

Cloquet Forestry Center
Continuous Forest Inventory for 2000:
Analysis and Integration with the Historical
Database

by

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Staff Paper Series No. 214

August 2011

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Table of Contents

List of Tables	ii
List of Figures	ii
Abstract	iii
Design and Use of the Cloquet Continuous Forest Inventory	1
Remeasurement and Compilation Methodology for 2000	5
Field Observations and Compilation	5
Additional Plot and Tree Level Observations	6
Results and Discussion	7
Covertypes Acreage	7
Per Acre Estimates	10
Remeasurement Recommendations	15
Biomass Measurement of Standing Dead Trees	15
Stand- and Plot-Level Covertypes Observations	15
Data Entry	15
Description of 1959 to 2000 Cloquet Forestry Center Continuous Forest Inventory	
Access Database	16
CFI Tree Tables (1959 to 2000)	16
CFI Plot Tables (1959 to 2000)	16
Damage Code Table	16
Acknowledgements	18
Literature Cited and References	18
Appendices:	
Appendix 1: Summary tables for CFC CFI by covertypes and stand size class for year 2000	20
Appendix 2: Field Instructions for CFC CFI year 2000 remeasurement	28
Appendix 3: Field Instructions supplement for CFC CFI year 2000 remeasurement	39

List of Tables

Table 1. CFC CFI main block plot covertype change matrix 1959 to 2000	8
Table 2. CFC CFI main block plot covertype distribution by stand size class for 2000	11

List of Figures

Figure 1. CFC main block with 2003 CIR Quickbird imagery and 2005 stand boundaries..	2
Figure 2. CFC main block with 2005 stand boundaries and covertype descriptions.....	3
Figure 3. CFC main block with CFO plot locations (n = 402)	4
Figure 4. CFC main block plot covertype distribution	8
Figure 5. CFC CFI main block stand size class distributions for major covertypes for all survey years, 1959 to 2000	9
Figure 6. CFC CFI main block number of trees per acre by species for trees with Dbh \geq 5 inches for all survey years, 1959 to 2000	12
Figure 7. CFC CFI main block cubic foot volume per acre by species for trees with Dbh \geq 5 inches for all survey years, 1959 to 2000	13
Figure 8. CFC CFI main block biomass (green tons) per acre by species for all measured living trees for all survey years, 1959 to 2000.....	14
Figure 9. CFC CFI main block plot and tree table Access database relationship matrix for 1959 to 2000.....	17

Abstract

The University of Minnesota, Cloquet Forestry Center (CFC) Continuous Forest Inventory (CFI) has been conducted every 5 to 10 years since 1959 and represents an invaluable resource for long-term analysis of forest growth and change for both academic and commercial natural resource management professionals. This report documents data collection methodology, editing, and results for the CFC CFI remeasurement conducted in the summer of 2000. Data analysis focused on the historical main contiguous block of ownership of the CFC and includes per acre descriptions of total trees, cubic foot volume, and biomass for both the entire block and for individual covertypes. Covertypes change trends by size class from 1959 to 2000 are also included. The analysis was conducted using a Microsoft Access database that has been updated to include data from all previous CFI measurement years. One objective of this analysis was to assess remeasurement forest conditions and trends. Another objective was to integrate the CFI data from 2000 with earlier measurement data in the form of a Microsoft Access database. The database was deemed appropriate to enhance the accessibility and utility of these data for the period spanning all collection years. Previous reports on the description and use of these data are also cited to facilitate further research and forest management planning on the CFC. In terms of forest change, compilation results indicate the volume (ft³), and biomass (green tons) on the CFC has increased considerably over the inventory period 1959 to 2000. Finally, suggestions are provided to enhance the next remeasurement and its suitability to address evolving science and management questions

Design and Use of the Cloquet Continuous Forest Inventory

Initially established in 1909, the University of Minnesota Cloquet Forestry Center (CFC) serves as an instructional, research, and outreach center for the University's forestry and related natural resources programs. The CFC's historically contiguous block (since the inception of the Continuous Forest Inventory [CFI]) is located in Carlton County with a legal description including all of sections 29 to 32 in T49N R17W, section 36 of T49N R18W, and the N½ of the NE ¼ of section 6 of T48N R17W (U of MN: 2004 Real Estate Inventory Report). For the purposes of this report, the CFC historically contiguous main block defines only those lands included in every CFI measurement year from 1959 to 2000. These lands are hereafter referred to as the CFC main block and total 3,309 acres. The CFC main block is further delineated into 506 covertype stands (see Figures 1 to 3 below) per mapping efforts led by Loeffelholz and Zimmerman (2005). The total acreage managed by the CFC is currently approximately 3,506 acres.

The CFC contains the typical forest covertypes of northeastern Minnesota and associated subboreal fire-dependent forest conditions. Under administration as a research and education forest since 1909, its detailed records have become regionally invaluable for studies of forest change and management. First conducted in 1959, the CFC CFI has been remeasured six times. Subsequent collection years include 1964, 1969, 1976, 1982, 1990, and 2000. The design of the CFI sample plot layout is a systematic sample with four random starts originally established for survey design research (see Reber and Ek 1983). Actual field observations were based on 1/7 acre permanently monumented plots. These permanent plots were established and remeasured from 1959 to 1976 for those plot locations falling in productive (largely upland) forest covertypes (350 plots) within the main block of the CFC. All trees with a Dbh \geq 5 inches were measured within these plots. In 1982, the CFI was expanded to include plots located within unproductive covertypes, i.e., including all of the original systematic sample grid points on the CFC. With this addition, the total number of main block plots surveyed in each collection year rose to 402 (Reber and Ek 1982). This number has remained consistent in subsequent CFI survey years. Additionally, 46 plots were also established on the noncontiguous Sawyer and Carlton county blocks owned by the University of Minnesota and managed by the CFC (bringing the total number of CFI permanent plots to 448). In 1982 a 1/100th acre circular plot was also added, sharing a plot center with the 1/7th acre plot locations. This small plot was established to collect sapling regeneration data for trees with a Dbh \geq 1 and $<$ 5 inches. For more information concerning the CFC CFI sampling and measurement details, see Tuhus et al. (1994) and Reber and Ek (1982).

The CFC CFI has been utilized in undergraduate and graduate instruction at the CFC for many years. It serves as a significant example of forest inventory design and methodology. It has also provided a basis for understanding in support of forest management planning on the CFC as illustrated by Moeur et al. (1980) and ultimately CFC management plans by Severs et al. (1992, 2003). Additionally, the CFI's design using systematic sampling with multiple random starts has helped clarify the behavior and statistical credibility of systematic sampling (Reber and Ek 1983). The regional STEMS forest growth model development has also employed these plot data for testing model performance (Holdaway and Brand 1983). It has also provided background or specific plot data for numerous other studies conducted on the CFC, e.g., Schwalm and Ek (2004). See Alm (1988) for a list of studies conducted on the CFC.

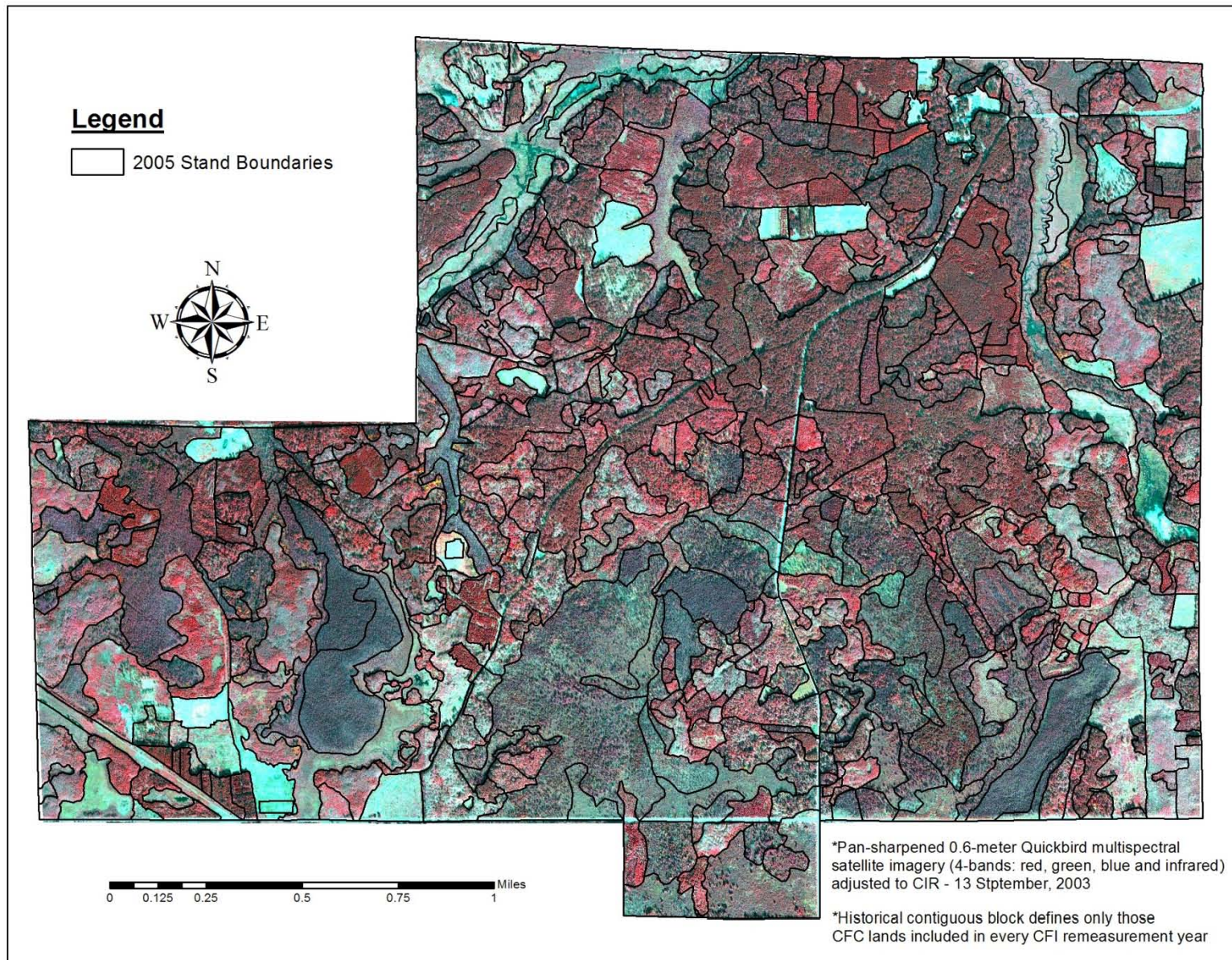


Figure 1. CFC main block with 2005 stand boundaries and 2003 Quickbird multispectral satellite imagery. NAD 1983 UTM Zone 15N.

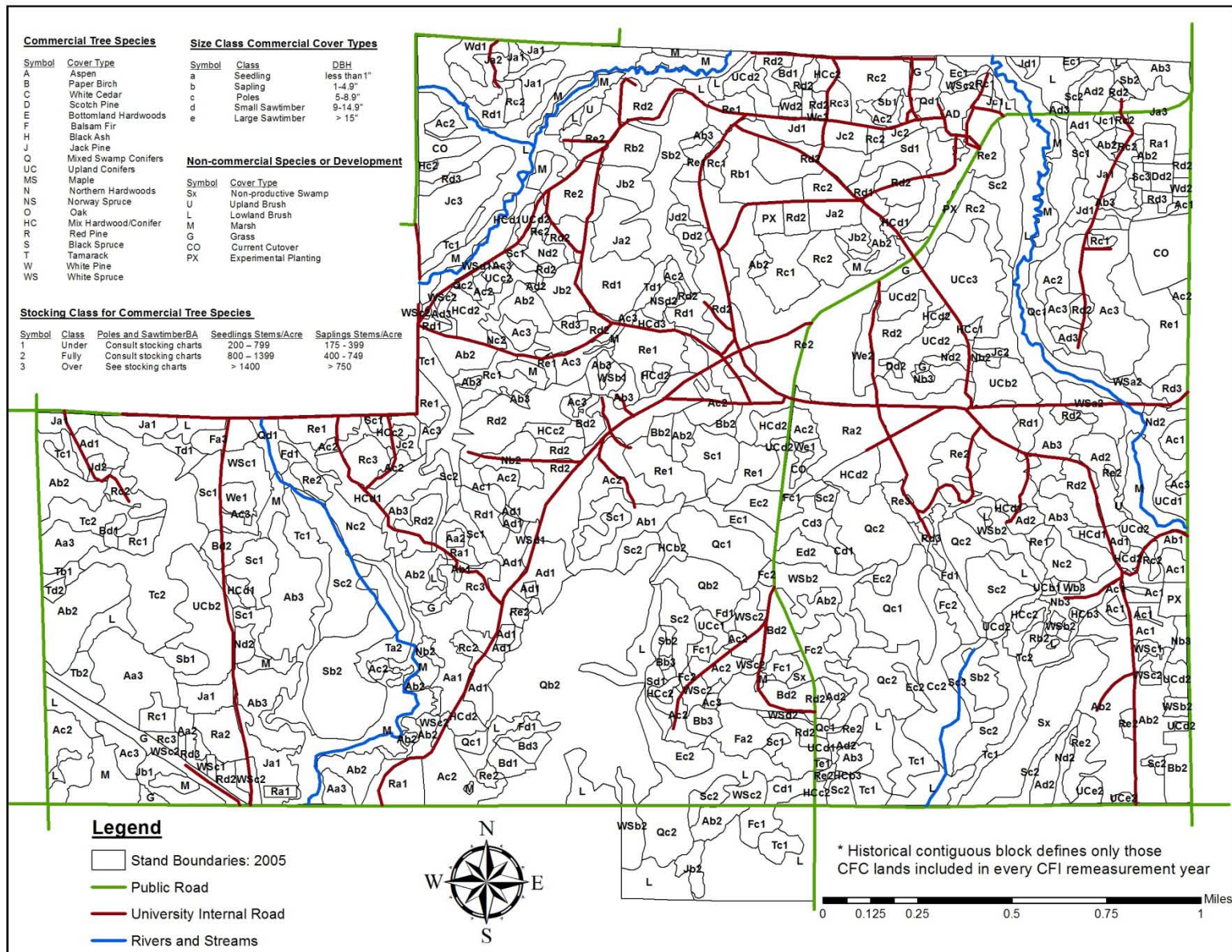


Figure 2. CFC main block with 2005 stand boundaries and covertype descriptions. NAD 1983 UTM Zone 15N.

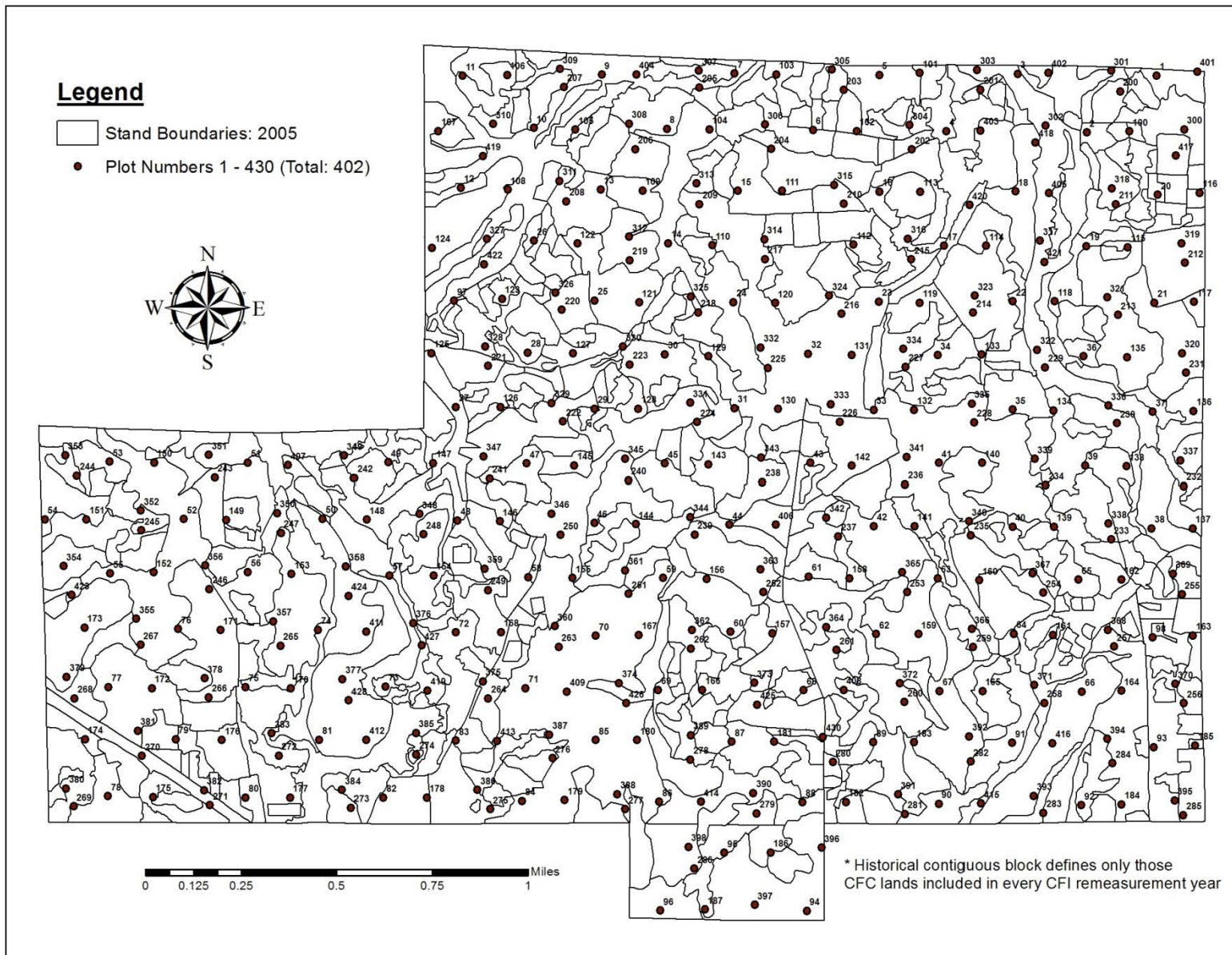


Figure 3. CFC main block with 2005 stand boundaries and CFI plot locations (n=402). NAD 1983 UTM Zone 15N.

Given these data and evolving questions about the forest and potential use of these records, the objectives of this study were (1) to compile CFC CFI data results for 2000, including the updating of 1950 to the present trend analysis begun by Tuhus and Ek (1994) and (2) integrate the CFC CFI plot and tree data for 2000 and earlier records to form a Microsoft Access database for 1959 to 2000.

Remeasurement and Compilation Methodology for 2000

Field Observations and Compilation

The CFI for 2000 utilizes the same plot layout and number of permanent plots as preceding CFI measurement years. All plot-level and tree-level observations and measurements were conducted on concentric 1/7th and 1/100th acre permanent plots falling in both productive and unproductive covertypes. Appendices 3 and 4 provide a detailed description of tree-, plot-, and stand-level data collected in sampling year 2000.

Total and merchantable heights (ft) were computed for all trees with a Dbh \geq 5 inches measured on 1/7 acre plots. Merchantable height requirements vary for calculation of volume (ft³) and biomass (green tons) as described below. All height calculations were developed using the following equation from Ek et al. (1981):

$$H = 4.5 + b_1(1 - e^{(-b_2 \text{Dbh})})^{b_3} \cdot S^{b_4} \cdot T^{b_5} \cdot B^{b_6}$$

where b_1 to b_5 are species specific coefficients, B=stand basal area (ft²/acre), Dbh= diameter (inches) at breast height (4.5 ft), e =base of natural logarithms, S=species site index and $T=1.00001-d/\text{Dbh}$ (where d =top diameter outside bark (dob) in inches).

Dominant tree age and total height data was measured in the field at a subset of plots in CFI measurement year 2000 and utilized to calculate species site index at a base age of 50 years for those plots using the following equation described in Hahn and Carmean (1982):

$$S = c_1 H^{c_2} (1 - e^{(c_3 A)})^{c_4 H^{c_5}}$$

where c_1 to c_5 are species-specific coefficients, A=tree age (years) and H= total tree height (ft)

When site index calculation was possible, conversion equations were utilized to determine site index for all tree species on each plot (Carmean and Vasilevsky 1971; Carmean 1979). When absent, this data was obtained from prior CFI measurement years. An average species site index was calculated across all CFI sampling plots over all sampling years for species measured within plots; resulting values were used when there was no historical precedent or when site index conversion was not possible.

Merchantable height (ft) was calculated to a 4-inch top d.o.b. for later biomass calculation. Total tree biomass (green tons) was calculated for living tree species with a Dbh \geq 5 inches measured on 1/7th acre permanent plots by summation of bole biomass (including stump biomass) to a 4-

inch top diameter and top biomass (including limbs) above merchantable height. Species-specific coefficients and descriptions of biomass calculation procedures can be found in Hahn (1984).

Separate total tree biomass calculations were completed for all trees < 5 inches Dbh measured on 1/100th acre plots using the following species independent equation from Hahn (1984):

$$\text{Total biomass (green tons)} = (4.8900625 \bullet \text{Dbh}^{2.4323866}) \bullet 0.8 / 2000$$

Merchantable height (ft) was calculated to a top diameter of ½ Dbh but not less than 4 inches for later cubic foot volume calculation for all trees ≥ 5 inches Dbh measured on the 1/7th acre permanent plots. Cubic foot volume was calculated for all measured trees with a Dbh ≥ 5 inches using Stone's composite equation (Hahn 1984):

$$\text{Volume (ft}^3\text{)} = (3.0086 \bullet 10^{-3} + S1 + S2 + S3 + S4 + S5 + S6 + S7 + S8) \bullet 79.0$$

where

$$S1 = (2.0355 \bullet 10^{-3})D$$

$$S2 = (-3.0018 \bullet 10^{-3})T$$

$$S3 = (6.2381 \bullet 10^{-5})D^2$$

$$S4 = (2.5705 \bullet 10^{-5})D^2H$$

$$S5 = (-7.0090 \bullet 10^{-6})H^2$$

$$S6 = (3.6708 \bullet 10^{-5})HT^2$$

$$S7 = (8.1400 \bullet 10^{-10})D^2H^3$$

$$S8 = (-1.9000 \bullet 10^{-9})D^2H^2T$$

D= diameter at breast height (inches), T= diameter at merchantable height outside bark (inches), H= merchantable height (ft).

The CFC CFI main block summary tables for year 2000 are located in Appendix 1. These summary tables include species per acre averages of number of trees, basal area (in²), volume (ft³) and biomass (green tons). Summaries also provide species averages by Dbh class. Summary tables have been created for major covertypes, including: red pine, jack pine, paper birch, and aspen. Main block summary tables have also been created for the entire forest, as well as hardwood and softwood covertypes. All summary tables include plot and stand numbers and total acreage is determined using a plot expansion factor of 8.23 acres (3,309 total acres/402 CFI plots located on the CFI main block).

Additional CFC CFI Plot-Level Observations

In 2000, plot-level observations of coctype, size class, and density class were supplemented with USDA Forest Service Forest Inventory and Analysis (FIA) condition class detail. Condition class observations were gathered according to FIA procedures (see Appendix 4) at each permanent plot within a concentric 1/4th acre circular plot. If multiple condition classes were identified for each plot then supplemental plot-level measurements and observations were collected for each condition class. Further, some existing plots were noted as occurring in coctype transition areas that included multiple conditions classes. If multiple condition classes were identified, then supplemental plot level measurements and observations were collected for

each condition class. The first additional measurements and observations catalogued water availability, water type identification, and its distance from plot center. Second, each condition class was defined by its land use type, physiographic class (soil water moisture availability), and disturbance. Finally, silvicultural activities since the previous CFC CFI survey year were recorded including: disturbance level (either natural or artificial as a percent of the total area surveyed), seedling regeneration (species counts documented as either natural or artificial), and a description of observable silvicultural treatments. See Appendix 4 for additional description of new 2000 CFI plot level measurements and observations. (Note: These data are included in the CFC CFI historical database as an independent table entitled “2000PlotLvl_FIA.”)

Additionally, up to three damage code observations were made in the field for each tree in the 2000 CFC CFI remeasurement. In 1990, only one damage code entry was made (if appropriate). Initially, the damage code entries were placed into one field. These codes have now been placed separately into three damage code data entry fields in the 2000 tree table. This will increase query efficiency within the Access database as now all damage codes can be located when designing a query. The previous method of side by side damage codes within the same field made searches for those individual damage codes impossible because the combined codes created a unique identifier. Those attempting future database queries/searches looking for specific damage codes or code ranges must compose a query including all damage code fields.

Results and Discussion

Given the 2000 remeasurement and compilation, major changes in the forest from earlier surveys are summarized below.

Covertypes Acreage

Summarizing the year 2000 main block covertypes acreage figures shows the acreage as 58% softwoods, 25% hardwoods, 14% unproductive or nonforest (including grass and brush), and 3% recently harvested (indeterminate covertypes). Figure 4 shows the number of plots by covertypes for both 1959 and 2000. (Note: Plots located in unproductive covertypes were not included in CFI measurements until 1982. Furthermore, covertypes definitions upland mixed hardwoods and cut/harvested were not included in CFI measurement year 1959.)

It is important to note that field crews in 2000 treated plot-level and stand-level covertypes observations as one observation. However, in earlier years stand-level covertypes designation was typically a separate observation based on the larger area around the plot. Consequently, Figure 4 was based on the plot-level type description. For expansions to the larger area, a factor of 8.23 acres per plot is appropriate for all CFI dates (from Reber and Ek 1982). However, for 1959 to 1976, the area surveyed was less than that in 1982 to 2000 as unproductive areas were omitted in the earlier surveys.

As observed by Tuhus et al. (1994), the percentage of jack pine within the total area of the CFC main block continues to decline. In 2000, only 27 plots or approximately 222 acres were designated as jack pine compared to 93 plots or 765 acres in 1959. A concurrent increase in the red pine covertypes has occurred, increasing from 387 acres in 1959 to 823 acres in 2000. The paper birch covertypes has also declined, from approximately 255 acres in 1982 to 74 acres in 2000. However, paper birch is a significant component in many stands dominated by other

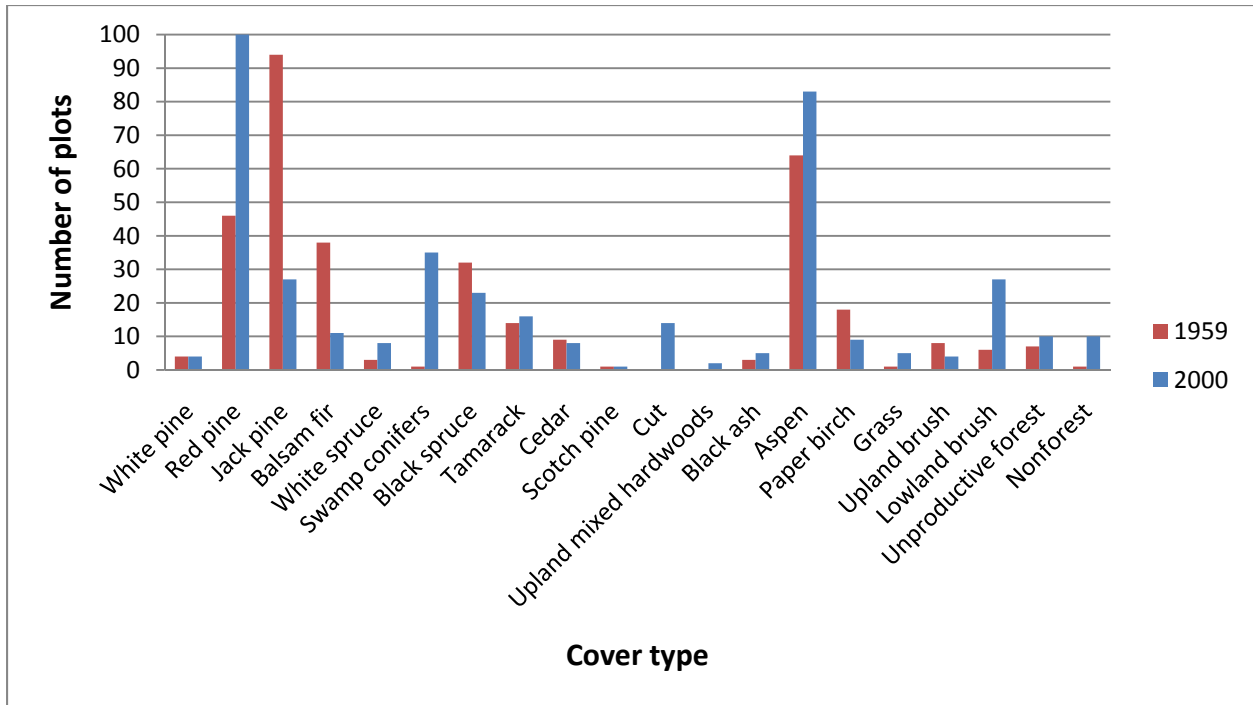


Figure 4. CFC CFI main block covertype distribution. Based on number of plots by covertype in 1959 and in 2000. Multiply by plot expansion factor of 8.23 to obtain acreage. Note n=350 for 1959 to 1976 and n=402 from 1982 to 2000.

Table 1. CFC CFI main block plot level covertype change matrix 1959 to 2000. For productive covertype plots only (n=350); includes only plots visited in both survey years; only productive covertypes were sampled in 1959.

Plot Cover Type 1959	code	Plot Cover Type 2000																		Total			
		1	2	3	4	5	6	7	8	9	10	44	52	55	60	61	70	71	72		80+	90+	*
White pine	1	3	1																				4
Red pine	2		42												3	1							46
Jack pine	3		43	23	1	1			2			5	1		15		1	2					94
Balsam fir	4				5	3	15	1		2		2		1	5	1			3				38
White spruce	5				1	1									1								3
Swamp conifers	6							1															1
Black spruce	7						8	16	3	1					3				1				32
Tamarack	8						1	1	9										1	1	1		14
Cedar	9						3			5				1									9
Scotch pine	10										1												1
Cut	44																						0
Upland mixed hardwood	52																						0
Black ash	55							2						1									3
Aspen	60	1	7	1	1	2			1			5			38	2	1	2	3				64
Paper birch	61								1			2			10	5							18
Grass	70		1																				1
Upland brush	71		1		1										5				1				8
Lowland brush	72						1						1						4				6
Unproductive forest	80+						2	1											3	1			7
Nonforest	90+																					1	1
Total		4	95	24	9	7	33	19	16	8	1	14	1	4	80	9	2	4	16	2	2	0	350

canopy species, whereas jack pine is only rarely found in other covertypes. The decline in paper birch as a dominant canopy species can likely be attributed to the natural succession of aging stands and management for aspen covertypes within the CFC main block. To better illustrate these covertime trends, Table 1 provides a covertime change matrix for plots measured in both 1959 and 2000. Further, Figure 5 provides the stand size class distribution for 1959 to 2000 for the four the major covertypes. The four major covertypes ranked by total cubic volume include: red pine, jack pine, quaking aspen, and paper birch. The year 2000 is the first CFI measurement in which quaking aspen total volume (ft³) exceeded that of paper birch in the historical main block.

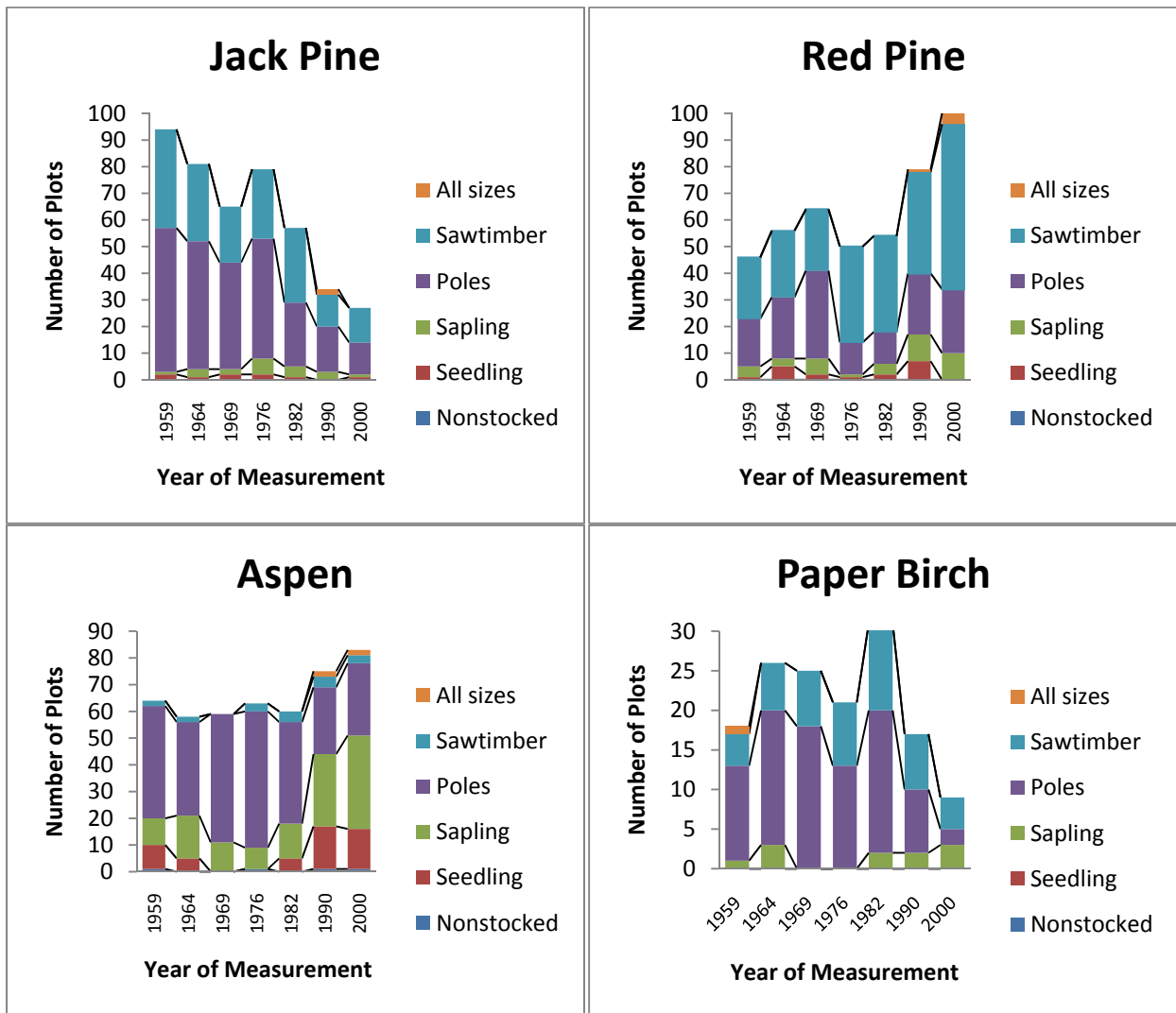


Figure 5. CFC CFI main block stand size class distributions for major covertypes for all survey years, 1959 to 2000 (n = 350 from 1959-1976 and n = 402 from 1982 to 2000).

Per Acre Estimates

Table 2 describes the stand size class distribution by coertype for 2000. Figures 6 to 8 show total trees, cubic foot stem volume, and biomass (green tons) per acre values over the period 1959 to 2000 for the CFC historical main block. These were computed using 2000 data together with summary tables for sampling years 1959 to 1976 provided in Tuhus and Ek (1994). Sampling years 1982 to 1990 were summarized through table queries within the CFC CFI historical Access database. Summary tables for per acre estimates for CFI plots in the CFC main block are shown in Appendix 1.

Importantly, CFI remeasurement years occurring before 1982 collected plot and individual tree data only on the 350 plots located in productive coertypes in the CFC main block. However, CFI 2000 per acre summaries in the appendix include all 402 plots (plot numbers in the range of 1 to 430) falling within the main block. Permanent plots beyond the historical main block were not included in this summary as some of them are not contiguous, or have been acquired, sold or otherwise transferred to other owners during the period 1959 to the present. Additionally, only trees with a tree class indicating a live stem (0, 1, 2, 3, 4, and 8) falling within the 1/100th or 1/7th acre plot were used in per acre calculations.

While the number trees per acre ($Dbh \geq 5$) have remained stable since the CFI measurement year 1990, significant increases in volume and biomass from 1959 to 2000 reflect management strategies that have resulted in more balanced size class distributions across all coertypes for the sake of sustained forest production and harvest yields in the future. Biomass (green tons/acre) includes trees <5 inches Dbh beginning in 1982, explaining the observable increase in biomass observed from 1976-1982 (Figure 8).

Table 2. CFC CFI main block plot covertype distribution by stand size class for 2000 (n=402).

Covertype	Stand Size Class*						Total (number of plots)
	Nonstocked	Seedlings	Saplings	Poles	Sawtimber	All sizes	
White pine		1			3		4
Red pine			10	24	62	4	100
Jack pine		1	1	12	13		27
Balsam fir			2		7	2	11
White spruce		1	2	4	1		8
Swamp conifers			2	26	2	5	35
Black spruce		3	6	12		2	23
Tamarack			1	12	3		16
N. white cedar				6		2	8
Scotch pine					1		1
Cut	7	6	1				14
Upland mixed hardwoods		1				1	2
Black ash				4		1	5
Aspen	1	15	35	27	3	2	83
Paper birch			3	2	4		9
Grass	5						5
Upland brush	1	1	1			1	4
Lowland brush (willow, alder)	13	8	5	1			27
Unproductive forest	4	2	4				10
Nonforest	7	2				1	10
Total	38	41	73	130	99	21	402

*Size Class specifications

Nonstocked

Seedlings Dbh <1 inch

Saplings Dbh ≥ 1 inch and <5 inches

Poles Dbh ≥5 inches to 8.95 inches for conifers and aspen

Dbh ≥5 inches to 10.95 inches for hardwoods

Sawtimber Dbh ≥ 9 inches for conifers and aspen

Dbh ≥ 11 inches for hardwoods

All sizes (implies uneven-aged stand)

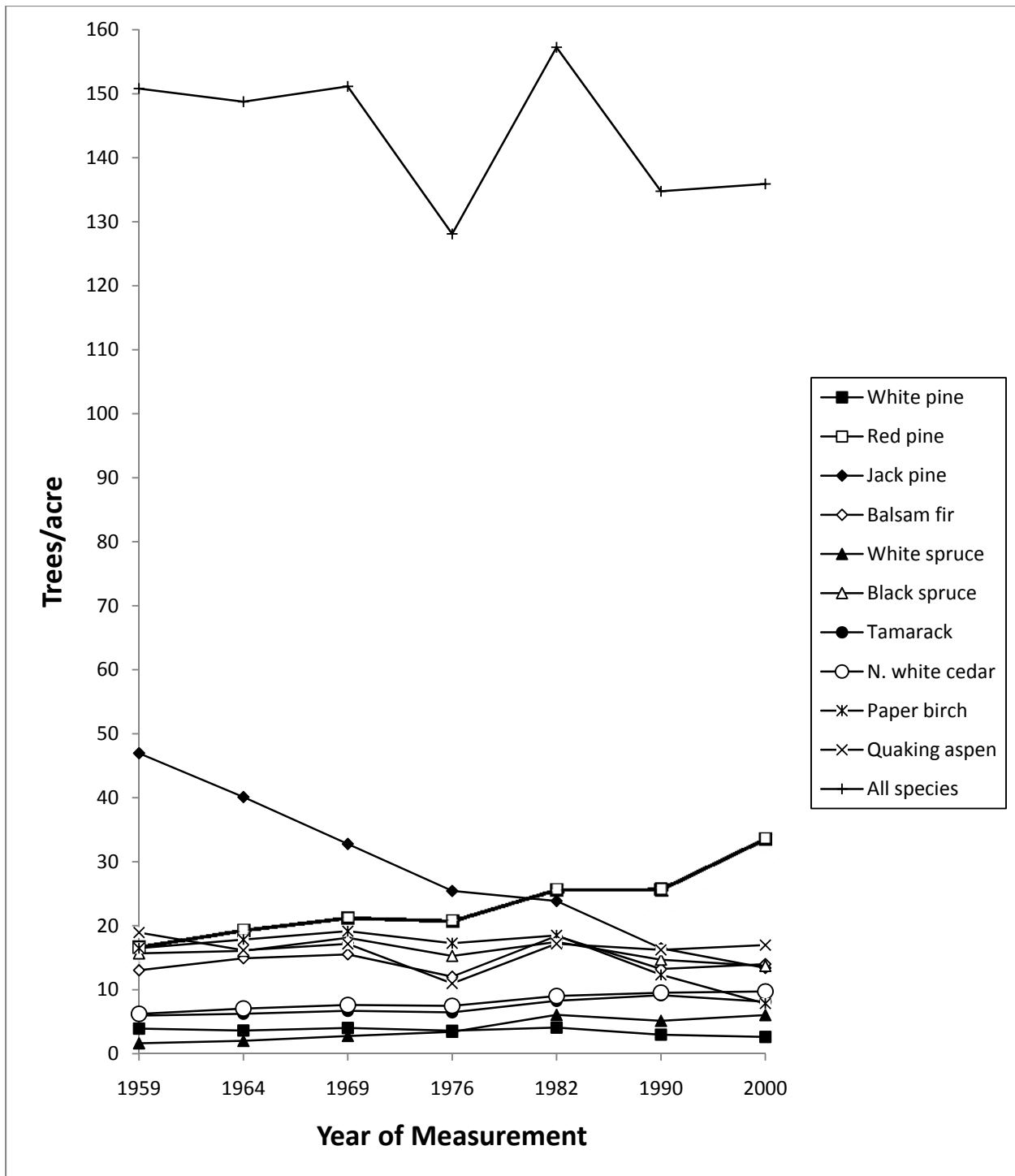


Figure 6. CFC CFI number of trees per acre by species for trees with a Dbh \geq 5 inches for all survey years, 1959 to 2000 (n = 350 from 1959 to 1976 and n = 402 from 1982 to 2000).

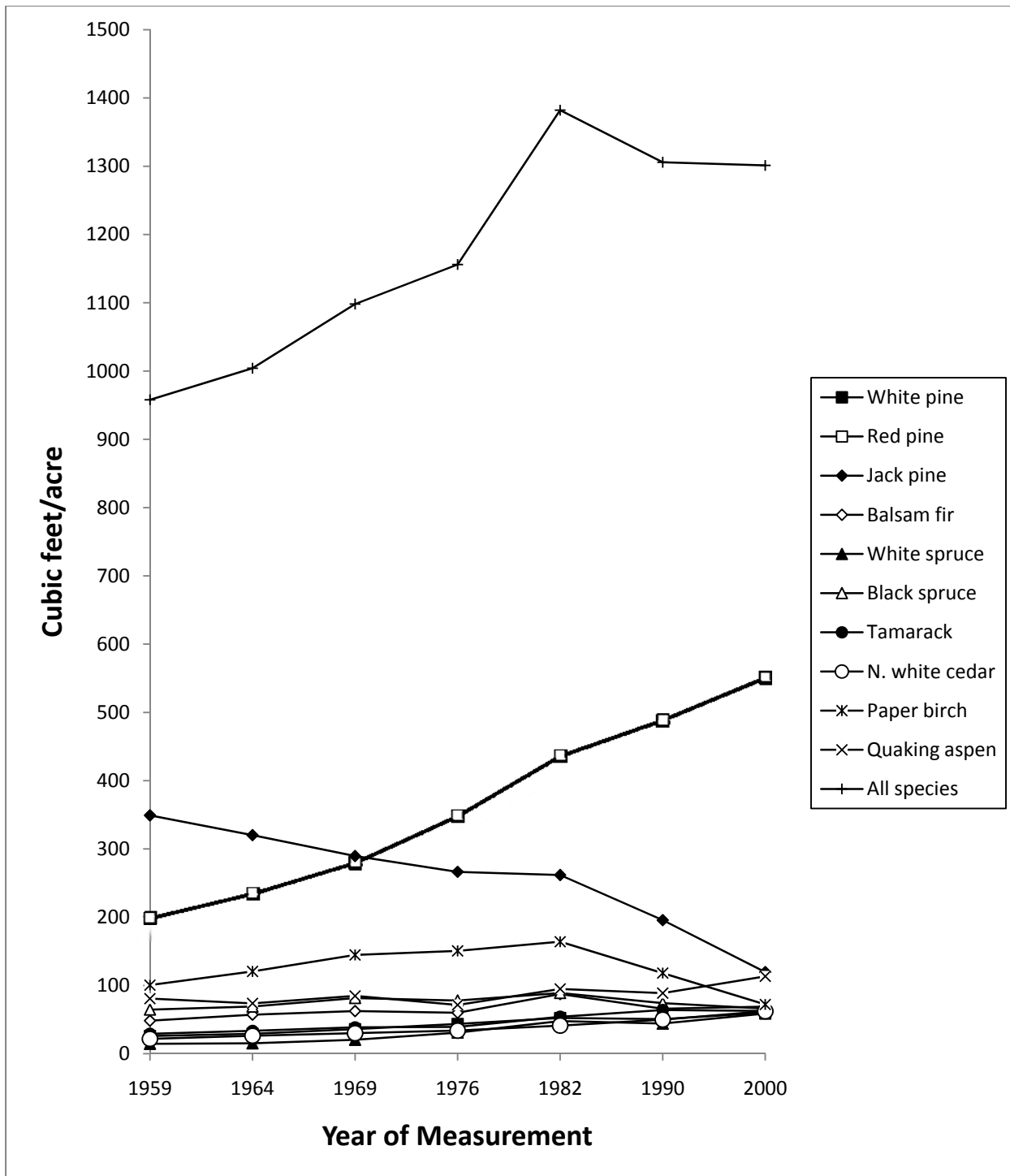


Figure 7. CFC CFI main block cubic foot stem volume per acre by species for trees with Dbh \geq 5 inches for all survey years, 1959 to 2000 (n = 350 from 1959 to 1976 and n = 402 from 1982 to 2000).

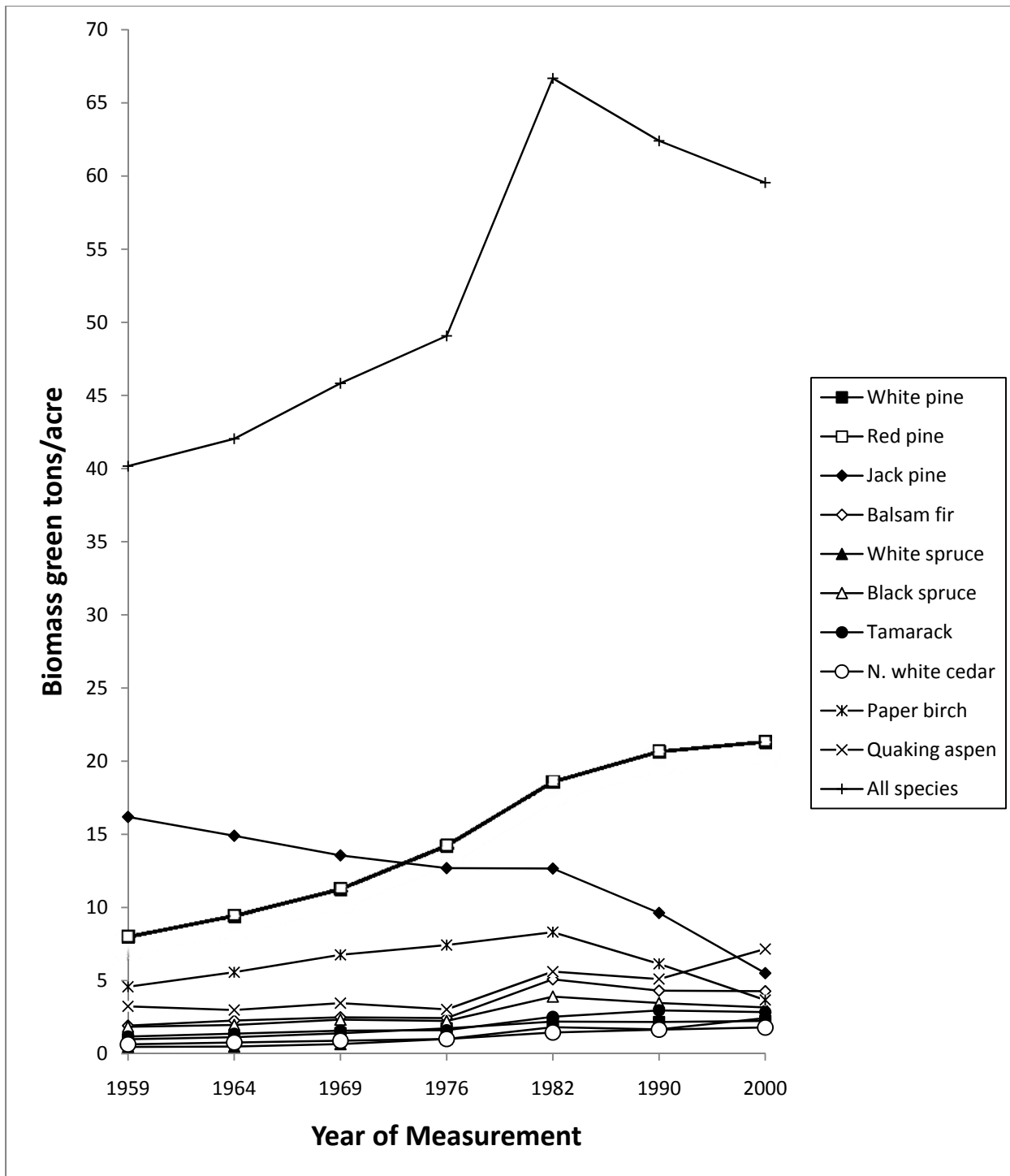


Figure 8. CFC CFI main block biomass (green tons) per acre by species for trees with Dbh \geq 5 inches for survey years 1959 to 1976 and Dbh \geq 1 inch for survey years 1982 to 2000 (n = 350 from 1959 to 1976 and n = 402 from 1982 to 2000).

Remeasurement Recommendations

Remeasurement of the CFC CFI is planned to support both forest management and future research. However, as research questions have evolved, several changes are recommended.

Biomass Measurement of Standing Dead Trees

The biomass of standing dead and down trees has become important to understanding nutrient cycling and carbon sequestration. This will require comprehensive inclusion and accurate characterization of tree class 61 (standing dead tree) and tree class 6 (dead down) stems and their Dbh, as well as damage codes as appropriate at the time of measurement (see Appendix 3). Though it cannot be confirmed with certainty from retrospective examination of 2000 CFI field tally sheets, it is likely that some stems have been erroneously classified as 6 (dead down) when 61 was the more applicable classification. This deduction is based on the fact that some trees with a tree class of 6 also had a Dbh measurement associated with them. Damage codes that indicate reduction in tree volume such as 710 (missing or dead top) are also important to note in such instances as they may result in a reduction in the tree's associated biomass. In this case, the tree would already be classified as standing dead by its tree class and a damage code of 710 would indicate a missing top. Such data will also facilitate estimation of biomass for previous CFI years. In any case, adoption of USDA Forest Service FIA field and compilation procedures, as a minimum, would incorporate these data (USDA Forest Service, Core Field Guide V. 5.0, 2010). This will ensure compatibility and utility for these data.

Stand- and Plot-Level Covertypes Observations

Stand- and plot-level covertime observations in the field have often been similar in past CFI remeasurements. For the year 2000, these observations were assumed to be identical, with the stand type being equal to plot type. This is not a problem for the CFC as covertime maps have also been updated for most CFI years. One can thus assign a stand covertime to a plot on the basis of the covertime map. However, for many surveys, such maps are unavailable. Consequently, for future survey design studies, it seems appropriate to return to taking both observations, i.e., for the plot and the surrounding specified larger minimum area (2.5 acres). It also seems appropriate to explore, for the CFC and perhaps statewide, a covertime algorithm for application to plot data as is used with FIA plot data, albeit simplified, as the FIA assumes more data detail than is collected in some management inventories.

Data Entry

The CFC CFI has progressed to rather detailed data entry. Given that, and the aid in accuracy provided by ready access to previous measurement data, the next measurement will require substantial electronic data entry capability in the field. This should consider the field entry time and accuracy, computerized checking of entries for errors and omissions, and support by ready reference to earlier CFI measurement data. Electronic field methodology will also speed the downloading, database entry, and any needed follow up on these data. This follow up, together with electronic communications, would further provide timely and direct consultation with field crews as observation and data entry issues arise.

Description of 1959 to 2000 CFC CFI Access Database

The CFC CFI records have been incorporated into a Microsoft Access 2010 database. This represents an update from an earlier Access database. The updated database relationships are shown in Figure 9. The sections below describe the various plot and tree data tables and how they might be utilized.

CFI Tree Tables

The individual tree data tables from all CFI survey years are connected by established relationships through *59-2000Tree* (formerly entitled “treetable”) which functions as a central cog. It is connected to 1959 to 2000 CFI individual tree tables by plot number and tree number. In addition to the above identifiers, *59-2000Tree* contains species codes, as well as azimuth and distance to plot center for all trees assessed in all CFI measurement years. These fields are not contained within tree tables for individual CFI survey years. This table has been updated to include new trees measured in 2000. Furthermore, azimuth, distance, and species code updates that were made in 2000 have been included in this revision. This table is connected to *59-2000Plot* table via CFI plot number.

Additionally, painted tree number (PTN), a secondary tree identification included in *59-2000tree* is not a unique identifier for trees within a plot. These numbers are unique in the field for a given CFI survey year, but a PTN observed in a given year does not preclude the possibility that a past tree was given the same PTN and has since died or been removed from the plot. *TreeNumber* is the only unique identifier for all trees occurring on a given plot across all CFI remeasurement years.

CFI Plot Tables

CFI plot-level data tables from all survey years are connected through established relationships with *59-2000Plot* (formerly entitled “plottable”) which functions as a central cog. It is connected to 1959 to 2000 plot-level data tables and *59-2000tree* by plot number. It contains plot location descriptions, UTM coordinates for all CFC CFI plots and stand numbers for all plots. Plot location descriptions have been updated to include observations made in the 2000 CFI. It also contains stand identification codes and covertype information that may be out of date in future survey years. Consequently, these codes and information were treated as such for the sake of 2000 CFC CFI data analysis after comparisons with 1999 and 2005 GIS stand data provided by the CFC (Loeffelholz 2005). Stand numbers provided in 1999 and 2005 associated with given plots do not necessarily correlate with past stand designations. For the sake of present and future data integrity, the past stand designations have been retained and present designations have also been included. Each field is clearly labeled as past or present stand numbers.

DamageCode Table

A table entitled *CodeTable* was present in the early Access database that contained damage codes utilized in the CFC CFI survey years 1990 and 2000. This table had no established relationships with those tables, though it has been updated to contain all damage codes outlined in the field instructions for both survey years and retitled *DamageCode*. In updating, relationships were created in the 1990 and 2000 CFI tree tables, which are the only CFI collection years to make such tree level observations.

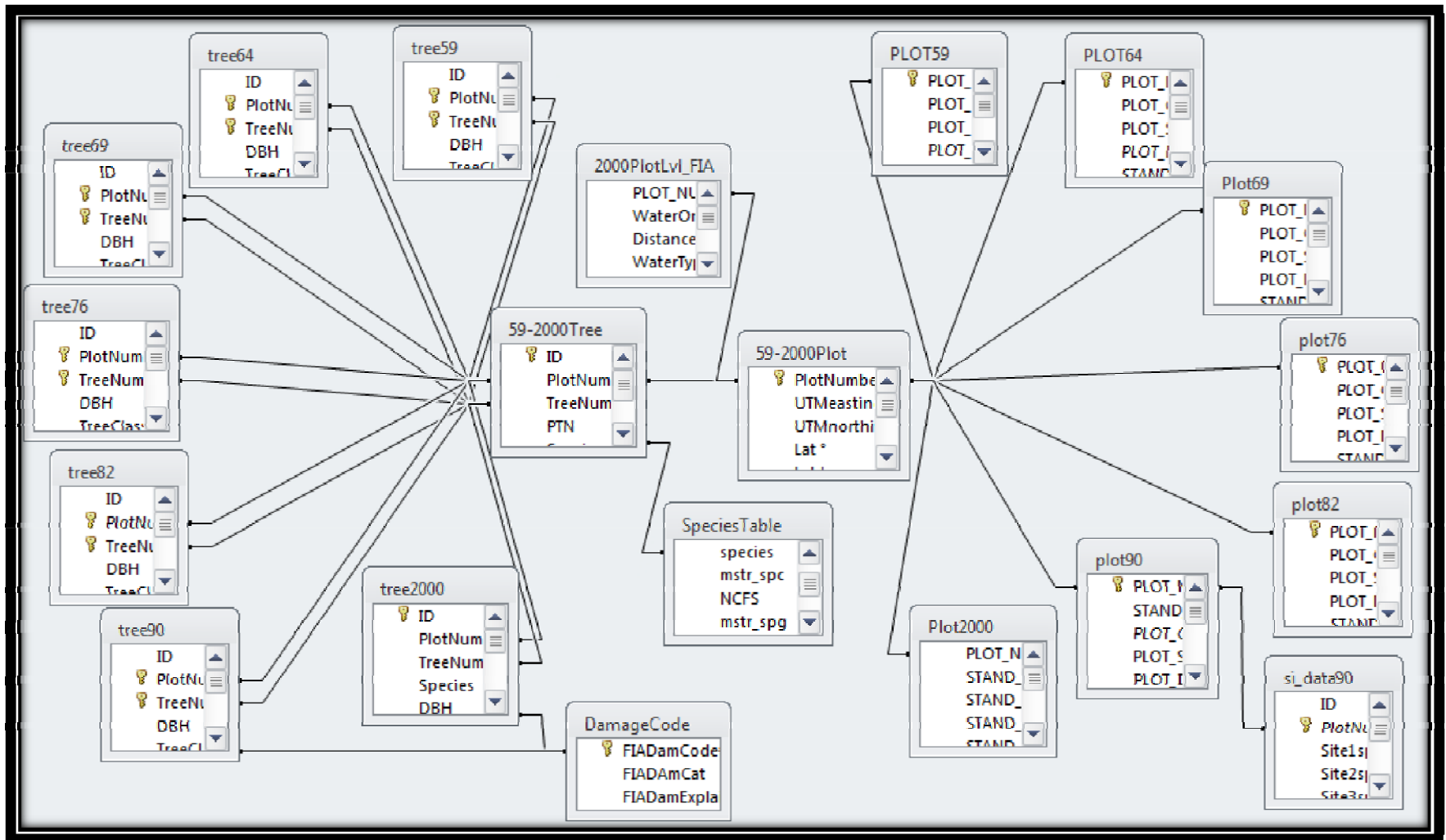


Figure 9. CFC CFI plot and tree table Access database relationship matrix for 1959 to 2000.

Acknowledgements

The authors wish to express their thanks to the field staff of recent and past CFC CFI inventories and specifically to Kristen M. Page who supervised the 2000 remeasurement. Thanks also go to John Zobel for assistance in improving the Access database. We also thank the staff of the Cloquet Forestry Center, especially Ron Severs and Chuck Kramer, for their numerous contributions to our understanding of the CFC forest dynamics and to ensuring the accuracy of the data as it describes forest change. Those efforts have helped immensely in creating an increasingly valuable database that will serve a number of management and science interests.

The authors also extend their thanks to John Zobel whose database expertise and advice has been greatly appreciated.

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Appendix 1: Summary tables for CFC CFI by covertype and stand size class for year 2000.

List of Tables

- 1-1. Entire Forest
- 1-2. Softwood
- 1-3. Hardwood
- 1-4. Jack pine
- 1-5. Red pine
- 1-6. Aspen
- 1-7. Paper birch

Table 1-1: Summary of 2000 Cloquet Forestry Center historical contiguous block CFI permanent plot data by species and Dbh class

Coverttype: Entire forest

All stocking levels

Area: 3308.46

Number of Plots: 402

Plot numbers: 1-430

Stand Numbers: all stands

Species	DBH (in.):	Trees (Number/acre)				Basal Area (ft ² /acre)				Volume (ft ³ /acre)			Biomass (tons/acre)
		0-5	5-9	9+	Sum	0-5	5-9	9+	Sum	5-9	9+	Sum	
White pine		1.24	0.70	1.93	3.87	0.04	0.17	2.32	2.53	2.67	57.31	59.98	2.24
Red pine		23.63	17.60	16.00	57.24	1.44	4.39	19.12	24.94	68.70	483.45	552.15	21.37
Jack pine		8.96	7.75	5.66	22.36	0.45	1.98	4.30	6.73	30.86	88.79	119.64	5.51
Balsam fir		87.81	11.93	2.07	101.81	2.76	2.85	1.36	6.97	42.58	26.37	68.96	4.27
White spruce		15.67	3.60	2.44	21.71	0.86	0.94	1.99	3.79	15.31	43.55	58.86	2.44
Norway spruce		0.00	0.07	0.03	0.10	0.00	0.02	0.02	0.04	0.28	0.41	0.69	0.02
Black spruce		57.46	12.19	1.53	71.18	2.21	2.84	0.92	5.98	47.19	18.93	66.13	3.16
Tamarack		10.95	5.62	2.51	19.08	0.56	1.46	1.87	3.88	24.64	38.00	62.64	2.85
N. white cedar		2.74	6.18	3.55	12.47	0.17	1.66	2.60	4.42	21.89	40.38	62.27	1.80
Scotch pine		0.00	0.05	0.14	0.19	0.00	0.01	0.18	0.19	0.17	4.09	4.25	0.16
Fraser fir/ Blue spruce		2.99	0.52	0.35	3.86	0.19	0.11	0.29	0.59	1.67	5.99	7.66	0.40
Sum Softwood		211.44	66.22	36.22	313.88	8.67	16.43	34.96	60.06	255.96	807.26	1063.22	44.23
Yellow Birch		2.49	0.07	0.03	2.59	0.02	0.02	0.02	0.06	0.23	0.39	0.62	0.04
Ironwood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Basswood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
American elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Slippery elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quaking aspen		132.34	12.92	4.06	149.32	4.67	3.17	2.68	10.52	55.05	58.36	113.41	7.16
Bigtooth aspen		29.35	0.94	0.30	30.59	0.80	0.26	0.18	1.25	5.13	4.16	9.29	0.79
Balsam Poplar		1.00	0.24	0.07	1.31	0.04	0.06	0.05	0.16	1.06	1.12	2.18	0.09
Paper birch		40.30	4.84	3.01	48.15	1.26	1.26	2.31	4.83	22.36	49.81	72.17	3.67
Red Maple		41.04	2.49	0.96	44.49	1.26	0.55	0.70	2.50	8.40	13.61	22.00	1.73
Sugar maple		1.49	0.07	0.00	1.56	0.02	0.02	0.00	0.04	0.24	0.00	0.24	0.02
Black ash		14.93	2.82	0.52	18.27	0.47	0.70	0.36	1.53	10.69	6.77	17.46	1.15
Red oak		0.00	0.02	0.02	0.03	0.00	0.00	0.02	0.02	0.03	0.32	0.35	0.02
Other		0.75	0.00	0.00	0.75	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Sum Hardwood		263.68	24.41	8.97	297.06	8.55	6.04	6.32	20.91	103.18	134.54	237.72	14.69
Willow		3.48	0.00	0.00	3.48	0.03	0.00	0.00	0.03	0.00	0.00	0.00	0.01
Green ash		0.00	0.03	0.00	0.03	0.00	0.01	0.00	0.01	0.17	0.00	0.17	0.01
Mountain maple		0.25	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black cherry		0.50	0.03	0.00	0.53	0.01	0.01	0.00	0.01	0.07	0.00	0.07	0.01
Choke cherry		3.73	0.00	0.00	3.73	0.09	0.00	0.00	0.09	0.00	0.00	0.00	0.05
Pin cherry		13.68	0.00	0.00	13.68	0.19	0.00	0.00	0.19	0.00	0.00	0.00	0.09
Service berry		1.74	0.00	0.00	1.74	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.01
Mountain ash		1.00	0.00	0.00	1.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Dogwood spp.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alder		83.08	0.00	0.00	83.08	0.99	0.00	0.00	0.99	0.00	0.00	0.00	0.43
Hazel		5.97	0.00	0.00	5.97	0.05	0.00	0.00	0.05	0.00	0.00	0.00	0.02
Hawthorne		0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.05	0.00	0.05	0.00
Sum Noncommercial		113.43	0.09	0.00	113.52	1.38	0.02	0.00	1.40	0.28	0.00	0.28	0.63
Sum All Species		588.56	90.72	45.19	724.47	18.59	22.49	41.28	82.36	359.42	941.80	1301.22	59.55
Mean					724.47				82.36			1301.22	59.55
Variance					525192.09				3111.86			1828794.44	2304.61
Standard Dev.					724.70				55.78			1352.33	48.01
CV					1.00				0.68			1.04	0.81

Table 1-2: Summary of 2000 Cloquet Forestry Center historical contiguous block CFI permanent plot data by species and Dbh class

Covertypes: Softwoods All stocking levels

Area: 1909.36

Number of Plots: 232

Plot numbers: 2 4 5 6 8 10 11 12 13 15 16 17 18 20 22 23 24 25 26 27 30 31 32 33 34 35 41 42 43 45 48 50 51 52 55 56 59 60 63 64 67 68 69 70 71 76 80 83 84 85 88 89 91 92 93 97 100 101 102 103 104 106 107 108 110 111 113 114
 116 119 120 121 122 124 127 128 129 130 131 132 136 137 140 141 142 143 145 147 148 149 150 152 156 160 161 165 166 167 168 171 172 175 179 180 181 182 183 186 202 203 205 206 207 208 209 210 211 212 214 216 217 218 219
 222 223 224 225 226 227 228 229 231 233 235 236 237 238 239 242 243 244 245 248 249 251 252 253 258 259 260 261 262 263 267 271 277 279 280 282 283 284 286 303 304 305 306 308 310 312 313 314 315 316 317 318 319 320 323
 325 329 330 331 332 333 334 335 338 339 340 341 342 343 346 347 351 352 355 356 358 359 360 361 362 363 365 366 367 369 371 372 373 375 376 378 382 387 388 392 394 398 400 406 407 411 413 417 419 424 426 428 429 430

Stand Numbers: 0 1 2 7 13 16 23 34 37 39 42 43 48 53 55 56 57 60 62 63 64 67 70 71 75 76 79 80 82 83 84 85 88 90 96 97 101 102 104 109 114 115 117 122 124 128 132 134 135 139 141 144 148 150 151 152 154 159 168 172 174 176
 179 182 185 187 188 190 191 192 193 195 200 204 206 207 210 212 214 215 219 223 225 228 234 241 242 243 244 246 247 249 253 256 257 260 265 269 277 278 279 282 285 286 287 289 290 293 294 296 297 310 311 314 321 323 329
 336 353 361 364 369 371 374 375 379 381 395 397 399 403 419 420 428 453 463 464 471 480 481 483 490

Species	DBH (in.):	Trees (Number/acre)				Basal Area (ft ² /acre)				Volume (ft ³ /acre)			Biomass (tons/acre)
		0-5	5-9	9+	Sum	0-5	5-9	9+	Sum	5-9	9+	Sum	All sizes
White pine		2.16	1.06	3.11	6.32	0.07	0.26	3.80	4.13	3.91	94.89	98.80	3.70
Red pine		34.91	27.67	26.16	88.74	2.15	6.93	30.90	39.98	108.69	784.60	893.29	34.42
Jack pine		11.64	12.58	9.26	33.48	0.65	3.20	6.80	10.65	49.86	139.86	189.72	8.69
Balsam fir		137.07	17.62	2.41	157.10	4.24	4.16	1.58	9.98	62.26	30.69	92.95	6.03
White spruce		18.97	5.13	3.50	27.59	1.07	1.37	2.70	5.13	22.54	59.06	81.60	3.30
Norwayspruce		0.00	0.12	0.06	0.18	0.00	0.03	0.04	0.07	0.49	0.70	1.19	0.04
Black spruce		62.50	20.82	2.41	85.73	2.99	4.85	1.47	9.31	80.57	30.28	110.85	4.91
Tamarack		11.21	8.66	3.89	23.76	0.64	2.29	2.70	5.63	39.18	55.29	94.47	4.17
N. white cedar		4.74	10.32	5.58	20.64	0.27	2.78	4.06	7.11	36.82	63.38	100.19	2.90
Scotch pine		0.00	0.06	0.24	0.30	0.00	0.01	0.31	0.32	0.19	7.08	7.28	0.28
Fraser fir/ Blue spruce		5.17	0.51	0.03	5.72	0.32	0.09	0.02	0.43	1.22	0.30	1.52	0.26
Sum Softwood		288.36	104.55	56.66	449.57	12.40	25.97	54.37	92.74	405.74	1266.13	1671.88	68.70
Yellow Birch		4.31	0.12	0.06	4.49	0.04	0.03	0.04	0.10	0.40	0.68	1.07	0.07
Ironwood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Basswood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
American elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Slippery elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quaking aspen		21.12	5.82	2.11	29.06	0.89	1.42	1.52	3.82	24.70	33.31	58.01	2.79
Bigtooth aspen		9.91	0.36	0.21	10.49	0.27	0.12	0.14	0.53	2.36	3.26	5.62	0.36
Balsam Poplar		1.29	0.06	0.06	1.41	0.05	0.01	0.04	0.10	0.17	0.83	0.99	0.06
Paper birch		39.66	6.13	2.32	48.10	1.45	1.54	1.70	4.69	27.14	36.37	63.51	3.53
Red Maple		40.52	2.11	0.72	43.35	1.20	0.47	0.50	2.18	7.34	9.91	17.25	1.48
Sugar maple		2.59	0.12	0.00	2.71	0.04	0.03	0.00	0.06	0.42	0.00	0.42	0.04
Black ash		20.69	2.41	0.39	23.50	0.44	0.59	0.29	1.32	8.86	5.42	14.28	0.96
Red oak		0.00	0.00	0.03	0.03	0.00	0.00	0.03	0.03	0.00	0.56	0.56	0.03
Other		0.43	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum Hardwood		140.52	17.14	5.91	163.57	4.39	4.20	4.25	12.84	71.38	90.34	161.71	9.32
Willow		1.29	0.00	0.00	1.29	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Green ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mountain maple		0.43	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black cherry		0.43	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Choke cherry		2.16	0.00	0.00	2.16	0.10	0.00	0.00	0.10	0.00	0.00	0.00	0.06
Pin cherry		9.91	0.00	0.00	9.91	0.17	0.00	0.00	0.17	0.00	0.00	0.00	0.09
Service berry		2.16	0.00	0.00	2.16	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.01
Mountain ash		0.43	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dogwood spp.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alder		56.03	0.00	0.00	56.03	0.68	0.00	0.00	0.68	0.00	0.00	0.00	0.30
Hazel		2.16	0.00	0.00	2.16	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.01
Hawthorne		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum Noncommercial		75.00	0.00	0.00	75.00	1.01	0.00	0.00	1.01	0.00	0.00	0.00	0.48
Sum All Species		503.88	121.69	62.58	688.14	17.80	30.17	58.62	106.59	477.12	1356.47	1833.59	78.50

Mean				688.14				106.59				1833.59	78.50
Variance				285563.67				2984.71				1962447.40	2444.89
Standard Dev.				534.38				54.63				1400.87	49.45
CV				0.78				0.51				0.76	0.63

Table 1-3: Summary of 2000 Cloquet Forestry Center historical contiguous block CFI permanent plot data by species and Dbh class

Covertype: Hardwoods All stocking levels

Area: 814.23

Number of Plots: 99

Plot numbers: 1 19 21 28 29 36 39 40 44 16 49 53 58 65 72 73 74 75 77 79 87 95 98 112 115 117 118 123 126 133 134 135 138 139 144 146 151 154 155 157 158 159 162 163 164 170 173 177 184 185 187 200 213 220 221 232 240 247 250 255 256 257 264 265 269 272 273 274 275 276 278 285 300 311 321 324 326 328 337 344 345 348 349 354 364 368 370 379 380 381 384 389 395 401 414 423 425

Stand Numbers: 20 71 102 103 104 105 112 113 119 123 137 140 144 154 163 167 172 178 186 192 197 203 205 212 217 220 221 227 229 234 235 238 244 248 251 255 266 269 273 276 283 285 291 299 303 304 310 320 321 326 330 331 335 336 337 340 341 347 348 349 357 370 372 376 378 411 412 425 427 430 447 470 485 491 519

Species	DBH (in.):	Trees (Number/acre)				Basal Area (ft ² /acre)				Volume (ft ³ /acre)			Biomass (tons/acre)
		0-5	5-9	9+	Sum	0-5	5-9	9+	Sum	5-9	9+	Sum	All sizes
White pine		0.00	0.07	0.28	0.35	0.00	0.02	0.28	0.30	0.34	5.55	5.89	0.21
Red pine		14.14	4.95	2.83	21.92	0.80	1.18	3.77	5.75	18.19	92.00	110.18	4.65
Jack pine		8.08	1.63	0.78	10.48	0.29	0.47	0.81	1.58	7.60	17.33	24.94	1.27
Balsam fir		15.15	6.01	2.69	23.85	0.62	1.52	1.81	3.95	23.17	34.68	57.84	2.72
White spruce		18.18	2.62	1.48	22.28	0.98	0.62	1.54	3.14	9.34	34.49	43.83	2.05
Norway spruce		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black spruce		5.05	0.35	0.35	5.76	0.17	0.10	0.18	0.45	1.60	3.59	5.18	0.25
Tamarack		2.02	0.57	0.07	2.66	0.14	0.16	0.04	0.34	2.40	0.54	2.93	0.22
N. white cedar		0.00	0.28	1.20	1.48	0.00	0.06	0.93	1.00	0.78	14.30	15.09	0.41
Scotch pine		0.00	0.07	0.00	0.07	0.00	0.01	0.00	0.07	0.22	0.00	0.22	0.01
Fraser fir/ Blue spruce		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum Softwood		62.63	16.55	9.69	88.86	3.00	4.14	9.37	16.51	63.63	202.48	266.11	11.80
Yellow Birch		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ironwood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Basswood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
American elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Slippery elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quaking aspen		435.35	37.83	11.53	484.71	15.80	9.31	7.34	32.45	162.07	158.91	320.98	21.80
Bigtooth aspen		73.74	2.83	0.71	77.27	2.18	0.77	0.41	3.36	15.03	9.23	24.26	2.12
Balsam Poplar		1.01	0.78	0.14	1.93	0.06	0.20	0.12	0.39	3.46	2.60	6.05	0.23
Paper birch		57.58	4.95	6.58	69.10	1.38	1.41	5.28	8.08	25.66	114.38	140.04	6.28
Red Maple		37.37	4.95	2.12	44.44	1.42	1.07	1.57	4.07	16.23	30.51	46.74	3.00
Sugar maple		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black ash		6.06	4.53	0.78	11.36	0.52	1.14	0.54	2.20	17.71	10.55	28.26	1.76
Red oak		0.00	0.07	0.00	0.07	0.00	0.01	0.00	0.01	0.10	0.00	0.10	0.01
Other		2.02	0.00	0.00	2.02	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.01
Sum Hardwood		613.13	55.93	21.85	690.91	21.39	13.92	15.26	50.58	240.25	326.18	566.44	35.22
Willow		5.05	0.00	0.00	5.05	0.05	0.00	0.00	0.05	0.00	0.00	0.00	0.02
Green ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mountain maple		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black cherry		1.01	0.14	0.00	1.15	0.01	0.02	0.00	0.04	0.27	0.00	0.27	0.03
Choke cherry		9.09	0.00	0.00	9.09	0.12	0.00	0.00	0.12	0.00	0.00	0.00	0.05
Pin cherry		28.28	0.00	0.00	28.28	0.29	0.00	0.00	0.29	0.00	0.00	0.00	0.12
Service berry		2.02	0.00	0.00	2.02	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01
Mountain ash		3.03	0.00	0.00	3.03	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.01
Dogwood spp.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alder		41.41	0.00	0.00	41.41	0.68	0.00	0.00	0.68	0.00	0.00	0.00	0.33
Hazel		5.05	0.00	0.00	5.05	0.04	0.00	0.00	0.04	0.00	0.00	0.00	0.01
Hawthorne		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum Noncommercial		94.95	0.14	0.00	95.09	1.22	0.02	0.00	1.25	0.27	0.00	0.27	0.58
Sum All Species		770.71	72.62	31.54	874.86	25.62	18.08	24.63	68.33	304.15	528.66	832.81	47.59

Mean	874.86	68.33	832.81	47.59
Variance	733866.83	1694.15	738200.98	1008.00
Standard Dev.	856.66	41.16	859.19	31.75
CV	0.98	0.60	1.03	0.67

Table 1-4: Summary of 2000 Cloquet Forestry Center historical contiguous block CFI permanent plot data by species and Dbh class

Coverture: Jack pine

All stocking levels

Area: 222.21

Number of Plots: 27

Plot numbers: 6 8 11 12 16 34 100 106 107 108 119 124 148 175 207 211 212 219 227 310 312 318 323 330 400 417 419

Stand Numbers: 0 1 2 34 39 48 55 63 67 70 79 79 80 102 114 122 132 135 192 353 374 375 381 419

Species	DBH (in.):	Trees (Number/acre)				Basal Area (ft ² /acre)				Volume (ft ³ /acre)			Biomass (tons/acre)
		0-5	5-9	9+	Sum	0-5	5-9	9+	Sum	5-9	9+	Sum	All sizes
White pine		0.00	0.52	1.81	2.33	0.00	0.11	2.76	2.87	1.72	65.53	67.25	2.56
Red pine		0.00	17.11	10.63	27.74	0.00	4.68	11.34	16.02	75.65	271.17	346.82	13.10
Jack pine		37.04	73.11	60.41	170.56	1.36	19.11	42.76	63.22	299.72	877.69	1177.41	52.06
Balsam fir		85.19	9.59	0.52	95.30	1.90	2.57	0.38	4.85	40.63	7.45	48.08	2.83
White spruce		0.00	7.00	3.37	10.37	0.00	1.75	2.42	4.17	28.23	52.68	80.91	2.57
Norway spruce		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black spruce		18.52	2.07	0.26	20.85	0.56	0.41	0.14	1.12	6.59	2.87	9.46	0.60
Tamarack		0.00	0.00	0.52	0.52	0.00	0.00	0.75	0.75	0.00	16.34	16.34	0.64
N. white cedar		0.00	0.26	0.00	0.26	0.00	0.04	0.00	0.04	0.49	0.00	0.49	0.02
Scotch pine		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fraser fir/ Blue spruce		0.00	0.52	0.26	0.78	0.00	0.16	0.13	0.29	2.77	2.57	5.34	0.18
Sum Softwood		140.74	110.19	77.78	328.70	3.82	28.83	60.68	93.33	455.81	1296.29	1752.10	74.57
Yellow Birch		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ironwood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Basswood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
American elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Slippery elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quaking aspen		18.52	7.78	4.15	30.44	1.48	2.02	3.53	7.03	35.33	78.98	114.31	5.27
Bigtooth aspen		3.70	0.00	0.00	3.70	0.14	0.00	0.00	0.14	0.00	0.00	0.00	0.07
Balsam Polpar		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paper birch		25.93	4.93	0.78	31.63	1.59	1.18	0.67	3.45	20.53	14.74	35.26	2.59
Red Maple		48.15	1.04	0.00	49.19	1.64	0.25	0.00	1.90	4.06	0.00	4.06	1.15
Sugar maple		3.70	0.26	0.00	3.96	0.13	0.05	0.00	0.18	0.69	0.00	0.69	0.11
Black ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red oak		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum Hardwood		100.00	14.00	4.93	118.93	4.98	3.51	4.20	12.68	60.61	93.72	154.33	9.18
Willow		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Green ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mountain maple		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black cherry		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Choke cherry		3.70	0.00	0.00	3.70	0.05	0.00	0.00	0.05	0.00	0.00	0.00	0.02
Pin cherry		7.41	0.00	0.00	7.41	0.06	0.00	0.00	0.06	0.00	0.00	0.00	0.02
Service berry		14.81	0.00	0.00	14.81	0.18	0.00	0.00	0.18	0.00	0.00	0.00	0.08
Mountain ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dogwood spp.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alder		11.11	0.00	0.00	11.11	0.16	0.00	0.00	0.16	0.00	0.00	0.00	0.07
Hazel		14.81	0.00	0.00	14.81	0.12	0.00	0.00	0.12	0.00	0.00	0.00	0.05
Hawthorne		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum Noncommercial		51.85	0.00	0.00	51.85	0.56	0.00	0.00	0.56	0.00	0.00	0.00	0.24
Sum All Species		292.59	124.19	82.70	499.48	9.36	32.34	64.88	106.58	516.42	1390.01	1906.43	83.99
Mean					499.48				106.58			1906.43	83.99
Variance					110642.40				2081.32			791148.89	1396.65
Standard Dev.					332.63				45.62			889.47	37.37
CV					0.67				0.43			0.47	0.44

Table 1-5: Summary of 2000 Cloquet Forestry Center historical contiguous block CFI permanent plot data by species and Dbh class

Covertypes: Red pine All stocking levels

Area: 823.0

Number of Plots: 100

Plot numbers: 5 10 13 15 18 22 23 24 25 30 31 32 33 35 41 43 45 83 89 92 93 101 102 103 111 113 114 120 121 122 127 128 129 130 131 132 137 140 141 142 145 168 172 181 202 203 205 206 208 208 210 214 216 217 218 222 223 224 225 226 228 231 233 236 238 242 248 249 271 284 304 305 306 308 313 314 315 316 320 325 329 331 332 333 334 335 338 339 340 341 343 346 347 352 369 375 382 394 429 430

Stand Numbers: 0 1 7 13 23 34 37 43 56 57 60 62 64 71 75 82 84 88 96 97 101 104 109 114 115 117 128 132 134 139 141 148 150 151 154 159 172 176 185 188 195 200 207 215 253 269 285 310 311 314 321 323 336 395 399 420 428 453 471 480 481 483 490

Species	Trees (Number/acre)				Basal Area (ft ² /acre)				Volume (ft ³ /acre)			Biomass (tons/acre)	
	DBH (in.):	0-5	5-9	9+	Sum	0-5	5-9	9+	Sum	5-9	9+	Sum	All sizes
White pine		4.00	2.10	3.22	9.32	0.06	0.51	4.36	4.92	7.71	112.37	120.08	4.49
Red pine		80.00	58.31	56.98	195.29	4.92	14.54	67.56	87.02	227.94	1719.86	1947.80	75.11
Jack pine		16.00	9.10	4.13	29.23	1.13	2.15	3.41	6.68	32.54	70.79	103.33	5.29
Balsam fir		72.00	5.39	1.33	78.72	2.05	1.30	0.93	4.28	19.96	18.40	38.36	2.69
White spruce		28.00	1.96	2.31	32.27	1.32	0.55	1.97	3.84	9.09	42.76	51.85	2.50
Norway spruce		0.00	0.28	0.14	0.42	0.00	0.07	0.09	0.16	1.13	1.63	2.77	0.10
Black spruce		9.00	0.28	0.14	9.42	0.15	0.07	0.12	0.34	1.25	2.49	3.74	0.18
Tamarack		1.00	0.00	0.00	1.00	0.03	0.00	0.00	0.03	0.00	0.00	0.00	0.02
N. white cedar		0.00	0.21	0.07	0.28	0.00	0.06	0.04	0.09	0.79	0.54	1.33	0.04
Scotch pine		0.00	0.14	0.21	0.35	0.00	0.03	0.27	0.30	0.45	6.27	6.72	0.26
Fraser fir/ Blue spruce		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum Softwood		210.00	77.77	68.53	356.30	9.66	19.27	78.75	107.67	300.86	1975.12	2275.98	90.67
Yellow Birch		9.00	0.00	0.00	9.00	0.08	0.00	0.00	0.08	0.00	0.00	0.00	0.03
Ironwood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Basswood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
American elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Slippery elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quaking aspen		31.00	9.73	2.80	43.53	1.01	2.32	1.93	5.26	40.46	42.34	82.80	3.85
Bigtooth aspen		22.00	0.84	0.49	23.33	0.59	0.27	0.33	1.20	5.47	7.57	13.04	0.82
Balsam Poplar		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paper birch		55.00	6.09	2.03	63.12	2.04	1.54	1.40	4.99	27.62	30.22	57.84	3.65
Red Maple		59.00	3.43	1.26	63.69	1.52	0.78	0.88	3.18	12.41	17.56	29.98	2.20
Sugar maple		5.00	0.21	0.00	5.21	0.05	0.05	0.00	0.10	0.79	0.00	0.79	0.06
Black ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red oak		0.00	0.00	0.07	0.07	0.00	0.00	0.00	0.06	0.00	1.29	1.29	0.07
Other		1.00	0.00	0.00	1.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Sum Hardwood		182.00	20.30	6.65	208.95	5.31	4.97	4.61	14.88	86.75	98.99	185.74	10.68
Willow		2.00	0.00	0.00	2.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.01
Green ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mountain maple		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black cherry		1.00	0.00	0.00	1.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Choke cherry		3.00	0.00	0.00	3.00	0.19	0.00	0.00	0.19	0.00	0.00	0.00	0.13
Pin cherry		14.00	0.00	0.00	14.00	0.16	0.00	0.00	0.16	0.00	0.00	0.00	0.07
Service berry		1.00	0.00	0.00	1.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Mountain ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dogwood spp.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alder		13.00	0.00	0.00	13.00	0.17	0.00	0.00	0.17	0.00	0.00	0.00	0.08
Hazel		1.00	0.00	0.00	1.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Hawthorne		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum Noncommercial		35.00	0.00	0.00	35.00	0.56	0.00	0.00	0.56	0.00	0.00	0.00	0.29
Sum All Species		427.00	98.07	75.18	600.25	15.52	24.24	83.36	123.11	387.61	2074.11	2461.72	101.64
Mean					600.25				123.11			2461.72	98.76
Variance					276979.77				3128.53			2604544.50	3067.96
Standard Dev.					526.29				55.93			1613.86	55.39
CV					0.88				0.45			0.66	0.56

Table 1-6: Summary of 2000 Cloquet Forestry Center historical contiguous block CFI permanent plot data by species and Dbh class

Covertypes: Aspen All stocking levels

Area: 683.09

Number of Plots: 83

Plot numbers: 1 19 28 29 36 39 40 46 49 53 72 73 74 75 77 79 87 95 98 112 115 117 118 123 125 126 134 135 138 139 144 146 151 155 162 164 170 173 177 184 185 187 200 213 220 221 232 240 247 250 255 256 257 264 265 269 272 273 274 275 278 285 300 321 324 326 328 337 344 345 348 354 364 370 379 380 381 384 389 395 401 425

Stand Numbers: 20 103 104 105 112 113 119 123 137 140 144 154 163 167 172 178 186 192 197 205 212 217 220 227 229 248 255 269 273 276 285 291 299 303 304 310 320 321 326 330 331 335 336 337 340 348 349 357 370 372 376 411 425 427 447 470 485 491 519

Species	DBH (in.):	Trees (Number/acre)				Basal Area (ft ² /acre)				Volume (ft ³ /acre)			Biomass (tons/acre)
		0-5	5-9	9+	Sum	0-5	5-9	9+	Sum	5-9	9+	Sum	All sizes
White pine		0.00	0.08	0.00	0.08	0.00	0.03	0.00	0.03	0.41	0.00	0.41	0.01
Red pine		12.05	5.14	2.87	20.06	0.70	1.22	4.29	6.21	18.91	97.62	116.53	4.84
Jack pine		9.64	1.52	0.59	11.75	0.35	0.43	0.64	1.42	7.01	13.48	20.49	1.11
Balsam fir		9.64	4.47	2.53	16.64	0.21	1.18	1.68	3.07	18.04	32.11	50.16	2.16
White spruce		13.25	1.86	1.27	16.37	0.65	0.45	1.30	2.40	6.77	29.18	35.95	1.60
Norway spruce		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black spruce		6.02	0.34	0.25	6.61	0.21	0.09	0.14	0.43	1.47	2.73	4.21	0.24
Tamarack		1.20	0.59	0.08	1.88	0.02	0.17	0.04	0.23	2.63	0.64	3.27	0.14
N. white cedar		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scotch pine		0.00	0.08	0.00	0.08	0.00	0.02	0.00	0.02	0.26	0.00	0.26	0.01
Fraser fir/ Blue spruce		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum Softwood		51.81	14.08	7.59	73.48	2.14	3.58	8.09	13.81	55.50	175.77	231.27	10.11
Yellow Birch		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ironwood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Basswood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
American elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Slippery elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quaking aspen		495.18	42.42	13.41	551.01	18.03	10.50	8.56	37.09	182.63	185.45	368.08	24.93
Bigtooth aspen		83.13	2.61	0.76	86.51	2.40	0.73	0.44	3.57	14.24	9.78	24.03	2.22
Balsam Poplar		1.20	0.76	0.08	2.05	0.08	0.21	0.07	0.35	3.58	1.54	5.12	0.21
Paper birch		56.63	2.70	3.80	63.12	1.36	0.73	3.15	5.24	12.79	67.91	80.70	3.93
Red Maple		40.96	3.63	2.11	46.70	1.51	0.77	1.59	3.88	11.52	30.96	42.48	2.84
Sugar maple		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red oak		0.00	0.08	0.00	0.08	0.00	0.01	0.00	0.01	0.12	0.00	0.12	0.01
Other		2.41	0.00	0.00	2.41	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.01
Sum Hardwood		679.52	52.20	20.16	751.88	23.40	12.95	13.81	50.16	224.89	295.65	520.54	34.15
Willow		4.82	0.00	0.00	4.82	0.05	0.00	0.00	0.05	0.00	0.00	0.00	0.02
Green ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mountain maple		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black cherry		0.00	0.08	0.00	0.08	0.00	0.02	0.00	0.02	0.20	0.00	0.20	0.02
Choke cherry		9.64	0.00	0.00	9.64	0.12	0.00	0.00	0.12	0.00	0.00	0.00	0.05
Pin cherry		26.51	0.00	0.00	26.51	0.25	0.00	0.00	0.25	0.00	0.00	0.00	0.10
Service berry		2.41	0.00	0.00	2.41	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.01
Mountain ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dogwood spp.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alder		12.05	0.00	0.00	12.05	0.21	0.00	0.00	0.21	0.00	0.00	0.00	0.10
Hazel		4.82	0.00	0.00	4.82	0.04	0.00	0.00	0.04	0.00	0.00	0.00	0.01
Hawthorne		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum Noncommercial		60.24	0.08	0.00	60.33	0.68	0.02	0.00	0.70	0.20	0.00	0.20	0.31
Sum All Species		791.57	66.37	27.75	885.69	26.21	16.55	21.90	64.67	280.58	471.42	752.00	44.57
Mean					885.69				64.67			752.00	44.57
Variance					781781.03				1604.61			708246.59	957.47
Standard Dev.					884.18				40.06			841.57	30.94
CV					1.00				0.62			1.12	0.69

Table 1-7: Summary of 2000 Cloquet Forestry Center historical contiguous block CFI permanent plot data by species and Dbh class

Covertypes: Paper birch All stocking levels

Area: 74.07

Number of Plots: 9

Plot numbers: 21 58 65 157 163 276 311 349 423

Stand Numbers: 71 102 235 251 266 283 341 378 430

Species	DBH (in.):	Trees (Number/acre)				Basal Area (ft ² /acre)				Volume (ft ³ /acre)			Biomass (tons/acre)
		0-5	5-9	9+	Sum	0-5	5-9	9+	Sum	5-9	9+	Sum	All sizes
White pine		0.00	0.00	1.56	1.56	0.00	0.00	1.52	1.52	0.00	27.50	27.50	0.98
Red pine		44.44	6.22	2.33	53.00	2.33	1.37	1.68	5.39	20.19	35.78	55.98	3.68
Jack pine		0.00	2.33	0.00	2.33	0.00	0.64	0.00	0.64	10.25	0.00	10.25	0.46
Balsam fir		22.22	7.00	3.89	33.11	2.26	1.71	2.88	6.85	26.35	55.50	81.85	4.94
White spruce		77.78	11.67	3.89	93.33	4.75	2.67	4.40	11.83	40.28	99.27	139.55	7.48
Norway spruce		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black spruce		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tamarack		11.11	0.78	0.00	11.89	1.40	0.15	0.00	1.54	2.13	0.00	2.13	1.08
N. white cedar		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scotch pine		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fraser fir/ Blue spruce		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum Softwood		155.56	28.00	11.67	195.22	10.74	6.55	10.49	27.77	99.20	218.06	317.26	18.61
Yellow Birch		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ironwood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Basswood		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
American elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Slippery elm		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quaking aspen		222.22	24.89	2.33	249.44	7.53	5.64	1.26	14.43	98.52	25.99	124.51	9.47
Bigtooth aspen		44.44	7.00	0.00	51.44	1.86	1.73	0.00	3.59	33.92	0.00	33.92	2.41
Balsam Poplar		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paper birch		88.89	24.11	33.44	146.44	1.64	7.25	26.47	35.36	136.16	577.39	713.55	28.93
Red Maple		11.11	7.78	3.11	22.00	0.55	1.83	1.77	3.11	28.51	35.17	63.67	3.22
Sugar maple		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Red oak		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum Hardwood		366.67	63.78	38.89	469.33	11.58	16.45	29.50	57.53	297.10	638.55	935.65	44.03
Willow		11.11	0.00	0.00	11.11	0.09	0.00	0.00	0.09	0.00	0.00	0.00	0.03
Green ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mountain maple		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Black cherry		0.00	0.78	0.00	0.78	0.00	0.11	0.00	0.11	1.10	0.00	1.10	0.12
Choke cherry		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pin cherry		22.22	0.00	0.00	22.22	0.33	0.00	0.00	0.33	0.00	0.00	0.00	0.15
Service berry		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mountain ash		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dogwood spp.		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alder		44.44	0.00	0.00	44.44	1.33	0.00	0.00	1.33	0.00	0.00	0.00	0.71
Hazel		11.11	0.00	0.00	11.11	0.06	0.00	0.00	0.06	0.00	0.00	0.00	0.02
Hawthorne		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum Noncommercial		88.89	0.78	0.00	89.67	1.81	0.11	0.00	1.92	1.10	0.00	1.10	1.04
Sum All Species		611.11	92.56	50.56	754.22	24.12	23.11	39.99	87.22	397.40	856.61	1254.01	63.68
Mean					754.22				87.22			1254.01	63.68
Variance					701802.17				1458.69			713329.43	854.82
Standard Dev.					837.74				38.19			844.59	29.24
CV					1.11				0.44			0.67	0.46

Appendix 2: Field instructions for CFC CFI year 2000 remeasurement.

Field Instructions for Remeasurement of Cloquet Forestry Center CFI Plots - 2000

I. Objectives:

The following instructions are intended to guide establishment of permanent forest growth and inventory plots at the Cloquet Forestry Center, University of Minnesota, Cloquet, Minnesota. These plots are intended for long term monitoring of forest stand growth and the development of growth and yield prediction models. They are also intended as an inventory of the entire property. Plot records may also aid a variety of research studies.

II. Materials required by each 2-person crew

1. Equipment

- a. 100' tape for plot radius and other distance determination
- b. Diameter (Dbh) tape for tree diameter at breast height determination (inches)
- c. Laser Technology Impulse 200LR with 1-4x scope and crosshairs and Sunnto compass and tripod for bearings and distances to trees and tree height measurement.
- d. Clinometer for slope percent and tree height measurement backup (Sunnto)
- e. Caliper for small diameters (plastic gauge)
- f. Clip board / tally sheet holder (aluminum)
- g. Hand compass for field navigation (Silva Ranger)
- h. Pocket stereoscope
- i. Axe for setting plot stakes
- j. Increment borer for determining tree age at breast height
- m. Cruisers vests
- n. 35 mm camera

2. Supplies

- a. Plot establishment and remeasurement instructions
- b. Map of area with sample plot locations plus individual plot location instructions
- c. Stereo coverage aerial photos with photo scale ruler
- d. Computer tally sheets for plots with previous data if available and space to record new data
- e. Field tally sheets from last remeasurement
- f. Pencils, etc.
- g. Flagging
- h. Plot stakes (2" x 2" x 36") treated wooden stakes with aluminum tags for all plots; 60" stakes for wetlands).
- i. Tree marking paint (white) tubes, quart cans, and brushes
- j. Film

III. Re-location of sample plots

1. Using plot location information in conjunction with aerial photos, locate plot center in field. If existing plot center cannot be found, a new center stake should be re-established as close to original as possible using available witness trees.
2. Verify plot location and plot number.

3. For new plots, establish centers corresponding to map locations found by extension of random start grid. Three or more witness trees should also be marked at the base by an arrow to the plot center and by a horizontal line at Dbh facing the plot center. These witness trees should have the distance and azimuth to the plot center recorded on the tally sheet and they should meet the following criteria:
 - a. Located within 100 feet of the plot center.
 - b. Not likely to die or be cut before the next survey.
 - c. Species easily located in the stand.
 - d. At least 5.0" Dbh (at least 2.0" Dbh if no 5.0"+ Dbh available).

Witness trees should be noted with a "W" near the right margin of the tally sheet on the line where data for that tree is recorded. If a witness tree is not on the 1/7 acre plot, write "not on plot" across tally line. The tree itself should be marked with a painted arrow (↯) from 2' above ground down to the ground pointing to the plot center.

4. Note any changes in plot location on tally sheet (attached).

IV. Measurement and recording of stand, condition class, and plot information.

An asterisk (*) next to designated information indicates that procedure and/or coding corresponds to that for the USDA Forest Service North Central Forest Inventory and Analysis (FIA) Codes.

Condition class* is a discrete combination of landscape attributes that describe the environment on all or a part of a plot. Examples of such attributes are forest type, stand size, stand density, and stand origin. To be recognized, a condition class must be at least 120 ft wide and 1 ac in size. Type, size, and density information will also be derived independently for each individual plot from quantitative sorting algorithms applied to only the data from that plot.

1. **Plot number**
2. **Compartment number.** Compartments on the Cloquet Forestry Center are nominally 40 acre areas corresponding to land survey breakdowns.
3. **Stand number.** Stands (polygons) on the Cloquet Forestry Center are mapped to a 2.5 ac minimum with a few exceptions for smaller, unique areas. Record stand or polygon number.
4. **Stand history/disturbance.*** Record the stand history. Consider only trees in the predominant stand-size of the stand. If stand boundaries are unclear and conditions are variable, focus on the 2.5 ac minimum area including the plot center. The area significantly affected must be at least 1 acre in size.

Table 1. Stand History Codes

Code	First digit	Code	Second digit
1	No disturbance	0	No disturbance
2	Timber stand improvement	1	1-4 years
3	Clearcut harvest	2	5-10 years
4	Partial harvest		
5	Natural—fire, insects, disease		
6	Man-caused—drainage, spray		
7	Planting of forest land		
8	Planting of nonforest land		
9	Natural regeneration of nonforest land		

5. **Cover type of stand.** If stand boundaries are unclear and conditions are variable, focus on the 2.5 ac minimum area including the plot center. The area considered must be at least 1 acre in size. The codings for the various cover types are given below. In classifying cover type, the plot will be the basis and classification will be based upon the crown density of the dominant species. When this is not clearcut, basal area will be the basis for the decision.

Table 2. Cover type

<u>Code</u>	<u>Productive forest Land</u>	<u>Code</u>	<u>Unproductive forest land</u>
01	White Pine	80	Unproductive lowland
02	Red pine	81	Christmas tree bog
03	Jack pine	83	Unproductive upland
04	Balsam fir	88	Reserved from cutting
05	White spruce		
06	Swamp conifers	<u>Code</u>	<u>Nonforest land</u>
07	Black Spruce	90	Nonforest
08	Tamarack	91	Farm land
09	Cedar	93	Urban and industrial
10	Scotch pine	94	Water
44	Cut (new classification not yet evident)	96	Marsh
52	Upland mixed hardwoods: mixture of birch, aspen, maple, oak, basswood, elm	97	Muskeg
55	Black ash	98	Right of way
60	Aspen	99	Other nonforest (sand dunes, rock outcrops, etc.)
61	Paper birch		
70	Grass		
71	Upland brush		
72	Lowland brush (willow, alder)		

6. **Size class of stand.** If stand boundaries are unclear and conditions are variable, focus on the 2.5 ac minimum area including the plot center. The area considered must be at least 1 ac in size.

Table 3. Size class codes

<u>Code</u>	<u>Class</u>
0	Nonstocked
1	Seedlings - under 1" Dbh
2	Saplings - 1" to 4.95" Dbh
3	Poles - 4.95" - 8.95" for conifers, aspen - 4.95" - 10.95" for hardwoods
4	Sawtimber - 9"+ for conifers and aspen - 11"+ for hardwoods
5	All sizes

7. **Density class of stand.** If stand boundaries are unclear and conditions are variable, focus on the 2.5 ac minimum area including the plot center. The area considered must be at least 1 ac in size.

Table 4. Stand Density Codes¹

<u>Code</u>	<u>Density</u>
0	Nonstocked (0-9%)
1	Poorly stocked (10- 39%)
2	Medium stocked (40- 69%)
3	Well stocked (70%+)

Size and density will be based upon the basal area (note 5 sq. ft B.A. = 1 cord and 1 cord = 500 bd. ft.) Use the following table as a guide:

Table 5. Stand size and density classification guide.

<u>Size Class</u>	<u>Unit per acre</u>	<u>Good</u>	<u>Density Medium</u>	<u>Poor</u>
Seedlings	trees	1,400 ¹ +	800 - 1400 ¹	200 - 800
Saplings	trees	700 +	400 - 700	100 - 400
Pole timber	cords ²	13 +	7 - 13	3 - 7
Small Sawtimber	MBF ²	6.0 +	3.0 - 6.0	1.0 - 3.0
Large Sawtimber	MBF ²	10.0 +	5.0 - 10.0	1.0 - 5.0

¹. Primarily for natural stands. With uniform spacing approximately 1000 TPA qualifies as good density of stocking.

². Volumes are net, board feet or international 1/4 inch Rule.

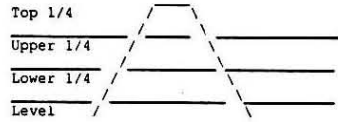
Note: Omit entry of plot covertype, size class, and density class—these will be computed from the tree tally on the plot.

8. **Aspect**
Represents the direction of drainage for the majority of the sample points, and is recorded as the azimuth of this direction. For instance, if the direction of drainage is 36 degrees, the code is 036. Direction due North will be recorded as 001.
9. **Percent slope**
Represents the degree of steepness for the majority of the plot and is recorded in percent as measured with a clinometer.
10. **Slope position**
Represents the location of the majority of the points in reference to topography of the immediate area.

Table 6. Slope position codes.

<u>Code</u>	<u>Position</u>
1	Top 1/4
2	Upper 1/4
3	Lower 1/4
4	Level of lowest 1/4

The following example has been included to aid in locating position of plot in reference to topography of the immediate area.



11. Slope length

At plot center or on the slope where the majority of the points fall, look up and down the slope and estimate total slope length to the nearest 1/2 chain (from 0000 to 999.5 chains). Slope length is measured to record the distance from the point where water starts to flow down slope (upper slope - ridge top) to the point where runoff enters a well defined channel, or at the bottom of the slope where deposition begins. For flatland and bottomland, record slope length as 0000.

12. Stand age and site index

For all plots:

- a. Determine year of stand origin from plantation records (years since planting) or from increment borings of 3 dominant crown class trees in stand (not necessarily on the plot) for major species.

Use the following table for determining total age for trees bored at Dbh (from p. 10, 1964, Field Instructions)

Table 6. Breast to total age conversion instructions¹

Species	Years to Dbh*
Aspen (moist site)	1
Aspen (dry site)	2
Birch	2
Jack pine	6
Red pine	8
Scotch pine	8
White pine	8
Ash	9
White spruce	10
Black Spruce	12
Balsam fir	10
Cedar	15
Tamarack	10

¹ The years to Dbh should be added to the ring count obtained from the increment core.

- b. Determine tree heights for above trees.
- c. Record these heights and ages on tally sheet for each plot in stand and indicate the source of age information (plantation records or increment borings).
- d. This same stand data may be assigned for several plots, i.e., each plot does not require separate height and age data.

V. Tree data to be entered on attached tally sheet (live stems and those dead since last remeasurement).

Two concentric plots will be measured at each sampling point.

1. Main: A 1/7 acre plot (radius 44.5 feet) for all live stems 4.95 inches Dbh and larger.
2. Subplot: A 0.01 acre subplot will be established (radius 11.78 feet) for all trees .95 inches Dbh and larger.

The sequence of measurement will be:

1. All standing trees (live and dead) in main plot beginning clockwise from north.
2. All standing trees (live and dead) trees in subplot plot (same clockwise pattern as above).

Main plot and subplot measurement items are:

- 1) **Tree number** (new trees in plot should be marked with a new tree number with paint above Dbh. To avoid confusion with old numbers, new tree numbers must begin higher than any old number).
- 2) **Tree species** from species code list.

Table 7. Tree species codes

<u>Code</u>	<u>Species</u>	<u>Code</u>	<u>Species</u>
01	White pine	73	Willow
02	Red pine	74	Green ash
03	Jack pine	80	Mountain ash
04	Balsam fir	81	Black cherry
05	White spruce	82	Choke cherry
07	Blace spruce	83	Pine cherry
08	Tamarack	84	Service berry
09	Northern white cedar	85	Mountain ash
10	Scotch pine	86	Dogwood species
21	Yellow birch	90	Alder
49	Ironwood	91	Haze!
50	Basswood		
51	American Elm		
52	Slippery Elm		
60	Quaking aspen		
61	Bigtooth aspen		
62	Balsam poplar		
64	Paper birch		
65	Red maple		
66	Sugar maple		
67	Black ash		
68	Red oak		
69	Other (specify on tally sheet, these will be given codes later)		

6: Norway spruce
11: Frasier fir
93: Hawthorne

- 3) **Dbh** measured and recorded to nearest 0.1". Measure with tape for trees ≥ 2.95 " Dbh; use caliper for smaller stems, measure at right angle to plot center.
- 4) **Total height** observed to nearest foot using Impulse 200 LR on first two trees from north on main plot and subplot (4 trees maximum).

- 5) **Crown class** primarily reflects the amount of sunlight received rather than the conventional "crown position" classification found in forestry textbooks. Record a one-digit code to show crown class of all live trees 1.0" Dbh and larger, as follows:

Table 8. Crown class codes

<u>Code</u>	<u>Crown Class</u>
0	<u>Predominant</u> . Trees which clearly originate from an earlier stand. This may be indicated by a number of factors such as tree diameter, height, condition, or species.
1	<u>Open grown</u> . Trees with crowns which have received full light from above and from all sides throughout all or most of the life of the tree, particularly during its early developmental period.
2	<u>Dominant</u> . Trees with crowns extending above the general level of the crown cover and receiving full light from above and partly from the sides; larger than the average trees in the stand, and with crowns well developed, but possibly somewhat crowded on the sides.
3	<u>Codominant</u> . Trees with crowns forming part of the general level of the crown cover and receiving full light from above, but comparatively little from the sides--usually with medium-sized crowns more or less crowded on the sides. (In stagnated stands, includes trees with small-size crowns crowded on the sides).
4	<u>Intermediate</u> . Trees shorter than those in the two preceding classes, but with crowns either below or extending into the crown cover formed by codominant and dominant trees, receiving little direct light from above, and none from the sides; usually with small crowns considerably crowded on the sides.
5	<u>Overtopped</u> . Trees with crowns entirely below the general level of the crown cover, receiving no direct light from above or from the sides.

In multiple-age stands with understory trees of younger age classes, crown classification is often difficult. As a general rule, the crown class for each tree should be judged in the context of its immediate environment; that is, those trees affecting it or being affected by it in terms of crown competition. For example, the intermediate and overtopped crown classes are intended to include only trees seriously affected by direct competition from adjacent trees.

- 6) **Crown ratio** is the percentage of total tree height that supports a full, live, green healthy, foliage that is effectively contributing to tree growth. Crown ratio is expressed as a percentage of total tree height and recorded as a 1-digit code for all live trees 1 inch Dbh or larger. For trees that have uneven length crowns, ocularly transfer branches to fill holes in the upper portion of the crown, until an even crown is visualized. For example, a tree might have scattered green branches extending over 60 percent of its total height, but by ocularly transferring branches to produce a full crown, the crown ratio might be 40 percent. Record crown ratio using the following one-digit codes:

Table xx. Crown ratio codes

<u>Code</u>	<u>Crown Ratio</u>
1	1 through 10 percent
2	11 through 20 percent
3	21 through 30 percent
4	31 through 40 percent
5	41 through 50 percent
6	51 through 60 percent
7	61 through 70 percent
8	71 through 80 percent
9	81 through 90 percent
0	91 through 100 percent

7) **Tree class**

Table 8. Tree class (status code)

<u>Code</u>	<u>Class</u>
0	Old live tree - measured at last measurement
1	Ingrowth on 1/7 acre main plot, Dbh less than 4.95 at last measurement
2/3	***used for past inventories
4	Tree obviously missed at last measurement
5	Harvested
6	Dead down
61	Dead standing
7	Missing
8	New tree in 1/100 acre subplot
9	<i>witness tree off of plot</i>

8) **Identification of tree's plot type**

Table 9. Tree Plot type

<u>Code</u>	<u>Plot type</u>
1	1/7 acre main plot
2/3	***used with earlier multiplot desing for 1/5 acre and point sample plot, respectively
4	tree <= 4.95" within 1/100 acre subplot
41	tree => 4.95" within 1/100 acre subplot

- 9) **Damage or cause of death** since last measurement. Enter up to three items separated by large slashes. Enter these in order of significance.

Table 10. Damage or cause of death

<u>Code</u>	<u>Description</u>
000	Healthy
100	Insect defoliators 101 Budworms; 110 Forest Tent Caterpillar; 113 Gypsy Moth
130	Shoot and branch insects 131 White pine weevil
140	Branch gall insects
150	Bole borers
170	Bark beetles
190	Root/root collar insects
200	Foliage diseases
210	Shoot Blights 212 <i>Scleroderris</i>
240	Bole rusts
250	Bole cankers 251 <i>Euypella</i> ; 252 <i>Hypoxyton</i> ; 254 <i>Nectria</i> ; 257 Butternut
260	Stem decay 261 <i>Phellinus pini</i> ; 262 <i>Phellinus tremulae</i> ; 263 <i>Inonotus obliquus</i>
271	Ash yellows
281	Dutch elm disease
282	Oak wilt
290	Root/butt rot 291 <i>Fomitopsis annosus</i> ; 292 <i>Armillaria</i> root rot
300	Weather 301 hail; 302 wind; 303 lightning; 304 frost cracks; 306 winter drying 307 flooding; 308 drought; 309 snow/ice
400	Animal damage 402 Moose/elk/deer; 403 rabbit; 404 beaver; 406 porcupine; 408 sapsucker; 409 cattle/domestic animals
500	Fire
600	Suppression
710	Missing or dead top
720	Poor form (sweep or crook)
800	Logging and related
900	Unknown (dead tree only)
901	Unknown defoliation
902	Unknown discoloration
903	Unknown decline/dieback
904	Unknown breakage
905	Unknown abnormal growth or crown form
906	Unknown canker
907	Unknown cracks
908	Unknown abnormal growth or bole form
909	Unknown insect holes

- 10) **Distance and azimuth.** To measure the distance, use the Impulse 200 LR and take a horizontal distance reading from plot center to the tree, then add the tree radius. Alternatively, hold the 100' tape from the plot center to the tree in a straight and horizontal path. Measure and record the horizontal distance from the plot center to the tree center at Dbh. Record to the nearest 1/10 foot. To measure the azimuth, take reading from plot center to the center of the tree. Record to the nearest degree. Work in a clockwise fashion until all trees have been measured.

VI. Field tally sheet background

An ACCESS program running on Windows 98 was written to produce the tally forms for this remeasurement. The tally sheets (sample attached) consist of plot information as well as stand information and will include previous measurement data if available. To indicate which values are to be recorded and where, pairs of parentheses, i.e., [], are printed. In most cases, the space provided is approximately equal to the number of digits which should be recorded.

Changes in stand number due to stand map revision should be noted by crossing out the old number and replacing it with a new one.

The ages of stands are to be recorded from previous records or from measurements taken while in the field.

The tally form has been designed with previous data to help answer questions that may arise in the field. The newly recorded data will subsequently be entered and added to the present data file to create an updated tree and plot database.

Blank space for new tree entries is offered by the brackets extending below the current data.

VII. Photo record

Take a 35mm color photograph of each plot from the south edge of the plot facing plot center with plot number card and pole or crew member clearly visible.

**Appendix 3: Field instructions supplement for remeasurement of CFC CFI
year 2000 remeasurement**

Field Instructions Supplement for Remeasurement of Cloquet Forestry Center CFI Plots - 2000

I. Objectives:

The items included below are intended to broaden the utility of the database and incorporate some Forest Inventory and Analysis (FIA) procedures. They are to be observed and recorded for the primary condition class and up to two additional classes as appropriate. The basis for this information is the presence of a condition class on the 1/7 acre plot itself (and optionally a 1/4 acre concentric circular plot, radius = 58.9 ft) as noted. To establish the framework for this detail, the condition classes and special features such as roads, streams, water bodies, abrupt change in topography, etc. are to be drawn on the attached map of the plot. However, no map is required if the 1/4 acre plot contains but one condition class, i.e., conditions are homogeneous across the plot, and there are no features requiring mapping.

II. Additional variables for the plot.

- 1) **Water on plot.*** Record the water source that has the greatest impact on the area within the annular plot (58.9 ft radius fixed area surrounding each subplot center). The coding hierarchy is listed in order from large permanent water to temporary water. Note that if **land use type** is non census or census water (codes 80 or 90 on next page), this entry may be left blank.

Code Water on Plot

- 0 None (no water sources within annular plot)
- 1 Permanent streams or ponds too small to qualify as noncensus water
- 2 Permanent water (too small to qualify as Census or noncensus water) in the form of deep swamps, bogs, marshes without standing trees present or with standing trees and less than 1.0 acres in size
- 3 Ditch/canal --human-made channels used as a means of moving water, such as irrigation or drainage which are too small to qualify as noncensus water
- 4 Temporary streams
- 5 Flood zones--evidence of flooding when bodies of water exceed their natural banks
- 9 Other (specify in field notes)

- 2) **Distance to water and water type.*** Measure and record the shortest straight line distance in ft from the plot center to the nearest water type. Note also the water type by the codes given for WTYP above.
- 3) **Seedling procedures.*** Stocking and regeneration information are obtained by counting seedlings within the 11.78 ft. radius subplot. Conifer seedlings must be at least 6.0" in length and less than 1.0" at DBH in order to qualify for tallying. Hardwood seedlings must be at least 12.0" in length and less than 1.0" at DBH in order to qualify for tallying. Record the number of seedlings of each species, by condition class. Count up to 5 individuals by species; if there are more than 5 individuals of any given species in any given condition class, then estimate. Code species in order from most abundant to least abundant.

II. Additional variables by condition class on plot.

4) **Land Use Type.*** Enter for each separate condition class on the plot.

Table 1. Land Use Type

Code Forest Land

- 20 Timberland (producing in excess of 20 ft³ yr-1)
- 21 Pastured Timberland
- 22 Plantation (artificially reforested Timberland)
- 40 Unproductive forest land (incapable of producing 20 ft³ yr-1)
- 41 Reserved forest land, unproductive
- 45 Reserved forest land, productive
- 46 Christmas tree plantation

Code Nonforest without trees

- 61 Cropland
- 62 Improved pasture
- 64 Idle farmland
- 65 Marsh
- 66 Other farmland
- 67 Urban and other
- 68 Rights-of-way
- 69 Nonforest-reserved
- 80 Noncensus water - Lakes, reservoirs, ponds, and similar bodies of water 1.0 acres to 4.5 acres in size; rivers streams, canals, etc., 30 feet to 200 feet wide.
- 90 Census water - Lakes, reservoirs, ponds, and similar bodies of water 4.5 acres in size and larger; rivers streams, canals, etc., more than 200 ft wide (1990 U.S. Census definition).

Code Nonforest with trees

- 50 Reserved, nonforest with trees
- 51 Cropland with trees
- 52 Pasture and rangeland with trees
- 53 Wooded strip (natural)
- 54 Idle farmland with trees
- 55 Marsh with trees
- 56 Narrow windbreak(less than 120' wide)
- 58 Shelterbelt (less than 120" wide)
- 71 Urban forest land locationally reserved
- 72 Urban and other with trees

5) **Physiographic class.*** Physiographic class is a measure of soil and water conditions that affect tree growth on the plot. Record the appropriate code. Land form, topographical position, and soil generally determine physiographic class. As a rule of thumb, look out 60 ft from the plot centers when determining physiographic class, but always use your best judgement when assessing any condition level variables.

Xeric -- Sites that are normally low or deficient in moisture available to support vigorous tree growth. These areas may receive adequate precipitation but experience a rapid loss of available moisture due to runoff, percolation, evaporation, etc.

Code Description

- 11 Dry Tops. - Ridge tops with thin rock outcrops and considerable exposure to sun and wind.
- 12 Dry Slopes. - Slopes with thin rock outcrops and considerable exposure to sun and wind. Includes most mountain/steep slopes with a southern or western exposure.
- 13 Deep Sands. - Sites with a deep, sandy surface subject to rapid loss of moisture following precipitation. Typical examples include sand hills, ridges and flats in the South, sites along the beach and shores of lakes and streams.
- 14 Other Xeric. - All dry physiographic sites not described above.

Mesic -- Sites that have moderate but adequate moisture available to support vigorous tree growth except for periods of extended drought. These sites may be subjected to occasional flooding during periods of heavy or extended precipitation.

Code	Description
21	Flatwoods. - Flat or fairly level sites outside of flood plains. Excludes deep sands and wet, swampy sites.
22	Rolling Uplands. - Hills and gently rolling, undulating terrain and associated small streams. Excludes deep sands, all hydric sites, and streams with associated floodplains.
23	Moist Slopes and Coves. -- Moist slopes and coves with relatively deep, fertile soils. Often these sites have a northern or eastern exposure and are partially shielded from wind and sun. Includes moist mountain tops and saddles.
24	Narrow Floodplains/Bottomlands. - Floodplains and bottomlands less than 1/4-mile in width along rivers and streams. These sites are normally well drained but are subjected to occasional flooding during periods of heavy or extended precipitation. Includes associated levees, benches, and terraces within a 1 mile limit. Excludes swamps, sloughs, and bogs.
25	Broad Floodplains/Bottomlands. - Floodplains and bottomlands 1/4-mile or wider in width along rivers and streams. These sites are normally well drained but are subjected to occasional flooding during periods of heavy or extended precipitation. Includes associated levees, benches, and terraces within a 1/4-mile limit. Excludes swamps, sloughs, and bogs with year-round water problems within the 1/4-mile limit.
26	Other Mesic. -- All moderately moist physiographic sites not described above.

Hydric -- Sites which generally have a year-round abundance or over-abundance of moisture. Hydric sites are very wet sites where excess water seriously limits both growth and species occurrence"

Code	Description
31	Swamps/Bogs. - Low, wet, flat forested areas usually quite extensive which are flooded for long periods or time except during periods of extreme drought. Excludes cypress ponds and small drains.
32	Small Drains. -- Narrow, stream-like, wet strands of forest land often without a well-defined stream channel. These areas are poorly drained or flooded throughout most of the year and drain the adjacent higher ground.
33	Bays and wet pocosins. - Low, wet, boggy sites characterized by peaty or organic soils. May be somewhat dry during periods of extended drought. Examples include sites in the Lake States with lowland swamp conifer.
34	Beaver ponds.
35	Cypress ponds.
36	Other hydric. - All other hydric physiographic site

- 6) **Artificial regeneration.*** For each condition class, record the code that best describes how the stand regenerated.

Code	Stand Origin	Description
0	Natural	Present stand shows no clear evidence of artificial regeneration. This includes unplanted, recently cut lands
1	Artificial	Present stand shows clear evidence of artificial regeneration

In some areas, trees are not planted in rows, and planted stands do not differ in physical appearance from natural conditions. In these cases, there is no need to differentiate conditions based on stand origin. Also record the predominant species (code) planted, but only when artificial regeneration (2.4.4) is coded "1". See list of tree species codes.

- 7) **Disturbance.*** For each condition class, record the code corresponding to the presence of the following disturbances. Disturbance can connote positive or negative effects. The area affected by any natural or human-caused disturbance must be at least 1 acre in size. Record up to three different disturbances per condition class from most important to lesser important as best as can be determined. Recognize only those disturbances that have occurred since the last measurement. Some of the disturbance codes below require "any visible evidence" others require "significant threshold". Significant threshold implies:

- (1) mortality and/or damage to 25 percent of individual trees, serious enough to meet minimum threshold requirements, and
- (2) 25% of all trees in the stand are impacted.

Code	Definition
00	None - No observable disturbance.
10	Insects - Significant threshold damage from insects.
20	Disease - Significant threshold damage from disease.
30	Weather - Significant threshold damage from weather other than the following:
31	Ice - Significant threshold damage from ice.
32	Wind - Significant threshold damage from wind (includes hurricane, tornado).
33	Flooding - Significant threshold damage from weather-induced flooding.
34	Drought - Significant threshold damage from drought.
40	Fire - Any visible evidence of crown and ground fire, either prescribed or natural.
41	Ground Fire - Visible evidence of ground fire.
42	Crown Fire - Visible evidence of crown fire.
50	Domestic animal - Visible evidence of domestic livestock (includes grazing).
60	Wild Animal - Significant threshold damage from wild animals other than the following:
61	Beaver - Significant threshold damage from beaver (includes flooding).
62	Porcupine - Significant threshold damage from porcupines.
70	Human - Any significant threshold human-caused damage not described in the disturbance codes listed above or the treatment codes listed below.
80	Other natural - Any significant threshold natural damage, not described in the disturbance codes listed above.

- 8) **Treatment.*** For each condition class, record the code corresponding to the presence of the following treatments since the last measurement. The area affected by any treatment must be at least 1 acre in size. Record up to three different treatments per condition class from most important to lesser important as best as can be determined.

The term ``merchantable stand' refers to stands at least 50% stocked with live or salvable dead trees 5.0 inches DBH or larger.

Code	Definition
00	None. No observable treatment.
10	Cutting. The removal of trees from a merchantable stand. <ul style="list-style-type: none"> 11 clearcutting without residuals 12 clearcutting with residuals 13 patch clearcut 14 strip clearcut 15 shelterwood cut 16 seed tree cut 17 group selection 18 single tree selection 19 thinning (commercial only)
20	Site preparation. Clearing, slash burning, chopping, disking, bedding, or other practices clearly intended to prepare a site for either natural or artificial regeneration. <ul style="list-style-type: none"> 21 clearing 22 slashburning 23 chopping, bedding 24 disking
30	Natural Regeneration. The establishment of a new stand by natural means on forest or nonforest land where the stocking of all live trees is now greater than 50%.
40	Artificial Regeneration. The establishment of a new stand by artificial means on forest or nonforest land where the stocking of all live trees is now greater than 50%. <ul style="list-style-type: none"> 41 planting 42 seeding
50	Other silvicultural treatment. The use of fertilizers, herbicides, girdling, pruning or other activities (not already listed above) designed to improve the commercial value of the residual stand. <ul style="list-style-type: none"> 51 herbicide treatment 52 girdling 53 felling (precommercial thinning) 54 pruning 54 other (specify)

- 9) **Boundary references.*** Boundary reference data are used to remeasure plots and to compute the area for the condition classes sampled on a plot. Record all boundaries between condition classes that occur within the sampled (fixed-radius) area on plots and subplots to a distance of 58.9 ft from the plot center. In addition to the recording procedures described herein, sketch maps of condition class boundaries onto the pre-printed plot diagrams on field tally sheets.

Reference, within the sampled area the approximate boundary of each condition class that differs from the condition class at a subplot center. A condition class consists of:

Forest type
Stand size
Stand density
Stand age
Stand origin
Disturbance
Land use type
Physiographic class
Permanent access roads
Temporary roads (e.g., logging roads)

Boundary referencing is done by recording azimuths and distances from subplot center to the reference points. Each boundary is marked by a maximum of three points -- two where the boundary intersects the subplot circumference, and one "corner" point between the two end points, if necessary. Only the corner point requires a distance, since the distance from the center to the circumference is always equal to the fixed plot radius. The following additional rules apply when referencing a boundary within a plot:

1. When a boundary between forest land and nonforest land or between two contrasting forest land conditions is clearly marked, use that feature to define the boundary. Examples of clear demarcation are a fence line, plowed field edge, sharp ridge line, and water's edge along a stream course, ditch, or canal.
2. When a boundary between forest land and nonforest land is not marked by an obvious feature, the boundary should follow the nonforest side of the stems of the trees at the forest edge.
3. When a boundary between two contrasting forest land conditions is not clearly marked, map along the stems of the contrasting condition. When the boundary between two contrasting forest land conditions is separated by a narrow linear inclusion (creek, fire line, narrow meadow, unimproved road), establish the boundary at the far edge, relative to subplot center, of the inclusion.
4. When a plot is remeasured, the crew will examine the boundaries referenced at last inventory. If no change has occurred, the current crew will retain the downloaded boundary data that was recorded at last inventory. If boundary has changed, or a new boundary is present, or the previous crew made an obvious error, record new or updated boundary data. Delete boundaries no longer distinct.

In recording, indicate the condition class that contrasts with the condition class located at the subplot center (e.g., the condition class on the other side of the boundary line).