FOURTH ANNUAL INVENTORY REPORT ON MAINE'S FORESTS

DEPARTMENT OF CONSERVATION
MAINE FOREST SERVICE
FOREST HEALTH & MONITORING DIVISION

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Fourth Annual Inventory Report on Maine's Forests

Synopsis

The fourth annual inventory report continues to reinforce an improved inventory situation from that reported seven years ago.

The improvement provides additional flexibility and time to address how Maine's forest landowners utilize existing mature forest resources, while anticipating a major flush of ingrowth: young, vigorous, and newly merchantable trees, within the next 10 years. This pending flush of ingrowth is particularly evident in the eastern and northern regions.

Timberland acreage is also stable; land use conversions in southern Maine are more than offset by the reversion of farmland to forestland across the remainder of the state.

Pulpwood inventory volume remains relatively stable, declining less than 1% annually over the last four years. While the Maine Forest Service expects this small rate of decline to continue for the next five years, we also expect an increase in inventory in five to 10 years due to the ingrowth of young, vigorous trees into merchantable sized classes.

Analyses of gross growth, mortality, and other new types of analyses of forest health indicators provide some additional insight about the health and sustainability of Maine's forests.

Fourth Annual Inventory Report on Maine's Forests

Executive Summary

The USDA Forest Service, in partnership with the Department of Conservation's Maine Forest Service, completed a full forest inventory in 1995. Starting in 1999, these partners began a new annualized inventory system that measures a 20% statewide sample of Maine's forest every year. Correspondingly, three annual reports were produced in 2000, 2001, and 2002. This fourth annual report is based on data collected from 681 plots in Panel #1, 688 plots in Panel #2, 666 plots in Panel #3, and 670 plots in 2002's Panel #4. The combined 2002 data provide a limited snapshot of estimates of forestland area, inventory, and change. The combined 4 years of data ***is*** strong enough to provide the following conclusions:

- Maine remains 90% forested and 97% of the forestlands are classified as productive timberland (Appendix A. Table 1).

- Significant increases in the statewide stocking of sapling trees in all the diameter classes (1", 2", 3", and 4"), and in the species groups of balsam fir, spruces, and red maple. The majority of these increases are located in the Northern Region, with the Eastern Region also having a significant contribution (Appendix A. Table 16, Table 16A, Table 16-A1, and Table 16-A2).

- In 2002, Maine's forests had an estimated inventory of 277 million cords of merchantable wood (pulpwood quality or better). This is a significant increase (+9%) from the 1995 inventory estimate (Appendix C. Figure 2).

- Current pulpwood quality or better volume is estimated at an average of 16.0 cords per acre. This is 1 cord per acre more than the 1995 estimate (Appendix C. Figure 1).

- There were no significant changes in net cubic foot volume of growing-stock trees in any species group in any of the 4 regions, since 1995. (Appendix A. Tables 19A, 19B, 19C, and 19D).

- For the first time, the estimated statewide board foot volume of sawtimber trees of all species posts a significant increase since 1995 (Appendix A. Table 27).

- There have been significant changes in timberland ownership. The Nonindustrial Private Ownership class increased by 1.9 million acres, and there was a corresponding 1.6 million acre decrease in the Forest Industry Ownership class (Appendix A. Table 2).

- Eighty-eight percent of the timberland area is in desirable stocking classes (moderately stocked and fully stocked), essentially unchanged from the 1995 estimate. (Appendix A. Table 10).

- This report introduces a new section depicting a variety of forest health indicators measured on FIA plots that help address issues related to biological, climatic, and human-induced disturbances.

FOURTH ANNUAL INVENTORY REPORT
ON
MAINE'S FORESTS

INTRODUCTION

The USDA Forest Service, Northeastern Research Station, Forest Inventory and Analysis (FIA) project, has been the major source of state level forest inventory information for Maine. This program provides periodic information on a variety of parameters describing forests and forest use: area and type of forest; species, size, and health of trees; and rates of tree growth, mortality, and removals.

The USDA Forest Service has conducted four periodic forest inventories in Maine:

Inventory Year	Measurement Period	Report Published
1959	1954 – 1958	1960
1971	1968 – 1970	1972
1982	1980 – 1982	1984
1995	1994 – 1996	1996

These efforts have been augmented by additional inventory efforts to address specific issues. Despite this level of monitoring, Maine has faced contentious debates concerning sustainable forest management over the past decade. The long period between periodic inventories did not serve Maine's policy discussions well and contributed to a high degree of uncertainty about the state of the forest resource.

In response to customer needs, FIA has a new Congressional mandate (Public Law 105-185, The Agricultural Research, Extension, and Education Reform Act of 1998) to change the way they conduct forest inventories nationwide, including:

1) Change from a periodic to an annual forest inventory which measures 20% of all inventory plots in each state each year;
2) Develop consistency in the program across all forest lands;
3) Produce complete state reports at five-year intervals.
4) Addition of analysis of forest health conditions and trends.

The 118th Maine Legislature authorized the Maine Forest Service to participate with the USDA Forest Service to implement an annual forest inventory (PL 1997 C.720). Maine was the first state in the Northeast to participate in this new inventory process and was the first state in the nation to convert to the new national core variables.

FIA field data collection is a two stage sampling process:

- Phase 2 or P2 sample comprises the first stage and these plots are currently located on a statewide systematic grid with an approximate intensity of one plot per 6,000 acres.
- The second stage sample, now known as Phase 3 or the P3 sample, collects other detailed tree-level indicators and site-level indicators. The P3 data collection is obtained from a less intense statewide sample of approximately 140 plots that have measured since 1994. P3 measurements from 1994 through 1999 were collected on plots implemented by the Forest Health Monitoring (FHM) Program of the USDA Forest Service. Since then, these measurements have been obtained from a 1/16th sub-sample of the FIA plots. The P3 sub-sampling scheme is structured to systematically sample the State of Maine on an approximate intensity of 1 plot per 96,000 acres. More information about the full suite of P3 measurements is available from the FIA Program at

  http://fia.fs.fed.us/library/ForestHealthIndicators.pdf

Fieldwork under the annual inventory system began in April 1999 and will be completed in 2003. Plots are located systematically across the state on all types of ownerships. As required by law, landowners are contacted for permission to access the plots. FIA maintains the list of exact plot locations; the plot location data is not released to any other group or individual.

The Maine Forest Service with cooperation and full support of FIA has to date published three annual reports:

Report Published	Measurement Period	Sample Size
October, 2000	1999	646
September, 2001	1999 – 2000	1,371
September, 2002	1999 – 2001	2,037

The differences between annual reports are attributable to both differences in sample sizes and temporal changes.

This fourth annual report provides various statewide and regional estimates of forest area; species, number, and size of trees; volume; and components of change. To date, four panels have been collected and the number of plots by panel and year are as follows:

Panel	Panel Year	# Of Plots
1	1999	681
2	2000	688
3	2001	666
4	2002	670
	Total	**2,705**

The annual inventory system is structured to aggregate all previous panel datasets into a single average. The goal after 2003 is to continue to aggregate into a moving average the most current 5-year's of data. The only reason to intensively examine a single year's worth of data would be to understand the immediate impact of a recent catastrophic event, e.g., 1938 Hurricane, 1998 Ice Storm, or Hemlock Woolly Adelgid.

This fourth annual report has three major enhancements in the estimation and analytical process:

- This report utilizes the 2000 Bureau of Census Land Area Acreage determination for each county. The net change from the previously incorporated 1990 Census is a statewide reduction of 1,916 acres (Table 1. Current Land Area by Major Land Class).

- This report provides a limited set of change estimates within 4 regions. The regions are aggregations of existing FIA Units, the smallest area on which past estimates have been normally based. The regions were chosen for their similarity in forest types, management, and climatic conditions, and are as follows:
  - Eastern Region – Hancock, Penobscot, and Washington counties, all are separate FIA units,
  - Northern Region – Aroostook, Piscataquis, and Somerset counties, all are separate FIA units,
  - Southern Region – Capital Region FIA unit (Kennebec, Knox, Lincoln, and Waldo counties) and the Casco Bay Region FIA unit (Androscoggin, Cumberland, Sagadahoc, and York counties), and
  - Western Region – Western FIA unit (Oxford and Franklin counties).

- An entirely new section examines Forest Health Indicators:
  - At the tree level, estimates are examined for gross growth, mortality, and residual (mathematical sum of gross growth and mortality), for each of 7 major species groups (balsam fir, spruces, white pine, hemlock, red maple, american beech, and intolerant hardwoods) and for two change periods. Balsam fir and american beech are then further examined at the regional level for these change estimates over a 20-year span.
  - Also at the tree level, crown conditions and damages are presented for 3 major growing-stock groupings (All Species, All Softwood Species, and All Hardwood Species) on a regional basis for two change periods. A more detailed regional perspective of changes in white pine and beech crown conditions and damages is also provided.

  - Site level impacts are presented with regional depictions and brief descriptions of soil erosion, down woody material, injury of bio-indicator plants from ground-level ozone, and lichen communities.

METHODS AND LIMITATIONS OF COMBINED DATASET

The annual inventory is designed to measure 20% (one-fifth) of the inventory plots every year. Estimates of forest characteristics can be derived from each annual measurement; however, the relatively small annual sample, by itself, yields estimates with lower precision than an inventory that measures all plots in a short period (the periodic inventory). Until the full five-year cycle is completed, the annual inventory may yield information that although, statistically valid, may fluctuate from year to year and cause concern or lack of confidence in some users (Gillespie, 1998).

A better approach for providing more precise estimates in the annual inventory is to use a moving average, combining the latest data with all previous year's data, i.e., 2002 data with the 1999, 2000, and 2001 data. The reliability of estimates using a moving average will improve as we progress through the first five-year measurement cycle. FIA and the Maine Forest Service have chosen to utilize this method of aggregating datasets in the interim annual reporting of inventory results.

Data on forest area and inventory from the combined dataset are reported in the tables in Appendix A. and Appendix D. Data on components of change from the combined dataset are reported in the tables in Appendix B. The tables correspond with the same numbered tables in the 1995 inventory report "Forest Statistics of Maine, 1995."

The combined inventory estimates are compared to the 1995 estimates using the 95% confidence limit as a statistical test of the estimated means. The 95% confidence limit is expressed as a range around the estimate of the mean. If the ranges for the two means (1995 and 2002) do not overlap, we are 95% certain that there is a statistically significant difference in the populations that were sampled to provide the estimates of those means. These statistically significant differences are noted where they occur in each of the tables in Appendix A.

Comparisons for significant differences between the 2002 data and the 1995 data for some classifications (Forest Type Group, Stand Size Class, and Stocking Class) can not be made, due to changes in definitions or algorithms used by FIA to compile the data (See footnote in Appendix A. Table 2). The 1995 data will not be reprocessed until a series of national level algorithms is thoroughly developed and tested. The new algorithms that classify plots into a specific Forest type, Stand Size Class, or the two Stocking Classes (Growing Stock and All Live) are forthcoming and will be incorporated as soon as possible. Estimates in this report are based on the current algorithms used by FIA.

Due to the small sample size of the combined data and as recommended by the FIA, county level estimates are not reported, and some species level and diameter classes have been aggregated into groups.

The data for estimating components of change is expanded in this report, with estimates presented at the state level and for four regions.

RESULTS & DISCUSSION

TIMBERLAND AREA

- **The 2002 inventory report shows that forestland area and timberland area are stable** (Appendix A. Table 1).

  The 2002 inventory continues to utilize a new stratification scheme that assigns an acreage expansion weight to the plot based on interpreted proportions of the forested and nonforested areas surrounding the immediate plot location and footprint. Also, the 2000 Bureau of Census data have been released; those acreage values are incorporated into this report. The State of Maine total land area remains at 19.8 million land acres as estimated by the 2000 Census.

  The major land use class of Timberland now includes Rural, Other Forestland, and Urban Forestland. The additional inclusion of Other Forestland and Urban Forestland adds an estimated 64,000 acres (approximately 8 plots, <1% of the sample) to the 2002 estimate of Timberland that are not represented in the 1995 estimate. MFS does not have the current information to restate the 1995 Inventory estimates to match the current classifications, calculated variables, and algorithms. It is our belief that these additional acres do not create a skewed representation and that the comparisons noted between the 2002 data and the 1995 data remain valid.

- **Maple/Beech/Birch remains the most common forest type group, with 7.2 million acres, followed by the Spruce-Fir group with 5.2 million acres. These two groups represent 72% of all timberland acreage, nearly identical to their combined representation of 73% in 1995** (Appendix A. Table 2)**.**

- **There have been significant changes in timberland ownership. The Nonindustrial Private ownership class increased 1.9 million acres, while the Forest Industry ownership class decreased 1.6 million acres** (Appendix A. Table 2).

  These net changes reflect a new distribution of land ownership and management corroborated by a separate analysis (Department of Conservation, Maine Forest Service, 2001). In that report, the Maine Forest Service introduced a new landowner category, *"Institutional Investor Timberlands* (forestlands owned by organizations that hold assets as fiduciaries for the benefit of others)." This landowner category is a subset of the broader Nonindustrial Private ownership class.

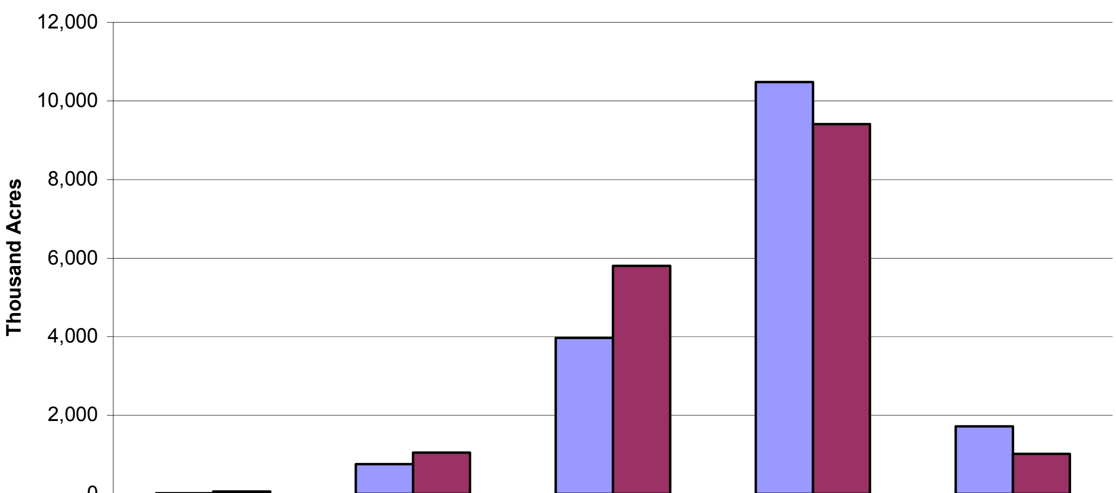
- **Timberland acres are fairly evenly distributed among the stand size classes and similar to the 1995 breakdown: Large Diameter stands represent 33%, Medium Diameter has a 38% share, and the Small Diameter class has a 29% share of the timberland acreage** (Appendix A. Table 3).

- **Stocking class assignments, based on just growing-stock trees, depict a general downward trend to lower stocking classes. Since 1995, the acreage of Moderately, Fully, and Overstocked Classes have declined 4%, with a corresponding increase in the Poorly and Nonstocked classes** (Appendix A. Table 4).

- **For all live trees (1.0" dbh and larger), the stocking class assignment depicts a similar downward trend to lower stocking classes. The acreage of Fully and Overstocked classes declined by 1.8 million acres, while the acreage of Moderately stocked class increased by 2.1 million acres** (Appendix A. Table 10).

- **In 2002, 87% of timberland acres (15.1 million acres) were in desirable stocking classes (moderately and fully stocked), a minor 2.5% increase from the 1995 classification** (Appendix A. Table 10 and Figure 1).

Figure 1. Distribution of Timberland area by Stocking Class of All Live Trees (1.0" Dbh and larger), 2002



	Nonstocked	Poorly Stocked	Moderately Stocked	Fully Stocked	Overstocked
1995	18.4	762.9	3,974.7	10,481.1	1,715.0
2002	57.6	1,048.6	5,806.2	9,408.3	1,018.3

- The 2002 estimate shows a significant decrease of 0.5 million acres in the 150 – 199 Basal Area class (square feet per acre) and an increase of 0.8 million acres in the 50 – 99 Basal Area class (square feet per acre) (Table 1 and Appendix A. Table 12).

MFS conducted an additional analysis to examine, what, if any, patterns could be found in the distribution of stocking class and stand size class among the current landowner classes for the 0 – 49 Basal Area class.

- There are an estimated 3.0 million acres in the 0 – 49 Basal Area class (Appendix A. Table 12 and Table 1).
    - 23% (0.7 million acres) are classified as nonstocked or poorly stocked. The Nonindustrial Private owner class contains 0.5 million of these acres.
    - Forest Industry has an over-representative share (1.1 million acres) of this basal area class; 82% of this ownership class acreage is in stands that are classed as small diameter and at least moderately stocked.

Table 1. Percentage of Timberland acres in the 0 - 49 sq. ft. basal area class - by ownership class, stand size class, and stocking class, (Basal Area is based on All Live trees tallied 1.0" dbh and larger), Maine, 2002

	Ownership Class			
Stand Size Class and Stocking Class	Public	Forest Industry	Nonindustrial Private	Subtotal of Stocking Class
Nonstocked Stands				
Nonstocked & Poorly Stocked	0.06%	0.13%	1.74%	1.93% [3]
Moderately Stocked	0.00%	0.00%	0.00%	0.00%
Fully Stocked & Overstocked	0.00%	0.00%	0.00%	0.00%
Subtotal of Nonstocked Stands	0.06%	0.13%	1.74%	1.93%
Owner Class Share of Stand Size Class	3.24%	6.60%	90.17%	
Small Diameter Stands				
Nonstocked & Poorly Stocked	0.48%	1.77%	5.39%	7.65%
Moderately Stocked	0.25%	10.14%	16.62%	27.02% [1]
Fully Stocked & Overstocked	0.75%	20.72%	24.95%	46.42%
Subtotal of Small Diameter Stands	1.48%	32.64%	46.97%	81.09%
Owner Class Share of Stand Size Class	1.82%	40.25%	57.92%	
Medium Diameter Stands				
Nonstocked & Poorly Stocked	0.82%	2.67%	6.27%	9.76%
Moderately Stocked	0.06%	1.00%	1.21%	2.27%
Fully Stocked & Overstocked	0.00%	0.04%	0.43%	0.47%
Subtotal of Medium Diameter Stands	0.88%	3.71%	7.91%	12.50%
Owner Class Share of Stand Size Class	7.07%	29.65%	63.28%	
Large Diameter Stands				
Nonstocked & Poorly Stocked	0.26%	0.80%	2.47%	3.53% [3]
Moderately Stocked	0.03%	0.54%	0.17%	0.74%
Fully Stocked & Overstocked	0.00%	0.04%	0.18%	0.22%
Subtotal of Large Diameter Stands	0.29%	1.38%	2.82%	4.49%
Owner Class Share of Stand Size Class	6.43%	30.77%	62.80%	
Ownership share of 0 - 49 sq. ft. basal area class	2.71%	37.85% [2]	59.43%	100.00%
Proportionate Ownership share of 17.34 million Timberland Acres	4.6%	32.7%	62.7%	

[1] 73% of all acres in the 0 - 49 sq. ft. basal area class are in the Small Diameter Stand Size Class and are in desirable stocking classes (moderately stocked, fully stocked, or overstocked)

[2] When compared to its proportional share of All Timberland acres, the Forest Industry ownership class has substantially more of this basal area class than the Public or Nonindustrial owners. The management of these low basal area stands will play an important role in the development of Maine's future forests.

[3] 5.5% of all acres in the 0 - 49 sq. ft. basal area class occur in the stand size class of Nonstocked or Large Diameter and also have a undesirable Nonstocked or Poorly Stocked stocking class, 77% of the acreage in these undesirable categories occurs on Nonindustrial Private ownerships.

Table 1A presents a regional perspective on the distribution of timberland acres by stand size class and stocking class for the 0 – 49 Basal Area class.

- The Northern Region (Aroostook, Piscataquis, and Somerset Counties) has more than its representative share of the acreage in the 0 – 49 sq. ft. basal area class; the region's 1.7 million acres comprise 56% of the total (Northern Region shaded cell in Table 1A).
- The Southern Region (Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties) has an over-representation of acreage in the Nonstocked & Poorly Stocked category. The 98,000 acres represent 35% of this region's total acreage in the 0 – 49 Basal Area Class (Sum of Southern Region shaded cells in Table 1A).
- This same over-representation in the Nonstocked & Poorly Stocked Category also occurs in the Western Region (Franklin and Oxford Counties), with 82,000 acres or 34% of this region's acres in the 0 – 49 Basal Area class (Sum of Western Region shaded cells in Table 1A).

Table 1A: Timberland acres in the 0 - 49 sq. ft. basal area class by region, stand size class, and stocking class based on All Live Trees tallied, Maine, 2002

	Region				
Stand Size Class and Stocking Class	Eastern	Northern	Southern	Western	Subtotal of Stocking Class
Nonstocked Stands					
Nonstocked & Poorly Stocked	15,266	35,530	6,792	-	57,588
Moderately Stocked	-	-	-	-	-
Fully Stocked & Overstocked	-	-	-	-	-
Subtotal of Nonstocked Stands	15,266	35,530	6,792	-	57,588
Small Diameter Stands					
Nonstocked & Poorly Stocked	75,732	102,570	32,028	18,380	228,710
Moderately Stocked	202,202	477,225	84,731	44,171	808,329
Fully Stocked & Overstocked	363,707	837,035	88,669	99,321	1,388,732
Subtotal of Small Diameter Stands	641,641	1,416,830	205,428	161,872	2,425,771
Medium Diameter Stands					
Nonstocked & Poorly Stocked	81,597	106,892	40,211	63,246	291,946
Moderately Stocked	8,863	38,548	4,849	15,688	67,948
Fully Stocked & Overstocked	8,890	2,102	2,947	-	13,939
Subtotal of Medium Diameter Stands	99,350	147,542	48,007	78,934	373,833
Large Diameter Stands					
Nonstocked & Poorly Stocked	18,113	69,026	18,562	-	105,701
Moderately Stocked	8,331	13,709	-	-	22,040
Fully Stocked & Overstocked	966	2,802	1,815	1,007	6,590
Subtotal of Large Diameter Stands	27,410	85,537	20,377	1,007	134,331
Subtotal - Nonstocked & Poorly Stocked	190,708	314,018	97,593	81,626	683,945
Subtotal - Moderately Stocked	219,396	529,482	89,580	59,859	898,317
Subtotal - Fully Stocked & Overstocked	373,563	841,939	93,431	100,328	1,409,261
Proportionate Regional share of 0 – 49 Basal Area class	783,667	1,685,439	280,604	241,813	2,991,523

NUMBER OF TREES

FIA typically combines species into species groups when reporting data on number of trees and volume, in order to overcome small sample size limitations. For the purposes of this report, **"species group"** and their specific inclusive species are defined in the glossary (p. 46 - 47):

For trees 5.0" dbh and larger, the combined data show:

- **The most abundant live commercial tree species groups are (in descending order) spruces, balsam fir, sugar maple/beech/birch, and red maple** (Appendix A. Table 13).

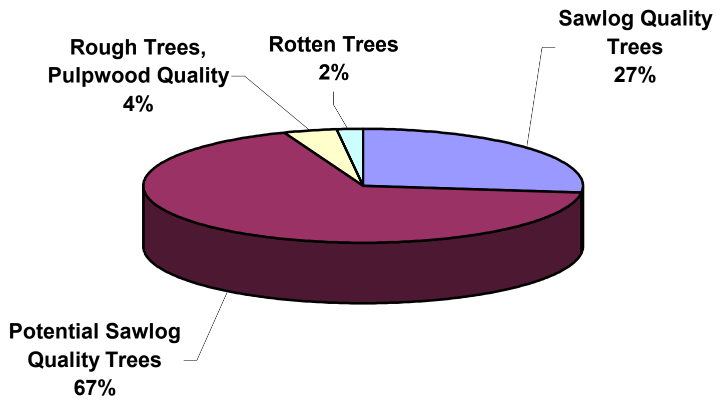
- **Since 1995, no significant differences occur in the number of growing-stock trees in any species group or in any of the three diameter groupings** (Appendix A. Table 14).

- **Tree Quality: Ninety-four percent of live merchantable-size softwood trees are either sawtimber or potential sawtimber trees and eighty-six percent of live merchantable-size hardwood trees are either sawtimber or potential sawtimber trees** (Appendix A. Table 13, Table 14, Figure 2A, and 2B).

  While these percentages are seemingly high, an examination of Figures 2A and 2B shows that only:
  - 1 out of every 2.5 potential sawlog quality softwood trees advances to the sawlog size and quality category, and
  - 1 out of every 5 potential sawlog quality hardwood trees advances to the sawlog size and quality category.

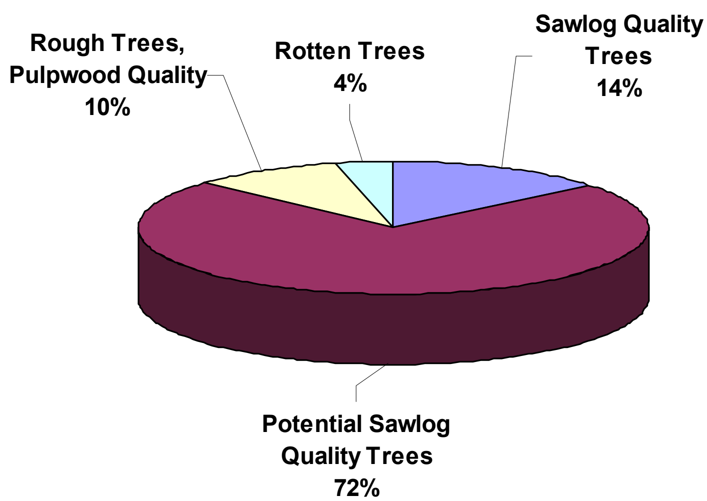
  This is a natural phenomenon that occurs over time. Increased competition for available space and limited resources leads to mortality and a decline in vigor for a high percentage of trees (a weeding out process).

Figure 2A. Distribution of live merchantable size (5.0" dbh and larger) softwood trees by Tree Class



- **Tree Quality: Ninety-eight percent of live merchantable-size softwood trees (5.0" dbh and larger) are Pulpwood Quality or Better and ninety-six percent of live merchantable-size hardwood trees are Pulpwood Quality or Better.** (Appendix A. Table 13, Table 14, Figure 2A, and Figure 2B)

Figure 2B. Distribution of live merchantable size (5.0" dbh and larger) Hardwood trees by Tree Class



- Table 15 provides estimates of standing dead trees, by their tree condition (intact top or broken top), and by three dbh groupings. The major interest, in standing dead trees, is for the wildlife habitat they provide in terms of den/nest locations, added vertical diversity, and long-term contributions to down woody material.

  At the species group level, current estimates of balsam fir standing dead trees had significantly decreased from the 1995 inventory, as the forest continues to rejuvenate itself from the recent budworm epidemic. On the other hand, a significant increase in standing dead white pine trees, probably a result of recent drought related impacts.

  For all species combined, there is a significant increase in the number of dead trees with intact tops for each of the three-dbh groups and for the condition's total. The dead tree with broken top condition class had a significant decrease in the smallest dbh grouping (5.0 – 10.9" dbh), driven by major reductions in balsam fir, which also contributes to a significant decrease for the total for this condition.

  The overall estimate for all standing dead trees of all tree conditions showed a significant decrease since 1995.

For all live trees 1.0" dbh and larger, the combined inventory shows:

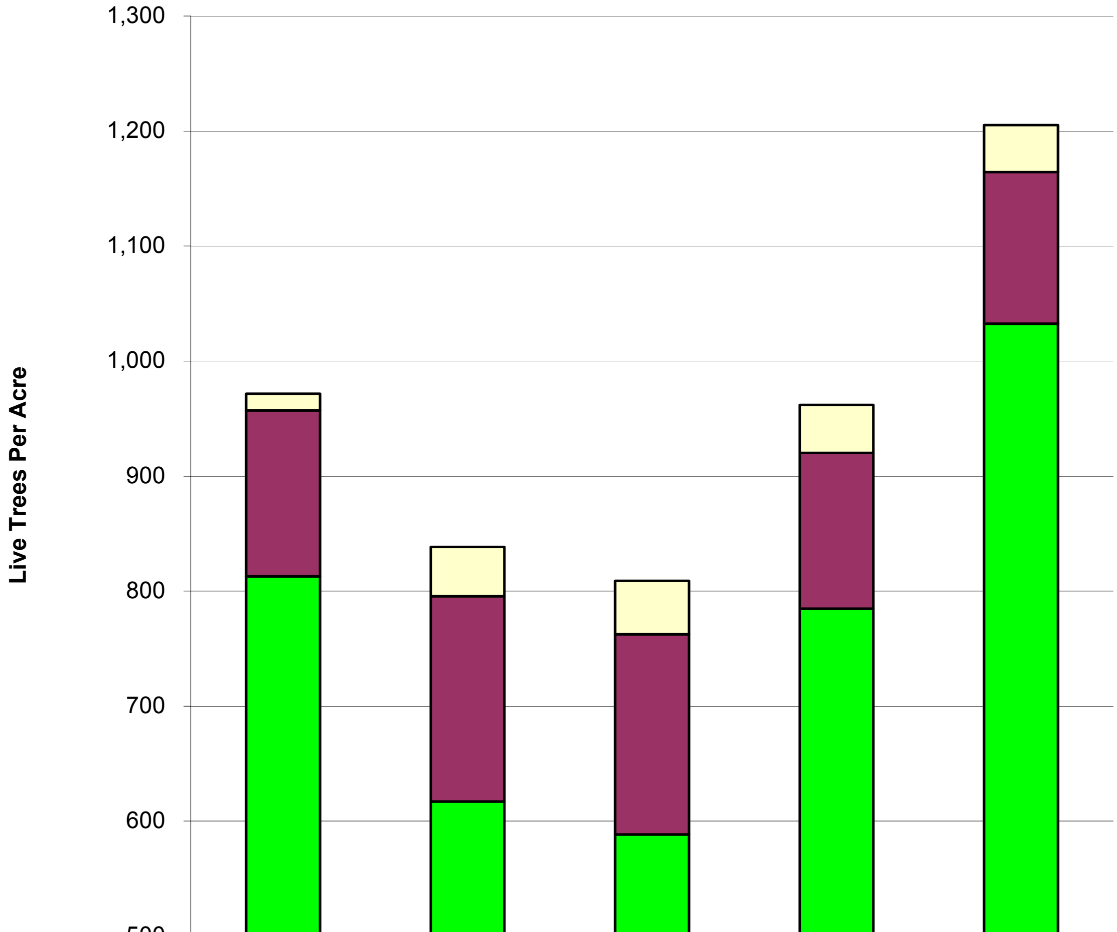
- **The most abundant commercial tree species groups are (in descending order) balsam fir, red maple, sugar maple/beech/birch, spruces, and intolerant hardwoods** (Appendix A. Table 16).

- **The largest increases, since 1995, in the number of live trees are (in descending order) for balsam fir, spruces, and red maple. Balsam fir has four times the increase of either the spruces or red maple species/species groups** (Appendix A. Table 16).

- **Since 1995, the only species group with an estimated decrease in the number of live trees is other misc. commercial hardwoods** (Appendix A Table 16).

- **Since 1995, there is an estimated 50% increase in the number of all softwood trees and a 14% increase in the number of all hardwood trees. These changes occur primarily in the sapling diameter class (1.0" - 4.9" dbh), with an estimated 31% increase on a per-acre basis** (Appendix A. Table 16 and Figure 3).

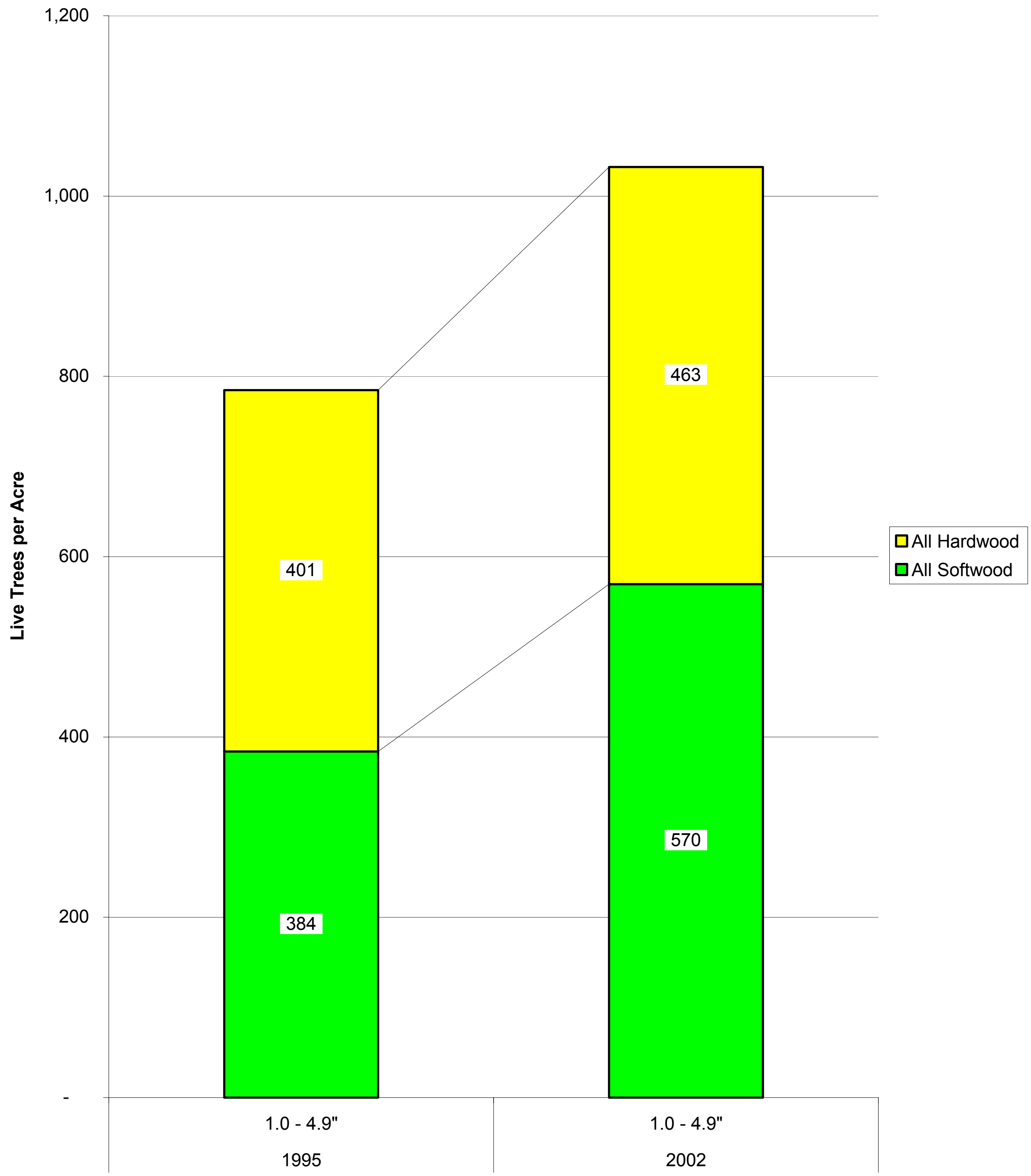
Figure 3. Major Size Class Distribution of Live Trees per Timberland Acre (Average Live Trees/Acre by DBH Grouping displayed)



	1959 USDA Forest Service	1971 USDA Forest Service	1982 USDA Forest Service	1995 USDA Forest Service	2002 USDA Forest Service
Sawtimber	15	43	46	42	41
Poletimber	144	179	174	135	132
Saplings	813	617	589	785	1,032

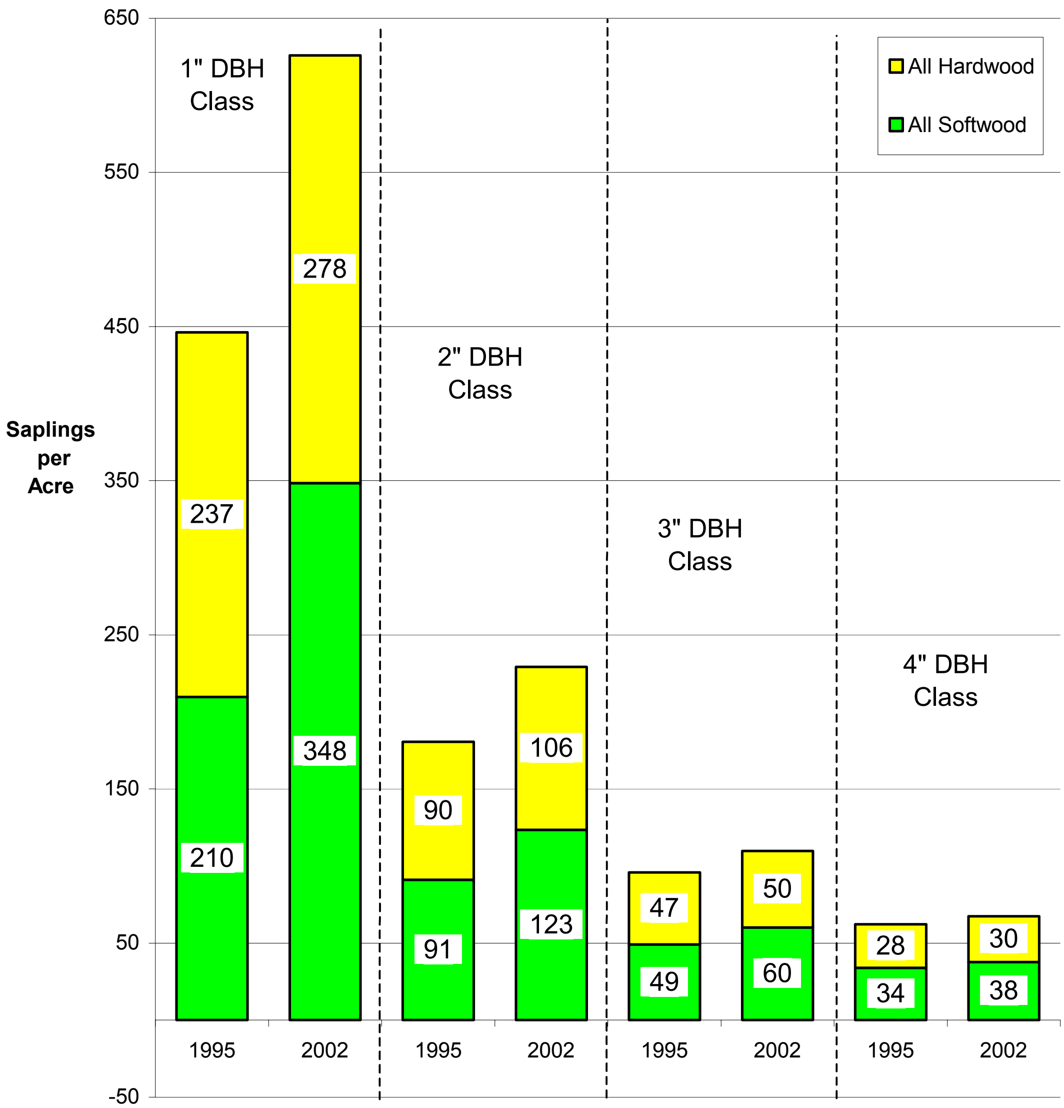
- **The dynamics occurring in saplings are primarily attributable to changes in the average per acre stocking of softwood species, representing 75% of the overall increase since 1995** (Figure 3 and Figure 4).

Figure 4. Hardwood and Softwood Saplings per acre, comparison between 1995 and 2002 Inventories



- Examining individual dbh classes, most of the increases in stocking occur in the 1" dbh class (72%), followed by the 2" dbh class (19%).
- Within all four dbh classes, softwood species represent the majority of the increase (Figure 5).

Figure 5. Change in Live Saplings per Acre, 1995 and 2002, by Softwood/Hardwood Groupings and by DBH Class



- A reassessment of the 1995 periodic inventory sapling data, by 1” dbh classes, allows a statistical test of significance of previously discussed descriptive observations regarding Figure 4 and Figure 5.

  The 2002 data estimates result in a significant increase in the total number of saplings occurring on all timberland acres in the 1’’, 2”, and 3” dbh classes, and a marginally significant increase in the 4” dbh class. These increases reaffirm the successful regeneration of Maine’s forests following the recent spruce budworm outbreak and associated concerns about sustainable harvesting. Even more encouraging, this wave of increased sapling stocking currently extends into the 4” dbh class, foretelling of merchantable ingrowth in less than 10 years.

  In addition, the following species groups experienced significant stocking increases in their sapling dbh classes: balsam fir (+57%), spruces (+55%), and red maple (+37%). Overall, softwoods had a significant increase of 52% and hardwoods had a significant increase of 18% in stocking across the state (Table 16A).

- A regional assessment of sapling-sized trees is provided in Tables 16-A1 through 16-A4, further delineating where the sapling increases are occurring.

  Estimates for the Eastern Region (Hancock, Penobscot, and Washington counties) have significant sapling increases in the 1” and 2” dbh classes (+51% and +30% respectively) and in balsam fir (+46%), red maple (+53%), All Softwood (+43%), and All Species (+37%) (Table 16-A1).

  The estimates for the Northern Region (Aroostook, Piscataquis, and Somerset counties) have significant increases in each of the 4 sapling dbh classes (+56%, +43%, +26%, and +21% respectively) and for balsam fir (+81%), spruces (+76%), red maple (+50%), All Softwoods (+75%), and All Species (+48%) (Table 16-A2).

  Finally, none of the estimates for the Southern Region or the Western Region depict any significant differences in any of the sapling dbh classes or for any species groups (Table 16-A3 and Table 16-A4).

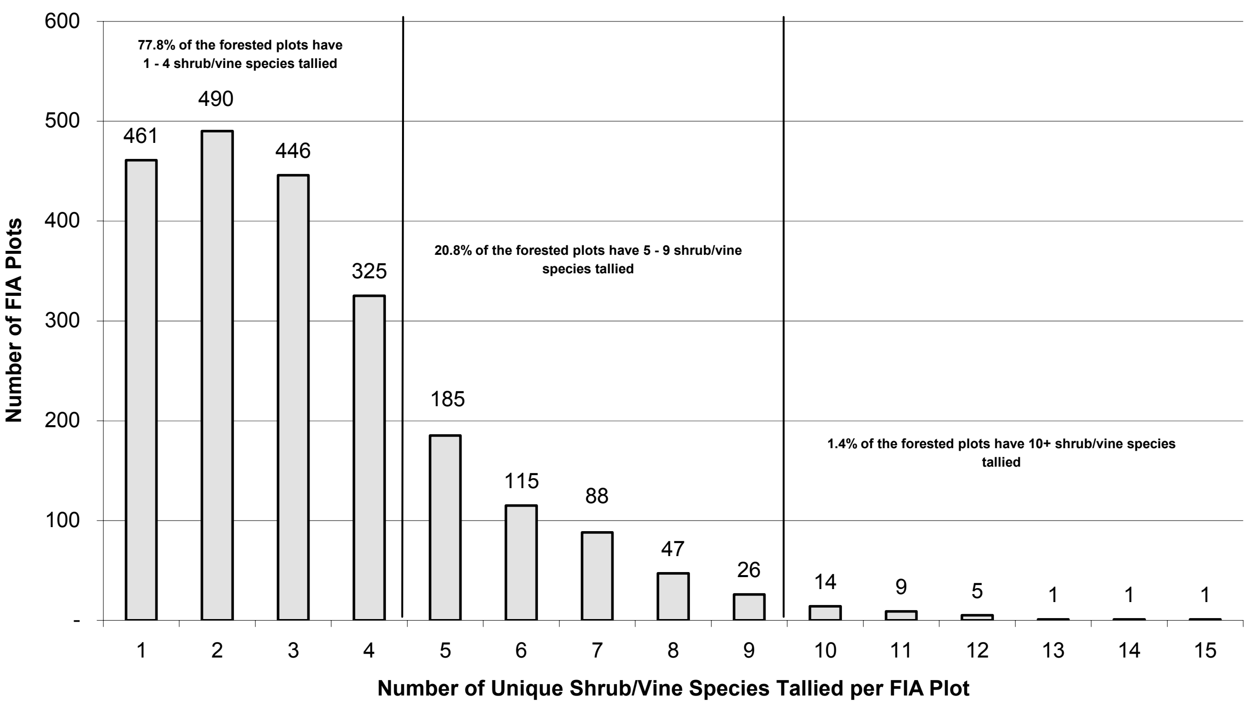
SHRUBS and VINES

There are four major groups (deciduous shrubs, evergreen shrubs, dwarf shrubs, and vines) and up to 96 unique species in the FIA Northeast Field Guide that are tallied on the four-milacre subplots. Up to 99 individuals can be recorded per species and condition class.

For the 2002 data, shrub and vine species were tallied on 86% of all forested plots. For these 2,214-forested plots with shrub/vine tally, deciduous shrubs were represented on 88% of the plots, followed by dwarf shrubs at 64%, evergreen shrubs at 12%, and vines at only 3%.

Figure 6 depicts just those forested plots with tally, representing the count of plots having unique species counts. Nearly 78% of the plots from the first four panels of data recorded 4 or less shrub/vine species and only 1.4% of the plots have a very high diversity of 10+ species being tallied.

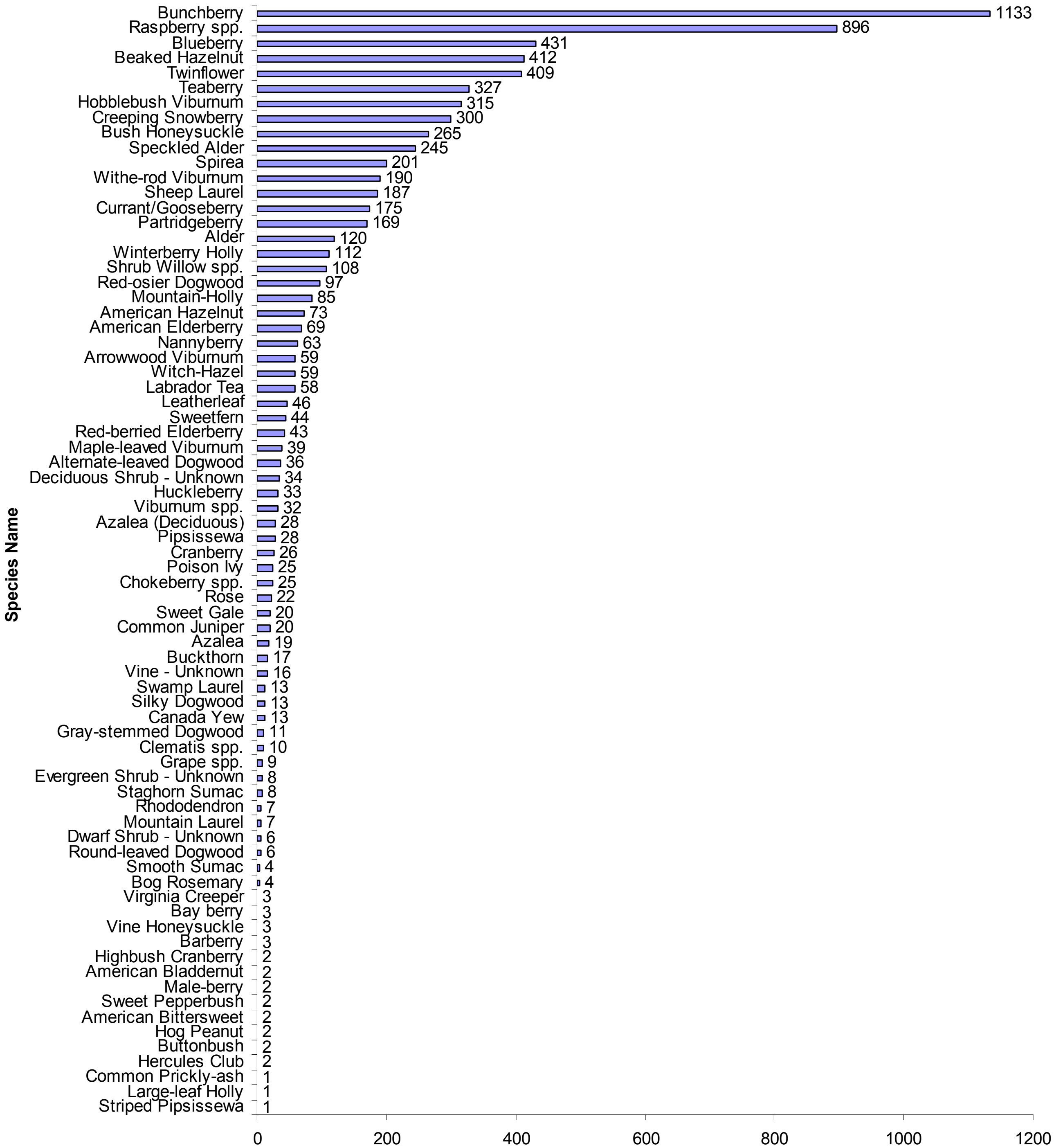
Figure 6. Shrub/Vine Species Richness Index (the number of FIA Plots (Panels 1 - 4) having a Total Count of Unique Shrub/Vine Species)



The top 5 most frequently recorded shrub species include:

- Bunchberry, being tallied on over 51% of the plots
- Raspberry, tallied on 41%, and
- Blueberry, Beaked Hazelnut, and Twinflower, each tallied on 19% of the plots

Figure 7. Out of 2,214 Forested Plots with tally, the number of plots that tallied specific Shrub and Vine Species (Panels 1 - 4)



VOLUME

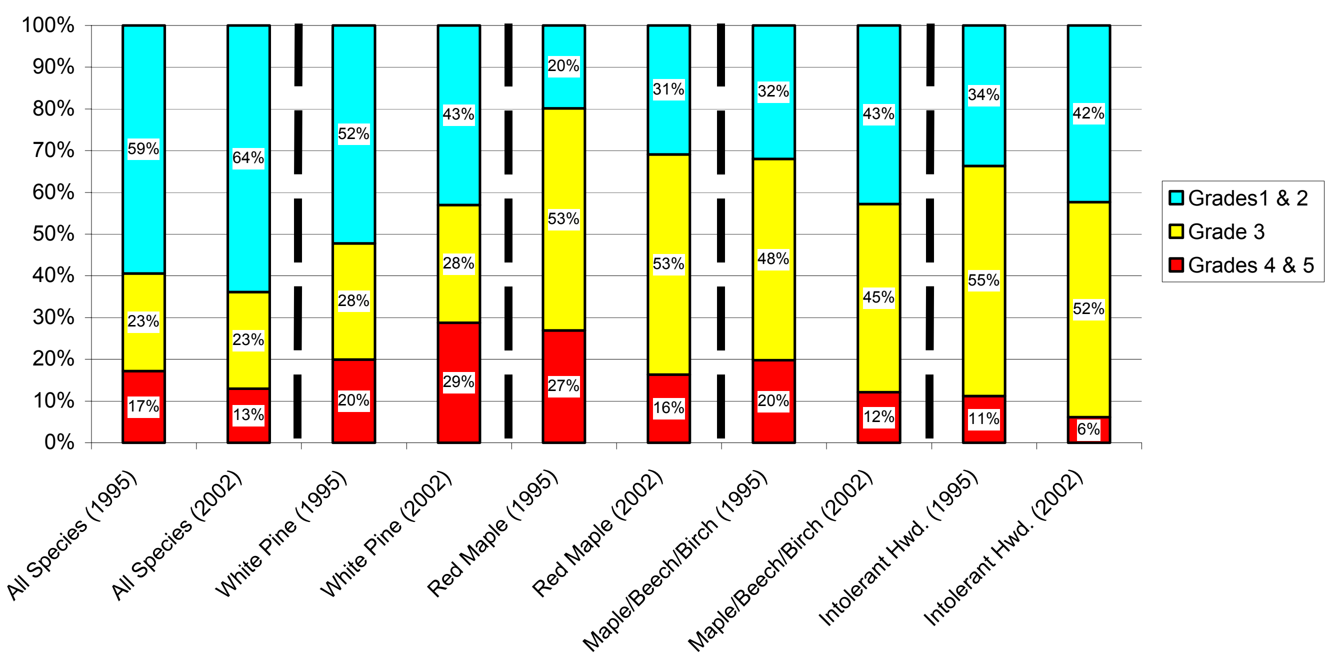
- **The 2002 estimate of growing-stock volume (22,538 million cubic feet) is significantly more than the 1995 estimate of 20,823 million cubic feet** (Appendix A. Table 19).

- **There are no significant differences in any of the three diameter groupings, statewide or by region** (Appendix A. Tables 19, 19A, B, C, and D).

- **Between 1995 and the 2002 estimate there are three new minor significant differences to note:**

    - **Hemlock growing-stock volume is slightly significantly more than the 1995 estimate** (Appendix A. Tables 19).
    - **The 2002 statewide estimated sawtimber volume of 51,306 million board feet is slightly significantly more than the 1995 estimate of 46,964 million board feet** (Appendix A. Table 27).
    - **The 2002 Grade 1 sawtimber volume estimate, for both Large Sawtimber and All Sawtimber, is significantly more than the respective 1995 estimates (Appendix A. Table 25).**

Figure 8. Grade Distribution (%) of All Sawtimber for All Species and for 4 major Species Groups, 1995 and the 2002 Inventories



In Figure 8, the trend in the distribution of white pine grades is counter to the flow of the other species groups depicted. White pine has increased its share in the poorer quality grades #4 & #5 by 9%, while its share of the better quality grades #1 & #2 has dropped 9%.

- **Significant increases in the following inventory components occurred between the 1995 and 2002 estimates in** (Appendix A. Table 23)**:**

    - **Volume of all live softwood trees: +10%**
    - **Volume of all live trees (Total – All Live): +9%**
    - **Volume of commercial tree species (Total – Commercial Trees): +9%**
    - **Volume of pulpwood quality (Total – Pulpwood Quality): +9%**
    - **Volume of growing-stock (Total – Growing Stock): +8%**
    - **Volume of sawtimber: +9%**

- **Pulpwood Quality or Better trees average 16.0 cords/acre. This is 1.0-cord/acre more than the 1995 estimate. Sixty percent of the gain occurs in softwood species** (Appendix C. Figure 1).

- **The 2002 inventory estimate of pulpwood quality trees or better is 23,578 million cubic feet (277 million cords). This is significantly more (9 percent) than the 1995 estimate of 21,597 million cubic feet (254 million cords). The chart in Appendix C. Figure 2, clearly depicts the impact of the increasing sample size, from the original 646 plots in 1999 to the current 2,705 plots in 2002, on the width of the respective estimate's 95% confidence interval band (**Appendix A. Table 23 and Appendix C. Figure 2).

- **A 2002 biomass estimate of 990 million dry tons, results from converting all trees and shrubs to their dry ton basis. This compares favorably to the respective 1995 estimate of 900 million dry tons. Biomass estimates are provided for each of the 4 regions and for individual tree-based components (Appendix D. Table 1).**

COMPONENTS OF CHANGE

Standard growth, mortality, and removal estimates will not become available until all 5 panels are measured. While estimates of area, numbers of trees, and volume are based on the measurement of 2,705 plots; components of change estimates are more constrained, based on just the re-measurement of a single 24-foot radius subplot on a subsample of 1,345 plots.

The combined impact is that only roughly 12% of the data collected to date are on remeasured trees. This small, highly variable sample does not yet support estimation of the standard components of change for growing-stock volume since the 1995 estimate.

As an alternative, MFS is presenting estimates of basal area change components based on available remeasured trees. Basal area is a direct conversion of the dbh measurement to represent the square foot surface area of the bole at that point. It is a two-dimensional construct, i.e., all 6.0" dbh trees have identical basal area, compared to deriving the three dimensional estimation of a tree's volume. Tree volume is estimated using species, dbh, merchantable-bole length, and cubic foot cull. It is rare that even two - 6.0" dbh spruce trees generate an identical merchantable volume, due to differences in bole length and cull defect. In order to meet legislative mandates and an expressed public interest in forest sustainability, basal area was chosen as the most available and stable change parameter to analyze and discuss.

The individual basal area components of change (Table 29) present some interesting indications of past change and future trends.

- The annual estimate of balsam fir ingrowth at 3.3 million square feet is more than its accretion, indicating that a younger forest is starting to cross over the minimum merchantability limit of 5.0" DBH. This is the first time since the 1971 inventory that any species has experienced more ingrowth than accretion. Continued monitoring of the ingrowth change component will indicate when Maine's forest resources will be revitalized with a wave of young, newly merchantable trees. Based on current indications and predictions this wave will cross over the merchantable limit within the next 5 – 10 years and positively influence inventory levels.

- The estimates of positive balsam fir net growth and positive Hemlock net change are major reversals from the 1995 components of change analysis.
- The annual total removal estimate of 28.6 million square feet, when roughly converted to volume, produces an estimate of 5.7 million cords, which compares very well to the reported average harvest of 6.1 million cords for the 6-year period of 1996 – 2001.
- The overall negative annual net change estimate of 12.7 million square feet – or a 1% annual rate of change - is not surprising. The forest principal is still being drawn down, pending the emerging merchantability of young stands established in the wake of spruce budworm salvage harvests in the 1970's and 1980's.
- The growing-stock decrement estimate nearly equals estimated mortality.
- Twenty-five percent of white pine's total removals are attributable to land use conversion.

Added this year are the regional assessments of basal area change components (Tables 29A, 29B, 29C, and 29D). Each region has some individual change highlights that bear noting:

Eastern Region (Table 29A)

- Balsam fir ingrowth exceeds the accretion change component.
- The sugar maple/yellow birch/american beech species group has the lowest annual net change (%) with a value of –3.4%.

Northern Region (Table 29B)

- Balsam fir ingrowth is 20% higher than its accretion change component.
- For both balsam fir and the spruces, mortality still represents 50% of the gross growth, resulting in a continuing annual percentage decline of 1.6% and 2.0% respectively.
- The high levels of growing stock decrement, that exceeds or equal mortality, for sugar maple/yellow birch/american beech and intolerant hardwood contribute to an annual percentage decline of 1.6% and 2.1% respectively.

Southern Region (Table 29C)

- Both balsam fir and intolerant hardwood mortality in this region exceed the gross growth change component.
- The spruces growing stock decrement estimate exceeds the gross growth value by 2 ½ times.
- White pine removals due just to land use conversion represents nearly sixty percent of the total removals for this species in this region.
- The annual percentage change in basal area for balsam fir (-8.1%), spruces (-7.6%), and intolerant hardwood (-3.3%) indicate multiple impacts to these species, including Balsam Wooly Adelgid, Spruce Bark Beetles, other noted coastal-related declines, and particularly in the case of hardwoods, residual Ice Storm damages.

Western Region (Table 29D)

- Balsam fir mortality exceeds the gross growth estimate and results in an overall annual percentage change of –3.8%.
- White pine harvest removals represent twenty-five percent of the total harvest in this region, and are the major contributor to this species annual percentage change of –3.4%.

MFS currently is collecting additional remeasured data from a subset of the plots measured in 1995, and still retained as part of the five annual panels. The approximately 500 plots in this separate study will provide an independent benchmark and check to the growth estimated by the annualized FIA system following the 2003 measurement season.

FOREST HEALTH INDICATORS

This new section investigates the health of Maine's forest resources as possibly related to some biological, climatic, and human-induced disturbances. Results are from analyses of plot data representing a diverse set of the following forest health indicators:

Tree-level Indicators

- Gross growth and mortality
- Crown conditions (dieback, crown density and foliage transparency)
- Stem and root decay
- Stem, root, and branch breakage
- Mechanical wounds

Site-level Indicators

- Ozone bioindicator plants
- Lichen communities
- Soil erosion measurements
- Down woody material and fuels

TREE LEVEL INDICATORS

Gross Growth, Mortality, and Residual Change Estimates (Basal Area basis), comparing 1995 (1982 – 1995) to 2002 (1995 – 2002), using P2 datasets

Estimates of annual gross growth and mortality are indicative of the general health and sustainability of tree species. Expression of these attributes as percentages (e.g. [annual growth in growing-stock basal area / standing growing-stock basal area] X 100) facilitates standardized comparisons of values for tree species and localities with values for the total forest in Maine. For example, if the mean annual rate of mortality for all growing-stock trees in Maine were 1%, then higher rates for given localities or species would be considered to be above "background" levels.

Another means to assess whether rates of mortality are higher than background levels is to refer to the national risk-mapping effort led by USDA Forest Service. This effort defines areas at a high risk of mortality from insects and diseases as those predicted to lose at least twenty-five percent of their basal area during a 15-year period (Lewis, 2002). The conversion to an annual basis then sets the critical threshold at -1.7% per year, which has been rounded to a breakpoint of –2.0% per year. In adhering to this risk mapping protocol, the mortality change component of –2.0% per year is used as the starting point of a series of progressive ranges, highlighting to resource professionals the threshold to begin to evaluate and investigate for the causal agents responsible (insects, disease, weather) for the noted risk level.

A method to assess rates in growth is to evaluate the residual value after mortality, which is the mathematical sum of the gross growth (positive) and mortality (negative) components of change. The minimum desirable value is 2.0% per year, which would then provide a final and positive net change component after accounting for the long-term annual harvest removal rate of approximately –2.0% per year.

In Table 2, these change components and thresholds are depicted for two change periods. The 1995 change period represents change between the 1982 and the 1995 periodic inventories of Maine. This depiction is a new estimation method developed by the USDA Forest Service Northeastern Area using remeasured data from Maine's 1995 Periodic Inventory. The 2002 change period is based on remeasured data collected to-date between 1999 and 2002, on Maine's four annual panels, and the 1995 periodic inventory. Seven species groups were initially selected for their potential and dynamic growth related impacts over the two change periods. These statewide estimates as presented, are also available on a region and FIA Unit basis for finer spatial resolution and detail.

The All Species Growing-Stock estimates depict a relatively stable situation, for each of the change periods: both gross growth and mortality are similar for each of the periods. The residual has had a minor drop since 1995, but both change period values are below the desired minimum value of 2.0%, deemed necessary to offset long-term harvest removal rates.

The All Softwood Growing-Stock estimates reflect a similar trend as just described, the three values are stable over the two periods, with the residual below the desired threshold for implied sustainability.

The All Hardwood Growing-Stock estimates depict a slight shift between the two change periods. The gross growth estimate drops 0.3% and mortality increases 0.3%, with a resultant residual value dropping from a desirable level of 2.2% in the 1995 change period to a value of 1.8% for the 2002 change period.

Table 2. Statewide Changes in the Proportionate Share of Gross Growth and Mortality Growing Stock Change Components (Sq. ft. of Basal area/Year) to the Total Basal Area Inventory and the Residual (%) remaining and available to offset Removals

Change Period	Gross Growth[3] as a % of Basal Area Inventory	Mortality[1] as a % of Basal Area Inventory	Residual[2] (Gross Growth (%) less Mortality (%))
	0.00 - 1.49%	0.00% - (0.99%)	> (1.99%)
	1.50 - 2.99%	(1.00%) - (1.99%)	(1.00%) - (1.99%)
	3.00 - 4.49%	(2.00%) - (2.99%)	(0.99%) - 0.99%
	4.50 - 5.99%	(3.0%) - (3.99%)	1.00% - 1.99%
	> 5.99%	>(3.99)%	> 1.99%
		Balsam Fir	
1982 - 1995	4.20%	-4.30%	-0.10%
1995 - 2002	5.06%	-3.40%	1.66%
		Spruces	
1982 - 1995	2.50%	-1.10%	1.40%
1995 - 2002	2.24%	-1.19%	1.05%
		Eastern White Pine	
1982 - 1995	3.00%	-0.30%	2.70%
1995 - 2002	3.52%	-0.55%	2.97%
		Eastern Hemlock	
1982 - 1995	2.90%	-0.30%	2.60%
1995 - 2002	2.60%	-0.35%	2.25%
		All Softwood Growing Stock	
1982 - 1995	2.90%	-1.40%	1.50%
1995 - 2002	2.95%	-1.35%	1.59%
		Red Maple	
1982 - 1995	3.00%	-0.40%	2.60%
1995 - 2002	2.60%	-0.53%	2.07%
		American Beech	
1982 - 1995	3.00%	-0.90%	2.10%
1995 - 2002	2.93%	-3.30%	-0.37%
		Intolerant Hardwood (White Birch and Aspen Species)	
1982 - 1995	3.10%	-1.10%	2.00%
1995 - 2002	3.09%	-1.47%	1.62%
		All Hardwood Growing Stock	
1982 - 1995	2.90%	-0.70%	2.20%
1995 - 2002	2.75%	-0.96%	1.80%
		All Species Growing Stock	
1982 - 1995	2.90%	-1.10%	1.80%
1995 - 2002	2.86%	-1.18%	1.68%

[1] **Mortality breakpoints are first set to highlight a Basal Area Change of 2.0% or higher, to conform to FHM Risk Mapping protocols**

[2] **Residual breakpoints are then set to highlight a minimum 2% level needed to offset overall average annual removals**

[3] **Gross Growth breakpoints are then set to provide a minimum 2% residual, allowing for a 1% background mortality level**

Two individual species (Balsam fir and American beech) were chosen for more detailed examination and discussion, with additional comments focused at the regional level. Balsam fir estimates provide a mixed response across the two change periods and the four regions. American beech displays overall negative developments in its estimates from period to period and discussion on the future implications of those changes (Table 3.).

Table 3. Regional Changes in the Proportionate Share of Gross Growth and Mortality Growing Stock Change Components (Sq. ft. of Basal area/Year) to the Total Basal Area Inventory and the Residual (%) remaining and available to offset Removals

Gross Growth	Mortality	Residual
0.00 - 1.49%	0.00% - (0.99%)	> (1.99%)
1.50 - 2.99%	(1.00%) - (1.99%)	(1.00%) - (1.99%)
3.00 - 4.49%	(2.00%) - (2.99%)	(0.99%) - 0.99%
4.50 - 5.99%	(3.0%) - (3.99%)	1.00% - 1.99%
> 5.99%	>(3.99)%	> 1.99%

Region	Change Period	Gross Growth(%) of Basal Area Inventory	Mortality (%) of Basal Area Inventory	Gross Growth (%) less Mortality (%)
			Balsam Fir	
Northern	1982 - 1995	3.90%	-5.90%	-2.00%
	1995 - 2002	5.36%	-2.70%	2.67%
Eastern	1982 - 1995	4.70%	-2.90%	1.80%
	1995 - 2002	5.88%	-4.31%	1.57%
Southern	1982 - 1995	5.00%	-1.60%	3.40%
	1995 - 2002	4.21%	-9.61%	-5.40%
Western	1982 - 1995	3.90%	-2.90%	1.00%
	1995 - 2002	3.27%	-3.46%	-0.18%
			American Beech	
Northern	1982 - 1995	2.60%	-1.10%	1.50%
	1995 - 2002	3.32%	-4.42%	-1.10%
Eastern	1982 - 1995	3.40%	-0.60%	2.80%
	1995 - 2002	2.64%	-3.27%	-0.63%
Southern	1982 - 1995	3.30%	-0.30%	3.00%
	1995 - 2002	1.84%	-0.30%	1.54%
Western	1982 - 1995	3.50%	-0.50%	3.00%
	1995 - 2002	2.99%	-2.55%	0.44%

Statewide, balsam fir represents the most dynamic species over the two change periods, going from a critical –0.1% residual situation in 1995, to a much improved 1.7% residual value for the 2002 change period. This reversal was accomplished by a major gross growth increase of 0.9%, coupled with a major decrease in the mortality, from 1995's estimate of -4.3% to the 2002 estimate of –3.4% (Table 2).

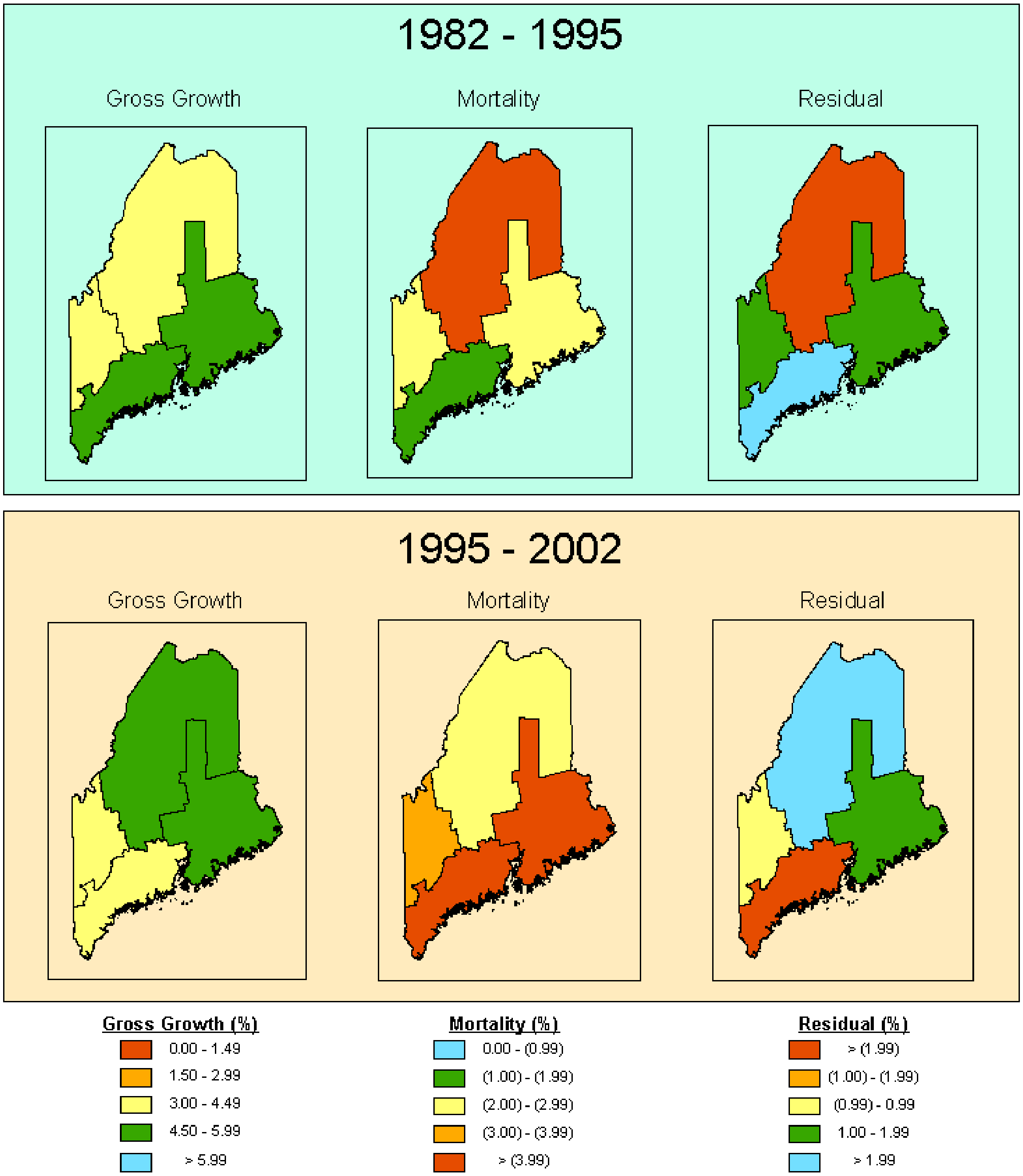
The balsam fir regional estimates are more mixed, due to varying impacts and stand development stages. A series of balsam fir graphs (Figure 9) present the same format of gross growth, mortality, and residual estimates for each of four regions and for each of the two change periods.

The Northern region provides the most positive response. The 2002 change period has a gross growth estimate of 5.4%, an increase of 1.5% over 1995 and this is coupled with a major reduction in mortality from the 1995 estimate of –5.9% to a 2002 estimate of –2.7%. The result is a complete turnaround of the residual estimate from an undesirable level of –2.0% to a current 2002 estimate that is at a desirable level of 2.7%.

Overall, the Eastern region had compensating changes from period to period that result in the residual staying within the same range. The gross growth increase of 1.2% was more than offset by mortality dropping 1.4%, going from a 1995 estimate of –2.9% to a critical level of –4.3% in 2002 estimate. A suspected mortality causal agent is a Balsam Woolly Adelgid infestation in Washington and Hancock counties.

In the counties that comprise the Southern region, balsam fir is not considered to be a major species. However, the major mortality increase, from 1995's estimate of –1.6%, to a –9.6% estimate in the 2002 period is a cause for concern. The suspected agents responsible for this large mortality increase include Balsam Woolly Adelgid, pathological butt rots, and drought. The residual value of –5.4% for the 2002 change period is not desirable.

Figure 9. Balsam Fir Gross Growth, Mortality, and Residual Components of Change estimates (basal area basis) comparing (1982 - 1995) to (1995 - 2002), by region, Maine 2002



Finally, the Western Region has a series of moderate changes between the two periods, decreased gross growth and increased mortality, resulting in an undesirable residual of –0.2% for the 2002 period.

Beech has a long history of negative impacts due primarily to the Beech Scale insect and the associated Nectria disease complex. Part of the interest in the well being of beech is that it is the primary “hard mast” food source in the Eastern and Northern regions. The annual availability of this food source has major impacts on both black bear and whitetail deer populations, so the 2002 change estimates are not very encouraging. The following discussion is referenced to the graphs in Figure 10.

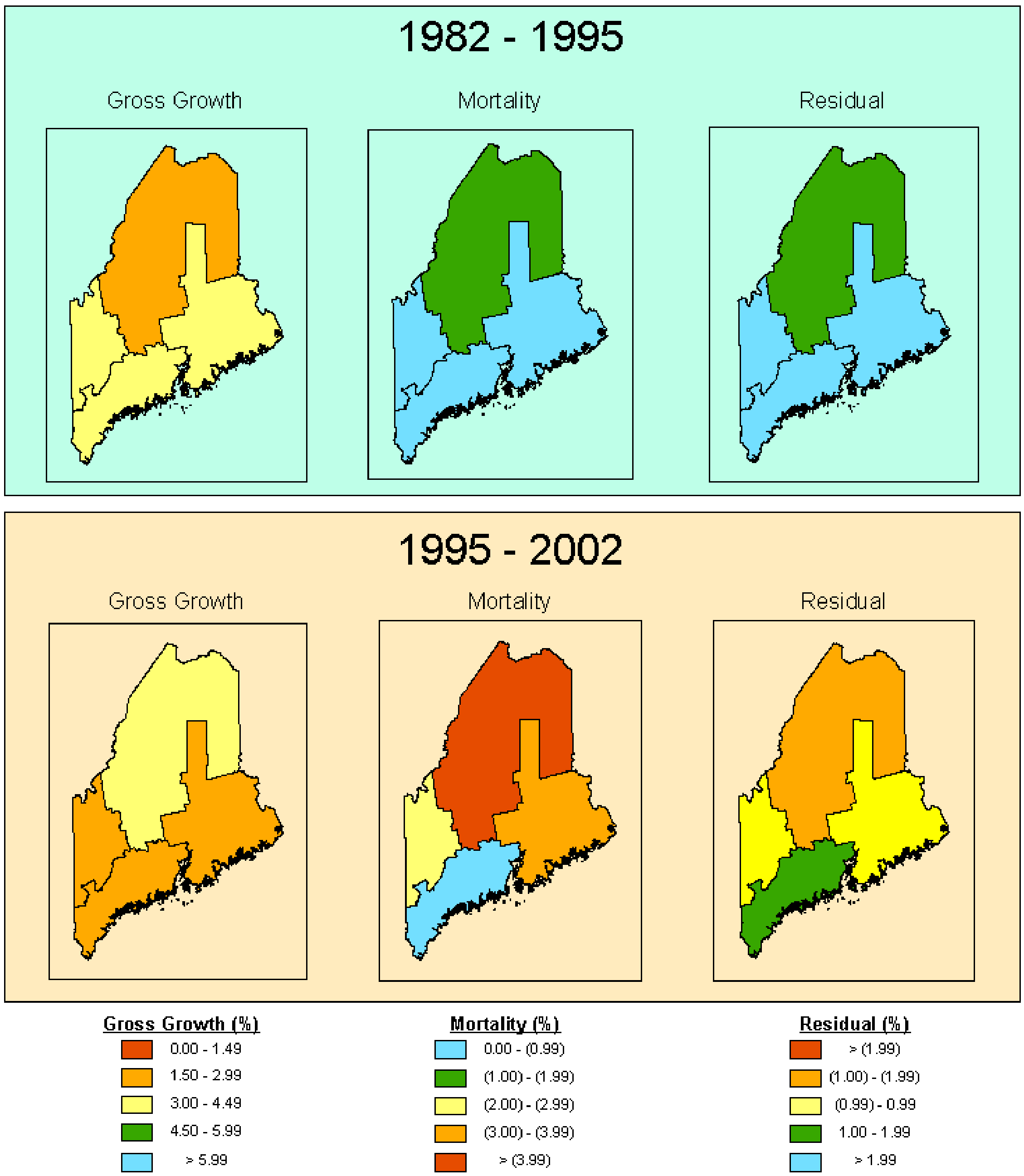
Gross growth in the Northern region increases to a 2002 estimate of 3.3%, not nearly enough to offset the huge mortality increase, from a 1995 estimate of –1.1%, to a current 2002 estimate of –4.4%. The resulting residual is an undesirable –1.1%. These radical changes warrant additional investigation to determine whether certain ranges of the beech distribution are experiencing mortality, i.e., large trees as major mast suppliers vs. small trees dying due to competition induced mortality; or whether other stresses such as insects/diseases/weather are involved.

In the Eastern region, gross growth has declined from 1995’s estimate of 3.4% to a 2002 level of 2.6%. Concurrently, mortality increased from the 1995 change estimate of –0.6% to a 2002 estimate of –3.3%, creating a cause for concern, since the resulting 2002 residual estimate is –0.6%.

The major change in the Southern region is the reduction in the gross growth change component, from a desirable 1995 estimate of 3.3% to a 2002 estimate of 1.8%. The mortality change estimate stayed constant at –0.3%, but due to the gross growth reductions, the residual estimate drops to 1.5%.

While the Western region has experienced a minor reduction in gross growth going from 3.5% to a current estimate of 3.0%, a four-fold increase in mortality drives the current residual to an undesirable 2002 estimate of 0.4%.

Figure 10. Beech Gross Growth, Mortality, and Residual Components of Change estimates (basal area basis) comparing (1982 - 1995) to (1995 - 2002), by region, Maine 2002



Crown Conditions and Damages

The P3 data collected for this analysis covers two separate change periods:
- 1995 (Plots measured in 1993 – 1997)
- 2000 (Same plots remeasured in 1998 – 2002)

The P3 data collection process emphasizes:
- tree-level crown conditions: light exposure; position; vigor; density; dieback; and transparency;
- the combined tree-level decay/damage locations and their severity of stem and root decay;
- stem, root, and branch breakage; and
- mechanical wounds

as a method to characterize the current health of a tree.

All of the crown conditions are collapsed into a single index value that is labeled "Unhealthy Crowns". "Unhealthy Crowns" are defined as containing an assessment of either:
- Dieback >20%, or
- Crown Density < 35%, or
- Foliage Transparency => 35%

The basal area of these trees as a share of the total basal area is then calculated and displayed as a percentage value on a plot-by-plot basis. Risk mapping protocols deem that values above 15% are critical and of concern.

The three assessments of damages and severity (stem and root decay; stem, root, and branch breakage; and mechanical wounds) provide an alternative focus for varying human and natural events and their potential impact to the long-term quality and productivity of the tree. A tree is considered damaged regardless of the location or the severity of the damage.

Table 4. Tree Counts used in each change period for estimating the crown conditions and damages in Table 5, Figure 11, and Figure 12

	All Species	All Softwood Species	All Hardwood Species	White Pine	American Beech
1995 Change Period (1993 – 1997 Measurements)					
Eastern	792	434	358	141	30
Northern	1646	1034	612	46	86
Southern	623	292	331	81	10
Western	429	148	281	5	28
2000 Change Period (1998 – 2002 Remeasurements)					
Eastern	917	558	359	155	28
Northern	1659	1046	613	48	87
Southern	573	274	299	69	5
Western	408	149	259	5	32

In examining the All Species section of Table 5, the Northern Region stands out for its damage estimates of Stem/Root Decay, for both periods, that are above 15% (minimum level of concern), while the 4% increase in the same metric for the Eastern Region makes the 2000 change period a new concern. These levels should be monitored and the data further analyzed to find if this decay is attributable to a specific species.

An even greater concern is the major increase in the Southern region's All Species estimate of Stem/Root/Branch Breakage from 3% to a 2000 estimate of 15%. This elevated level also indicates the need to continue to examine more specific estimates for an explanation.

The All Softwood estimates are consistent except for the same two areas in both the Southern and Western regions, where unhealthy crowns increased 5% and breakage has a 6% increase, respectively.

In the Eastern and Northern regions, with estimates above 21%, stem/root decay has been and remains critical for the All Hardwood species group. Meanwhile, the Southern region went from the minimum level of concern (15%) in the 1995 period to a more critical level of 20% in the 2000 change period. In addition the Southern region has a 10% increase and the West region has a 5% increase in breakage.

Table 5. Percentage of Growing-Stock Basal Area to Total Basal Area Impacted by various Forest Heath conditions and damages, by region, 1995 (P3 Plots remeasured 1993 – 1997) and 2000 (P3 Plots remeasured 1998 – 2002)

Basal Area Represented (%)
0 - 5%
6 - 10%
11 - 15%
16 - 20%
21%+

Region	Change Period	Unhealthy Crowns	Stem/Root Decay	Stem/Root/Branch Breakage	Mechanical Wounds
		All Species Combined			
East	1995	9%	14%	13%	2%
	2000	6%	18%	7%	2%
North	1995	8%	16%	6%	4%
	2000	7%	19%	5%	2%
South	1995	9%	9%	3%	1%
	2000	9%	12%	15%	2%
West	1995	9%	12%	8%	7%
	2000	8%	10%	10%	9%
		All Softwood Species Combined			
East	1995	5%	8%	10%	3%
	2000	3%	10%	5%	3%
North	1995	7%	12%	2%	3%
	2000	6%	11%	3%	1%
South	1995	7%	4%	4%	3%
	2000	12%	7%	10%	2%
West	1995	5%	7%	2%	5%
	2000	10%	8%	8%	10%
		All Hardwood Species Combined			
East	1995	12%	22%	11%	2%
	2000	10%	25%	10%	0%
North	1995	12%	21%	10%	9%
	2000	7%	24%	7%	4%
South	1995	12%	15%	5%	1%
	2000	8%	20%	15%	1%
West	1995	11%	11%	11%	8%
	2000	10%	12%	16%	9%

For a more detailed regional perspective, white pine and american beech were chosen to provide a more detailed discussion on changes in crown conditions and damage assessments over the two change periods:

1995 (1993 – 1997) and
2000 (1998 – 2002)

For White Pine (Figure 11) the focus will be on changes estimated in the Southern Region. Three of the four indexes show a major increase between the 1995 and the 2000 estimates. The 13% increase in unhealthy crowns provides a real impact assessment of both the 1998 Ice Storm damage and the lingering effects of climatic related stress from drought and decline. The equivalent increase in breakage from 1995's zero estimate to a current estimate of 13% is likely attributable to the 1998 Ice Storm. The estimated 5% increase in stem and root decay needs continued monitoring to see if the other mentioned damages result in even larger decay estimates in the future.

The crown and damage assessments of beech (Figure 12) substantiate the previously noted regional growth, mortality, and residual estimates. In the Eastern region, the consistently high levels of unhealthy crowns, stem/root decay, and breakage for both change periods are noted. Also, over the two change periods, the Northern region has equal or worse estimates of unhealthy crowns and damages related to stem/root decay.

Figure 11.

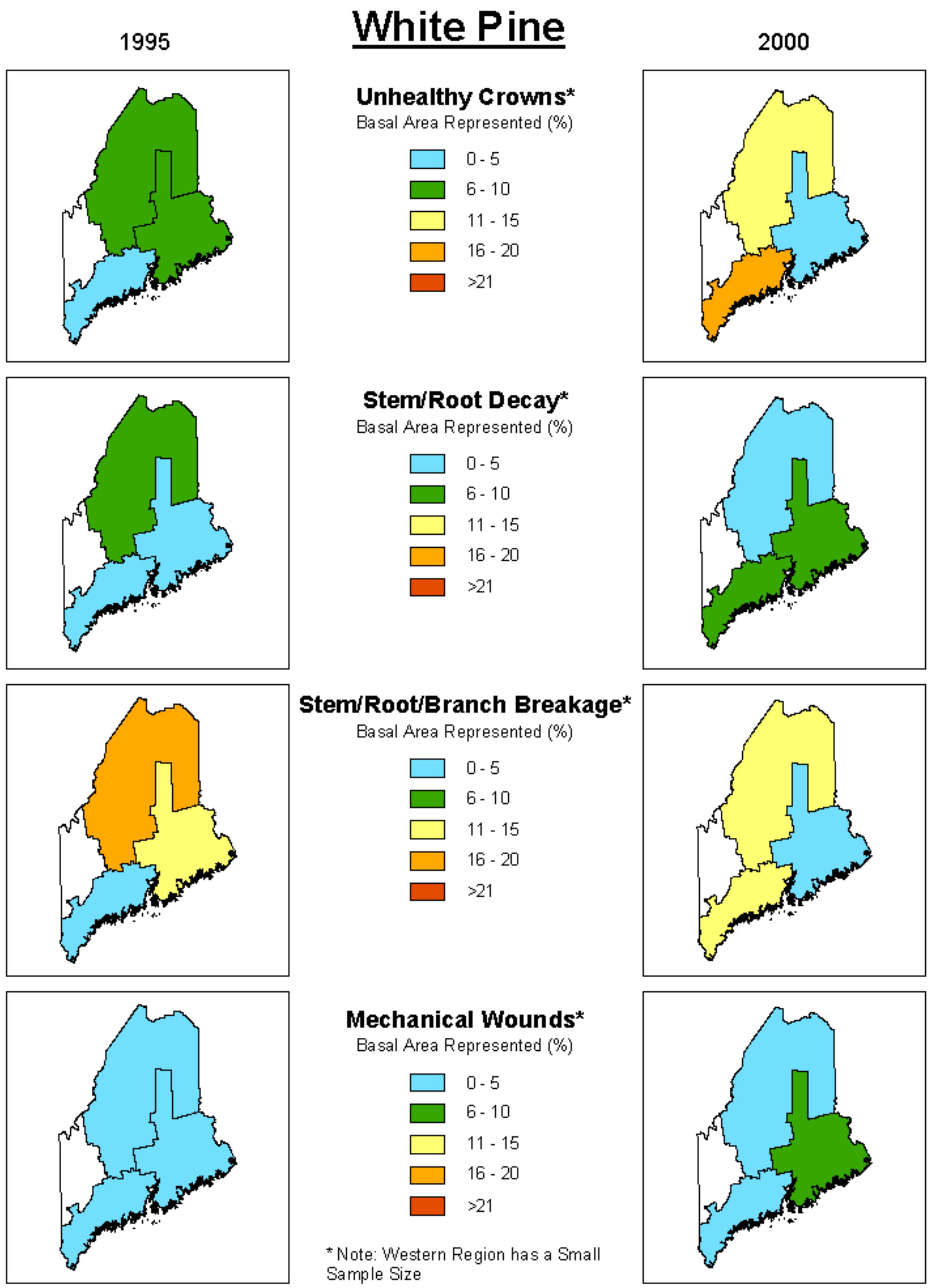
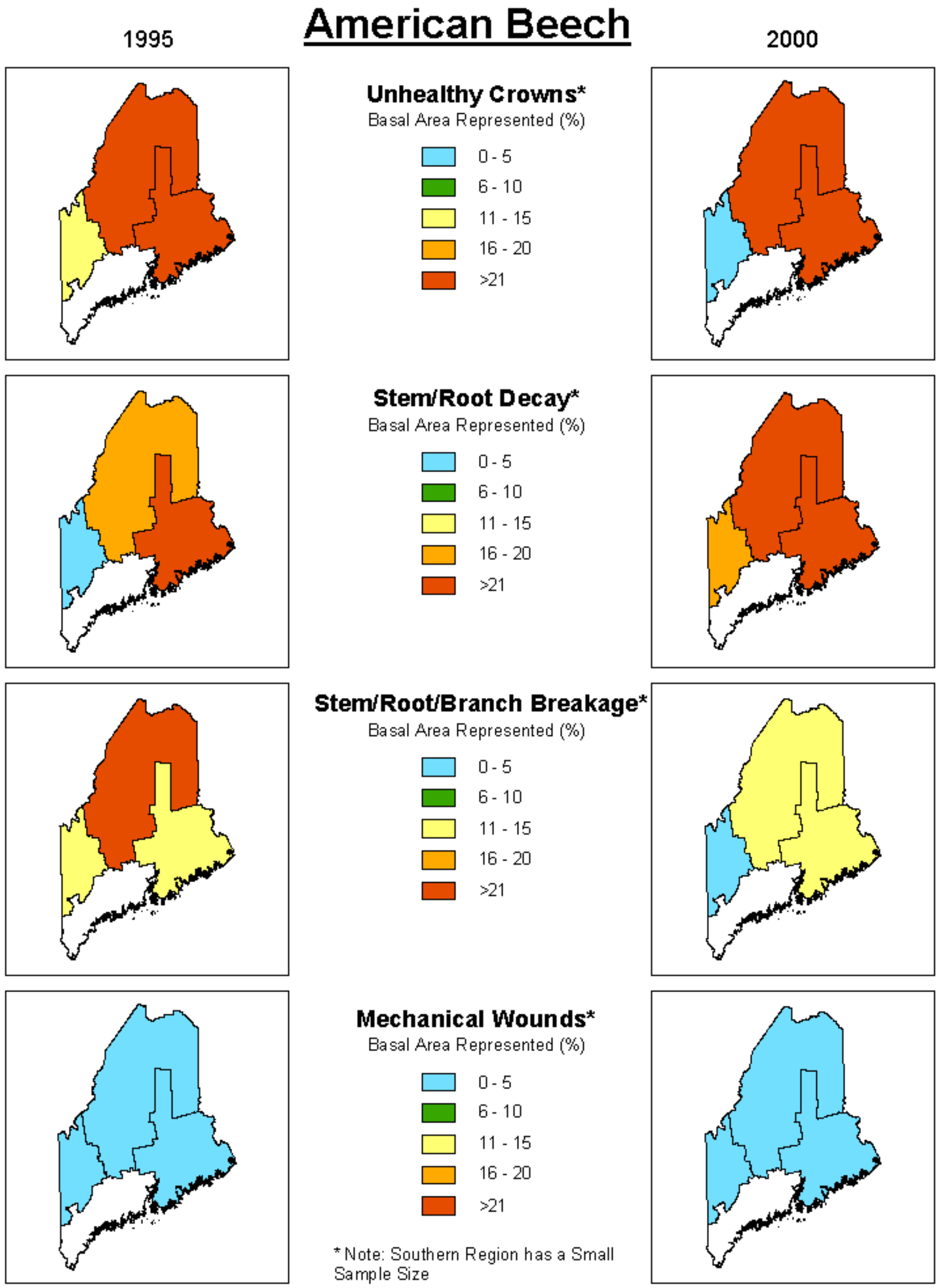

White Pine
1995
2000
Unhealthy Crowns*
Basal Area Represented (%)
0 - 5
6 - 10
11 - 15
16 - 20
>21
Stem/Root Decay*
Basal Area Represented (%)
0 - 5
6 - 10
11 - 15
16 - 20
>21
Stem/Root/Branch Breakage*
Basal Area Represented (%)
0 - 5
6 - 10
11 - 15
16 - 20
>21
Mechanical Wounds*
Basal Area Represented (%)
0 - 5
6 - 10
11 - 15
16 - 20
>21
* Note: Western Region has a Small Sample Size

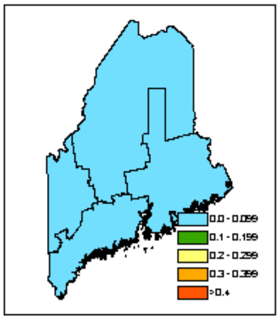
Figure 12.


American Beech
1995
2000
Unhealthy Crowns*
Basal Area Represented (%)
0 - 5
6 - 10
11 - 15
16 - 20
>21
Stem/Root Decay*
Basal Area Represented (%)
0 - 5
6 - 10
11 - 15
16 - 20
>21
Stem/Root/Branch Breakage*
Basal Area Represented (%)
0 - 5
6 - 10
11 - 15
16 - 20
>21
Mechanical Wounds*
Basal Area Represented (%)
0 - 5
6 - 10
11 - 15
16 - 20
>21
* Note: Southern Region has a Small Sample Size

SITE LEVEL INDICATORS

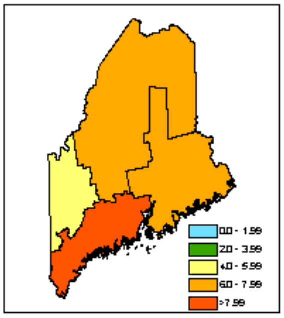
Figure 13. Four site-level estimates and a description of their regional implications.

Forest Health Indicators



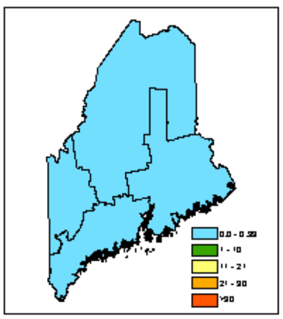
Soil Erosion (1998 - 2001) (Tons/Acre/Year)

Soil Erosion in the forest is generally low due to a variety of factors: the protective cover by existing vegetation at a variety of levels and scales; the rapid green-up of a disturbed area; and Maine's evenly distributed precipitation regime. However, forested locations with steep slopes, lack of cover, or compacted areas due to skidding can have annual soil losses exceeding 0.4 tons/acre/year. None of the four regions, nor any FHM plots within this sample, have evidence of an existing soil erosion problem.



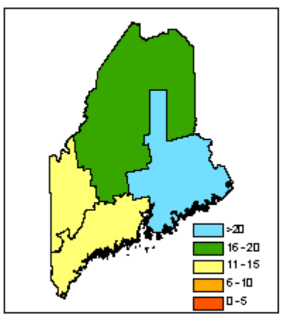
Down Woody Material (2001) (Tons/Acre)

This graph combines the estimates of Fine Woody Debris (dead branches, twigs, wood splinters that are 0.1 to 2.9 inches in diameter) and Coarse Woody Debris (dead pieces of wood that are 3.0+ inches in diameter). Down woody material (DWM) can be viewed as either a detriment or a benefit to forest health. The detriment perspective is the increased risk of wildfire that DWM contributes as a fuel. The benefit perspective is what DWM adds to wildlife habitat. There is some regional discrimination in terms of DWM in the four regions of Maine: the southern region has the highest estimate at almost 9 tons/acre; the neighboring western region has the lowest estimate at just over 4 tons/acre; and both the northern and eastern regions have similar estimates of approximately 7 tons/acre.



Ground-level Ozone Injury (1998 - 2001)
(Injury Index for Ozone-sensitive Plant Species)

Forest exposure to high amounts of ground-level ozone can potentially reduce productivity. This graph depicts an injury index based on three ozone-sensitive plant species (Milkweed, Black Cherry, and Blackberry) that serve as indicators of potential problems. There is no evidence of ozone injury in any of the four regional areas.



Lichen Communities (1998 - 2001)
Average Species Richness per Plot

Lichens contribute to the diversity of forest structure and processes, and serve as surrogate indicators of forest exposure to air pollutants and climatic changes. The species richness index displayed represents the average number of lichen species located within a 1-acre annulus of each FHM plot center. The eastern region is the richest in terms of species found, followed closely by the northern region. Both the southern and western regions are equal and more average in richness when compared to the other two regions.

ADDITIONAL INFORMATION:

http://www.fs.fed.us/ne/fia/states/me/me.html

For the following links:
- Highlights of the 1995 Maine Inventory
- To view distribution maps of 14 important species
- To view/print a copy(s) of the tables from the 1995 statistical report

http://www.maineforestservice.org

Under the Current Publications bar, the following publication can be viewed and downloaded:
- Third Annual Inventory Report on Maine's Forests,
  Released September 25, 2002
- Charts from Third Annual Inventory Report on Maine's Forests

REFERENCES:

Gillespie, Andrew. 1998. ***Pros and Cons of Continuous Forest Inventory: Customer Perspectives***. Presented at the "Integrated Tools for Natural Resources Inventories in the 21st Century" Conference, August 16-19, 1998, Boise, Idaho.

Griffith, Douglas M.; Alerich, Carol L. 1996. ***Forest Statistics for Maine, 1995***. Resource Bulletin NE-135. Radnor, PA: US Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 134 pages.

Lewis, J.W. 2002. ***Mapping risk from forest insects and diseases***. USDA Forest Service, FS-754. 60 pages.

GLOSSARY

Accretion – The estimated net growth on surviving growing stock trees that were measured during the previous inventory (divided by the number of growing seasons between surveys to produce average annual accretion). Accretion does not include the growth on trees that were cut during the period, nor those trees that died. This component of change uses the incremental difference in the tree's basal area between the two inventories.

Basal Area – The cross-sectional area of a tree stem at breast height, expressed in square feet.

Board Foot – A unit of lumber measurement 1 foot long, 1 foot wide, and 1 inch thick, and 1,000 Board Feet = 1 MBF.

Commercial Species – Tree species currently or prospectively suitable for industrial wood products; excludes species of typically small size, poor form, or inferior quality.

Diameter at Breast Height (dbh) – The diameter outside bark of a standing tree measured at 4 ½ feet above the ground.

Forestland – Land at least 10% stocked by forest trees of any size, or land that formerly had such a tree cover and is not currently developed for a non-forest use.

Gross Growth – The arithmetic sum of the Ingrowth and Accretion components of change.

Growing Stock Decrement – Includes growing stock trees in the previous inventory that are classified as rough or rotten in the current inventory (divided by the number of growing seasons between surveys to produce average annual growing stock decrement). This component of change uses the previous tree's basal area.

Growing Stock Increment – Includes either rough or rotten trees in the previous inventory that are classified as growing stock trees in the current inventory (divided by the number of growing seasons between surveys to produce average annual growing stock increment). This component of change uses the current tree's basal area.

Growing Stock Tree (or Growing Stock) – A classification of timber inventory that includes live trees of commercial species meeting specified standards of quality and vigor. Cull trees (rough and rotten trees) are excluded.

Growing Stock Volume – Net volume, in cubic feet, of growing stock trees 5.0 " dbh and larger from a 1-foot stump to a minimum 4.0" top diameter outside bark of the central stem, or to a point where the central stem breaks into limbs. Net volume equals gross volume discounted by cubic foot cull defect (%).

Harvest – Includes growing stock trees harvested or killed in logging, cultural operations (such as timber stand improvement) or land clearing on land that remains in timberland. This component of change uses the previous tree's basal area.

Hard Hardwoods – Defined solely for use in Table 22, these are hardwood tree species with an average specific gravity greater than 0.50. Typical species tallied in Maine include: Maples (Sugar, Mountain), Yellow Birch, American Hornbeam, Hickories, American Beech, Apples, Eastern Hophornbeam, Chokecherry, Oaks, and American Mountain-Ash.

Ingrowth – Includes growing stock trees that became 5.0" dbh or larger during the period between inventories (divided by the number of growing seasons between surveys to produce average annual ingrowth). Also, includes growing stock trees, 5.0" dbh and larger, that are growing on land that was reclassified from noncommercial forestland or nonforest land to timberland. This component of change uses the current tree's basal area.

International ¼-inch rule – A log rule formula for estimating the board-foot volume of logs. The mathematical formula is:

$$(0.22D^2 - 0.71D)(0.904762)$$

for 4-foot sections, where D = diameter outside bark at the small end of the log section. This rule is used as the USDA Forest Service standard log rule in the Eastern United States.

Land Use Removal – Includes growing stock trees, 5.0" dbh and larger, that are on land that was reclassified from timberland to noncommercial forestland or to nonforest land during the period between surveys. This component of change uses the previous tree's basal area.

Mortality – Includes growing stock trees that die from natural causes before the current inventory (divided by the number of growing seasons between surveys to produce average annual mortality). This component of change uses the previous tree's basal area.

Net Change – The difference between the current and previous inventory estimates of growing stock (divided by the number of growing seasons between surveys to produce average annual net change). It is the arithmetic sum of Net Growth minus Removals.

Net Growth – The resultant change from natural causes in growing stock during the period between surveys (divided by the number of growing seasons between the surveys to produce average annual net growth). It is the arithmetic sum of Gross Growth, minus Mortality, plus Growing Stock Increment, minus Growing Stock Decrement components of change.

Other Softwoods – Defined solely for use in Table 22, means any tree in the Order ***Coniferales*** that is not in the genus ***Pinus.***

Owner Class – A variable that classifies land into finer categories of ownership.

> **Forest Industry** – Land owned by companies or individuals that operate wood-using plants.
> **Nonindustrial Private** – Land owned by companies, non-governmental organizations, or individuals that do not operate wood-using plants.
> **Public** – Land owned by federal, state, municipal, or county government.

Pines – Defined solely for use in Table 22, means any tree in the genus ***Pinus.***

Poletimber Tree – A tree that is at least 5.0" dbh, but smaller than sawtimber size trees.

> **Softwood Species:** 5.0" – 8.9" dbh
> **Hardwood Species:** 5.0" – 10.9" dbh

Potential Sawtimber (i.e. Sawlog Quality) Tree – A commercial tree species that is field coded as a growing stock tree but is below the minimum dbh for sawtimber (<9.0" for softwoods and <11.0" for hardwoods).

Pulpwood Quality Tree – A commercial tree species that is field coded as a growing stock tree or as a rough cull tree.

Residual – Represents the arithmetic sum of the Gross Growth and Mortality components of change.

Rough Cull Tree – A live tree with less than 1/3 of its gross board foot volume coming from logs that meet size, soundness, and grade requirements; and more than ½ of the board foot cull is due to sound defects such as sweep, crook, etc. Or a live poletimber tree that prospectively will have less than 1/3 of its gross board foot volume coming from logs that meet size, soundness, and grade requirements; and more than ½ of the prospective board foot cull is due to sound defects such as sweep, crook, etc.

Salvable Dead Tree – A tree, with a current 5.0"+ dbh and a tree class code of 5 (Dead), is of recent mortality and still has intact bark. The tree may be standing, down, or leaning, and may have either an intact or broken top.

Sapling Tree – A live tree with a 1.0" – 4.9" dbh.

Sawlog Top – The point on the bole of a sawtimber tree above which a sawlog cannot be produced. The minimum sawlog top is 7.0" diameter outside bark for softwoods and 9.0" diameter outside bark for hardwoods.

Sawtimber Tree (i.e. Sawlog Quality Tree) – Softwood trees that are at least 9.0" dbh **or** hardwood trees that are least 11.0" dbh, that contain at least 1 – 12 foot log **or** 2 – noncontiguous 8 foot logs, that meet minimum sawlog grade specifications. In addition, the tree must have 1/3 or more of its gross board foot volume as merchantable material.

Sawtimber Volume – Net volume, in board feet, by the International ¼-inch rule, of sawlogs in sawtimber trees. Net volume equals gross volume discounted by board foot cull defect (%), which accounts for deductions for rot, sweep, and other defects that affect the use of lumber.

Soft Hardwoods – Defined solely for use in Table 22, these are hardwood tree species with an average specific gravity of 0.50 or less. Typical species tallied in Maine include: Maples (Stripe, Red, Silver, Norway), Birch (Paper, Gray), White Ash, Poplars (Balsam Poplar, Eastern Cottonwood, Bigtooth Aspen, Quaking Aspen), Cherry (Pin, Black), Willows, Basswood, and Elm.

Species Group – as used in the Appendix A. Tables and in the annual report, species groups include the following species:

Group
Balsam Fir – balsam fir
Spruces – white spruce, red spruce, and black spruce
Eastern White Pine – eastern white pine
Northern White Cedar – northern white cedar
Hemlock – eastern hemlock
Other Miscellaneous Softwoods – these merchantable sized (5.0" dbh and larger) species were tallied in 1999, 2000, 2001, or 2002: plantation larch, tamarack, norway spruce, jack pine, red pine, pitch pine, pond pine, scotch pine
Red Maple – red maple
Sugar Maple/Beech/Yellow Birch – sugar maple, american beech, and yellow birch
Intolerant Hardwoods – paper birch, cottonwood species, balsam poplar, eastern cottonwood, bigtooth aspen, quaking aspen

Other Miscellaneous Commercial Hardwoods – these merchantable sized (5.0" dbh and larger) species were tallied in 1999, 2000, 2001, or 2002: silver maple, norway maple, ohio buckeye, sweet birch, shagbark hickory, white ash, black ash, green ash, butternut, black cherry, white oak, scarlet oak, northern red oak, black oak, black willow, basswood species, american basswood, elm species, american elm
Noncommercial Hardwoods – these merchantable sized (5.0" dbh and larger) species were tallied in 1999, 2000, 2001, or 2002: maple species, striped maple, mountain maple, serviceberry, birch species, gray birch, american hornbeam, osage-orange, apple species, eastern hophornbeam, pin cherry, chokecherry, willow species, american mountain-ash
All Unknown Species – Tree Species-Unknown/Not Listed

Stand Size – A stand descriptor that indicates which size-class of trees constitutes the plurality of stocking in the stand. This variable is field assigned, and then is also calculated as part of the USDA Forest Service plot data validation process. The calculated value is used to assign stand size classes in this report.

Large Diameter Stand Size Class is comprised of:
- ≥ 10% stocking of trees of any size,
- > 50% stocking of trees with diameters ≥ 5.0" dbh, and
- Stocking of large diameter trees exceeds the stocking of medium diameter trees.

Medium Diameter Stand Size Class is comprised of:
- ≥ 10% stocking of trees of any size,
- > 50% stocking of trees with diameters ≥ 5.0" dbh, and
- Stocking of medium diameter trees exceeds the stocking of large diameter tree.

Small Diameter Stand Size Class is comprised of:
- ≥ 10% stocking of trees of any size, and
- > 50% stocking of trees with diameters < 5.0" dbh.

Nonstocked Stand Size Class is comprised of:
- < 10% stocking of trees of any size

Small Diameter Trees – Trees with a dbh range of 1.0" – 4.9"

Medium Diameter Trees – For softwood species, this is a tree with a dbh range of 5.0" – 8.9". For hardwood species, this is a tree with a dbh range of 5.0" – 10.9".

Large Diameter Trees – For softwood species, this is a tree with a 9.0" dbh and larger. For hardwood species, this is a tree with an 11.0" dbh and larger.

Stocking – The relative degree of occupancy of land by trees, measured as basal area or the number of trees in a stand, by size, age, or spacing; as compared to the basal area or number of trees required to fully utilize the growth potential of the land; that is, the stocking standard.

This variable is field assigned. In the USDA Forest Service data validation process, a national algorithm is used to calculate this variable. The calculated variable is used in this report.

The 5 stocking classes are:

Nonstocked	< 10% stocking
Poorly Stocked	≥ 10% Stocking and < 35% Stocking
Moderately Stocked	≥ 35% Stocking and < 60% Stocking
Fully Stocked	≥ 60% Stocking and < 100% Stocking
Overstocked	> 100% Stocking

Timberland – Forest that is producing or capable of producing crops of industrial wood and is not withdrawn from timber utilization by statute (Acadia National Park, Appalachian Trail Corridor) or administrative designation (Baxter State Park, Bureau of Parks & Lands Ecological Reserves) (Land withdrawn from timber utilization must be publicly owned land).

Areas qualifying as timberland have the capability of producing in excess of 20 cubic feet per acre per year of industrial wood under management. Currently inaccessible and inoperable areas are included, except when the areas are small and unlikely to become suitable for the production of industrial wood in the foreseeable future.

Timberland may be nonstocked provided that neither any natural condition, nor any activity by humans, prevents or inhibits the establishment of tree seedlings.

Rural – Defines a subset of forestland, which is now grouped into Timberland. This category represents the historical and traditional acreages classified as Timberland in previous inventories, and has the identical definition.

Other Forestland – Defines a subset of forestland, which is now grouped into Timberland. It is producing, or capable of producing, crops of industrial wood, but is associated with, or part of a nonforest land use. In the past, these areas would have been treated as inclusions in the nonforest land use because they were considered part of a development. The minimum area for classification as Other Forestland is one acre and these strips of timber must have a crown width at least 120 feet wide. Some examples of land that could be classified as Other Forestland are forested portions of city parks, forested land in highway medians and rights-of-way, forested areas between ski runs, and forested areas within golf courses. *Generally, although surrounded by nonforest development, these areas have not been developed themselves, and exhibit natural, undisturbed understories.*

Urban Forestland – Defines a subset of forestland, which is now grouped into Timberland. Land that except for its location would ordinarily be classified as timberland. This land is either nearly (surrounded on three sides), or completely, surrounded by urban development, whether commercial, industrial, or residential. This land meets all the criteria for timberland, that is, at least one acre; capable of producing at least 20 cubic feet per acre per year of industrial wood; is not developed for some use other than timber production; and is not reserved by a public agency. It is extremely unlikely that such land would be used for timber products on a continuing basis. Such land may be held for future development, or scheduled for development. (The timber that is present may be utilized only at the time of development.) The land may be undeveloped due to periodic flooding, low wet sites, steep slopes, or their proximity to industrial facilities that are unfavorable to residential development. *Forested areas within city parks are not urban forestland; it may be Other Forestland, if the requirements are met. City Parks cannot be classified as Urban Forestland as it is currently defined.*

Total Removals – Represents the arithmetic sum of the Harvest and Land Use Removal components of change.

APPENDICES

NOTE:

a) All tables in this report may not add to the row, column, or table totals due to rounding.
b) All estimates in this report are derived from ground plots, except where noted.