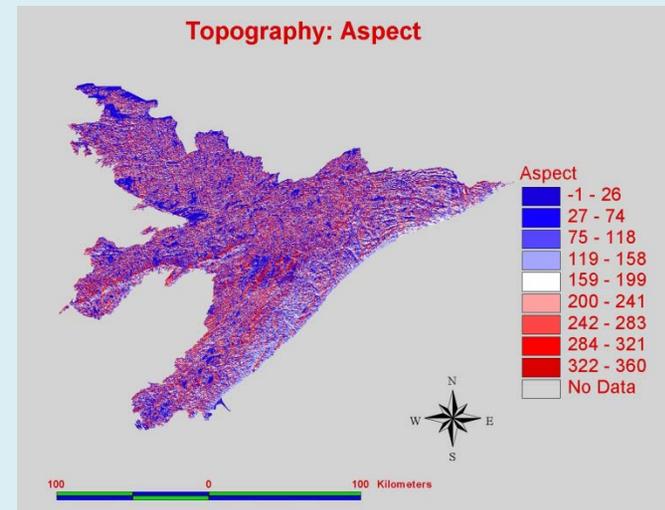
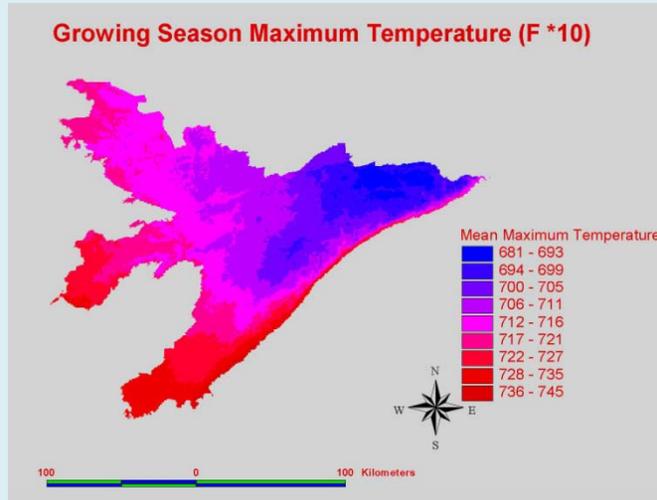
Predicted Native Plant Community classes for county forest lands in Koochiching Co.

**NPC**

- FDn33
- FDn34
- FDn43
- FPn61
- FPn63
- FPn71
- FPn81
- MHn35
- MHn44
- MHn46
- MRn83
- WFn53
- WFn55
- WFn64
- WMn82
- APn80



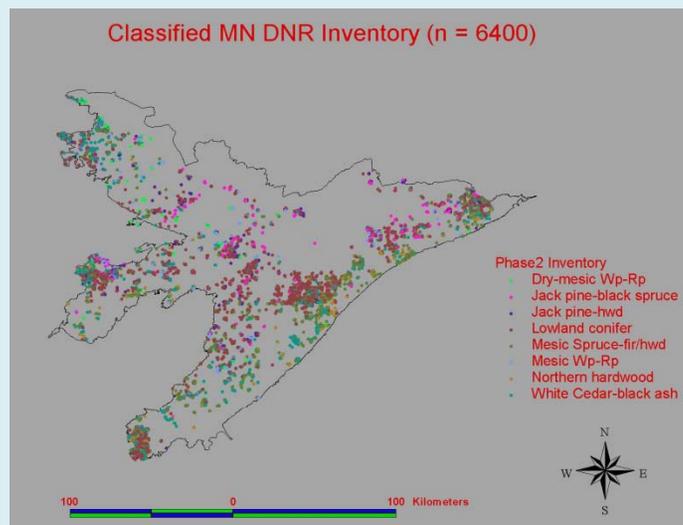
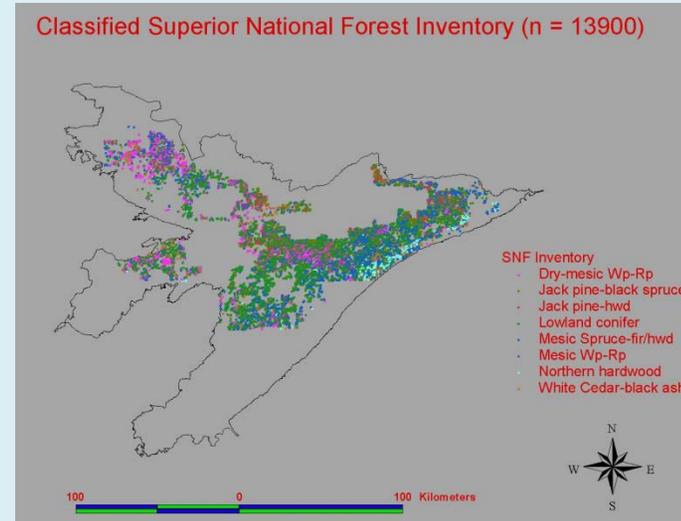
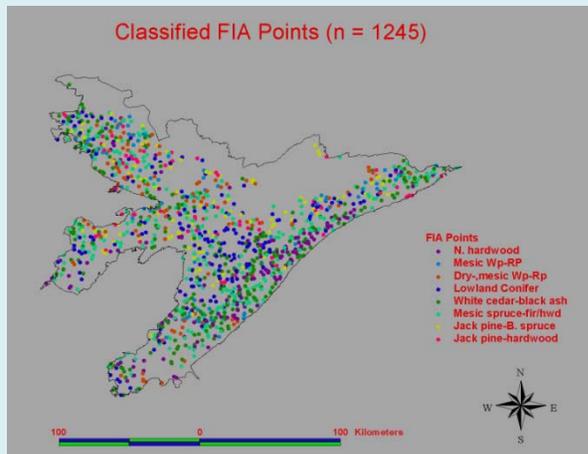
# Northern Superior Upland Landscape Ecosystems



Step 1 – use climate, soil,  
physiography to identify  
landscape units

White and Host 2000

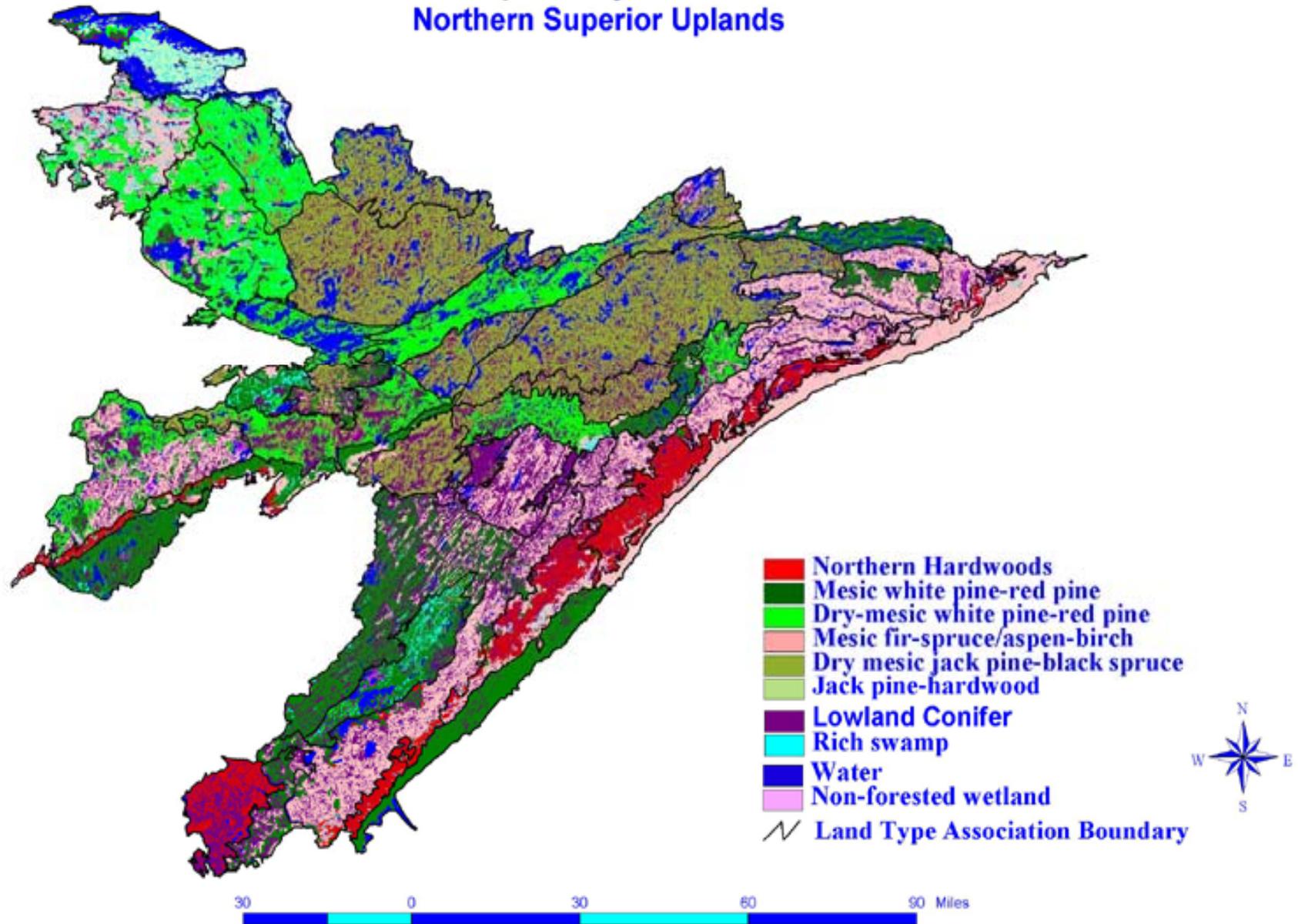
# Northern Superior Upland Landscape Ecosystems



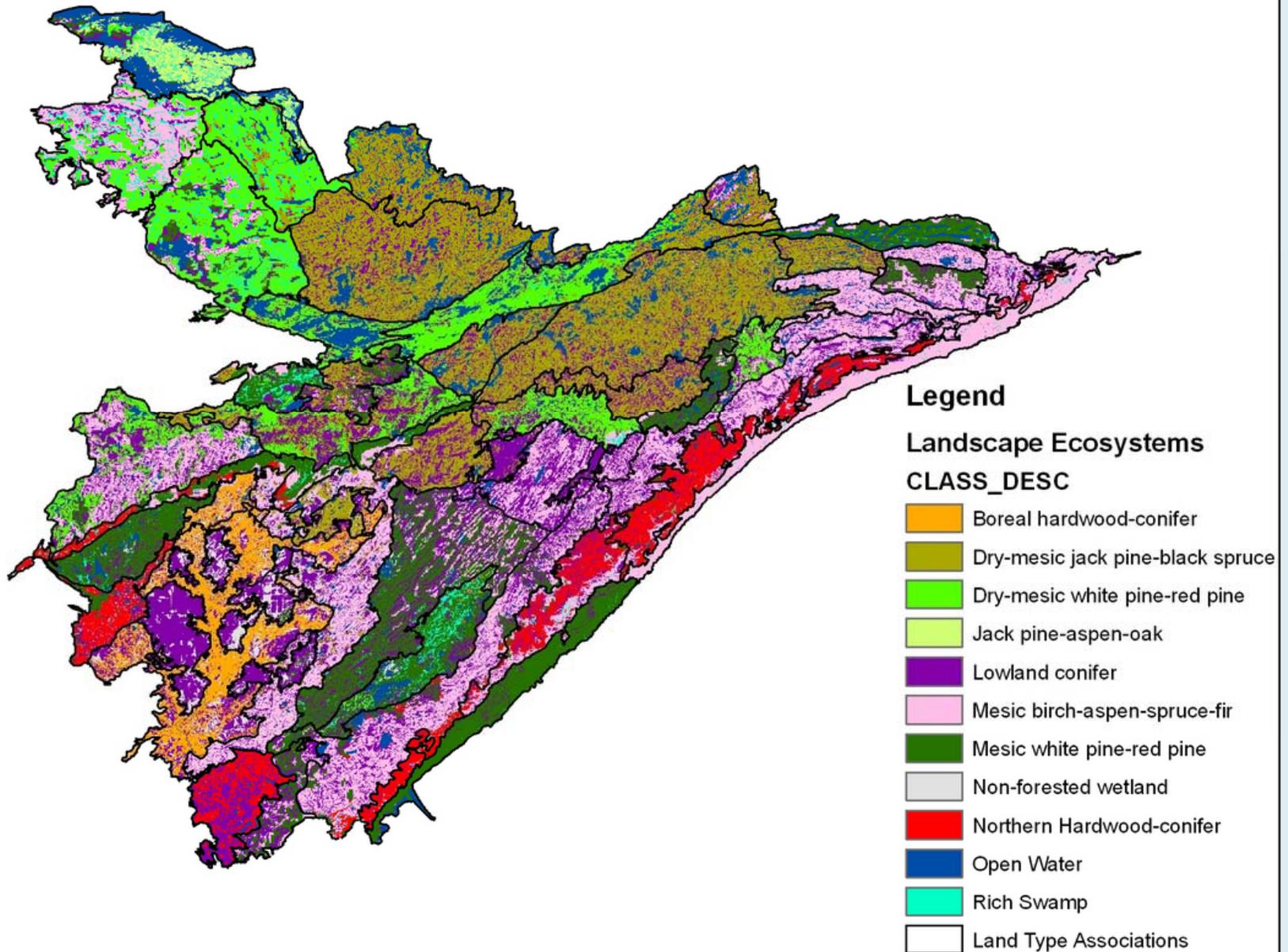
Step 2 – intersect landscape  
units with forest inventory data  
from late successional stands

White and Host 2000

## Landscape Ecosystem Classes Northern Superior Uplands



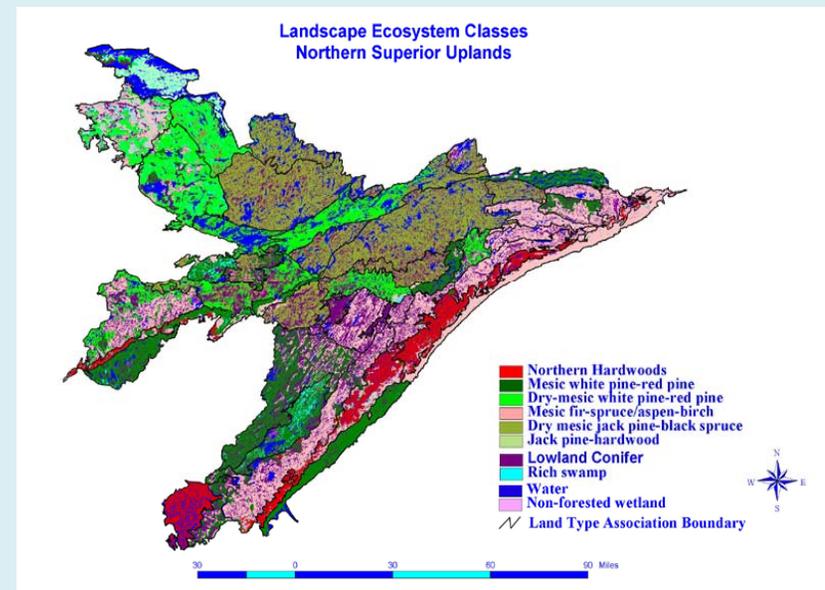
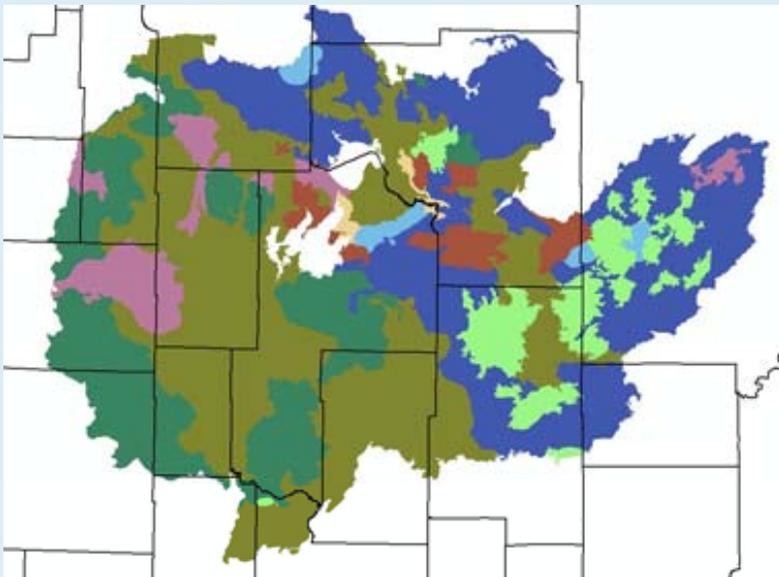
# Landscape Ecosystems: Northern Superior Uplands with Tamarack Lowlands/St. Louis Moraines



White, Host, Peters June 2012

# Current effort

- Spatial resolution of the Drift and Lake Plains is low (e.g. broad land units) compared to the Northern Superior Uplands and other systems.
- No single NPC Class map available across the Province 212 (Laurentian Mixed Forest)



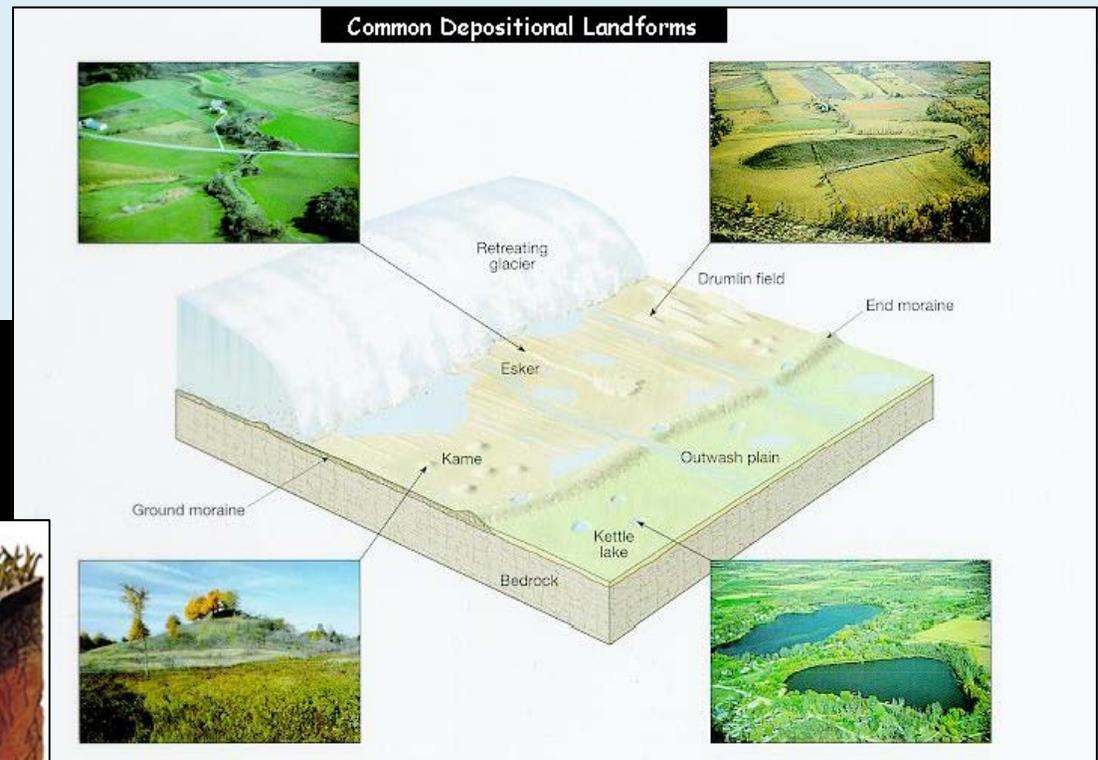
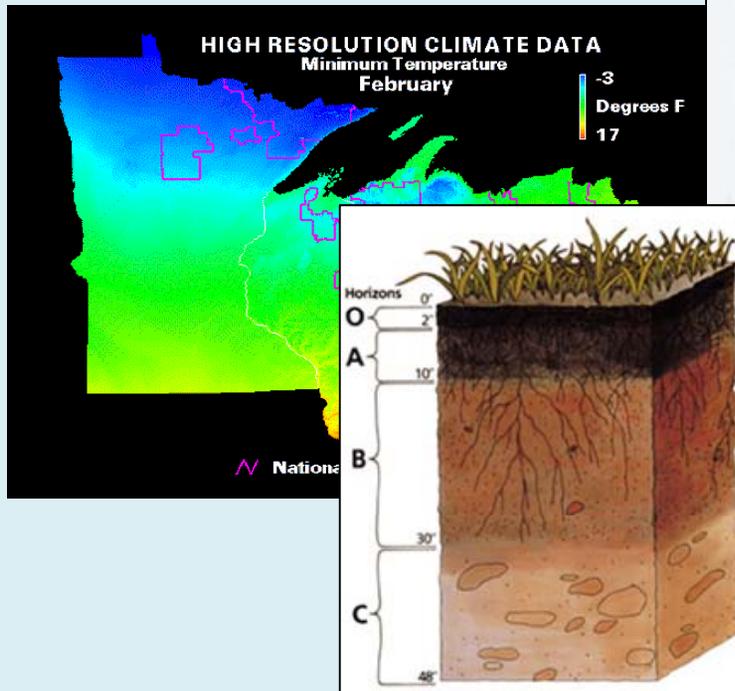
# Current Effort

- Drift and Lake Plains
- Southern Superior Uplands
- Western Superior Uplands
- Area facts
  - 26 Counties
  - ~12,000,000 acres
  - 18,750 sq mi



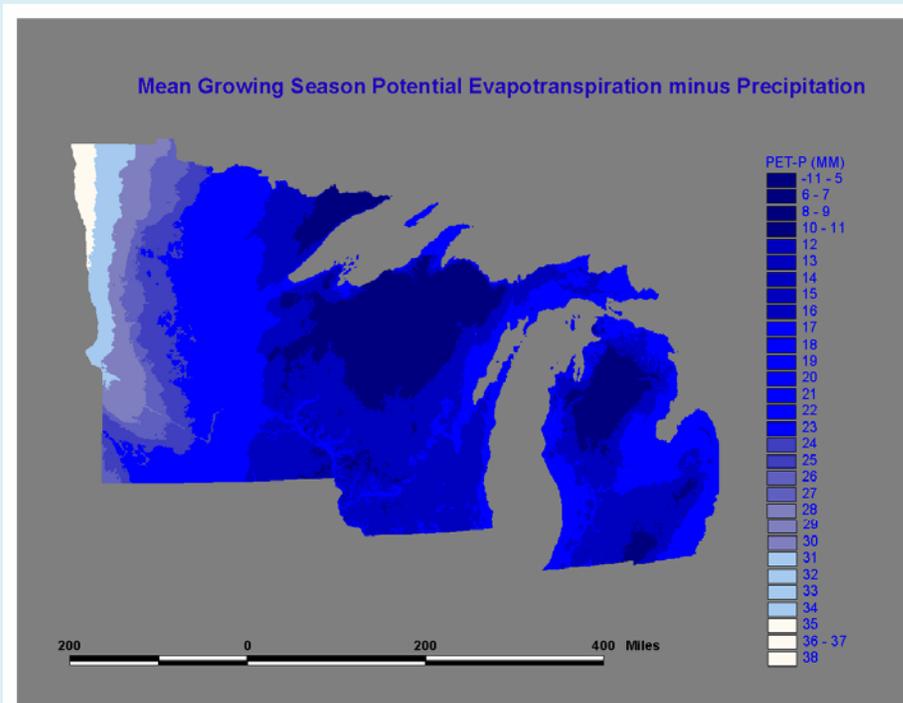
# Modeling Strategy

- Summarize factors controlling distribution of NPCs
  - Climate
  - Geomorphology
  - Soils



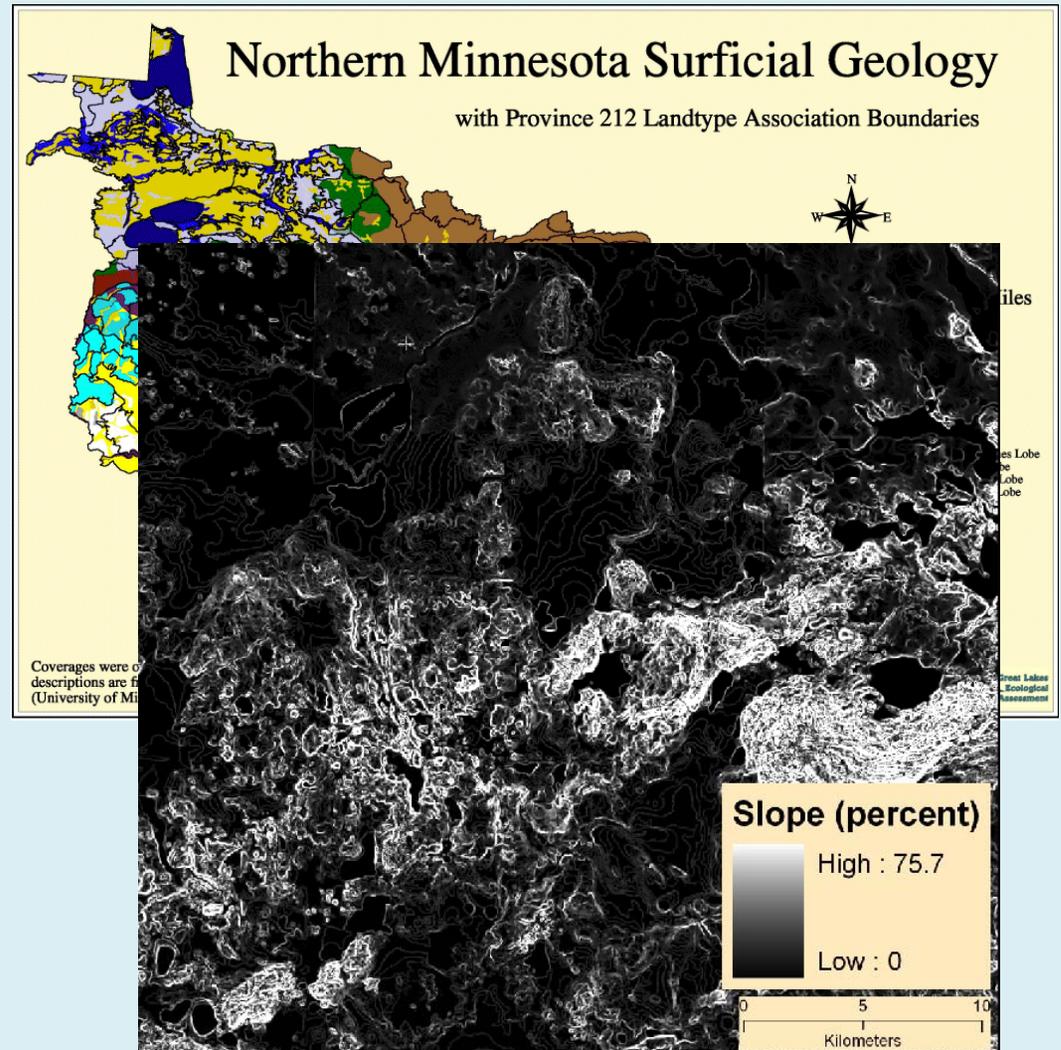
# Climate

- # Frost-free days
- Minimum temperature
- Maximum temperature
- Potential Evapotranspiration



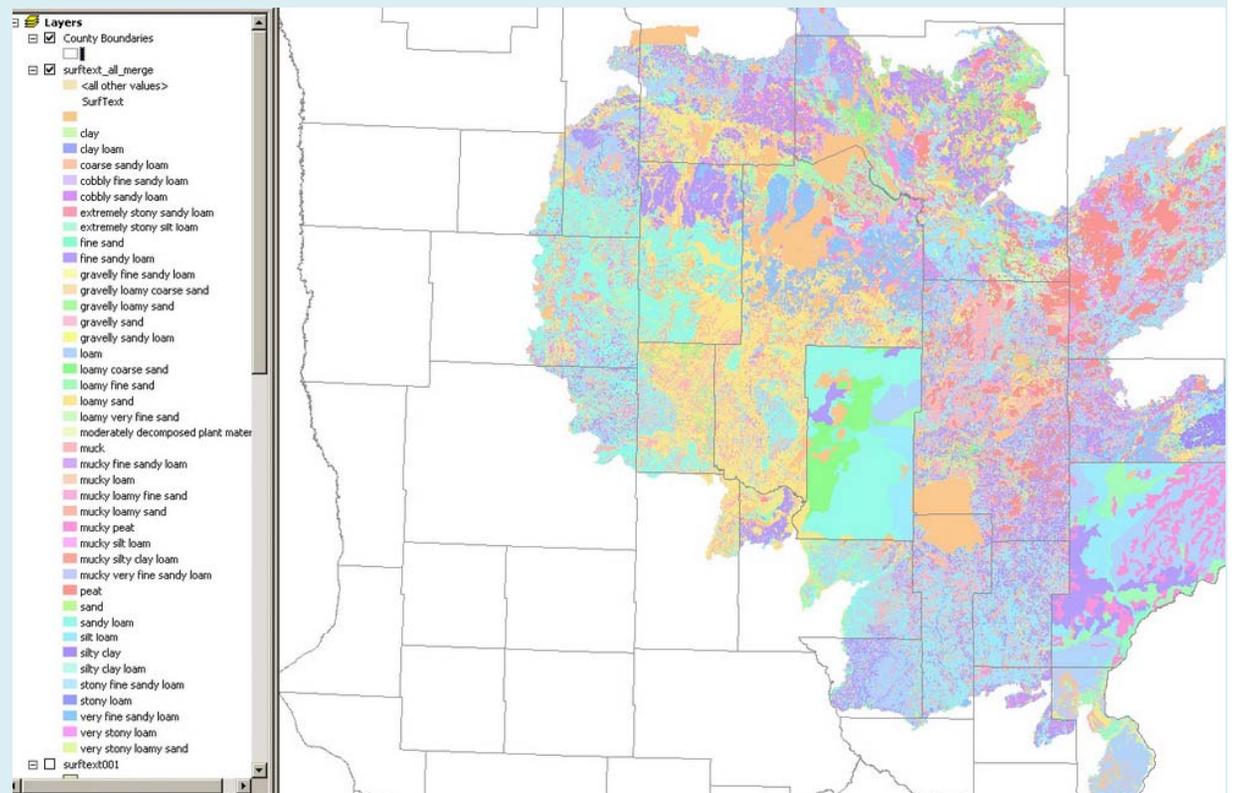
# Geomorphology

- Geomorphic association
- Subsection
- Landtype Association
  - Clustered based on similarity
- Elevation
  - Topographic Moisture Index
  - Slope
  - Aspect



# Soils (SSURGO)

- Soil Texture (40 and 8 classes)
- Drainage class
- Soil K-Factor
- Cation Exchange Capacity



# Releve Data

- MN DNR Releve surveys
  - List of understory plants
  - Forest overstory
  - Soil profile info
  - Site description

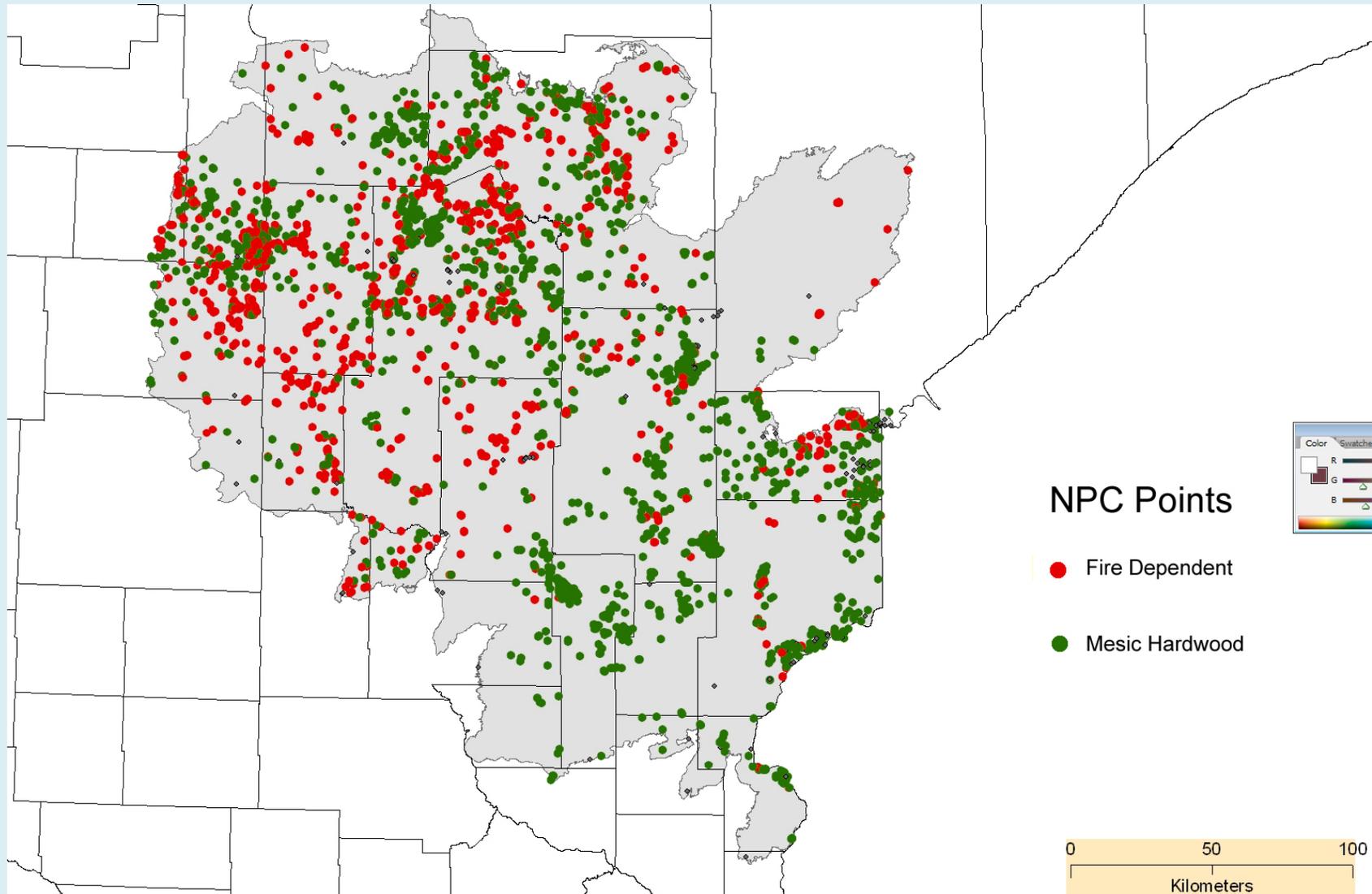


*A Handbook for Collecting  
Vegetation Plot Data  
in Minnesota:  
The Relevé Method*

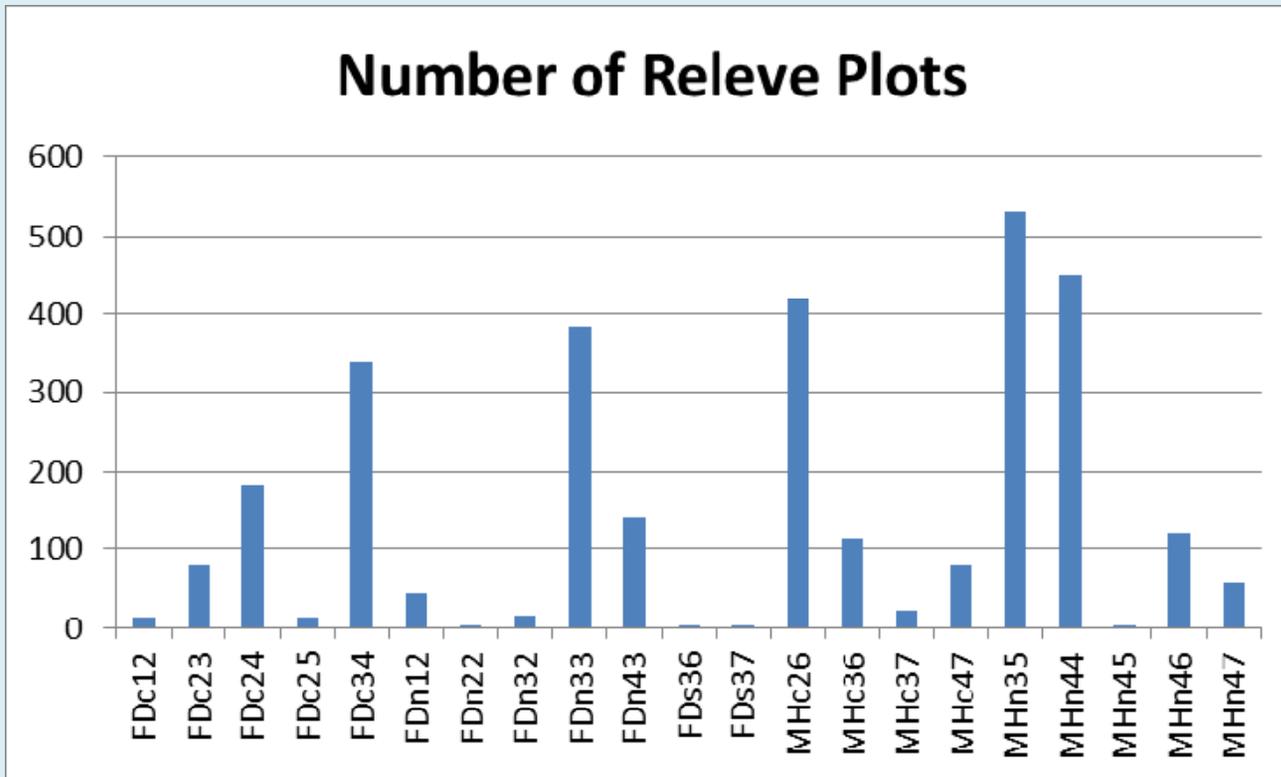


Minnesota Department of Natural Resources

# Releve plots: 3500 in study area



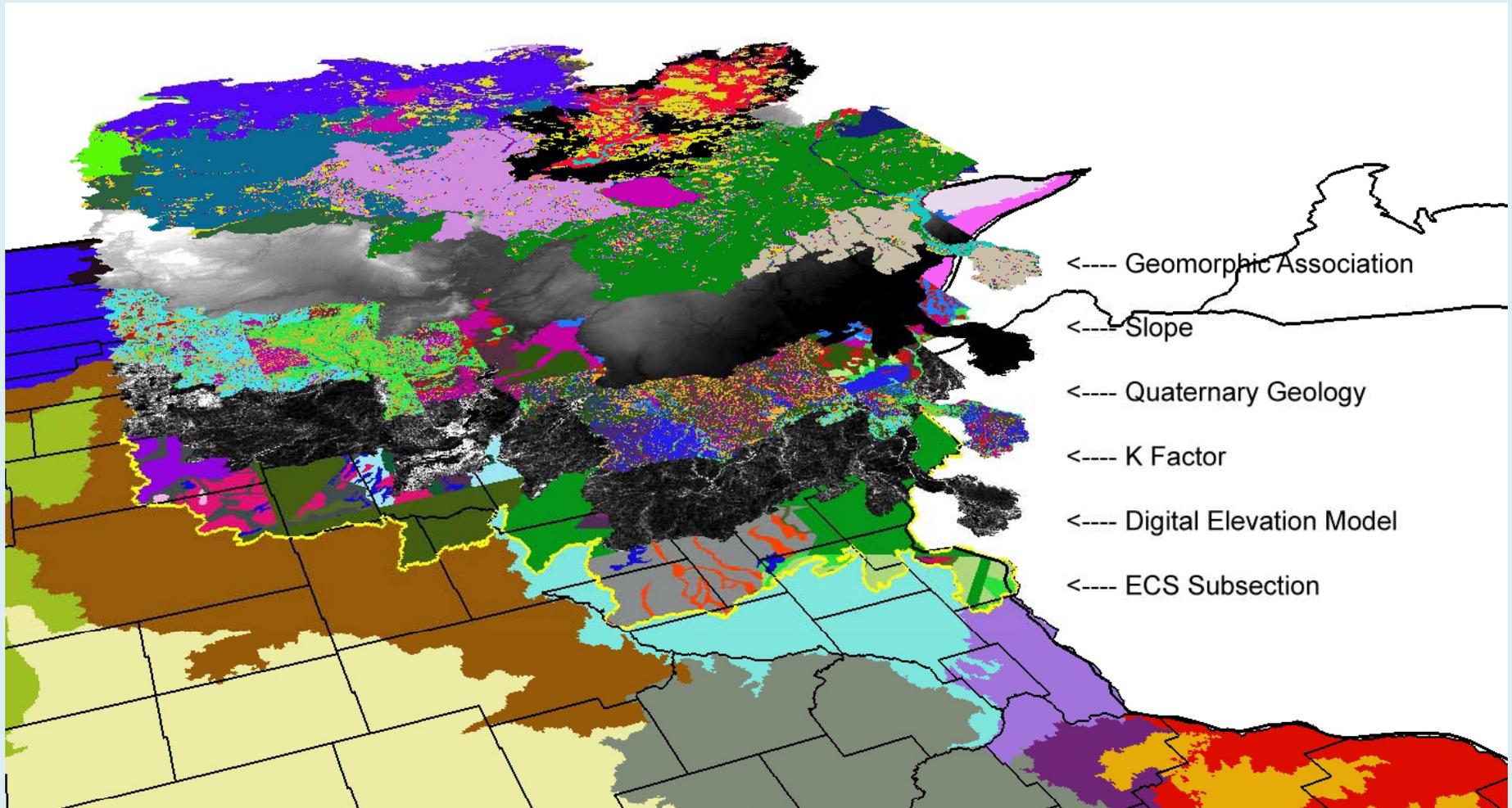
## Number of Releve Plots



# GIS Analysis

- Study area gridded to 30 m pixels
  - 3 x 3 moving window to summarize spatial data layers
- Run across all 3 subsections
- Intersect each releve point with the gridded spatial data
  - Describes the climate, landform, soils for each releve

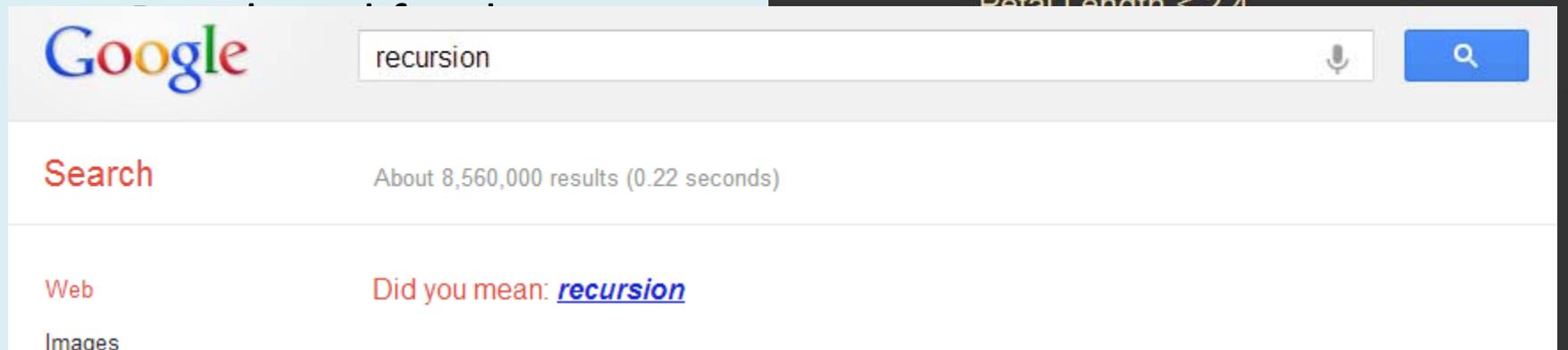
# Gridded map layer



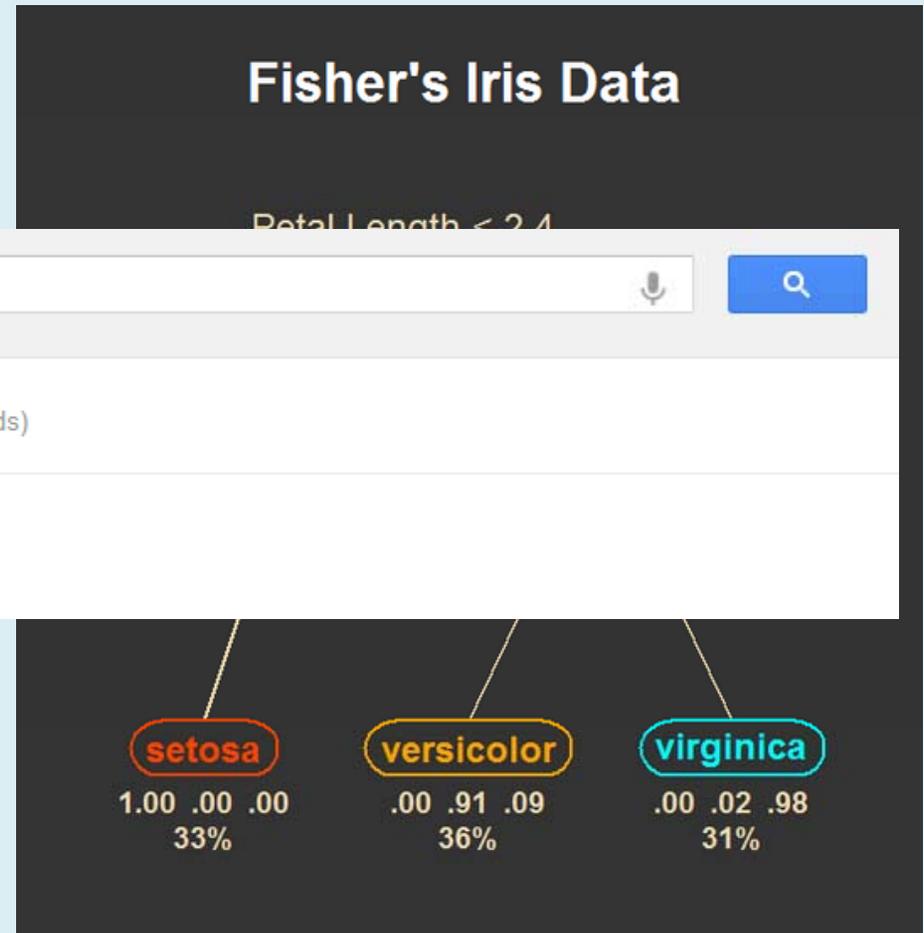
This creates the input data for classification

# Classification technique

- Recursive partitioning (RPART)

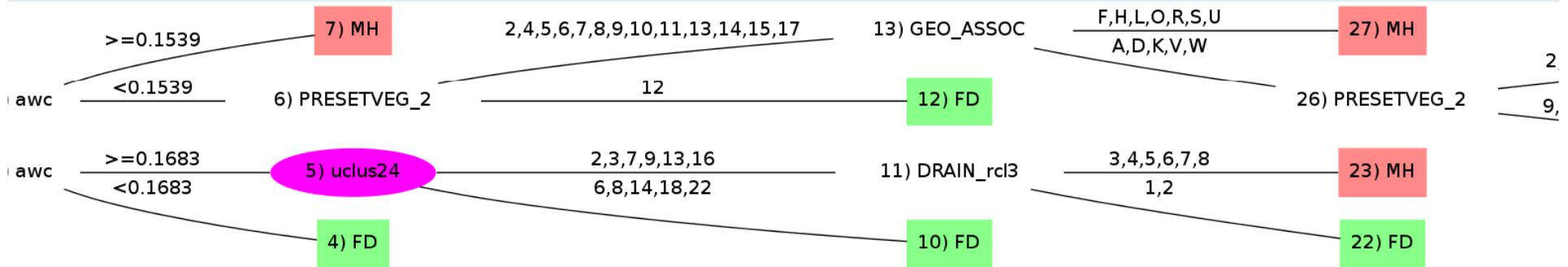


"Tree"



# NPC System-level Classification Tree

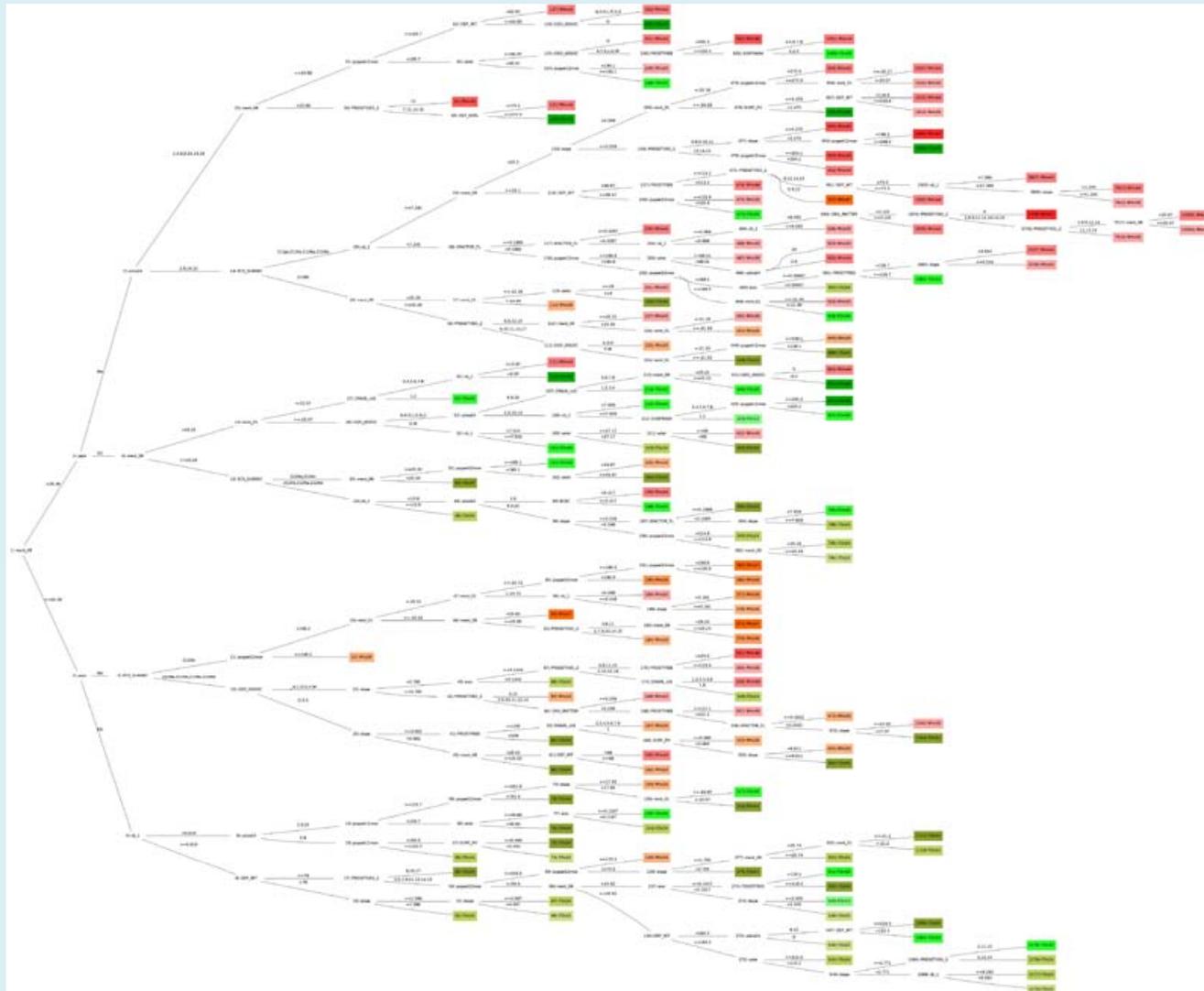
Presettlement Type 12  
= Jack Pine



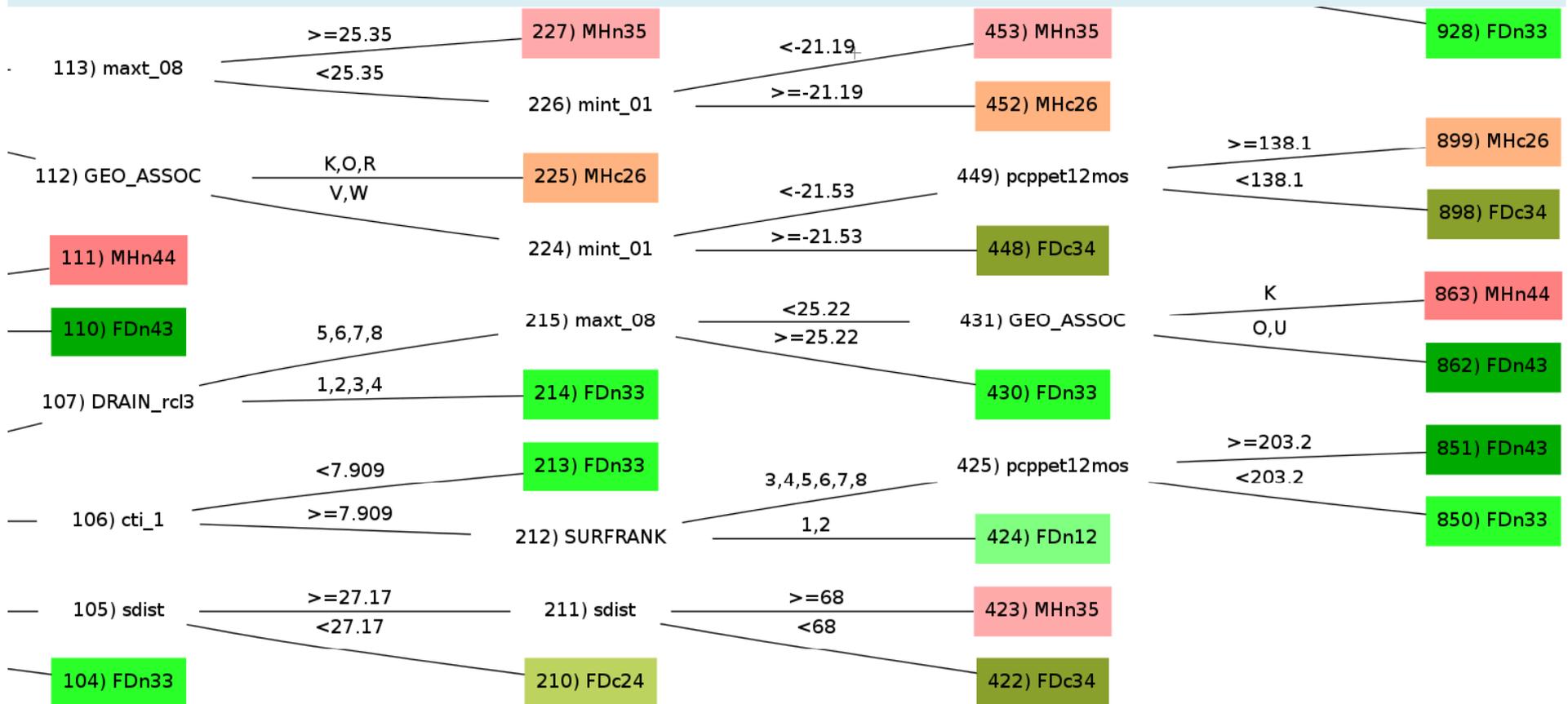
Available  
Water  
Capacity

Drainage  
Class 1-2  
Gravelly  
sand to  
loamy fine  
sand

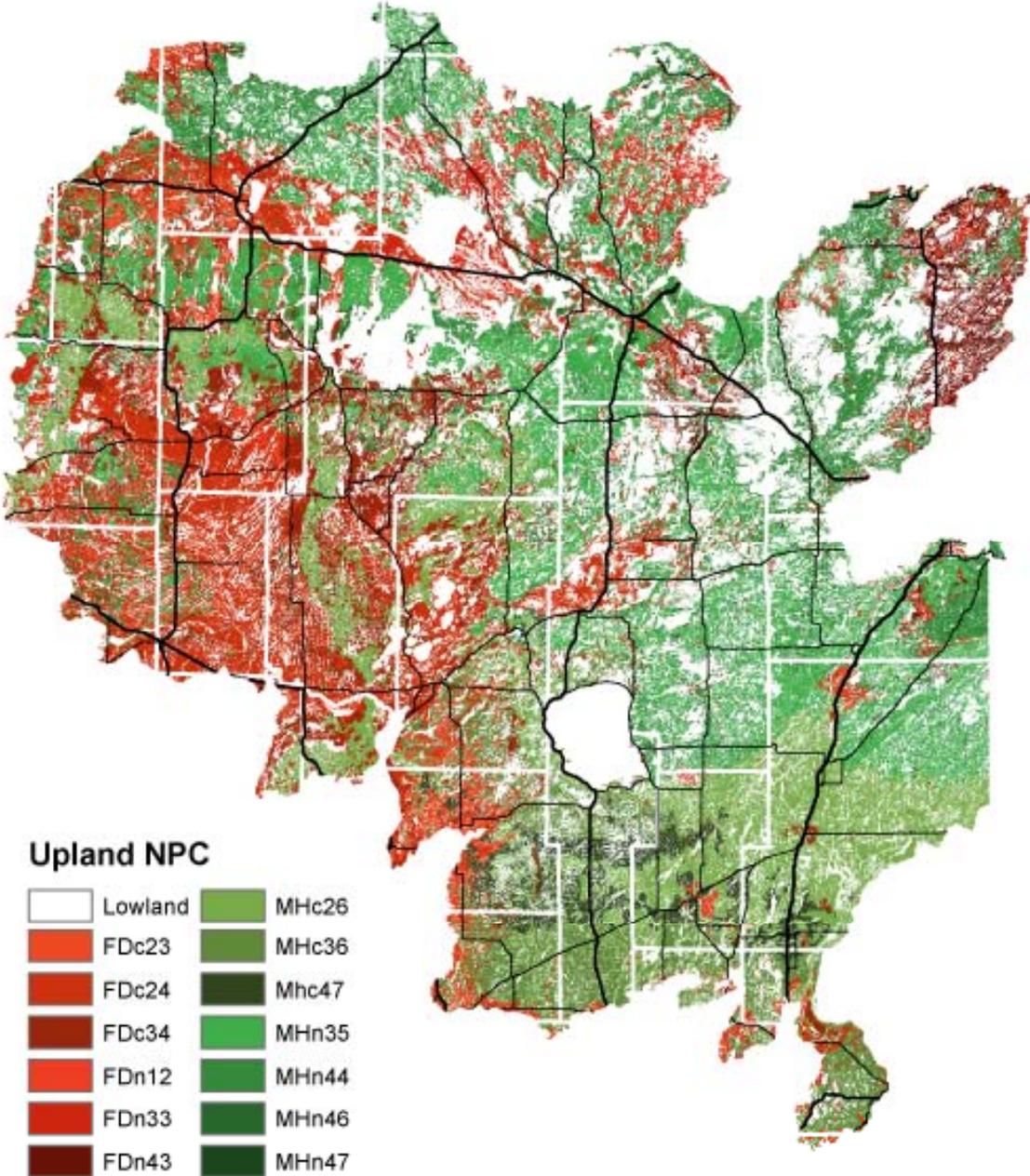
# NPC Class-level Classification Tree

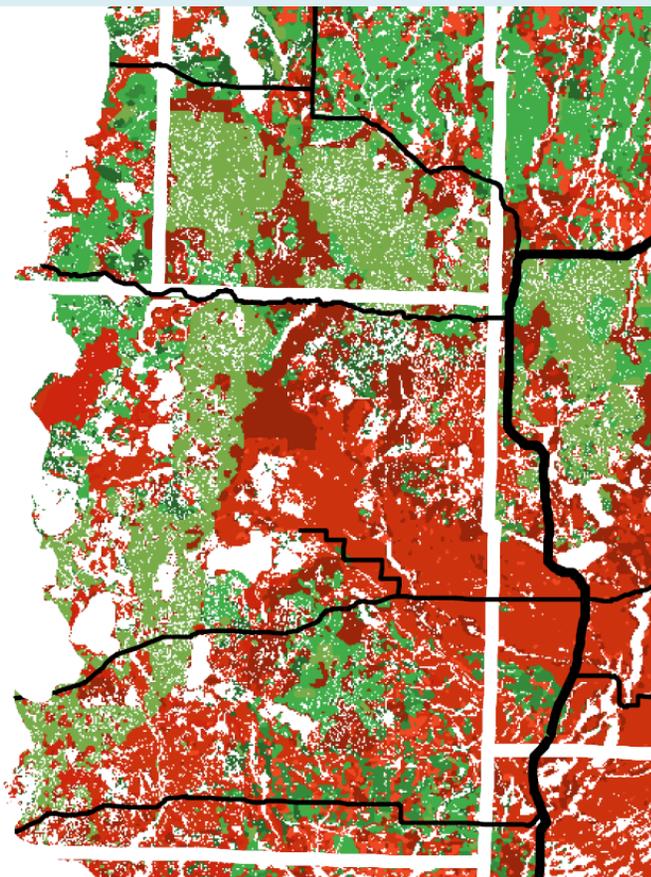


# NPC Class-level Classification Tree detail

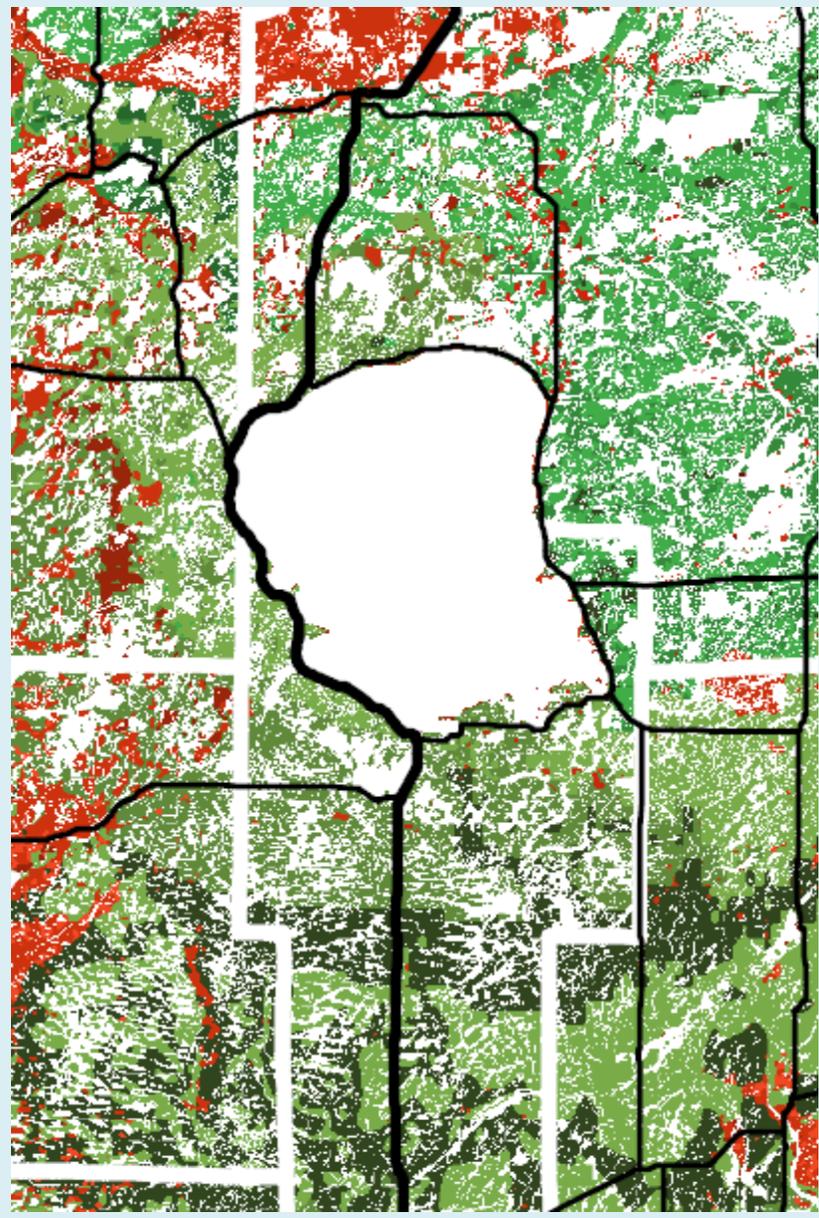
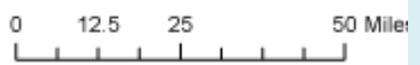
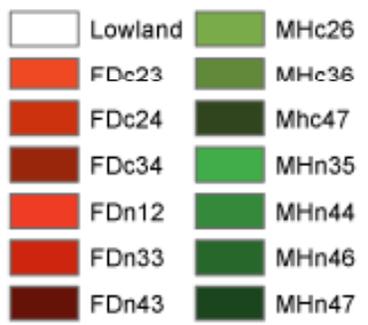


# FD and MH Classes





**Upland NPC**



# Applications: Land Ownership Assessment

Drift and Lake Plains							
NPC Class	County	Federal	Private	Public	State	Tribal	Grand Total
FDc23	342	8819	242735	1219	32919	524	286557
FDc24	1040	37374	644999	2999	109115	14020	809547
FDc34	403	45168	455883	1226	172286	2073	677039
FDn12	47	1472	16455	47	10787	121	28929
FDn33	2526	132529	350534	2337	159018	5115	652058
FDn43	644	2571	93343	821	70462	2598	170439
MHc26	217	21580	232732	1225	244814	2753	503321
MHc47	5	1305	5833	23	3202	10	10379
MHn35	2636	171486	500771	1418	335901	1935	1014146
MHn44	4297	82326	564883	2164	288028	6148	947846
MHn46	497	27371	108880	492	50169	1215	188624
MHn47	97	5915	15539	186	5925	2	27665
<b>Total</b>	<b>12,751</b>	<b>537,916</b>	<b>3,232,592</b>	<b>14,157</b>	<b>1,482,627</b>	<b>36,515</b>	<b>5,316,557</b>
Western Superior Uplands							
NPC Class	County	Federal	Private	Public	State	Tribal	Grand Total
FDc23	21	384	129618	139	3720	4	133886
FDc24	368	432	217733	552	9263	19	228367
FDc34	29	75	59077	187	3534	36	62938
FDn12			69		43		112
FDn33	52	45	27376	48	4930	81	32533
FDn43	38	23	8928	20	3958	21	12987
MHc26	286	2481	583588	193	104775	2558	693881
MHc36	81	98	416194	615	24609	397	441994
MHc47	325	1	178195		21874		200395
MHn35	1006	236	226436	251	98477	167	326573
MHn44	344	76	93203	104	50696	61	144484
MHn46	21	8	4488	10	5169	6	9702
MHn47			1237		252		1489
<b>Total</b>	<b>2,569</b>	<b>3,858</b>	<b>1,946,142</b>	<b>2,120</b>	<b>331,300</b>	<b>3,350</b>	<b>2,289,340</b>

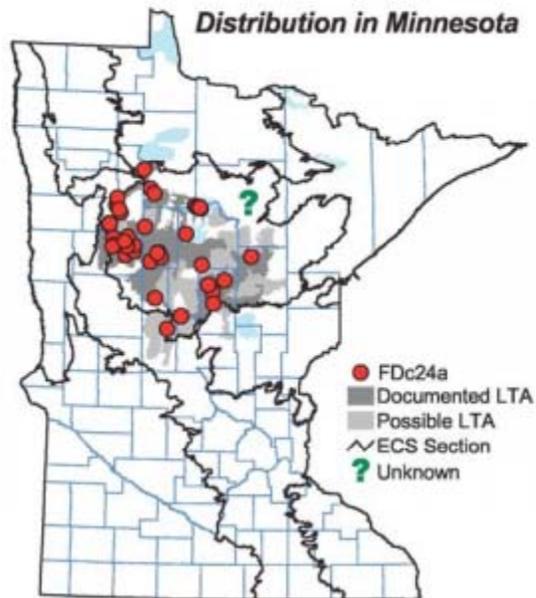
# Silvicultural Applications

## Silviculture Program Silviculture Interpretations

This web page is comprised of general native plant community information that can be used to prescribe and support stand-level management. For each native plant community, information is presented that will introduce foresters to natural disturbance regimes, **stand dynamics**, growth stages, tree behaviors and seasonal operability. General species-specific forest health information also is presented.

### Your Involvement in the Process

As you read the native plant community material we hope that you will take the time to read the material carefully and if you choose, make comments for improvement or corrections or additions to the material. As well, we need you to let us know other information that you think would be useful to others that are reading this material. If you have comments you would like to make, call your regional **Silviculture Program leaders** for discussion and inclusion to the comments page. **THANK YOU**



The range of FDC24 forests in Minnesota (shaded) and distribution of releve samples (red dots).

### Native Plant Community Classification

#### Acid Peatland Forest System

- [APn81 .pdf](#)

#### Fire-Dependent Forest System

- [FDC24 .pdf](#)
- [FDC34 .pdf](#)
- [FDn12 .pdf](#)
- [FDn32 .pdf](#)
- [FDn33 .pdf](#)
- [FDn43 .pdf](#)
- [FDs37 .pdf](#)

# FDc24 – Central Rich Dry Pine Woodland

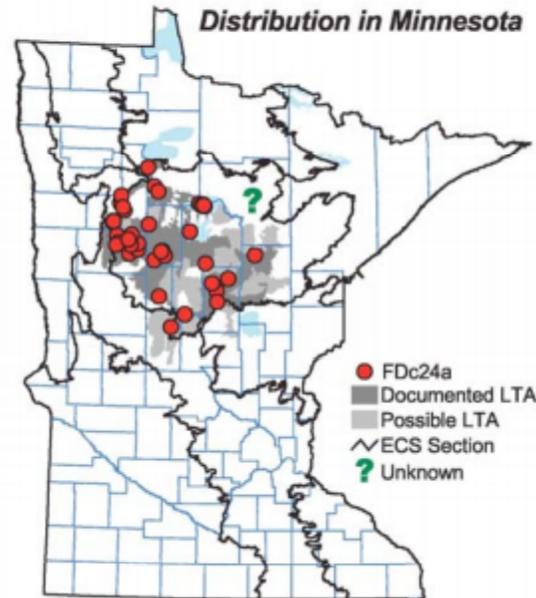
## Natural Disturbance Regime, Stand Dynamics, and Tree Behavior

### Introduction and Management Highlights

Central Rich Dry Pine Woodlands (FDc24) are a common fire-dependent community in the Northern Minnesota Drift and Lake Plain ecological Section of Minnesota. Detailed descriptions of this community are presented in the DNR [Field Guides to Native Plant Communities of Minnesota](#).

### Commercial Trees and Opportunities

As a commercial woodland, FDc24 sites offer a very limited selection of crop trees and incredible variety of possible structural conditions. Jack pine, red pine, quaking aspen and bur oak are all ranked as trees with excellent suitability for FDc24 sites by virtue of their frequent occurrence and high cover when present on FDc24 sites (see [Suitability Tables](#)). Quaking aspen though produces poor-quality pulp on sites this dry, and bur oak does not produce logs commercial interest in the present market. Paper birch and red oak are ranked as having good suitability, and stands can be managed to perpetuate these trees as co-dominants. Birch though, is short-lived on FDc24 sites, and red oak does not produce useable logs.



The range of FDc24 forests in Minnesota (shaded) and distribution of releve samples (red dots).

### Jack Pine

- ∞ excellent habitat suitability rating
- ∞ early successional
- ∞ open (large-gap) regeneration strategist
- ∞ regeneration window at 0-40 years

### Red Pine

- ∞ excellent habitat suitability rating
- ∞ mid-successional
- ∞ open regeneration strategist
- ∞ regeneration window at 0-20 years

# FDc34 – Central Dry-Mesic Pine-Hardwood Forest

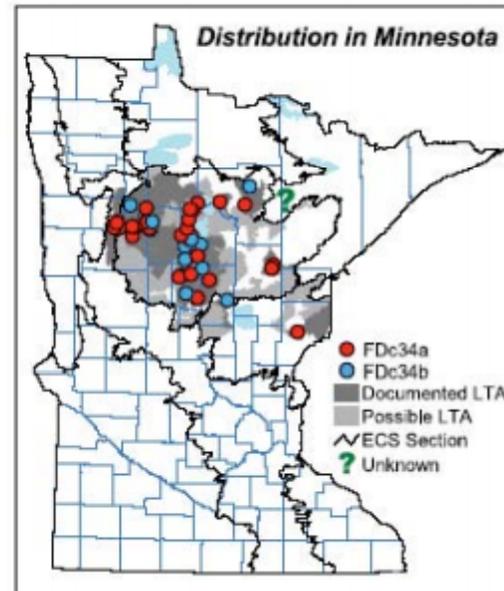
## Natural Disturbance Regime, Stand Dynamics, and Tree Behavior

### Summary and Management Highlights

Central Dry-Mesic Pine-Hardwood Forests (FDc34) are a common community found almost entirely within the Northern Minnesota Drift and Lake Plains Section of Minnesota (Figure 1). Detailed descriptions of this community are presented in the DNR [Field Guides to Native Plant Communities of Minnesota](#).

### Commercial Trees and Management Opportunities

As a commercial forest, FDc34 sites offer a wide selection of crop trees and possible structural conditions. Red pine, white pine, quaking aspen, northern red oak, paper birch, and red maple are all ranked as excellent choices as crop trees by virtue of their frequent occurrence and high cover when present on FDc34 sites (see [Suitability Tables](#)). Bur oak, big-toothed aspen, and jack pine are ranked as good crop trees, and stands can be managed to perpetuate these trees as co-dominants, especially when present or with evidence of former presence (e.g. stumps) in a particular stand. Basswood is ranked as just a fair choice of crop tree, but stands can be managed to maintain their presence as minor trees for purposes other than timber production.



**Figure 1.** The range of FDc34 forests in Minnesota (shaded) and distribution of releve samples (red and blue dots).

### Red Pine

- *excellent habitat suitability rating*
- *mid-successional*
- *open regeneration strategist*
- *regeneration window at 0-30 years*

### White Pine

- *excellent habitat suitability rating*
- *late-successional*
- *large-gap (small-gap) regeneration strategist*
- *regeneration window at 0-40 years*

<b>Drift and Lake Plains</b>							
<b>NPC Class</b>	<b>County</b>	<b>Federal</b>	<b>Private</b>	<b>Public</b>	<b>State</b>	<b>Tribal</b>	<b>Grand Total</b>
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<b>Western Superior Uplands</b>							
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## MHc26 – Central Dry-Mesic Oak-Aspen Forest

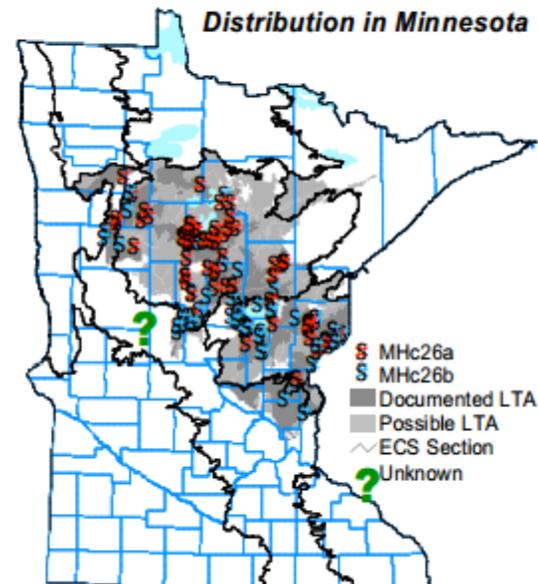
### Natural Disturbance Regime, Stand Dynamics, and Tree Behavior

#### Summary and Management Highlights

Central Dry-Mesic Oak-Aspen Forests (MHc26) are a common hardwood community found mostly within the Northern Minnesota Drift and Lake Plain and Western Superior Uplands ecological Sections of Minnesota. Detailed descriptions of this community are presented in the DNR [Field Guides to Native Plant Communities of Minnesota](#).

#### Commercial Trees

As a commercial forest, MHc26 sites offer a wide selection of crop trees and possible structural conditions. Northern red oak, quaking aspen, paper birch, red maple, basswood, sugar maple, bur oak, and big-toothed aspen are all ranked as excellent choices as crop trees by virtue of their frequent occurrence and high cover when present on MHc26 sites (see [Suitability Tables](#)). White pine and red pine are ranked as good crop trees, and stands can be managed to perpetuate these trees as co-dominants, especially when present or with evidence of former presence (e.g. stumps) in a particular stand.



The range of MHc26 forests in Minnesota (shaded) and distribution of releve samples (red and blue dots).

Dominant canopy trees of MHc26			
Tree	Percent Presence	Mean Percent Cover When Present	Suitability Index*
Northern red oak ( <i>Quercus rubra</i> )	81	35	5.0
Quaking aspen ( <i>Populus tremuloides</i> )	41	21	4.7
Paper birch ( <i>Betula papyrifera</i> )	58	14	4.7
Red maple ( <i>Acer rubrum</i> )	44	14	4.5
Basswood ( <i>Tilia americana</i> )	45	13	4.5
Sugar maple ( <i>Acer saccharum</i> )	29	16	4.3
Bur oak ( <i>Quercus macrocarpa</i> )	28	17	4.3
Big-toothed aspen ( <i>Populus grandidentata</i> )	25	18	4.2

...likely success of natural regeneration with little silvicultural manipulation

## MHn35 – Northern Mesic Hardwood Forest

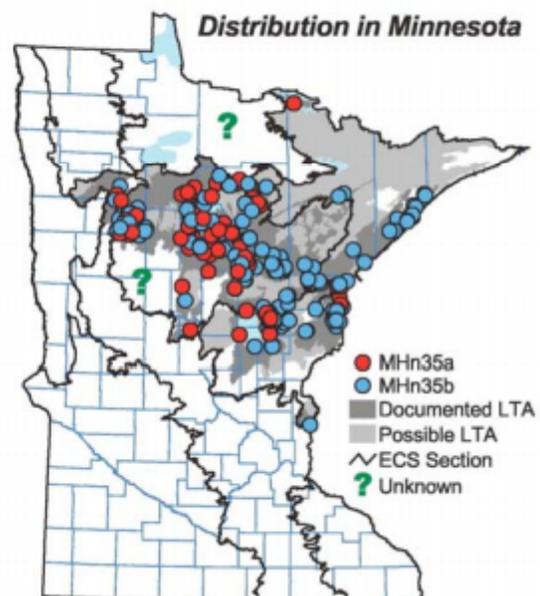
### Natural Disturbance Regime, Stand Dynamics, and Tree Behavior

#### Summary and Management Highlights

Northern Mesic Hardwood Forests (MHn35) are a common hardwood community found mostly within the Northern Minnesota Drift and Lake Plain, Western Superior Uplands, and Northern Superior Uplands ecological Sections of Minnesota (see map). Detailed descriptions of this community and ecological maps are presented in the DNR [Field Guides to Native Plant Communities of Minnesota](#).

#### Commercial Trees

As a commercial forest, MHn35 sites offer a wide selection of crop trees and possible structural conditions. Sugar maple, basswood, northern red oak, paper birch, quaking aspen, and red maple are all ranked as excellent choices as crop trees by virtue of their frequent occurrence and high cover when present on MHn35 (see [Suitability Tables](#)). Big-toothed aspen and white pine are ranked as good crop trees, and stands can be managed to perpetuate these trees as co-dominants, especially when present or with evidence of former presence (e.g. stumps) in a particular stand. Bur oak, yellow birch, and balsam fir are ranked as just fair choices of crop trees, but stands can be managed to maintain their presence as minor trees for purposes other than timber production.



The range of MHn35 forests in Minnesota (shaded) and distribution of releve samples (red and blue dots).

#### Dominant canopy trees of MHn35

Tree	Percent Presence as Tree	Mean Percent Cover When Present	Suitability Index*
Sugar maple ( <i>Acer saccharum</i> )	81	32	5.0
Basswood ( <i>Tilia americana</i> )	65	15	4.8
Northern red oak ( <i>Quercus rubra</i> )	49	20	4.7
Paper birch ( <i>Betula papyrifera</i> )	61	13	4.6
Quaking aspen ( <i>Populus tremuloides</i> )	31	20	4.4
Red maple ( <i>Acer rubrum</i> )	31	12	4.1

**Silviculture Systems for MHN35: No arrow - least favorable, ↑ Favorable, ↑↑ Very Favorable**

	Silviculture Systems	Clearcut	Patch Cutting	Group Seedtree	Dispersed Seedtree	Uniform Shelterwood	Group Shelterwood	Irregular Shelterwood	Group Selection	Strip Selection	Single Tree Selection
	Regeneration Strategy										
Northern Red oak	Large-gap (Small-gap)		↑	↑	↑	↑↑	↑↑	↑↑	↑↑	↑	↑
Red Maple	Large-gap (Small-gap)		↑	↑	↑	↑↑	↑	↑↑	↑↑	↑	↑
Sugar Maple	Small-gap							↑	↑↑	↑↑	↑↑
Basswood	Small-gap (Large-gap)		↑	↑		↑	↑↑	↑↑	↑↑	↑↑	↑
Quaking Aspen	Open (Large-gap)	↑↑	↑↑	↑↑	↑↑		↑				

**Quaking Aspen**

Agent	Growth stage	Concern/ Effect
Armillaria root disease	All stages	Mortality
Forest tent caterpillar	"	Defoliation
Hypoxylon canker	Pole-sized and larger	Topkill and mortality
Saperda borer	"	Mortality
Stem decay = white trunk rot	"	Volume loss

**WATCHOUTS!**

∞ In over-mature stands, prolonged defoliation will accelerate mortality.

∞ Harvest during the winter to ensure adequate regeneration.

∞ To estimate the basal area of a stand affected by white trunk rot, determine the basal area with conks then multiply that number by 1.9.

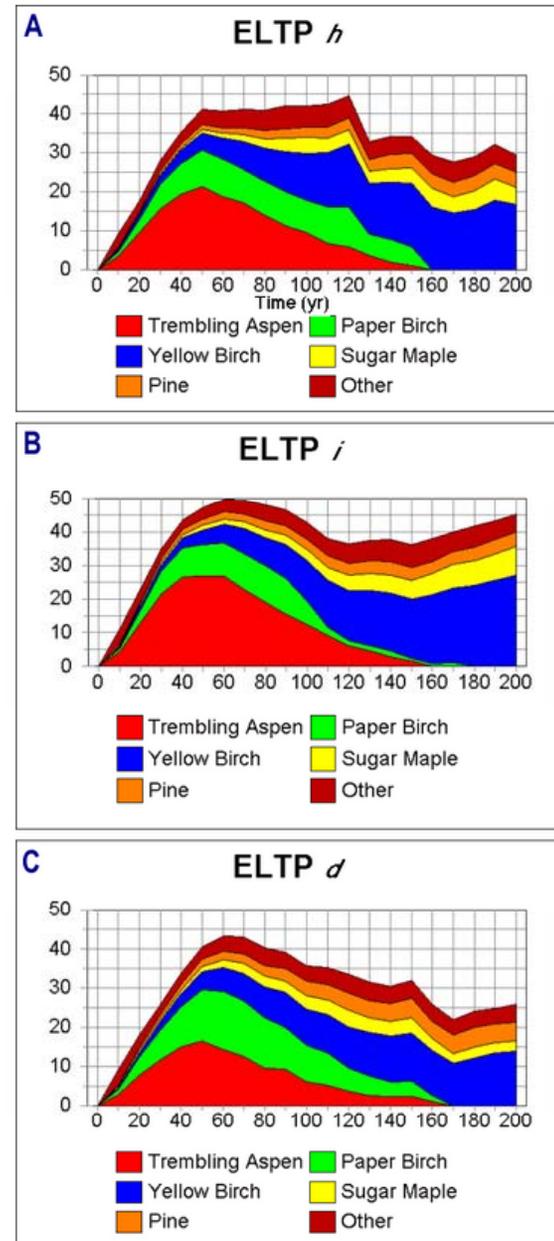
# Applications: Economic

- Class level NPCs vary in successional patterns mean annual biomass increment

Host, G. E., K.S. Pregitzer, C.W. Ramm, D.P. Lusch, and D.T. Cleland. 1988. Variation in overstory biomass among glacial landforms and ecological land units in northwestern Lower Michigan. *Canadian Journal of Forest Research* 18:659-668.

Host, G. E. and J. Pastor. 1998. Modeling forest succession among ecological land units in northern Minnesota. *Conservation Ecology*, 2(2): 15.  
[www.consecol.org/vol2/iss2/art15](http://www.consecol.org/vol2/iss2/art15).

Fig. 2. Simulated forest successional patterns, given bare-ground starting conditions for six Ecological Landtype Phases on the Chippewa National Forest, north-central Minnesota. The scale numbers on the y - axes represent basal area in m<sup>2</sup>/ha.

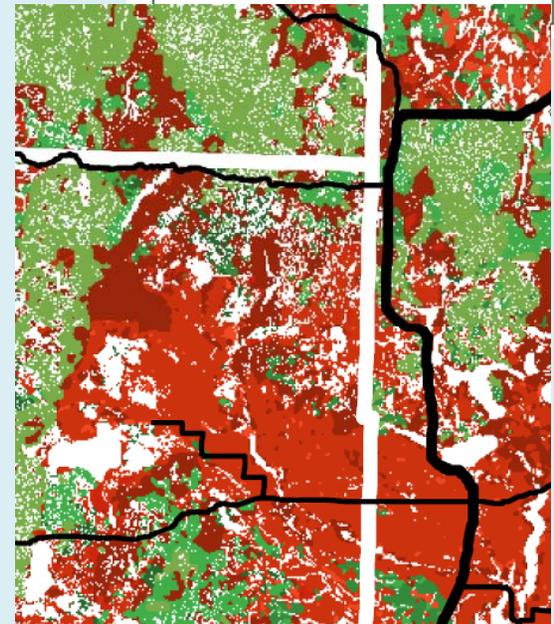
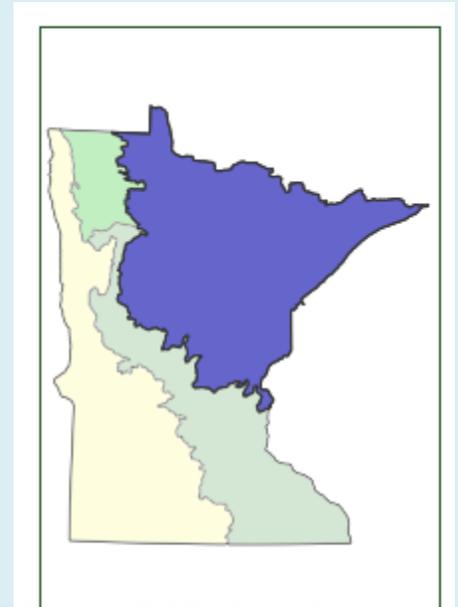


# Applications: Social

- What are the risks involved in populating historically fire-dependent ecosystems?
- What are the risks of not harvesting overmature or late successional stands in settled areas?
- Does fire risk change in highly fragmented landscapes?
- How will risk change in a changing climate?

# Conclusions

- Now have wall-to-wall high resolution maps for the Laurentian Mixed Forest Province
- Maps are keyed to MN DNR Classification at system and class levels
- Provide a basis for ecological, social and economic analyses



# Acknowledgements

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# Talking Points

- How to move forward?
  - What is the appropriate classification?
  - What is the appropriate classification resolution?
    - System (6 forested)? Class (~30+)? Aggregated classes?
  - How do we crosswalk with cover types and model outputs?

System	NPC Class	NPC name	NSU type	Dominant species		NOT	NOT	Landform
Fire-dependent Forest/Woodland	FDn12	Northern Dry-Sand Pine Woodland	Jack pine-hardwood	jack pine	red pine	black spruce	white pine	
Fire-dependent Forest/Woodland	FDn32	Northern Poor Dry-Mesic Mixed Woodland	Jack pine-black spruce	jack pine	black spruce	birch	white pine	flat sandy lacustrine
Fire-dependent Forest/Woodland	FDn33	Northern Dry-mesic Woodland		aspen	black spruce	jack pine	red maple	
Fire-dependent Forest/Woodland	FDn43	Northern Mesic Mixed Forest	Mesic white pine red pine	red pine	white pine	jack pine	black spruce	
Mesic Hardwood Forest	MHn44	Northern Wet-Mesic Boreal Hardwood-Conifer Forest		aspen	balsam fir	basswood		fines sandy lake plain, river drainage, lake was
Mesic Hardwood Forest	MHn46	Northern Wet-Mesic Hardwood Forest		basswood	black ash			sloping morains
Mesic Hardwood Forest	MHn47	Northern Rich Mesic Hardwood Forest	Sugar maple	sugar maple	basswood	aspen	balsam fir	only on Ponemah Point
Mesic Hardwood Forest	MHc37	Central Mesic Hardwood Forest						
Floodplain Forest	FFn57	Northern Terrace Forest						
Floodplain Forest	FFn67	Northern Floodplain Forest						
Wet Forest	WFn53	Northern Wet Cedar Forest		white cedar	balsam fir	aspen	elm	
Wet Forest	WFn55	Northern Wet Ash Swamp		black ash		white cedar	balsam fir	
Wet Forest	WFn64	Northern Very Wet Ash Swamp		black ash		paper birch	aspen	
Wet Forest	WFw54	Northwestern Wet Aspen Forest		balsam poplar	aspen	white cedar	balsam fir	
Forested Rich Peatland	FPn63	Northern Cedar Swamp		white cedar				peatland
Forested Rich Peatland	FPn71	Northern Rich Spruce Swamp (Water Track)		black spruce	tamarack			peatland, east side
Forested Rich Peatland	FPn81	Northern Rich Tamarack Swamp (Water Track)		tamarack	black spruce			peatland
Forested Rich Peatland	FPw63	Northwestern Rich Conifer Swamp		tamarack	black spruce			west edge of MOP on V
Acid Peatland	APn81	Northern Poor Conifer Swamp		black spruce	tamarack			extensive in MOP, spar
Acid Peatland	APn80	Northern Spruce Bog		black spruce				extensive in MOP, spar