

Using Forest Inventory & Analysis (FIA) Data for Silvicultural Interpretation

Background

The research branch of the US Forest Service provides a continuous census of the nation's forests through their Forest Inventory and Analysis (FIA) program. Although national forest inventory dates back to 1929 in Minnesota, the current system of permanent FIA plots has been in place for about 40 years. For statistical purposes, the plots are distributed in a stratified random design. Most plots do not fall in forested areas. The actual number of forested plots that are maintained (i.e. re-sampled) has varied from one inventory cycle to another, depending upon need and participation of state and county land management agencies. For the 1977 (cycle 4) we were able to retrieve 8,864 forested FIA plots. The 1990 cycle (cycle 5) was more intense, yielding 12,257 forested plots. Recently, the FIA program has abandoned cyclic inventory and has moved to a schedule of continuous inventory where about 20% of the plots are sampled every year, i.e. 5 years pass between re-measurement of the same plots. The intensity of the continuous inventory is considerably less than was accomplished in the earlier cycles. Since about 2000, one can retrieve slightly more than data for 4,000 plots at any point in time.

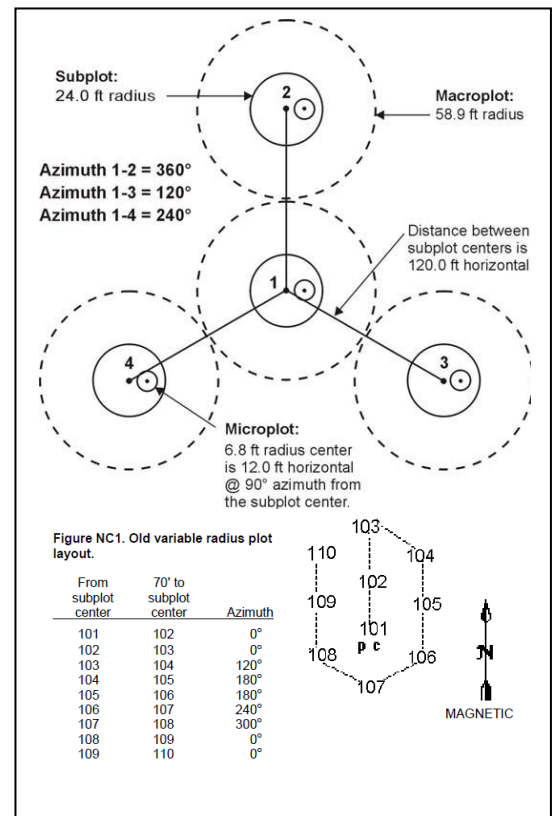
FIA data provide a wealth of information that might be used for silvicultural interpretation. We investigated several applications for each NPC class, but we found two to be most useful for silvicultural interpretation:

1. Development of modern stand dynamic models (succession) for comparison to PLS models.
2. "Situation analysis" where situations are combinations of diameter classes and inferred canopy conditions that affect species differentially with regard to:
 - a. Abundance in the 1990 cycle
 - b. Survival between the 1997 and 1990 cycles

Data

Our primary interest in FIA data is for comparison to historic information gleaned from the PLS data ca. 1850-1900 (Almendinger 1996). FIA plots provide a modern benchmark that is comparable to PLS survey corners. Our interest was to either corroborate the "natural" stand dynamic model developed from the PLS data, or to understand the modern departure from that model. Departure is almost certainly due to the fact that managed disturbance or the lack of disturbance doesn't affect forests as did natural events such as fire, wind, and disease.

For our purpose of comparing forest conditions ca. 1850-1900 with modern forests, plot density was more important than being current, thus the large 1990 database was used to represent modern forest conditions.



Generalized layout of the current 4-subplot FIA design (above, P2 plot) and the older 10-subplot design (below).

(U.S. Forest Service, 1986, 2006)

FIA plots are composed of subplots (previous page) where trees are measured and tallied. The older design consists of 10 subplots and is being replaced by a newer design (P2 plots) comprising 4 subplots. However, plot centers have been conserved throughout the design change so that old subplot 101 is the same as plot 1 in the new design.

For our purpose, we are interested in the FIA subplots and the older plot design in use for the 1990 inventory cycle. Specifically, FIA foresters recorded from subplot centers the data we used for interpretation:

1. **Species** of trees (>5" dbh) within the limiting distance of a 37.5-factor prism
2. **Species** of saplings (1-5" dbh) within 6.8 feet of the plot center (1/300 acre)
3. **Distance** of prism trees from subplot center in feet
4. **Diameter** of prism trees in inches
5. **Azimuth** of prism trees
6. **Survival** of trees from one cycle to the next

Creating the Database for Native Plant Community (NPC) Silvicultural Interpretations

Native Plant Community Assignment

Silvicultural interpretations are organized about the 52 forested NPC Classes in Minnesota. This means that in order to use FIA data, we had to create a model that assigned sets of subplots to a NPC Class. The same model that we used to assign PLS survey corners was applied to the FIA subplots, except for the fact that FIA subplots tend to have more attending trees than PLS survey corners have bearing trees. For any Class, selected subplots had to:

1. occur on landforms (LTAs) where we have modern samples of the community (range)
2. have attending trees typical of the community (>30% frequency in the NPC releve sample set)
3. and NOT have trees atypical of the community (<5% frequency in the NPC releve sample set)

It is possible for an individual subplot to contribute to the analysis of more than one community but more often, subplots were eliminated from all analyses because of atypical species combinations. If FIA plots, were heterogeneous with regard to subplot community assignments, only the subplots with the dominant NPC were used. If no NPC occurred on more than 3 of 10 subplots, then entire FIA plot was eliminated from the analysis. Community mixture within the rough acre of an FIA plot happens in Minnesota because of the incredible amount forest acreage in riparian edge between terrestrial forest and wetlands or lakes. Also, the glaciated terrain of Minnesota results in many sharp contacts between sorted materials and till, creating abrupt changes in forest communities.

A set of FIA subplots was assigned to every wooded Native Plant Community class in the state for the purpose of developing a stand-dynamic model comparable to the PLS model and for summarizing abundance and survival in different canopy situations.

Stand Dynamics

Understanding natural stand dynamics is the essence of prescription writing. Without some understanding of how dynamics affect tree establishment, thinning, recruitment, competitive ability, form, longevity, and succession during "unsupervised" stand maturation – foresters cannot write worthwhile prescriptions. For the most part, prescriptions are written to alter, accelerate, or allow the natural course of events in a forest in order to meet a management objective.

To construct a successional model, subplots must be assigned an age. Ideally, we would want to know years since the last stand-replacing disturbance, but this is unknown for most plots. Also, FIA stand age is a property of the most prevalent condition of the plot and not of the individual subplots. Because of these shortcomings and because we wanted to compare the FIA model with the PLS model, we chose to apply the same strategy as was used for the PLS model. Stand age was assigned as the estimated age of the oldest tree in a subplot. Presumably, the age of the oldest tree is a minimum estimate of how long the stand has avoided a catastrophic disturbance. Note that corner can be assigned an age beyond the biological longevity of its old-growth species. However, this method does reasonably rank subplots with smaller-diameter/younger trees for the first 100 years

or so. We believe that this is good enough to make some broad interpretations about stand dynamics and tree recruitment throughout the early years of stand maturation.

We assigned tree-age and hence the stand-age estimates by relying on the general relationship of tree diameters to age. For each species, we used FIA site-index trees to create quadratic equations that model the age/diameter relationship.

$$\text{Age} = C + A * dbh + B * dbh^2 \text{ (where } C \text{ is a constant, } A \text{ \& } B \text{ are coefficients from FIA model)}$$

FIA tree ages were estimated from their diameters by using a quadratic equation that was fit to FIA site-index trees. FIA subplots were then assigned “stand ages” equal to that of the age of the oldest/large-diameter tree on the subplot.

Subplots were then placed into age-classes in order to calculate the relative abundance of species within the age-class. In order to make relative abundance graphs, the subplots were placed into 10-year age classes with the exception of the initial 15-year class that matches the 15-year disturbance “recognition window” used to calculate the rotations of fire and windthrow in the PLS dataset. Thus, subplots were assigned to age classes when the diameter of the oldest tree would lead us to believe that it was between 0-15 years old, 15-25 years old, 25-35 years old, etc. Age-class 10 includes trees at survey corners where the oldest tree was estimated to be between 0 and 15 years old; age-class 20 holds trees at survey corners where the oldest tree was estimated to be between 15 and 25 years old, etc. For tabular comparison to PLS models, the FIA subplots were placed into broader, unequal age-classes coincident with the growth-stages.

Subplots were collected into either 1) 10-year age-classes to calculate the relative abundance of species and make plots or 2) into broader age-classes that match the PLS growth-stages for tabular comparison.

Situation analysis

The FIA data were too sparse to construct a table that allows comparison of recruitment windows based upon diameter subordination. The main reason for this is that quaking aspen dominates a lot of modern forests and populations of most conifers have crashed in historic times. For example, FIA plots retrieve very little data for trees like jack pine and tamarack, even on sites that were historically dominated by these trees. By simplifying the FIA data into just three broad diameter classes, and six structural “situations” we were able to perform a similar analysis to confirm or cause us to re-examine our PLS interpretations.

We wanted to get a general impression of how often a species is seen in certain structural. Subplot situations are assumed from the diameter of the largest tree at a subplot. Each subplot was assigned one of three stand categories: 1) sapling stand where the largest diameter tree was under 4”, 2) pole stand where the diameter of the largest tree was 4-10”, and 3) tree stand where the largest diameter tree was >10” dbh. Different tree situations arise when smaller diameter trees at a subplot are tallied as being in the same class or a class subordinate to the largest tree.

A canopy situation is tallied for a subplot tree when it occurs as:

1. a sapling in a sapling stand (situation 11)
2. a pole in a pole stand (situation 22)
3. a tree in a tree stand (situation 33)

A sub-canopy situation is tallied for a subplot tree when it occurs as:

1. a sapling in a pole stand (situation 12)
2. a pole in a tree stand (situation 23)

A remote canopy situation is tallied for a subplot tree when it occurs as:

1. a sapling in a tree stand (situation 13)

Trees show characteristic patterns of abundance among the six structural situations because of species differences regarding their ability – or lack of ability – to develop advance regeneration. Usually, intolerant species like aspen, tamarack, or jack pine are more prevalent in canopy situations. Mid-tolerant species like the oaks are usually prevalent in sub-canopy situations. Shade-tolerant species like sugar maple and ash tend to have overwhelming numbers of saplings in remote canopy situations. When a species shows a change in pattern among the 52 forest classes, it indicates that all shade is not cast equally by different canopy species or it indicates that site conditions can affect a tree's tolerance.

Subplot trees were tallied by 6 structural “situations” in order to assess their ability to develop viable advance regeneration by NPC as stand height and stocking matures.

Mortality and Survival

Both the stand dynamic model and situation analysis above result in a snapshot composite of different abundance by age or situation. Changes in a species relative abundance is assumed due to differential mortality as stands gain height, stratify, and age. A great advantage of FIA inventory is that the actual fate of individual trees measured from one cycle to another, and actual mortality should jive with assumptions from the composite models.

To augment our situation analysis we calculated the actual survivorship of tree species by situation. The survival rate for species by situation was calculated between the 1977 and 1990 cycle for individual trees. Survival rate is the proportion of 1977 subplot trees still alive in 1990. We did not bother to calculate the actual annual rate using the true dates of inventory because it is intended to be just a rough estimate of survival over a time period that roughly matches situation change or silvicultural entry under selective systems. In other words, sapling stands become pole stands and pole stands become tree stands in about 15 years. Also, foresters employing silvicultural systems that make use of advance regeneration commonly want to know what will happen to existing regeneration if its release is deferred until the next entry in about 15 years.

Survivorship of subplot trees was calculated for the 6 structural “situations” in order to predict regeneration dynamics over a roughly 15-year period in order to make silvicultural decisions concerning the need to silviculturally alter the situation or allow it to continue.

References

- Almendinger, J.C. 1996. *Minnesota's Bearing Tree Database*. Biological Report No. 56. Minn. Dept. Nat. Res., St. Paul, MN.
- U.S. Forest Service 1986. *North Central Region Forest Inventory and Analysis: Field instructions for Missouri and Minnesota*. St. Paul, MN.
- U.S. Forest Service. 2006. *Forest Inventory and Analysis National Core Field Guide: Field data collection procedures for phase 2 plots*. North Central Version 3.0. St. Paul, MN.

Standard FIA-derived Tables Silviculture and Forest Management

From the FIA analyses, we have created a standard set of tables for each wooded NPC. Below is a summary of these standard products, followed by an example of each with an account of methods, purpose, and applications.

Table FIA-1, *Structural situations of trees*, provides a count of subplot trees and their relative abundance in 6 structural situations. This table can be used to:

1. Estimate the success of trees in the initial cohort, i.e. open strategists that are favored by open conditions and intense, recent disturbance
2. Estimate the success of trees as subordinates under a proximal canopy, i.e. large-gap strategists grow more slowly than initial-cohort trees but outlive them persisting, in the subcanopy to eventually be released in large gaps.
3. Estimate the success of “seedling bankers,” beneath a remote canopy, i.e. small-gap strategists favored under full canopy and low-light conditions.
4. High presence in situation 33 is not diagnostic of recruitment ability because the origin of the stand is not known, but in general, correlate with suitability (PLS-1).

Table FIA-2, *Survival of trees in different situations*, provides a count of subplot trees and their survival rate between 1977 and 1990 in the FIA inventory. This table can be used to:

1. Estimate the short term (~10-15 years) population trends of advance regeneration if a stand is left untreated.

Figure SUM-1, *Abundance of trees in pre-settlement and modern times by historic growth-stage*, provides a then-and-now comparison of the relative abundances of all trees by growth-stage. Also shown is a comparison of the relative abundance of the growth-stages across the landscape. This figure can be used to:

1. Determine if species have changed their successional position due to the differences between modern land management and natural regenerating events.
2. Identify species that are in peril and those that are expanding their range.
3. Compare the landscape balance of growth-stages from historic times to the present.

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(Example FIA-1) Structural Situations of Trees in Mature MHn35 Stands

Percentages of structural situations for trees as recorded in Forest Inventory Analysis (FIA) subplots modeled to be samples of MHn35 forests. Subplot (stand) situations are inferred from the diameter of the largest tree at a subplot: 1) young sapling stand (<4" dbh); 2) immature pole stand (4-10" dbh); 3) mature stand (>10" dbh). Different tree situations are generated when the smaller diameter trees at a subplot are tallied as being in the same class or a class subordinate to the largest tree. Situation 33, trees in stands of trees, provides no insight about regeneration, but all other classes indicate the preference of a tree to be in an emerging canopy (situations 11 and 22); immediately subordinate to canopy trees (situations 12 and 23), or remotely subordinate to the canopy (situation 13). Row shading groups trees by their most common situation. For each species, the raw tree count is provided for assessing reliability.

Species	Tree Count	Structural Situations					
		11	22	12	23	13	33
Quaking Aspen	491	21%	13%	12%	9%	8%	37%
Big-toothed Aspen	31	19%	--	16%	3%	13%	48%
Sugar Maple	1178	2%	16%	13%	19%	28%	22%
Basswood	840	3%	6%	8%	21%	12%	50%
Paper Birch	549	4%	19%	4%	36%	3%	34%
Red Oak	534	3%	7%	4%	15%	4%	67%
Red Maple	340	8%	19%	14%	23%	17%	19%
Balsam Fir	102	8%	15%	27%	30%	17%	3%
Bur Oak	100	2%	12%	2%	18%	5%	61%
Yellow Birch	24	--	4%	--	13%	4%	79%
White Pine	11	--	18%	27%	--	--	55%
Ironwood	362	13%	3%	20%	8%	56%	0%
Canopy Situations 11 = Sapling in a young forest where saplings (dbh <4") are the largest trees 22 = Poles in a young forest where poles (4" < dbh < 10") are the largest trees 33 = Trees in a mature stand where trees (>10" dbh) form the canopy Subcanopy Situations (proximal canopy) 12 = Saplings under poles 23 = Poles under trees Understory Situation (remote canopy) 13 = Saplings under trees							

FIA-1, Brief Methods

FIA plots and subplots were modeled as belonging to a NPC Class. For the acceptable subplots, every tree was placed into one of three diameter classes: saplings <4" diameter, poles 4-10" diameter, and trees >10" diameter. Every subplot was assigned a canopy class based upon the diameter class of the largest trees: sapling stands, pole stands, or tree stands. The frequency of occurrence for every subplot tree was tabulated by all possible combinations of plot and tree combinations.

The primary purpose of Table FIA-1 is for checking against Tables R-2 and PLS-5 as to the abilities of trees to recruit beneath a canopy. Reconciliation of these three tables is the primary means of generalizing about species' regenerative strategies: open, large gap, or small gap.

FIA-1, Silvicultural Applications

1. **Estimate the success of trees in the initial cohort, i.e. open strategists that are favored by open conditions and intense, recent disturbance**
 - a. In general, trees with peak presence in situations 11 and 22 are open strategists.
 - b. Corroborative evidence in Table R-2 are trees with poor-to-fair R-, SE-, and SA-index.
 - c. Corroborative evidence in Table PLS-5 are trees with windows of recruitment where peak recruitment is the initial age-classes (0-20 years).
2. **Estimate the success of trees as subordinates under a proximal canopy, i.e. large-gap strategists grow more slowly than initial-cohort trees but outlive them persisting, in the subcanopy to eventually be released in large gaps.**
 - a. In general, trees with peak presence in situations 12 and 23 are large-gap strategists.
 - b. Corroborative evidence in Table R-2 are trees with fair-to-good R-, SE-, and SA-index, usually displaying a recruitment bottleneck at SE and SA heights.
 - c. Corroborative evidence in Table PLS-5 are trees that tend to have peak recruitment in a G1 or G2 window and have "humped" recruitment curves (not shown) that start in middle age-classes (non-zero minimums in the peak column).
3. **Estimate the success of trees subordinate, "seedling bankers," beneath a remote canopy, i.e. small-gap strategists favored under full canopy and low-light conditions.**
 - a. In general, trees with peak presence in situation 13 are small-gap strategists.
 - b. Corroborative evidence in Table R-2 are trees with excellent-to-good R-, SE-, and SA-index.
 - c. Corroborative evidence in Table PLS-5 are trees with peak recruitment windows that start in the mid-successional age classes and increase with time, peaking in and ingress window (I1 or I2).
4. **High presence in situation 33 is not diagnostic of recruitment ability because the origin of the stand is not known, but in general, correlate with suitability (PLS-1).**

(Example FIA-2) Survival of Trees in Different Structural Situations in MHn35 Stands

Thirteen-year survival rate of trees in different silvicultural situations on Forest Inventory and Analysis (FIA) subplots modeled to be MHn35 forests. Survival rate is the proportion of trees recorded in the 1977 FIA cycle that were still alive in the 1990 cycle. Subplot (stand) situations are inferred from the diameter of the largest tree at a subplot: 1) young sapling stand (<4" dbh); 2) immature pole stand (4-10" dbh); 3) mature stand (>10" dbh). Different tree situations are generated when the smaller diameter trees at a subplot are tallied as being in the same class or a class subordinate to the largest tree. Row shading groups trees with peak survival in the same situation. For each species, the raw tree count is provided for assessing reliability. **BEWARE**, survival rates in parentheses are based upon five or fewer trees in that situation.

Species	Tree Count	Structural Situations					
		11	22	12	23	13	33
Basswood	840	0.93	0.78	0.80	0.85	0.73	0.88
Paper Birch	549	0.92	0.39	0.51	0.61	0.45	0.71
Quaking Aspen	491	0.77	0.46	0.71	0.32	0.61	0.57
Big-toothed Aspen	31	1.00	--	(1.00)	(1.00)	(1.00)	0.79
Sugar Maple	1178	0.61	0.86	0.74	0.87	0.82	0.80
Red Oak	534	0.71	0.56	0.90	0.83	0.85	0.84
Ironwood	362	0.75	0.60	0.95	0.78	0.90	(1.00)
Red Maple	340	1.00	0.58	1.00	0.89	0.81	0.91
Balsam Fir	102	0.67	0.43	0.88	0.56	0.81	(0.20)
Bur Oak	100	(1.00)	0.75	(1.00)	0.82	(0.71)	0.88
White Pine	11	--	(0.50)	(1.00)	--	--	0.75
Yellow Birch	24	--	(1.00)	--	(0.23)	(1.00)	0.76
Canopy Situations							
11 = Sapling in a young forest where saplings (dbh <4") are the largest trees							
22 = Poles in a young forest where poles (4" < dbh < 10") are the largest trees							
33 = Trees in a mature stand where trees (>10" dbh) form the canopy							
Subcanopy Situations (proximal canopy)							
12 = Saplings under poles							
23 = Poles under trees							
Understory Situation (remote canopy)							
13 = Saplings under trees							

FIA-2, Brief Methods

FIA plots and subplots were modeled as belonging to a NPC Class. For the acceptable subplots, every tree was placed into one of three diameter classes: saplings <4" diameter, poles 4-10" diameter, and trees >10" diameter. Every subplot was assigned a canopy class based upon the diameter class of the largest trees: sapling stands, pole stands, or tree stands. Different tree situations are generated when the smaller diameter trees at a subplot are tallied as being in the same class or a class subordinate to the largest tree. The survival rate, the proportion of trees recorded in the 1977 FIA cycle that were still alive in the 1990 cycle, was calculated for trees in all situations. This is essentially the same table as FIA-1, except survival is expressed rather than frequency.

FIA-2, Silvicultural Applications

1. **Estimate the near-future (13 years) population dynamics of trees in different situations following an examination or inventory.**
 - a. The absolute estimates of survival can be applied to estimates of trees-per-acre in a stand to see if adequate stocking of advance regeneration will hold, improve, or deteriorate without silvicultural intervention.
 - b. Comparative estimates of survival (between species) can be applied to predict if stand composition will improve or deteriorate without silvicultural interpretation.
 - c. No matter what the situation (22 or 23) poles 4-10" dbh have the greatest mortality and need for silvicultural intervention.
2. **Estimate the success of trees in the initial cohort in the near future, situation 11.**
 - a. In general, all trees have fairly high survivorship in the 11 situation because they are young (small diameter) and the effects of stand self-thinning have yet to occur.
 - b. In general, open strategists have higher survival in 11 situations than small-gap strategists; however large-gap strategists span the full range of survivorship values.
3. **Estimate the amount of self thinning that will occur in the near future, situation 22.**
 - a. In general, all trees have peak mortality in the 22 situation because of stand self-thinning.
 - b. In general, large-gap strategists have the highest survival during self-thinning. Open and small-gap strategists tend to have lower survival in 22 situations, but there are many exceptions.
4. **Estimate the success of trees as subordinates under a proximal canopy in the near future, situations 12 and 23.**
 - a. In general, tree survival beneath a proximal canopy is poor (particularly situation 23), but not as poor as in self thinning stands.
 - b. In general, gap strategists (large or small) have better survival in subordinate canopy situations than open strategists.
5. **Estimate the success of trees beneath a remote canopy in the near future, situation 13.**
 - a. In general, trees have good survival beneath a remote canopy.
 - b. In general, small-gap species have the highest survival in 13 situations; large-gap trees have moderate survival; and open strategists have the poorest survival.
6. **Estimate the survival of canopy trees in the near future, situation 33.**
 - a. In general, trees have rather poor survival rates after achieving 10" dbh. This is a surprising result as they are established and have survived natural thinning. However, harvesting is a contributing factor to mortality in our analysis.
 - b. In general, and as expected, small-gap species have the highest survival as large trees; large-gap species have intermediate survival; and open strategists have the poorest survival.

(Example SUM-1) Abundance of MHn35 trees in Pre-settlement and Modern Times by Growth-stage

Relative abundance (%) of trees at Public Land Survey corners and FIA subplots modeled to represent the MHn35 community and estimated to fall within the young, mature, and old growth-stages. Arrows indicate increase or decrease between growth-stages. Green shading and text was used for the historic PLS data and blue was used for the FIA data. Percents on the bottom row allow comparison of the balance of growth-stages between the pre-settlement landscape (ca. 1846-1908 AD) and the modern landscape (ca. 1990 AD).

Dominant Trees	Forest Growth Stages									
	0 – 55 yrs		55 – 95 yrs		95 – 205 yrs		205 – 295 yrs		> 295 yrs	
	Young		T1		Mature		T2		Old	
Paper Birch	38%	9%	↘↘		28%	7%	↘↘		12%	0%
Quaking Aspen (incl. Big-toothed)	20%	22%	↘↘		6%	4%	↘		4%	0%
Red Oak	10%	6%	↘		5%	11%	↘		1%	0%
Balsam Fir	5%	4%	↘		3%	2%	↘		1%	0%
American Elm	3%	2%	↘		2%	3%	↘		0%	0%
White Spruce	1%	1%	↗↗		13%	0%	↘↘		-	0%
Basswood	6%	9%	↗		9%	19%	↘		6%	0%
White Pine	1%	0%	↗		7%	1%	↗↗↗		31%	0%
Sugar Maple (incl. Red)	11%	33%	↗		14%	36%	↗↗		29%	50%
Ironwood	1%	7%	↗		1%	7%	↘		1%	0%
Bur Oak	1%	1%	↗		2%	3%	↗↗↗↗↗		0%	50%
Miscellaneous	3%	6%			10%	7%			15%	0%
Percent of Community in Growth Stage in Pre-settlement and Modern Landscapes	39%	29%	51%	52%	8%	18%	1%	1%	1%	0%

Data for MHn35 comprise 5,794 PLS corners, involving 14,778 bearing trees and about 1,234,122 acres of the forest class. Comparable modern conditions were summarized from 3,470 FIA subplots that were modeled to be MHn35 sites.

SUM-1, Brief Methods

This table is the result of a parallel analysis of PLS and FIA data. The same modeling technique (LTAs, and tree probabilities) as described for the PLS data and FIA data in general was used in both cases with the exception that FIA plots allowed for more sophisticated modeling because subplots usually have more trees (>4) and we lumped tree presence across sampling cycles. Otherwise, the same computer program was applied to both the PLS and FIA data.

Columns were set by the growth-stage analysis of PLS data.

SUM-1, Silvicultural Applications

- 1. Determine if species have changed their successional position due to the differences between modern land management and natural regenerating events**
 - a. In general, it is far more common for trees to occupy the same successional position – early, middle, or late – now as they did historically.
 - b. Usually, changes in successional position relate to logging not killing late successional trees (maples and white spruce) as fire once did.
 - c. Consequently, prescriptions should focus on diminishing some species as much as the usual focus on regeneration or release.
- 2. Identify species that are in peril and those that are expanding their range**
 - a. In general, Table PLS/FIA-1 offers some specificity (NPC Class) to the assessment of population trends of trees in Minnesota.
 - b. In general, fire-dependent trees (pine & oak) have populations depressed from their former state and fire-sensitive trees (maple & fir) have increased their range and abundance.
 - c. In some cases, species-specific diseases have caused wholesale loss of once-dominant trees (e.g. American elm, butternut, etc.) that are not likely to recover even with silvicultural attention.
- 3. Compare the landscape balance of growth-stages from historic times to the present**
 - a. In general, Table PLS/FIA-1 offers some specificity (NPC Class) to the historic trends in the balance of forest age-classes on the landscape.
 - b. In general, NPC Classes show much greater departure from historic conditions than is apparent from cover-type or species summaries. This is broadly true because the current practice of setting rotation age and usually clear-cutting does not offer the variety of disturbance regimes that characterized the different NPC Classes.
 - c. In general, the greatest departure from historic condition involves very old or very young forests.