Edge Effects on Vegetation Communities in Old-Growth and Managed Forest Landscapes

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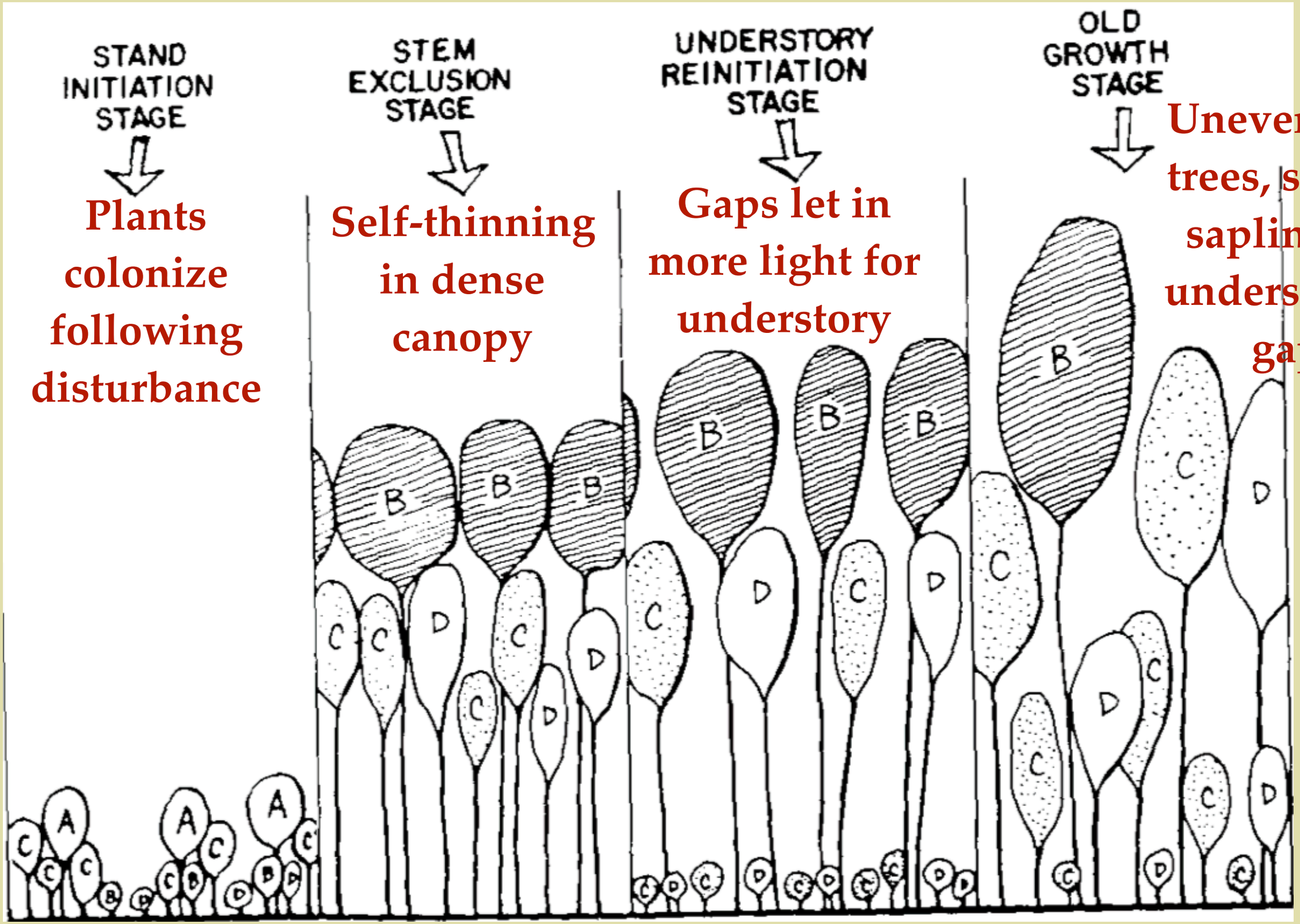
Background

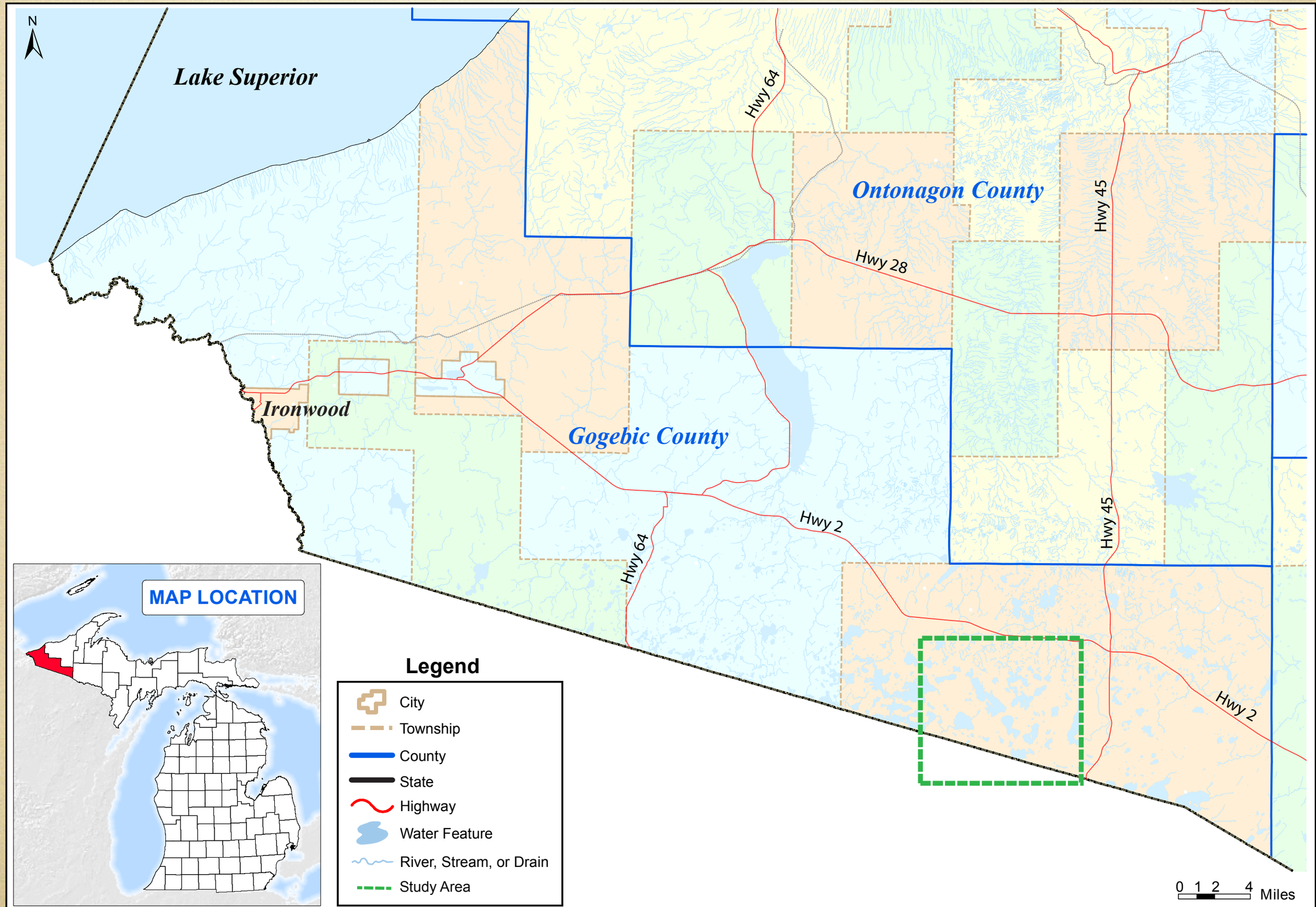
- Approximately 1% of forests in Great Lakes Region are old-growth (never harvested), as estimated in 1995
- Remaining old-growth forests are in disjunct patches and isolated from other old-growth stands
- Various types of land use surround these remaining old-growth stands
- Effect of surrounding land use unknown

Old-Growth Model

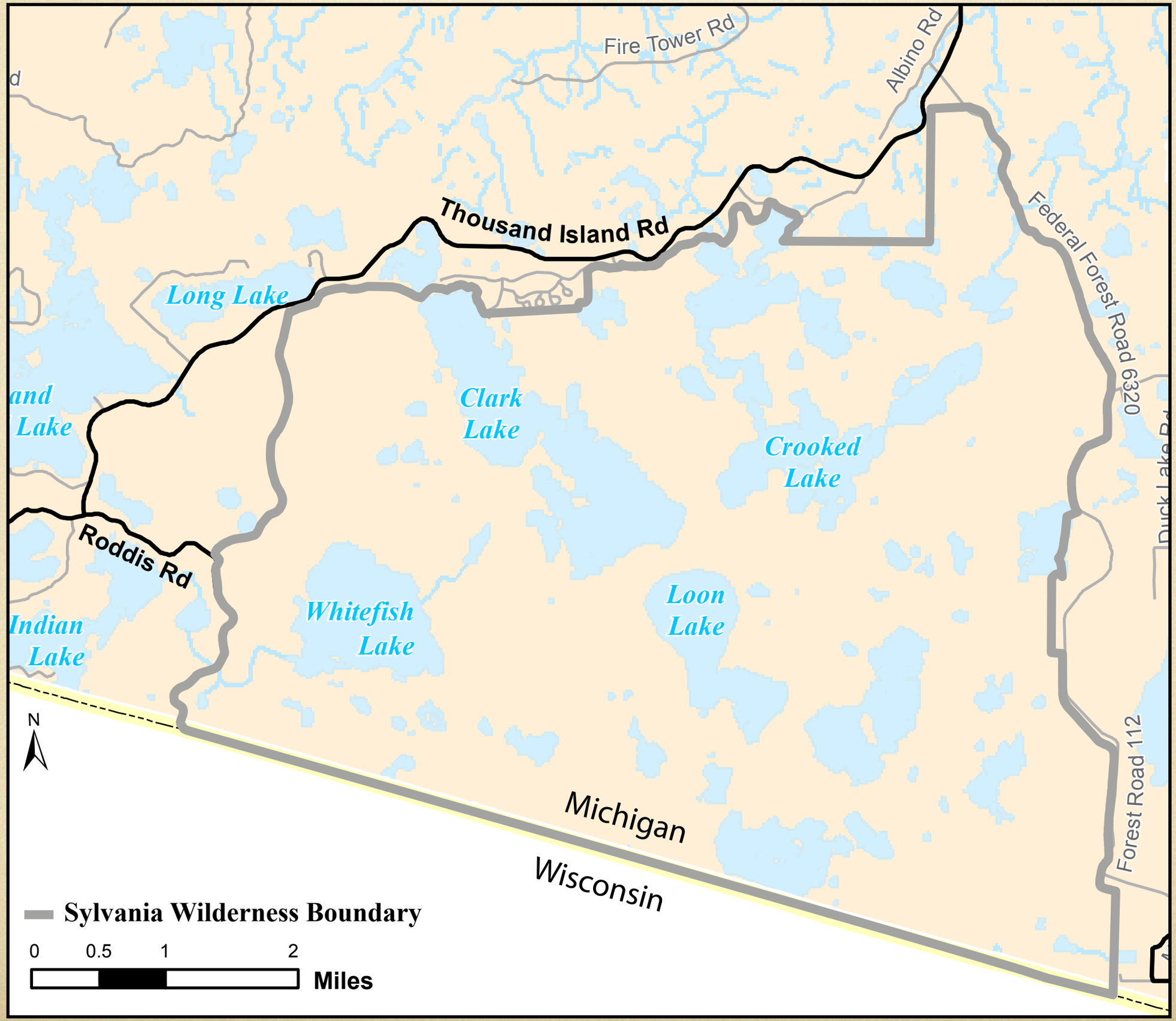


Oliver (1981)

Study Area


N
Lake Superior
Ironwood
Gogebic County
Ontonagon County
Hwy 64
Hwy 28
Hwy 45
Hwy 2
Hwy 64
Hwy 45
Hwy 2
MAP LOCATION
Legend
City
Township
County
State
Highway
Water Feature
River, Stream, or Drain
Study Area
0 1 2 4
Miles

Sylvania Wilderness



Study Area Land Use

Michigan Side of Border

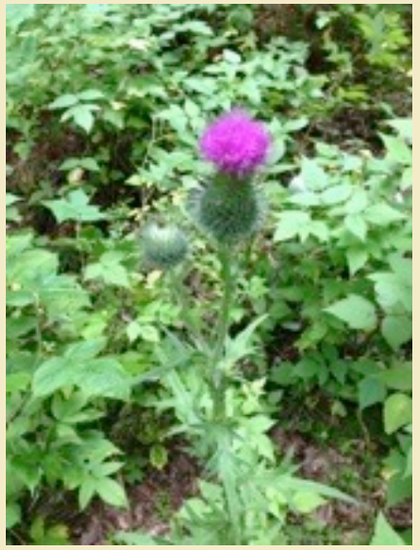
- Entirely within the Sylvania Wilderness
- Limited activities allowed (e.g., timber harvest, hunting, and motorized engines all prohibited)

Wisconsin Side of Border

- Privately owned land (family trusts, LLCs, or school trusts)
- Management varies depending on owner, but timber harvest allowed (and occurs)

Sylvania

Private Land



Research Questions

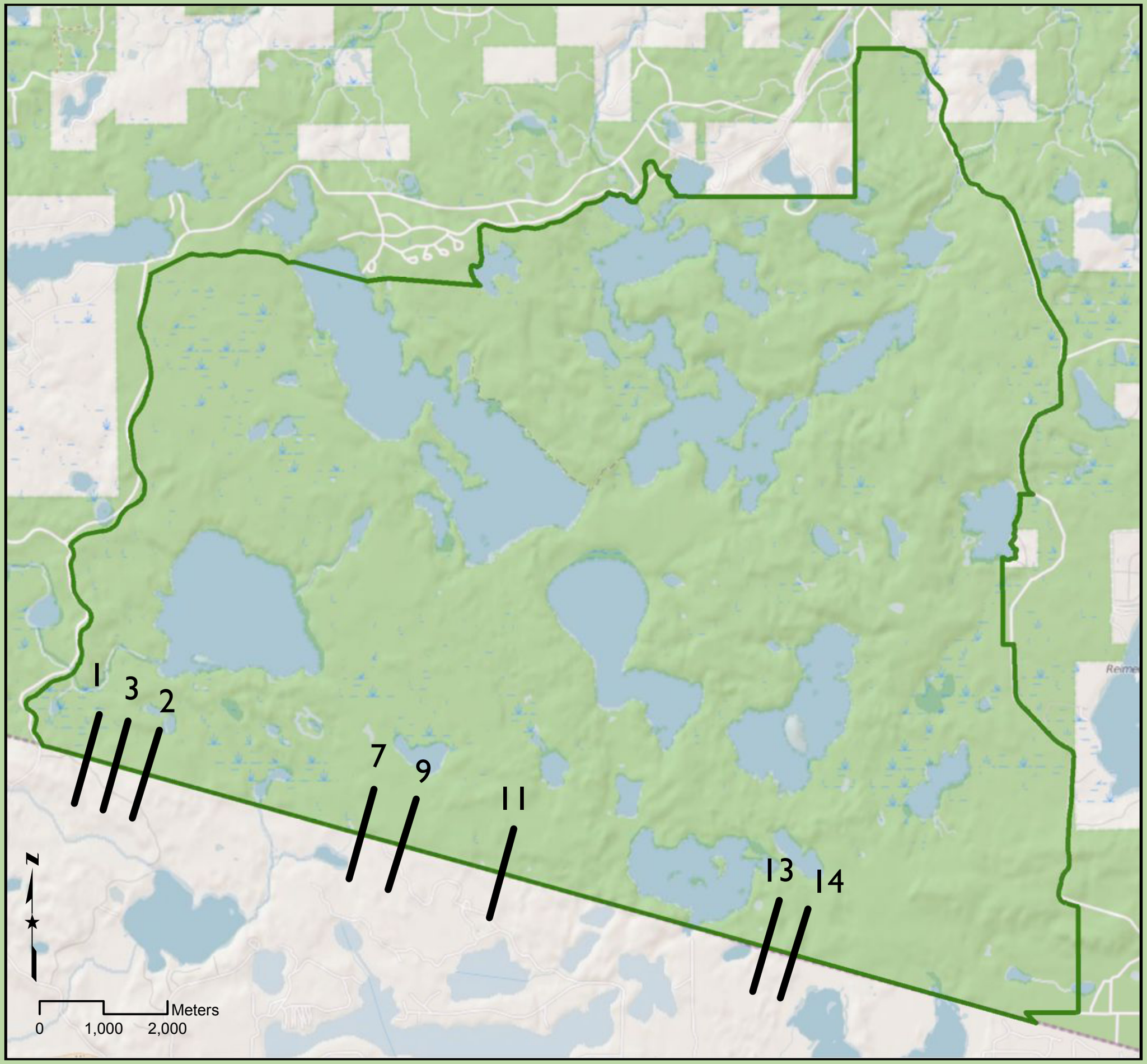
- Is there a *difference* between variables collected on wilderness land and managed land?
- If there is a difference, *how* do variables change from wilderness border?
- If variables do change, *where* does this change occur (i.e., in distance *from* the border)?

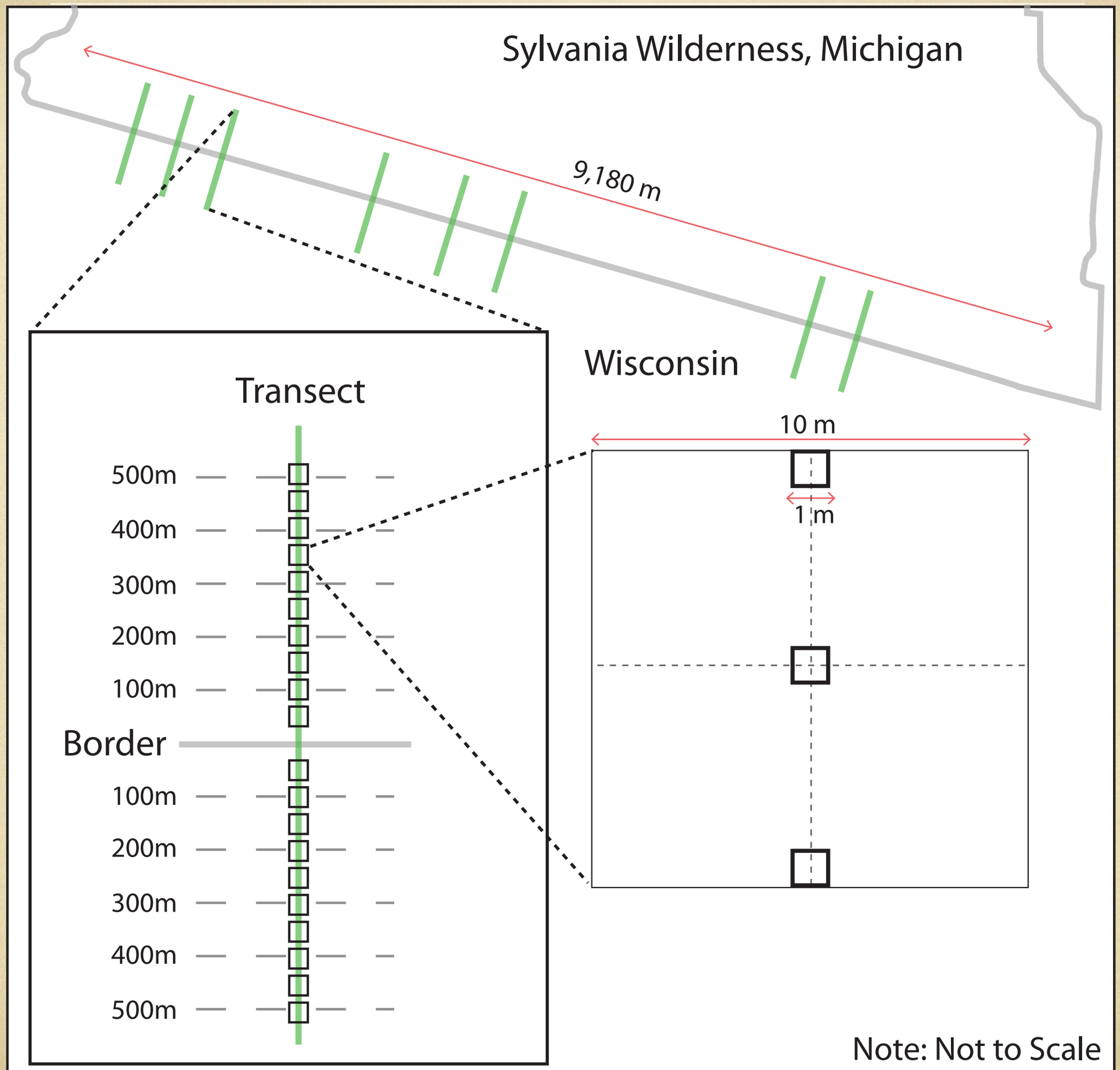
Specific Variables of Interest

- Abundance: *Number of plots* species present
- Frequency: *Proportion of plots* species present
- Density: Number of *species per unit area*
- Dominance: *Area* species occupies (cover/DBH)
- Importance: Average of summed *relative* frequency, *relative* density, and *relative* dominance (for trees)
- Heterogeneity: *uniformity* of species distribution
- Diversity: *species variability* (Shannon-Weiner diversity index)
- Richness: Number of *different species* present
- Evenness: *Equitability* of abundance ("shape")

Field Methods

- Eight random transects across wilderness border (500 m/side; 1 k total length)
- Every 50 m sampled a 10 m x 10 m plot (trees, saplings, shrubs, stand characteristics)
- Twenty plots total per transect (10 plots/side with plots #1-10 on MI side and #11-20 on WI side)
- Three 1 m x 1 m nested sub-plots within each plot (herbs and seedlings)


1
3
2
7
9
11
13
14
N
0
1,000
2,000
Meters


Sylvania Wilderness, Michigan
9,180 m
Wisconsin
Transect
500m
400m
300m
200m
100m
Border
100m
200m
300m
400m
500m
10 m
1 m
Note: Not to Scale

All Data Collected

- Distance from border
- Slope & Aspect
- Tree species, size, & distribution
- Tree canopy index
- Sapling species & abundance
- Shrub species & cover
- Seedling species & abundance
- Herb ID & cover
- Canopy height
- Canopy cover
- Windfalls
- Snags
- Reiterated trunks
- Basal sprouts
- Graminoids
- Bare soil
- Non-vegetated area
- Coarse woody debris

Important Data Collected

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- ~~Slope and Aspect~~
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- ~~Reiterated trunks~~
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Research Q#1

How and *where* does *plot*-level *vegetation* (trees, shrubs, and saplings) differ from wilderness to adjacent managed lands?

10x10 Plot Data Collected

- Distance from border (calculated in GIS; ignore lat/long location)
- Tree ID and size ("diameter at breast height")
- Sapling ID and number (count) of each sapling
- Shrub ID and percent cover of each shrub

Trees: Species, Size, Height

Tree: identified species if > 10 cm DBH, unbranched, and > 5 m height

- *Size*: Diameter at breast height (for area)

$A = \pi r^2$

$C = 2\pi r$

"pi tape"

- Circumference measured

- Tape units divide by pi for diameter

- Calculate area from diameter

Saplings Species & Count

Sapling: < 10 cm DBH, > 1 m height

- Species identification
- Species counts

Shrub Species and Cover

Shrub: multi-stemmed, woody, and usually < 5 m height

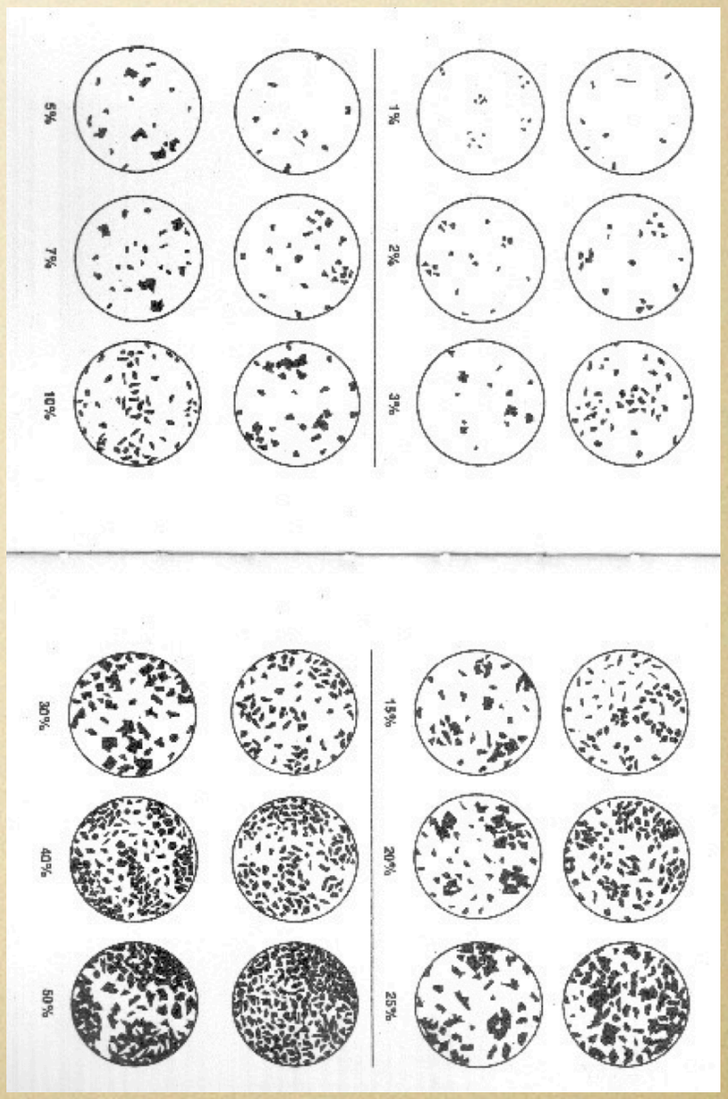
- Species identification
- Percent cover

Research Q#2

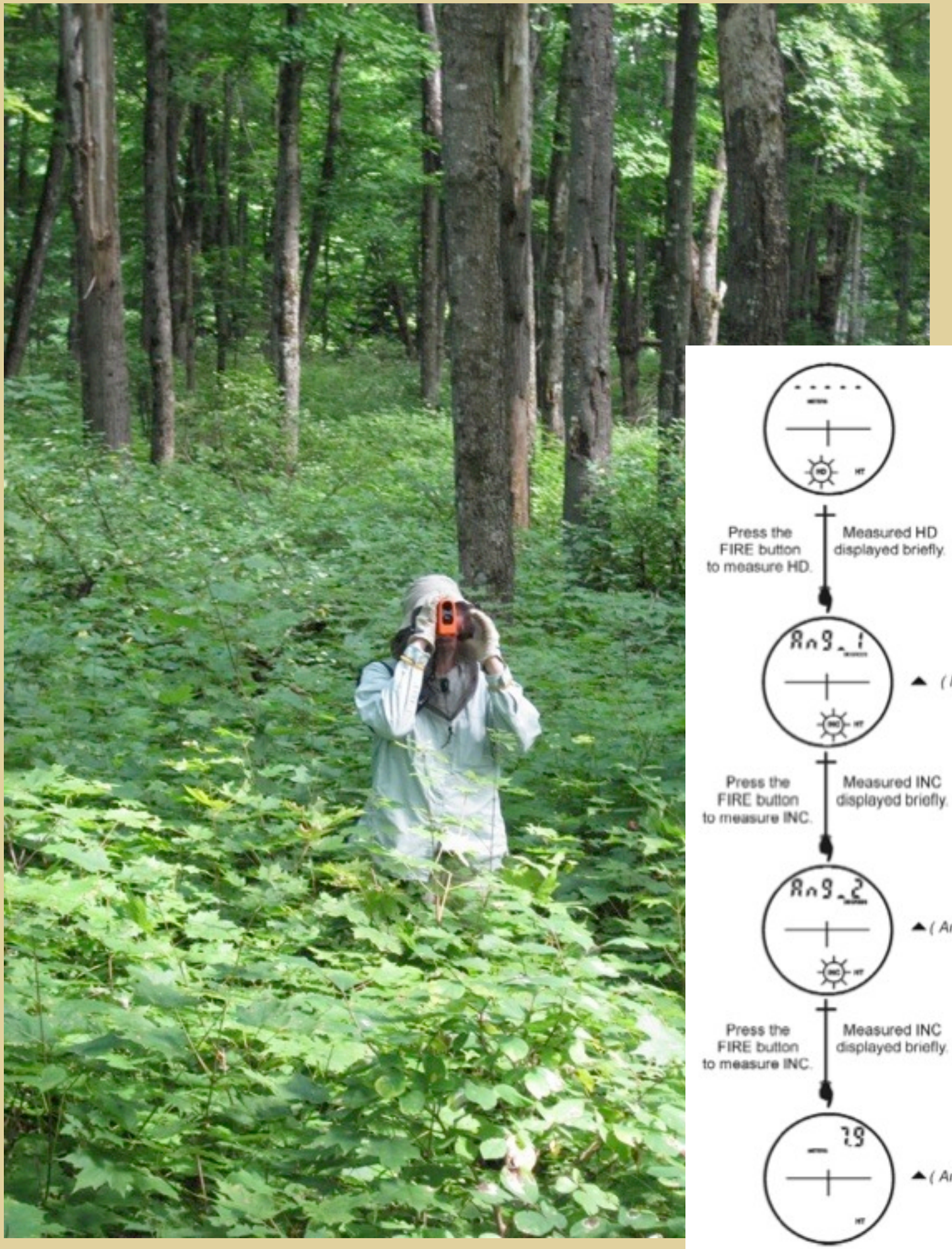
Does *canopy structure* or *stand characteristics* differ from wilderness to adjacent managed lands?

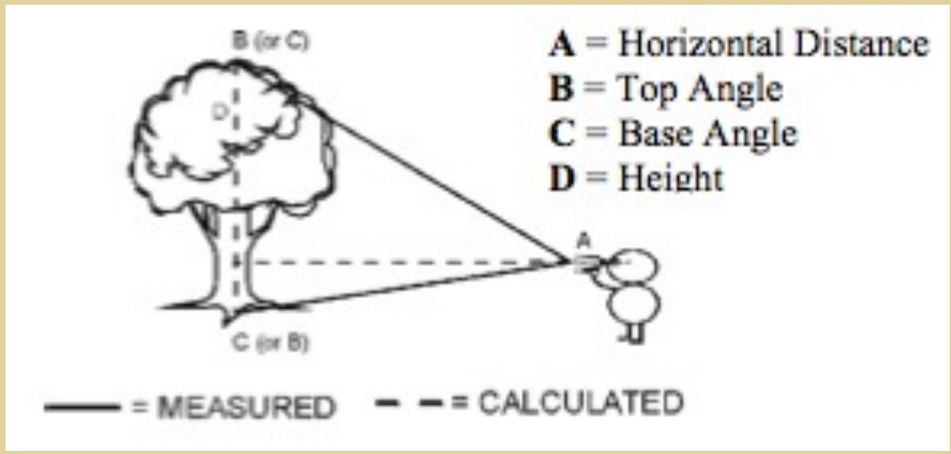
10x10 Plot Data Collected

- Canopy height
- Percent canopy cover
- Abundance of windfalls and snags
- Percent cover coarse woody debris, graminoids, and non-vegetated areas

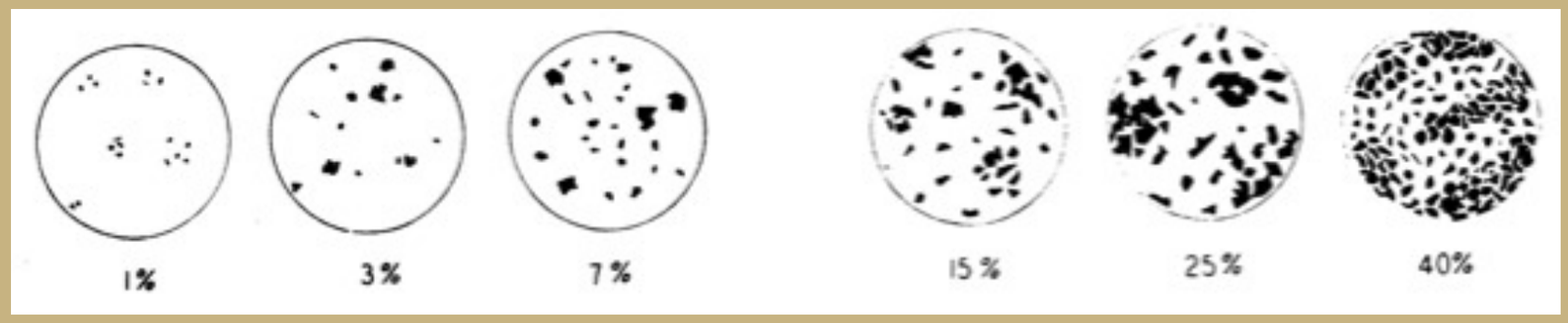


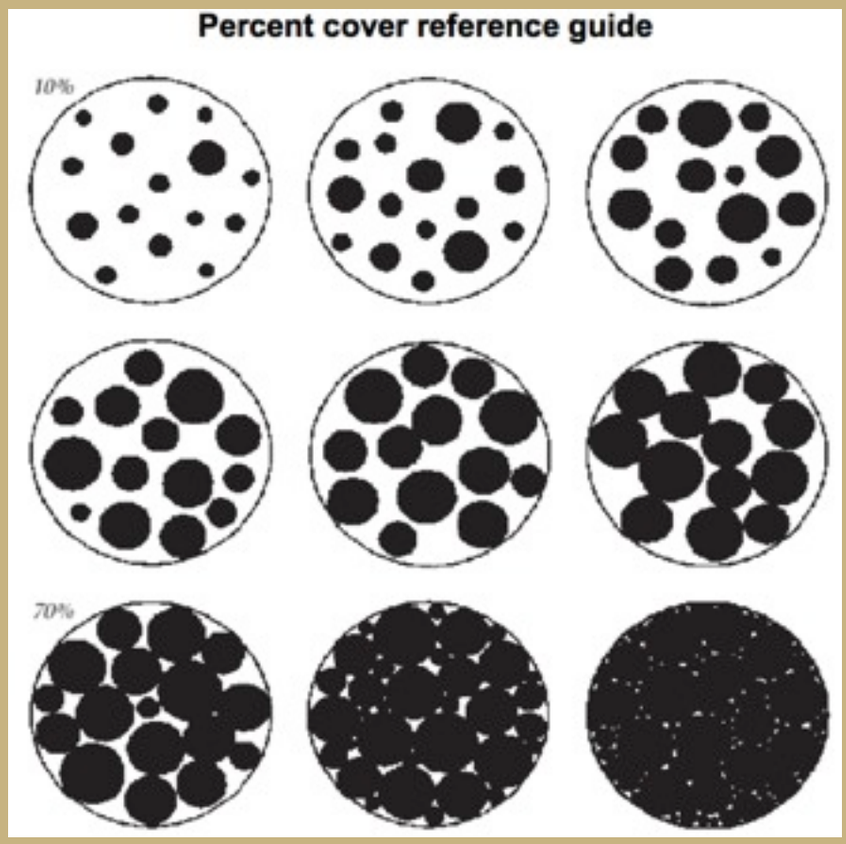
Canopy Structure: Height



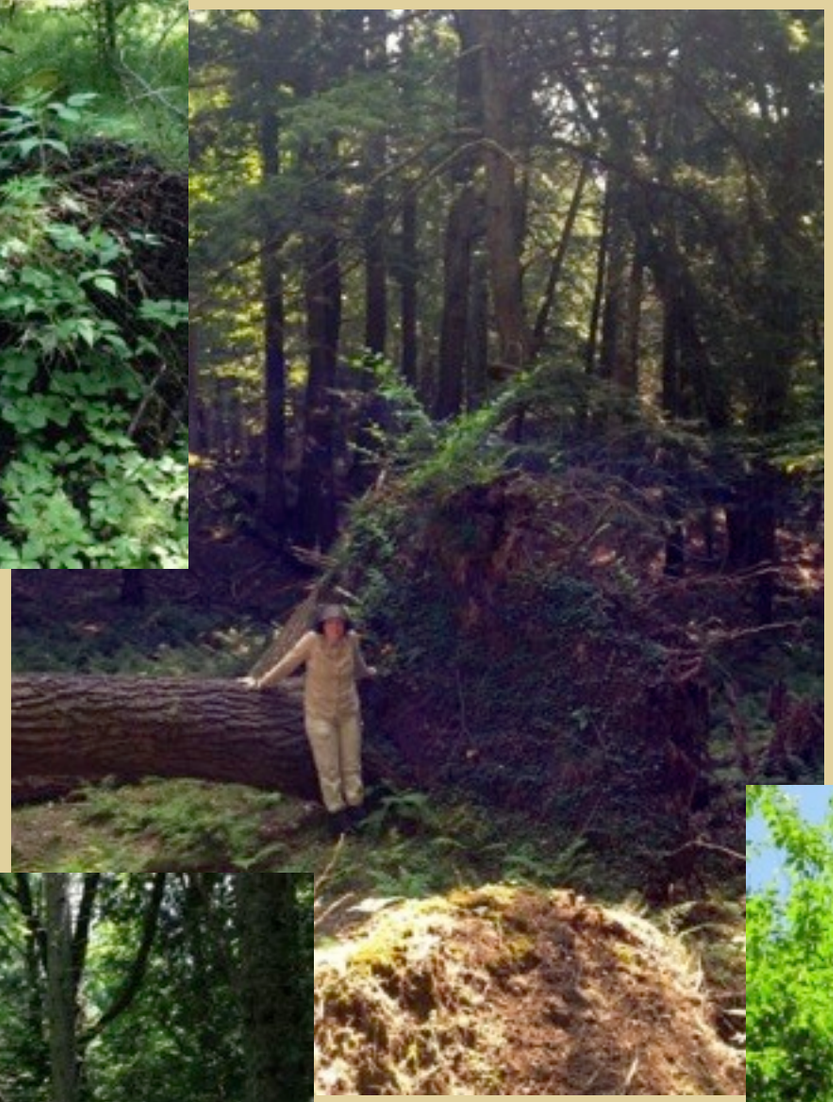


Canopy Structure: Cover





Stand Characteristics: Disturbances



Windfalls

Snags

Stand Characteristics: Cover

Coarse Woody Debris: downed woody material (>20cm DBH)

Non-Vegetated Areas: no vegetation, but still covered (e.g., in leaf litter)

Graminoids: cover of grasses or grass-like species

Research Q#3

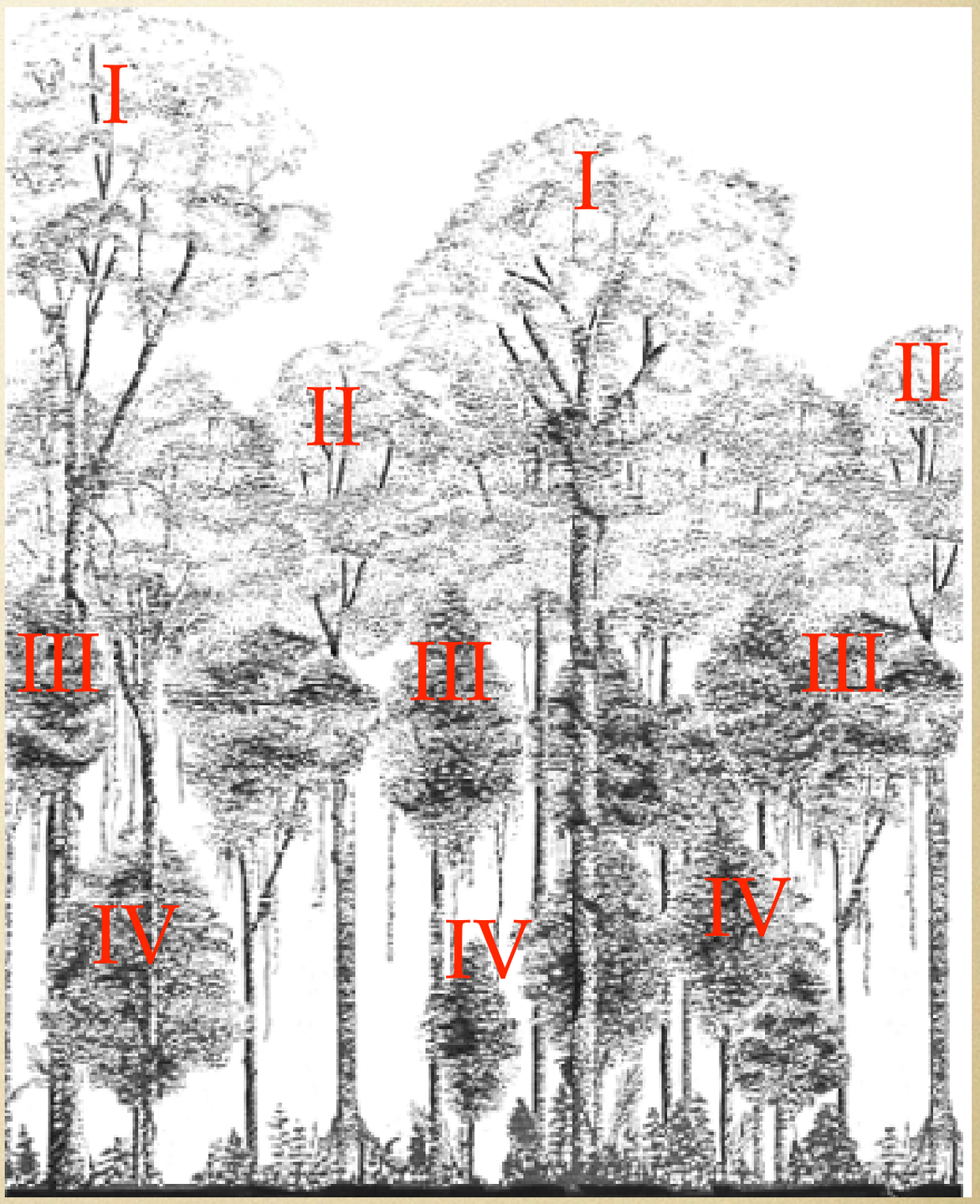
Does *canopy heterogeneity* or *spatial heterogeneity* differ from wilderness to adjacent managed lands?

10x10 Plot Data Collected

- Canopy index for each tree
- Distances to 4 closest trees in cardinal directions

Tree Heterogeneity: Canopy

- I: upper canopy (≥ 80% vertically exposed)
- II: lower canopy (< 80% vertically exposed)
- III: upper understory (crowns reached canopy foliage)
- IV: lower understory (crowns entirely below canopy trees)

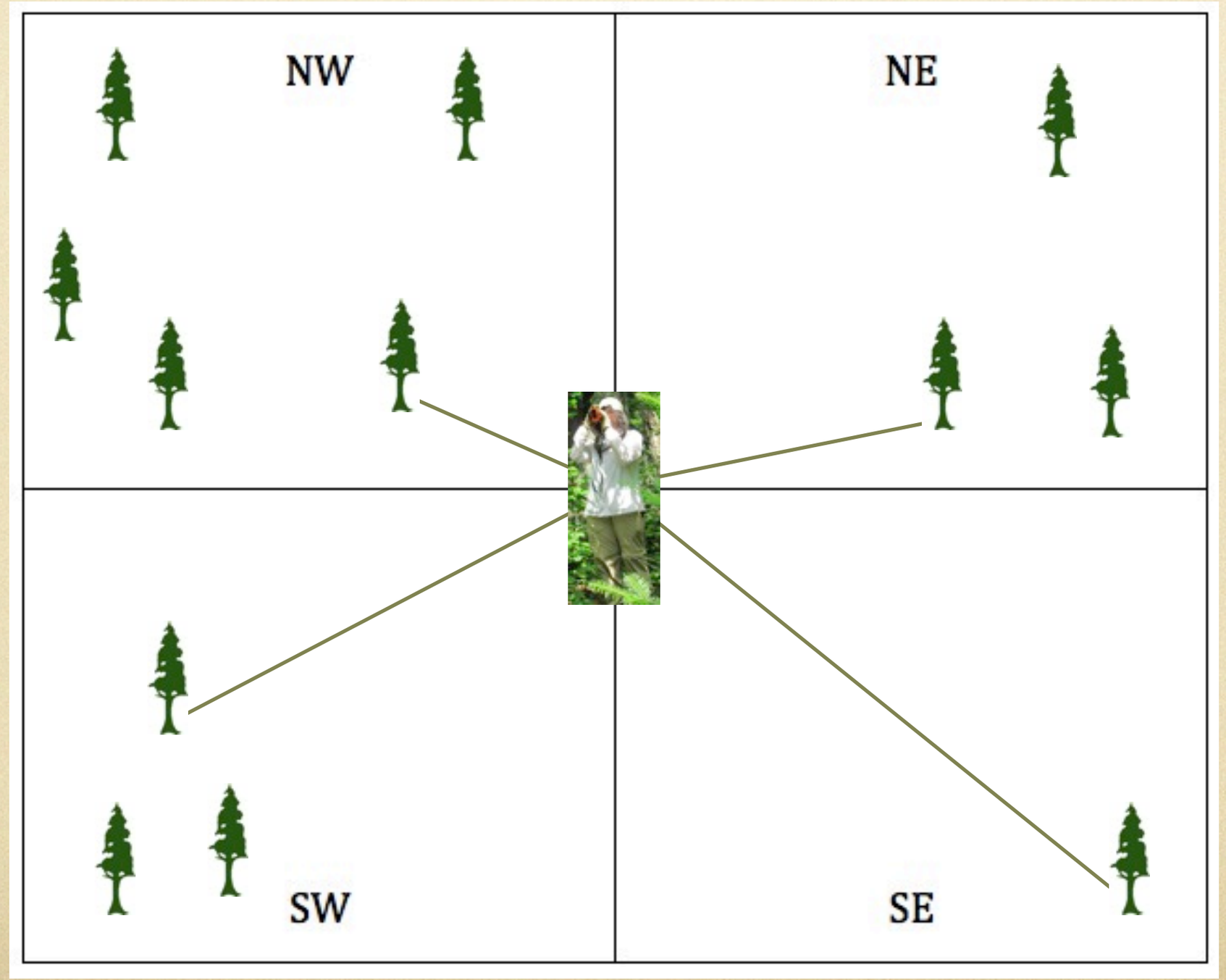


Aiba and Kohyama (1997)

http://rainforests.mongabay.com/

Tree Heterogeneity: Spatial

Point quarter distance method for trees



Research Q#4

How and *where* does *sub-plot* vegetation (herbs and seedlings) differ from wilderness to adjacent managed lands?

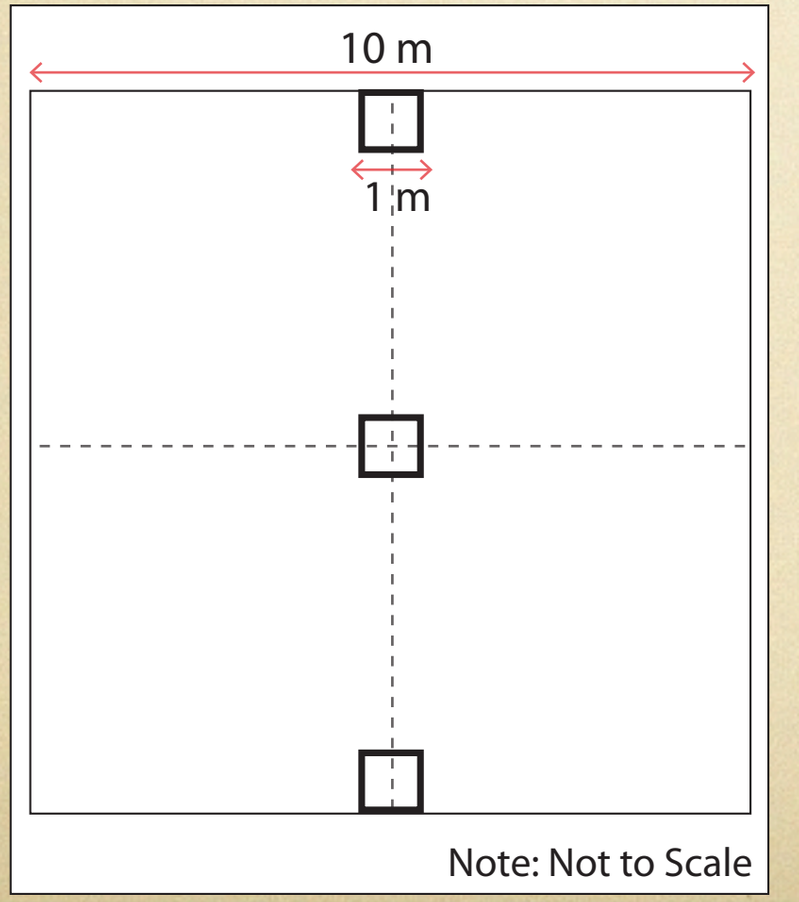
1x1 Subplot Data Collected

- Seedling ID and number of each seedling (count)
- Herbaceous ID and percent cover of each species

Seedlings: Species & Counts

Seedling: tree species < 1 m height

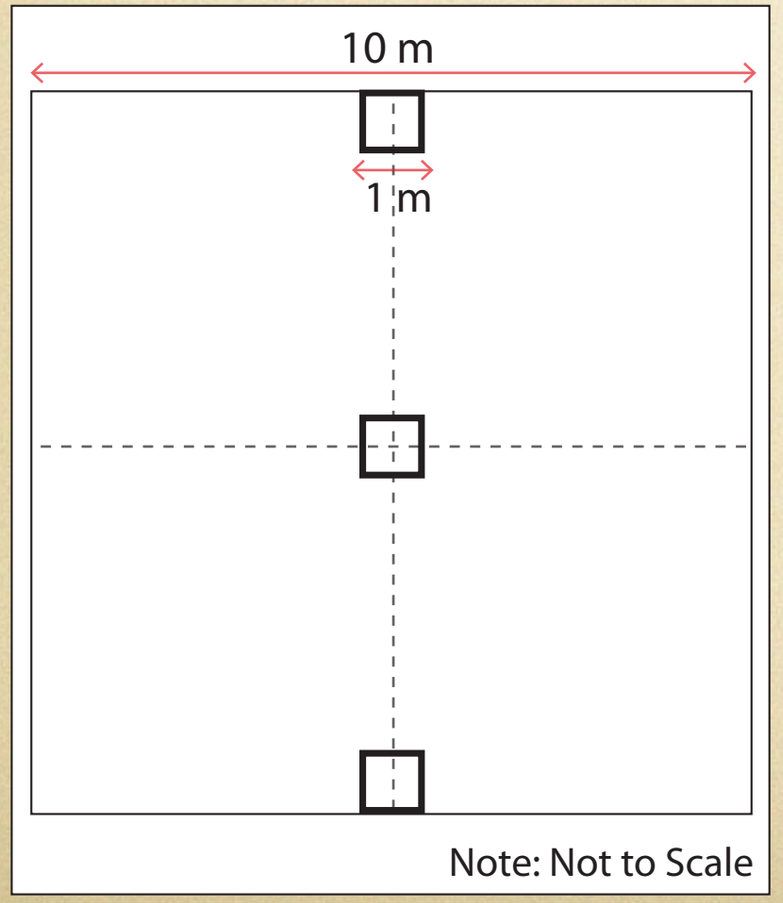
- Species ID and counts in 3 subplots



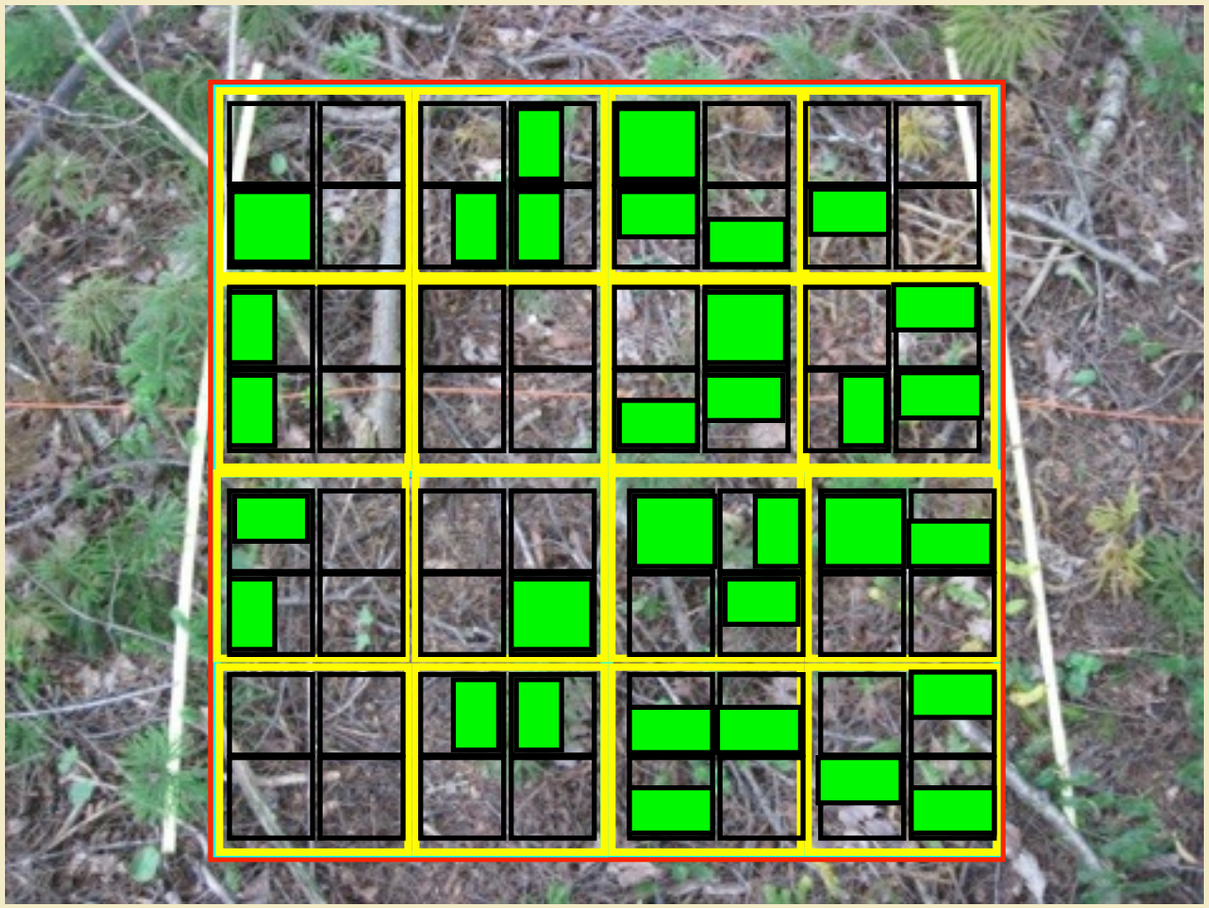
Herbs: Species & Cover

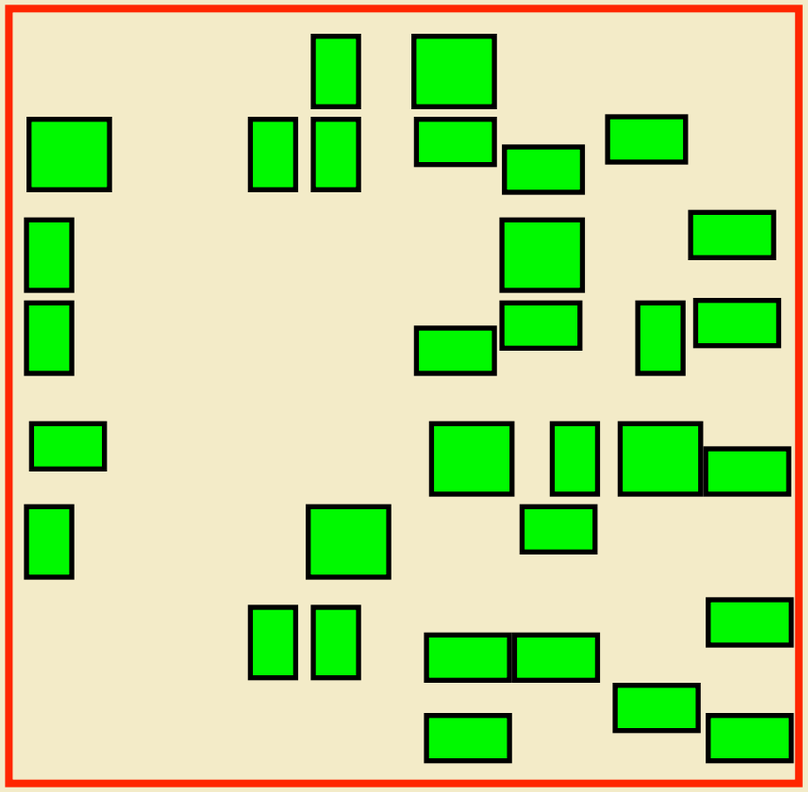
Herb: non-woody (herbaceous) forbs (non-grass flowering plant) and graminoids

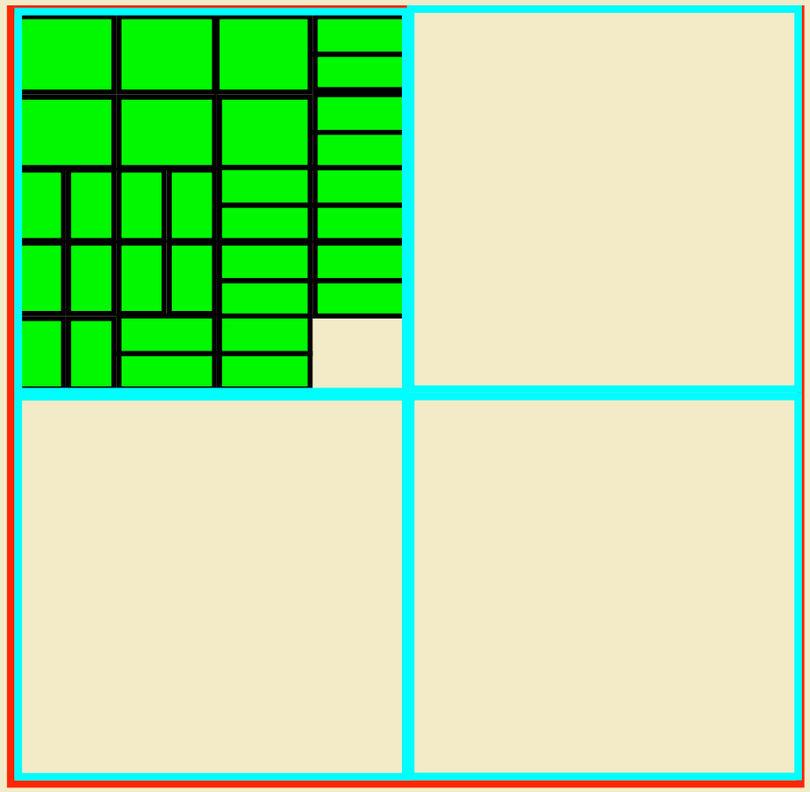
- Herb ID and percent cover
- 3 subplots



Estimating Cover







≈ 25%

= represents plant cover

Research Q#5

Is there a difference in *species diversity* as a function of distance from the wilderness border and *where* does this occur?

Diversity Metrics

- Species Richness: number of different species
- Shannon-Weiner Diversity Index: the proportion, *p*, of species *i* in the total sample is multiplied by natural log; result summed across all species and multiplied by -1
- Evenness: divide the Shannon Diversity Index value by the natural log of species richness (the total number of species)

Shannon-Diversity (H')

	Sp A	Sp B	p_A	p_B
Plot 1	99	1	0.99	0.01
Plot 2	50	50	0.50	0.50

$$H' = -\sum_{i=1}^{s} p_i \log p_i \longrightarrow H' = -\sum_{i=1}^{2} p_i \log p_i$$

For Plot 1 $H' = -1[0.99 \bullet \log(0.99) + 0.01 \bullet \log(0.01)] = 0.024$

For Plot 2 $H' = -1[0.5 \bullet \log(0.5) + 0.5 \bullet \log(0.5)] = 0.301$

- s = number of species (e.g., 2)
- p_i = proportion of individuals belonging to species i

Importance Value (Trees)

= (relative dominance + relative density + relative frequency)/3

- Relative dominance: basal area of a single tree species in a plot per total basal area of all tree species in a plot
- Relative density: number of single tree species in each plot per total number of tree species in each plot
- Relative frequency: number of a single species observations in a plot per total species observations found in each plot

Example: Relative Density

$$\text{Relative density}_j\,\% = \frac{(100 \bullet \text{Density}_j)}{\sum_{j=1}^{p} \text{Density}_j}$$

- Relative density of species *j* = ratio of its density to the overall density, the sum of the densities of the *p* species
- Commonly expressed as percent