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Investigations into the Potential of Measuring Biodiversity in Maine's Forests with Forest Inventory and Analysis (FIA) Data

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Investigations into the Potential of Measuring Biodiversity in Maine's Forests with Forest Inventory and Analysis (FIA) Data

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I. INTRODUCTION

There is growing recognition that biological diversity (biodiversity) is a global asset of tremendous value to present and future generations. In the United States, early efforts to preserve biodiversity focused on species preservation and led to the passage of the Endangered Species Act (1973), the Marine Mammal Protection Act (1972), and other federal and state legislation. Since the 1970s, conservation goals have broadened to include not just individual species, but to encompass the entire system of biological resources. The central concern is that the diversity of the earth's biological system be preserved in order to maintain its capacity to adapt to changing conditions. At the 1992 Earth Summit in Rio de Janeiro, 168 of the world's nations adopted the Convention on Biological Diversity, an international agreement designed to promote the conservation and sustainable use of biodiversity.

Biodiversity is a concern locally, as well as internationally. Within Maine's borders is a diverse mix of ecosystem types, as well as the largest undeveloped area of forest in the U.S. east of the Mississippi River. In 1994, the Maine Forest Biodiversity Project was begun to explore ways to maintain the biodiversity and biological integrity of Maine's forests (Gawler et al. 1996). The central activity of the project is the organization of conferences at which a diverse group of stakeholders (forest landowners, environmental groups, scientists, representatives of state and federal agencies, and others) discuss issues related to biodiversity in Maine's forests. The project has developed an ecological reserves inventory for Maine. As well, working committees have been formed to examine biodiversity in the working forest, provide public outreach, and improve biodiversity assessment.

The purpose of this report is to present preliminary results from the work of the Forest Inventory and Analysis (FIA) Committee. The FIA is a unit within the USDA Forest Service responsible for conducting forest inventories. FIA inventories are plot-level surveys conducted periodically on a state-by-state basis. They provide information on many characteristics of the forest, including forest area, tree volume and species, and tree removals and mortality. Inventories were conducted in Maine in 1959, 1971, 1982, and 1995 (Table 1). The objective of the FIA Committee is to explore the potential for using FIA data to measure and assess changes in biodiversity in Maine's forests. In fall 1997, a cooperative agreement between the Maine Forest Service and the University of Maine was developed to provide funding for a preliminary

analysis. The work was conducted by the authors of this report, and between January and June 1998 the FIA Committee met regularly to discuss our progress on the project.

Biodiversity exists at all levels, ranging from genetic diversity within species to species diversity within ecosystems to ecosystem diversity across the landscape. We present here the results of our initial effort to use FIA data to assess biodiversity in Maine's forests. Biodiversity is a complex issue and, from the start, it was apparent that the FIA data are inadequate for examining all facets of biodiversity. Nevertheless, the FIA provides the most comprehensive and detailed data on Maine's forests and can be used to measure some indicators of forest biodiversity, in particular those related to tree species and stand characteristics. Other aspects of biodiversity in Maine have been outlined in Gawler et al. (1996).

In this report, we focus on selected indicators of biodiversity amenable to measurement with FIA data. In section II, we provide additional details on the FIA data and the approach taken to analyze them. For researchers who plan to conduct similar analyses, discussion of the problems we found insurmountable may be as valuable as discussion of the problems we made progress in solving. Therefore, in the next section we try to chronicle the steps taken during the course of this project. In section III, we present and discuss our results. To help demonstrate the range of potential uses of the FIA data, we include most of the measures developed during the study. We provide some explanation of the results, but given the preliminary nature of our findings, stop short of drawing conclusions regarding biodiversity in Maine's forests. In section IV, we summarize the findings of this study and discuss directions for future research.

II. METHODS

The starting point for our work is a list of forest characteristics and corresponding FIA measures developed by the FIA Committee (Table 2). The FIA Committee first identified a list of forest characteristics that could be used to assess biodiversity and then matched the forest characteristics to measures from the FIA data. In many cases, the FIA measures are proxies for the forest characteristics. For instance, since direct measurements of crown closure are not available in the FIA database, the Committee proposed a proxy measure based on basal area. For some forest characteristics (e.g., wildlife corridors), no information is available in the FIA database.

Table 1. Reports of forest inventories that have been conducted in Maine by the USDA Forest Service, Northeastern Forest Experiment Station.

Ferguson, R.H., and Longwood, F.R. 1960. The Timber Resources of Maine. Upper Darby, PA: USDA, Forest Service, Northeastern Forest Experiment Station.

+ Report on the timber resources of Maine based on the findings of a forest survey made in 1954–58.
+ 75 pages

Ferguson, R.H., and Kingsley, N.P. 1972. The Timber Resources of Maine. Resource Bulletin NE-26. Broomall, PA: USDA, Forest Service, Northeastern Forest Experiment Station.

+ Statistical report on the second forest inventory of Maine conducted in 1971.
+ Many of the statistics published in this report were later recomputed and published with 1982 data in a subsequent report.
+ 129 pages

Powell, D.S., and Dickson, D.R. 1984. Forest Statistics for Maine: 1971 and 1982. Resource Bulletin NE-81. Broomall, PA: US Dept. of Agriculture, Forest Service, Northeastern Forest Experiment Station.

+ A statistical report on the third forest survey of Maine conducted in 1982.
+ Changes in inventory procedures in 1982 render inappropriate direct comparisons to data from the 1971 survey published in 1972. For this reason, much of the 1971 data was recomputed and presented in this report.
+ 194 pages

Griffith, D.M. and Alerich, C.L. 1996. Forest Statistics for Maine, 1995. Resource Bulletin NE-135. Radnor, PA: USDA, Forest Service, Northeastern Forest Experiment Station.

+ Statistical report on the fourth inventory of Maine conducted in 1994–96.
+ Changes in procedures or definitions render inappropriate direct comparisons to selected data from the 1982 survey published in 1984. For this reason, selected tables from the previous report were recalculated and presented in this report.
+ 134 pages

The FIA inventories are conducted state-by-state on a five- to 15-year cycle. The inventories begin with a land classification analysis based on an aerial-photo sample. The aerial photos are used to classify land according to use (e.g., forest, agriculture, urban). Ground-level inventories are then conducted on a sample of plots to collect detailed information on forest-related variables such as forest type, volume per acre, and stand size. The plot-level and aerial-photo data are used together to determine expansion factors. Expansion factors are the number of acres that a plot represents for estimating key aggregate forest descriptors: area, volume, growth, mortality, and removals. See Hansen et al. (1992) for an overview of the FIA sampling design and consult the reports listed in Table 1 for details on individual inventories.

FIA inventories were conducted in Maine in 1959, 1971, 1982, and 1995. For the most recent inventory, the data are available in two formats. The first is the Eastwide Forest Inventory Data Base (hereafter, Eastwide Data Base) (Hansen et al. 1992). The Eastwide Data Base is a standardized database of FIA inventories for states in the eastern U.S. The Eastwide Data Base contains three broad classes of variables: county, plot, and tree records. The county records include general information about plots, such as the county in which they are located and the year of the inventory. The plot records include basic plot-level information (forest type, stand size class, land use, ownership, expansion factors, etc.) and the tree records include data on individual trees (e.g., status, species, diameter, volume). Some of the variables are measured directly (e.g., tree diameters) and others (e.g., tree volumes) are derived using algorithms developed by the Forest Service.

The Eastwide Data Base contains a subset of the data collected as part of FIA inventories. There are 71 variables reported in the Eastwide Data Base and 183 in the complete database (hereafter, the Full Data Base) for the 1995 Maine inventory. The Forest Service does not publish the Full Data Base, but we obtained it for the 1995 inventory from the USDA Forest Service Northeastern Forest Experiment Station. The only documentation available for the Full Data Base is the "Field Instructions" manual provided to FIA inventory crews (USDA Forest Service, 1995). Table 2 provides a complete list of the variables in the Full Data Base for 1995. The broad classes of variables are plot variables, ecotype variables, tree and reproduction variables, and calculated volumes and weights. Plot and ecotype variables are analogous to county and plot records, respectively, in the Eastwide Data Base. A given plot may be subdivided into ecotypes if there are sufficient within-plot differ-

ences in land use, forest types, stand origin, and stand size. Tree and reproduction variables correspond to tree records in the Eastwide Data Base and volumes and weights are calculated with algorithms applied to measured variables.

For the 1995 Maine inventory, there are 3001 sampled plots and, due to multiple ecotypes on single plots, 3271 plot records. Given the large amount of data, it is essential to devise methods of summarizing the information. At early FIA Committee meetings, we discussed the possibility of using indices, such as species richness and evenness indices described in Patil and Taillie (1982). For instance, as in Hoover and Parker (1991), we can measure tree species richness on each plot by the number of species present and use all the plot measures to construct a richness distribution for the state. We decided not to use indices extensively because committee members expressed the concern that they may yield misleading results (see Hunter 1990).

A second approach considered involves establishing a reference plot and then comparing conditions on FIA plots to the reference plot. A reference plot might correspond to a stand with relatively old trees (e.g., Trombulak 1995), a managed stand that supports a high level of diversity, or a stand representing average conditions in the forest. For instance, to apply this approach to the vertical diversity/layering characteristic (Table 2), we would first identify the crown class distribution for the selected reference plot. We would then calculate distributions for each FIA plot and compare them to the reference distribution. At the early meetings, there was general agreement that the reference case approach should be pursued.

There are many ways to compare distributions, including simply comparing moments of the distributions. One approach that we investigated is to use the cross-entropy measure. If the reference distribution is given by q_k, where $k=1,...,K$ indexes discrete events, and the distribution on a given plot is p_k, the cross-entropy measure is given by $CE = \sum_{k=1}^{K} p_k \ln(p_k / q_k)$ CE equals 0 if p_k and q_k are identical and becomes increasingly positive as p_k and q_k become increasingly dissimilar.

In addition to the reference case approach, there was strong consensus that a valuable perspective could be gained by examining changes in the FIA measures over time. Although sample designs changed from one inventory to the next, plots from earlier inventories were revisited in the 1971, 1982, and 1995 inventories

(844 plots were sampled in all four inventories). Thus, it is possible to assess plot-level changes in some of the proposed FIA measures over a period of almost forty years.

Table 2. Characteristics of forest biodiversity and measurement with FIA data

Forest Characteristic	Measure Available in FIA Data
1. Coarse woody debris	Tons/acre of woody debris (1995 inventory only) or number of standing dead trees
2. Native species composition and number	Density of trees by species and diameter class
3. Mast	Number of trees or volume/acre of important mast-producing species
4. Vertical diversity/layering	Distribution of trees by crown class
5. Degree of crown closure	Basal area by species over 1 inch dbh
6. Tree size	Diameter distribution of trees by species
7. Forest floor characteristics	Thickness of organic layer and depth to water
8. Soil productivity	Site productivity class, site index, and physiographic class
9. Diseases and pests	
10. Stream structure characteristics	
11. Age structure of landscape	Acreage by stand age by stand type
12. Frequency of old stands and structures	Combine basal area and tree vigor
13. Large blocks of contiguous forest	
14. Distribution of native forest communities	
15. Diversity of stand sizes and shapes	
16. Riparian zones	
17. Wildlife corridors	
18. Special habitats	
19. Public access	
20. Roads	
21. Conversion to forest and non-forest uses	Conversion rates by end use and landowner class

Table 3. Variables in the full data base for the 1995 Maine inventory.

#	Description
PLOT VARIABLES	
1	State code
2	Unit code
3	County code
4	Plot Number
5	Sample kind
6	PI class
7	Current month
8	Current day
9	Current year
10	Previous land use
11	Pervious month
12	Previous year
13	Cruiser number
14	Tallyperson number
15	Point history
16	Owner class
17	Disturbance since photo
ECOTYPE VARIABLES	
18	Species 1 - site index
19	DBH 1 - site index
20	Height 1 - site index
21	Specie 2 - site index
22	DBH 2 - site index
23	Height 2 - site index
24	Species 3 - site index
25	DBH 3 - site index
26	Height 3 - site index
27	Ecotype piece number
28	Left azimuth of ecotype
29	Corner azimuth of ecotype
30	Corner distance from PC to ecotype
31	Right azimuth of ecotype
32	Land use of ecotype
33	Forest type (field crews) of ecotype
34	Stand origin of ecotype
35	Stand size class of ecotype (field crews)
36	Stand age class (field crews)
37	Timber management class
38	Water on plot
39	Physiographic class
40	Slope of plot
41	Aspect of the slope
42	Terrain position
43	Stand history
44	Stocking class of all live trees
45	Stocking class of growing-stock trees
46	Percent of area for the ecotype piece
47	# if ecotype is within other ecotype
48	Ecotype number

#	Description
TREE AND REPRODUCTION VARIABLES	
49	Reproduction point number
50	Reproduction line number
51	Current tree number
52	Species code
53	Horizontal distance
54	Current diameter at breast height
55	Azimuth of tree from PC
56	Stem count at 3.7' repro plot
57	Stem count at 6.8' repro plot
58	Tree condition
59	Tree grade for sawtimber trees
61	Current cubic foot height
62	Current board foot cull
63	Board foot soundness
64	Current cubic foot cull
65	Cubic foot soundness
66	Crown ratio
67	Crown class
68	Tree damage class
69	Special damage code 1st occur.
70	Special damage code 2nd occur.
71	Special damage code 3rd occur.
72	Current tree class
73	Current merch class
74	Current tree history
75	Previous tree number
76	Previous diameter at breast height
77	Previous tree history
78	Previous tree class
79	Previous merch class
80	Special note of tree
81	Special note of tree
82	Special note of tree
CALCULATED VOLUMES & WEIGHTS	
83	Current gross cubic foot volume
84	Current net cubic foot volume
85	Current gross board foot volume
86	Current net board foot volume
87	Upper stem volume
88	Lower stem volume
89	Gross merchantable tree weight - dry
90	Gross total tree weight - dry
91	Net merchantable tree weight - dry
92	Net total tree weight - dry
93	Total tree weight - dry
94	Net upper stem weight - dry
95	Net lower stem weight - dry
96	Net branch weight - dry
97	Net foliage weight - dry
98	Net stump and root weight - dry

#	Description
99	Gross total tree weight - green
100	Net total tree weight - green
101	Gross merchantable tree weight - green
102	Net merchantable tree weight - green
103	Total tree weight - green
104	Net upper stem weight - green
105	Net lower stem weight - green
106	Net branch weight - green
107	Net foliage weight - green
108	Net stump and root weight - green
109	Previous gross cubic foot volume
110	Previous net cubic foot volume
111	Previous gross cubic foot volume
112	Previous net board foot volume
113	Current gross cubic foot volume - growth
114	Current net cubic foot volume - growth
115	Current gross board foot volume - growth
116	Current net board foot volume - growth
117	History kind for tree
118	Increment decrement (+ -)
119	Regressed total height
120	Hardwood/Softwood code
121	Commercial non-commercial code
122	Species grouped by 18 FIA classes
123	Species grouped by 28 EASTWIDE classes
124	Species grouped by 4 major classes
125	Wildlife mast tree code
126	Years between measurements
127	Current tree size
128	Previous tree size
129	Current diameter classes
130	Previous diameter classes
131	Current truncated diameter
132	Previous truncated diameter
133	Current numbers of trees
134	Previous numbers of trees
135	Growth numbers of trees
136	Basal area of tree
137	Total number of reproduction stems
138	Super county
139	Combined collapsed class
140	Growth collapsed class
141	Tot. area of small pieces of ecotype on a plot
142	Previous board foot height
143	Previous cubic foot height
144	Total height regression coefficient
145	Previous stand age
146	X UTM coordinate (null on this file)
147	Y TUM coordinate (null on this file)
148	UTM zone
149	Indicate if pt. Used in stocking **0-NO 1-YES**
150	Land use trend
151	"Generic owner class (20, 30, 40, etc.)"
152	"Owner group (1 = NF, 2- other public, etc)"
153	Current cubic foot volume as used in growth
154	Previous cubic foot volume as used in growth
155	Current board foot volume as used in growth
156	Previous board foot volume as used in growth
157	Cu.ft. volume growth class used for making tables
158	Annual cubic foot volume change
159	Bd.ft. volume growth class used for making tables
160	Annual board foot volume change
161	STATUS code for EASTWIDE
162	TCLASS for EASTWIDE
163	Total cubic foot volume change
164	Total board foot volume change
165	Absolute value of annual cubic foot volume change
166	Absolute value of annual board foot volume change
167	Negative CUBVP if tree is accretion
168	Negative BRDVP if tree is accretion
169	Number of forested points in ecotype
170	Number of trees in ecotype
171	Stocking class based on all live trees
172	Stocking classed based on growing stock trees
173	Stand size based on all live trees
174	Forest type based on all live trees
175	Forest type group based on all live trees
176	Previous forest type
177	All live stocking percent
178	Growing-stock stocking percent
179	Population expansion factor for current area estimates
180	Population expansion factor for current trees estimates
181	Population expansion factor for growth estimates
182	Longitude to the nearest 100 seconds
183	Latitude to the nearest 100 seconds

Source: U.S. Forest Service (1995).

We worked on the project for approximately six months, during which time we met four times with the FIA Committee to receive input and guidance. Initially, we worked only with the 1995 Full Data Base. We had envisioned spending most of our time on the reference case analysis; however, most of our effort was directed at refining the FIA measures of the forest characteristics (Table 2). In some cases, there were problems with the FIA data that prevented us from developing the proposed measures; in others, discussion of the results spawned new ideas about how to use the data. At the end of six months, we had worked on all 11 forest characteristics for which FIA data were available. In two cases (soil productivity, age structure of landscape), missing data prevented us from producing any results.

Most of the results are derived from the 1995 Full Data Base. The 1982 data were readily available only in the Eastwide Data Base format, and we encountered many problems trying to link these data to the 1995 data. First, as discussed above, the Eastwide Data Base contains a subset of the variables in the Full Data Base. In some cases, we could not construct measures for 1982 corresponding to those developed for 1995. Second, the Forest Service changed their algorithm for computing stocking between 1982 and 1995, and this meant that forest type designations were not consistent across the two inventories. Forest type information is essential for several of our measures. Finally, 844 plots listed as remeasured in the 1995 inventory did not appear in the 1982 data, for reasons too complicated to expand on here. Unfortunately, the missing plots are those that were sampled in 1959 and 1971.

III. RESULTS

This section presents selected measures of biodiversity developed from FIA data. Subsections are devoted to each of the forest characteristics outlined by the FIA committee (Table 2). Each subsection describes the FIA measure proposed by the committee, the measures that were examined, and a brief interpretation of the corresponding figures and charts. For some indicators, multiple measures are presented. Related statistical tables are included in an appendix.

In some cases, we display our results using maps that show selected characteristics of the individual FIA sample plots. The geographic coordinates of the plots recorded in the FIA database are intentionally rounded to preserve confidentiality. Nevertheless, we use the maps to portray general geographic trends or characteristics where the issue of precision is of less importance.

A. Overview

This subsection presents an overview of the Maine forest in terms of the current distribution of forest-type groups, the location of plots by forest-type group, changes in the forest-type distribution since 1982, and tree condition.

The USDA Forest Service classifies forest land into species groupings depending upon the species of trees that form a plurality of live-tree stocking. These forest types are further aggregated into nine different major categories of forest type groups that share closely associated species or site requirements. In Maine, the predominant forest-type groups are the northern hardwood and spruce-fir, which together account for 73% of the state's forest land. Aspen-birch and white pine–red pine forest type groups make up 20% percent of the forest, while four other forest-type groups each constitute 3% or less of the statewide forest (Figure 1). While there are no loblolly pine trees in Maine, the loblolly forest type group does include pitch pine forests that make up less than 0.1% of the statewide total.

As shown in Figure 2, the spruce-fir and northern hardwood forest type groups dominate the northern two-thirds of the state. White pine-red pine and oak-hickory forest type groups are more likely to be found in the southern portions of Maine. The third largest forest type group, aspen-birch, occurs throughout the state and is not shown on the map.

Changes in the species composition of the Maine forest between 1982 and 1995 are depicted in Figure 3. The FIA used different

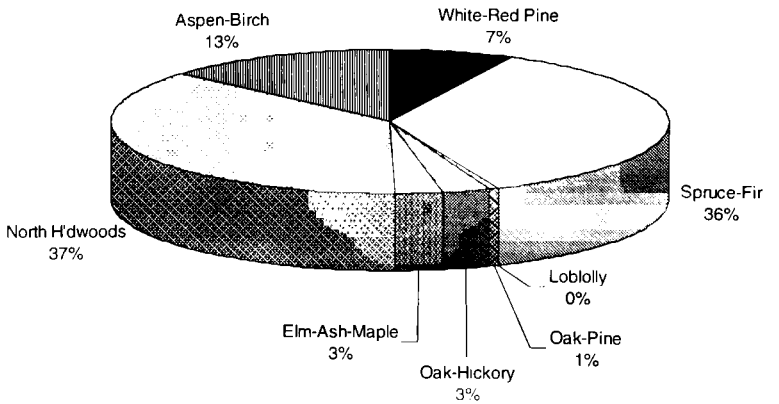

Figure 1. Acreages of Maine's forest by forest type.

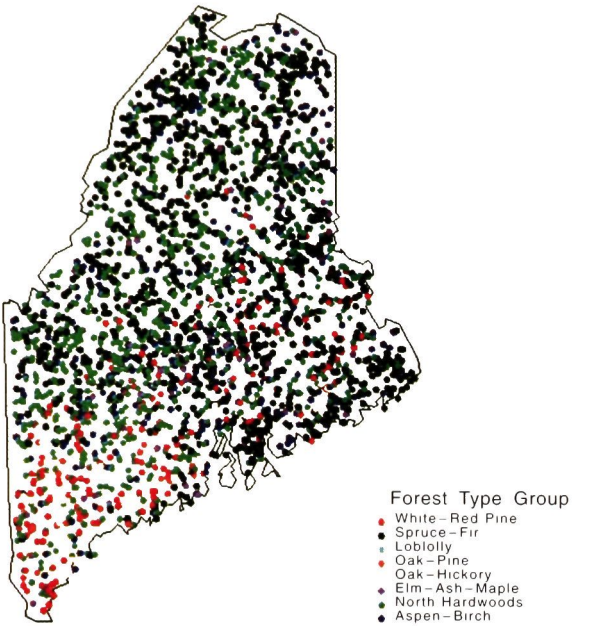

Figure 2. Forest-type groups in Maine's forest lands, FIA plots, 1995.

algorithms to determine forest-type groupings for the 1982 and 1995 inventories, and this means that the forest-type information found in the FIA databases is not comparable. However, corrected data is available in the inventory report for 1995 (Griffith and Alerich 1996) and these data were used to create Figure 3. The dominance of the spruce-fir and northern hardwoods forest type groups is plainly visible in the chart. It is also clear that these two important groups have experienced the greatest absolute change during the 13-year period between the two latest inventories. More specifically, in 1982 Maine had 7,563,700 acres of spruce-fir timberland. By 1995, this acreage had declined by more than 20% (a loss of 1,552,500 acres) to 6,011,200 acres. During that same time, the area of timberland in northern hardwood forest type groups grew by more than 16% (an increase of 903,200 acres), from 5,505,700 acres in 1982 to 6,408,900 acres in 1995. The greatest relative change took place in the number of acres in the elm-ash-red maple forest type group which increased by 41.5%. This represents an absolute increase of approximately 127,400 acres.

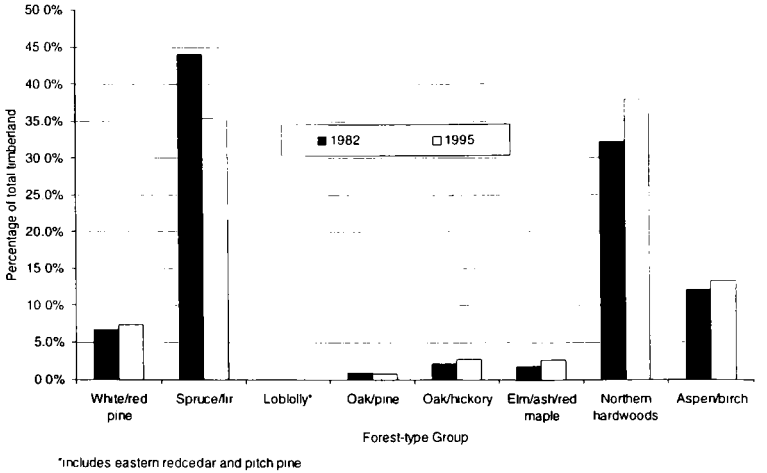

Figure 3. Area of Maine timberland by forest-type group, 1982 and 1995.

There were an estimated 3.6 billion trees in Maine's forests in 1995 that were 5.0 inches or greater diameter at breast height (dbh). Of those, approximately 3.1 billion (81.6%) were live trees with live, intact tops. A small number of live trees existed with broken or dead tops. The remaining dead trees, of which there were 0.5 billion, included standing snags and dead trees with intact or broken tops, and fallen dead trees that had not yet reached a stage of advanced decay. Roughly two-thirds of all dead trees were classified as snags (Figure 4). A snag is defined as "a dead tree, or what remains of a dead tree, that is at least 5.0 inches dbh and 4.5 feet tall and is missing most of its bark. Most often they will have been dead for several years—sometimes, for more than a decade" (US Forest Service 1995:65).

B. Coarse Woody Debris

Proposed FIA measure: Tons per acre of woody debris, or number of standing dead trees

An important indicator of biodiversity is the presence of dead trees and coarse woody debris that serve as habitat for many kinds of wildlife and as a food source for fungi, insects, and other decomposer organisms (Smith et al. 1997). Cavities in standing dead trees and snags up to 10 inches dbh provide homes for many

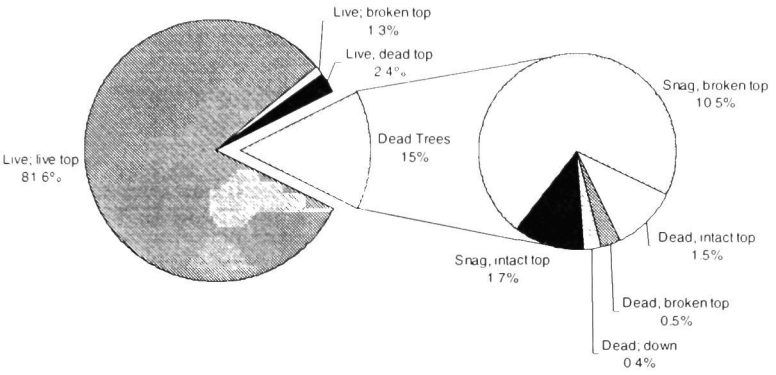

Figure 4. Trees in Maine's forests, by condition class on forest land, 1995.

bird species, while larger snags may be used simultaneously by a number of birds and mammals. Fallen trees and limbs are important sources of shelter for smaller species that do not climb or fly.

Data in the FIA database include counts of dead trees, by species, by size. In selected states, including Maine, the latest FIA inventory also measured coarse woody debris on the ground. Coarse woody debris consists of dead tree boles, limbs, and other woody pieces that are no longer physically connected to a living tree. At the time of this study, however, the coarse woody debris data was unavailable. As a result, the indicators in this section of the report rely primarily upon measures of dead trees. Many individual tree characteristics, including tree class and condition, are recorded in the FIA inventory only for trees at least 5.0 inches dbh. Therefore, the measures in this section relate only to trees of that size.

One classification of trees in the FIA database is depicted in Figures 5 and 6. This classification, taken from published statistical reports, is an indicator of overall tree quality for trees 5.0 inches dbh and larger. Live trees are categorized as preferred, acceptable, rough cull, or rotten cull. Dead trees are either salvable or nonsalvable, with snags falling into the category of nonsalvable. In 1982, approximately 11.5% of trees on Maine's timberlands were dead and nearly evenly split between salvable and nonsalvable. In 1995, the percentage of trees that were dead had risen slightly to 14.5%. The more notable change is in the composition of the dead

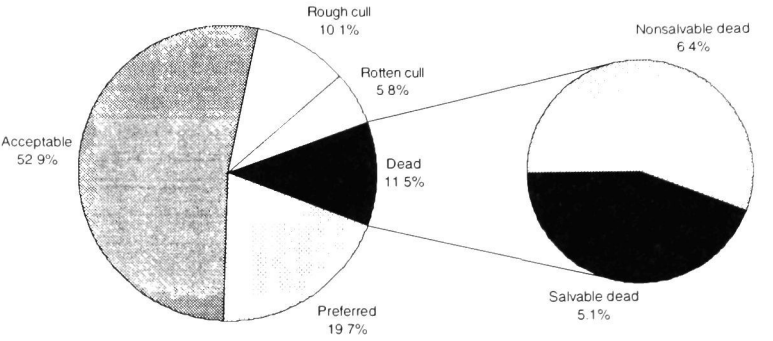

Figure 5. Trees in Maine's forests, 1982. All trees 5.0+ dbh, on timberland, by tree class.

trees. In 1995, the number of nonsalvable dead trees outnumbered the salvable ones by a ratio of nearly six to one.

Figure 7 combines the information from Figures 5 and 6 to more clearly show the absolute changes in the numbers of trees on Maine timberlands by tree class. While the focus of this section of the report is on dead trees, it is worth noting the very substantial and significant change that has taken place in the categories of live trees. At this time it is not clear if the reported numbers accurately represent this degree of change in actual quality of live trees or if an alternative explanation (e.g., changes in definition) exists.

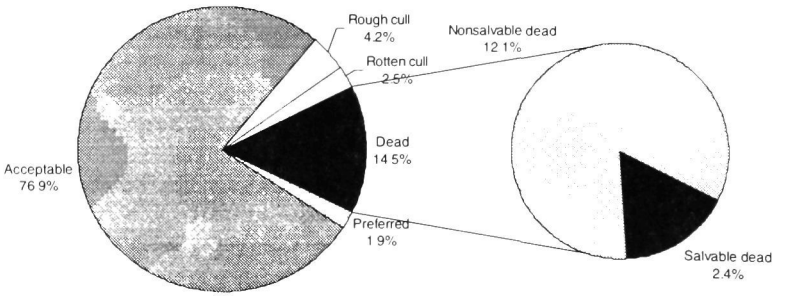

Figure 6. Trees in Maine's forests, 1995. All trees 5.0+ dbh, on timberland, by tree class.

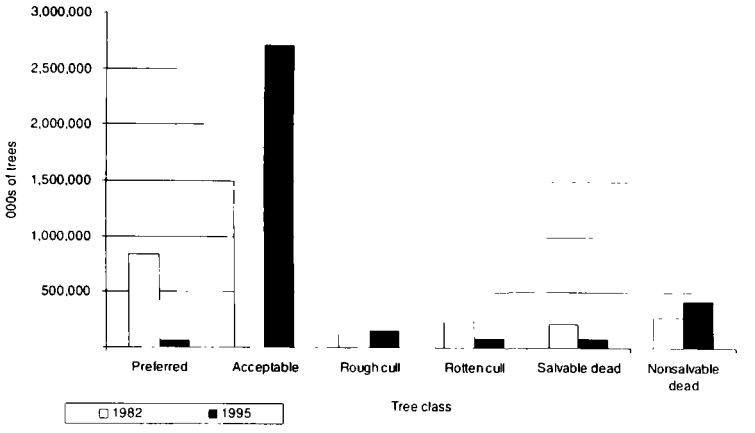

Figure 7. Trees in Maine's forests, 1982 and 1995. All trees 5.0+ dbh, on timberland, by tree class.

Another way in which dead trees are classified in the FIA database relates to the condition of the tree and the status of the top portion of the tree. Standing dead trees are listed as either dead or snags, with tops that can be either broken or intact. A fifth category exists for dead trees that are down and not in an advanced state of decay. Snag is a special classification included in selected state FIA inventories to indicate the presence of important wildlife habitat trees. They include standing trees that have been dead for several years and have lost most of their bark. In Maine, nearly 85% of the dead trees are listed as snags, and most of them are trees with broken tops. No other category represents more than 10% of the statewide total number of dead trees.

Figure 9 is a geographical representation of individual FIA plots that shows the density of dead trees on a per acre basis. The yellow points represent plots on which no dead trees at least 5.0 inches dbh were present. The green points are sample plots where the estimated number of dead trees per acre ranges from 1 to 49, and the black points are those plots where the estimated density of dead trees is at least 50 trees per acre. The only apparent geographic difference is in the highest density category. There are relatively fewer plots in the southern regions of the state where the density of dead trees exceeds 50 trees per acre.

The higher densities of dead trees in the northern region of the state are explained by the predominance of spruce-fir forest types

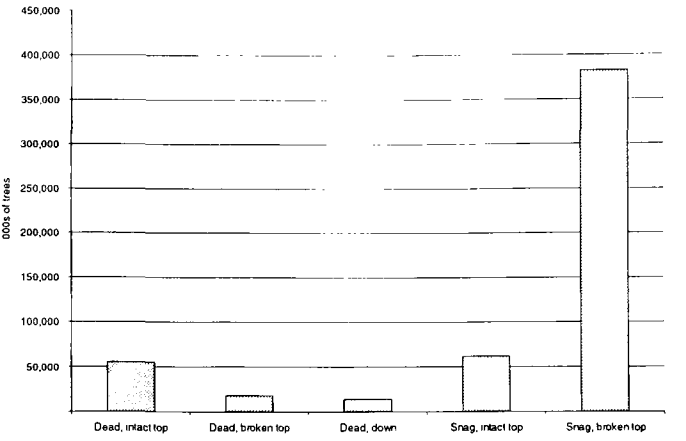

Figure 8. Condition of dead trees in Maine's forests. Condition class of all dead trees 5.0+ dbh, 1995.

in the north (see Figure 2). Spruce-fir stands tend to have higher densities of dead trees than other forest type groups, in part because of spruce budworm infestations prior to the 1995 inventory. Statewide, spruce-fir forests have 42 dead trees per acre, a density that is much higher than any other group and 45% higher than that found in the elm-ash-maple forest type group, which has the second highest density of dead trees.

Figure 10 portrays the numbers of trees and acreage associated with different densities of dead trees. The vertical bars represent the numbers of dead trees in each of the density categories that appear at the bottom of each vertical bar. The numbers of trees associated with the bars are read from the vertical axis at the left of the chart. Each vertical bar is divided into segments that represent different size categories of dead trees. The line in the chart connects the points that indicate the number of acres of forested land in each of the density categories. The number of acres is read on the vertical axis at the right of the chart.

The greatest total number of dead trees is found on those plots with 25 to 50 dead trees per acre, and most of those trees are between 5 and 10 inches dbh. This category accounts for 150 million of the total 534 million dead trees in the state. Fewer total trees are found on plots with higher densities owing to lower total acreage associated with the higher densities. The density category that

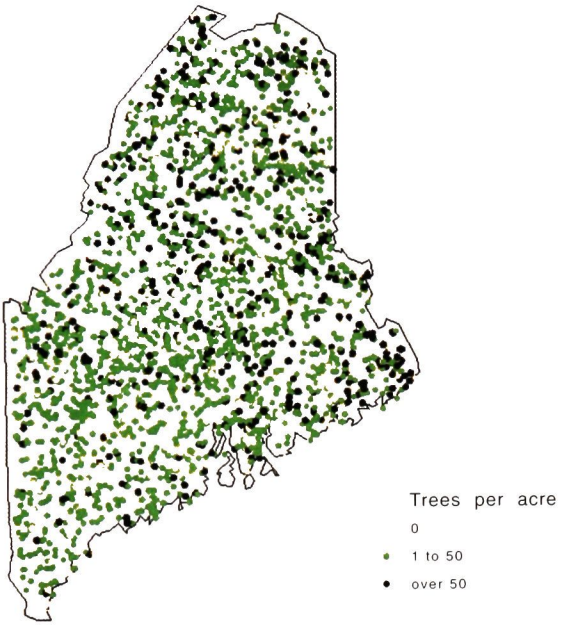

Figure 9. Dead trees in Maine's forests. Number of dead trees 5+ dbh, per acre, 1995.

occurs most frequently is found on plots with 1 to 25 dead trees per acre, with decreasing acres at higher density levels. Those plots account for 7.9 million of the total 17.7 million forested acres in the state. Approximately 2.6 million acres have no dead trees on them.

The change in the number of standing dead trees in the state from 1982 to 1995 is shown in Figure 11. The 1982 FIA Eastwide Data Base does not include condition details for dead trees. These data are taken from *Forest Wildlife Habitat Statistics for Maine 1982,* (Brooks et al. 1986) and *Forest Statistics for Maine, 1995* (Griffith and Alerich 1996). Each bar on the chart represents a different tree size category. The number of trees in the smaller and medium-size categories increased 6% and 12%, respectively, while the number of largest trees, those greater than 15 inches dbh, declined by 17%. In absolute terms, there were 28.1 million more of the smaller and medium-size trees (between 5 and 15 inches dbh) in 1995 than there were in 1982. During that period, there was a net loss of 3.3 million dead trees 15 inches dbh and larger.

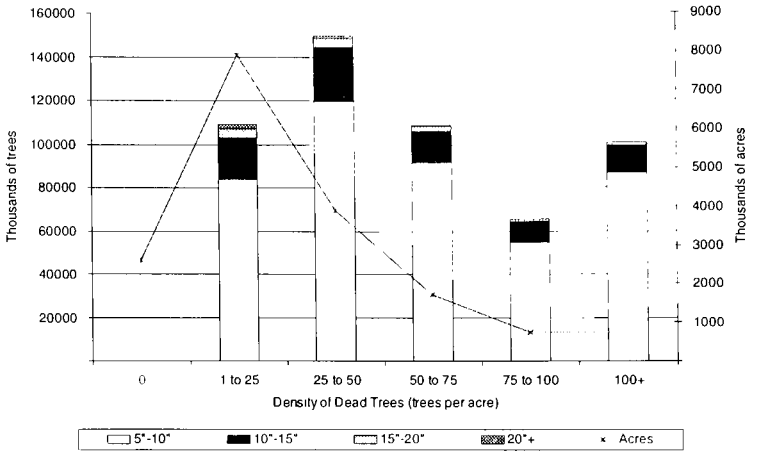

Figure 10. Dead trees in Maine's forests, 1995. Trees 5.0+ dbh, on forested land.

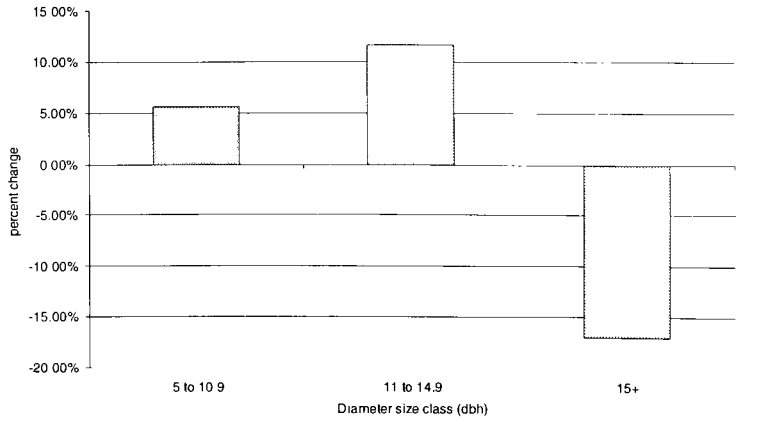

Figure 11. Change in number of standing dead trees, by size diameter class (dbh), Maine, 1982 to 1995.

C. Native Species and Composition

Proposed FIA measure: Density of trees by species and diameter class

Maine's forests are host to a number of different tree species native to the northeastern United States. Tree species composition has important implications for all organisms living in the forest (Hunter 1990). For example, tree species composition influences the food sources available for browsing mammals such as deer (see subsection D) and the availability of insects for foraging birds. At a more general level, deciduous forests tend to have richer biota than coniferous forests. Measures of biodiversity that can be derived from the FIA database are the number and distribution of various tree species.

The tree species found on Maine's forest lands are shown in Figure 12. This chart is a presentation of tree density for all live trees 5.0 inches D.B.H. and greater. Since the data are presented for all species on a statewide basis, the chart also depicts the frequency distribution for species in the state. The most numerous tree species is balsam fir with a statewide density of approximately 38 live trees per acre. Balsam fir is followed by red spruce, northern white cedar, and red maple, each with 23 to 25 trees per acre.

One facet of biodiversity is the variety of living organisms within an ecological system. While trees are the defining feature of a forest ecosystem, many other species contribute to the diversity of the ecosystem, and the presence of many tree species does not necessarily translate into diversity among other living organisms. With these caveats, we present a measure of tree species richness in Figure 13, defined as the number of tree species present on each of the FIA plots. Tree species richness ranges from zero to fourteen. Figure 13 shows the distribution of plots by tree species richness in the 1982 and 1995 inventories. In 1982, the greatest number of plots (representing 3.75 million acres) had six tree species. In the 1995 inventory, the peak occurs at the same number of species (six) but this corresponds to fewer acres. There is a discernible shift in the distribution to the right in 1995 as compared to 1982, indicating an overall increase in tree species richness.

The species richness distribution for 1995 that was presented in Figure 13 is depicted geographically in Figure 14. This map portrays the individual FIA sample plots according to the number of different species of trees at least 1.0 inch dbh. The yellow points are those plots with fewer than five different species. The green points represent sample plots with five to nine different species,

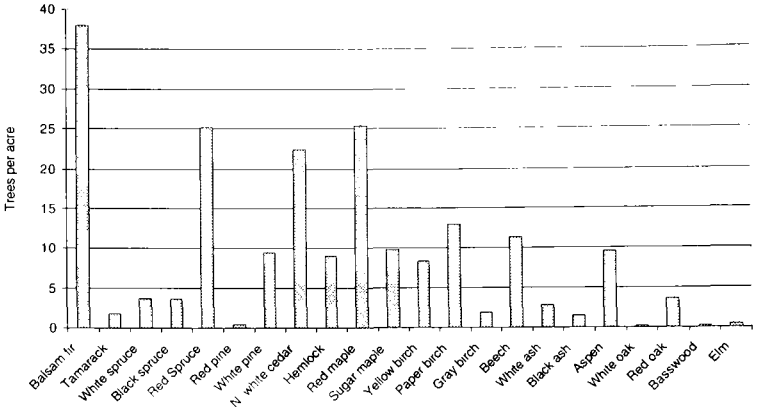

Figure 12. Live trees in Maine's forests. Trees per acre, 5.0+ dbh, by species, statewide, 1995.

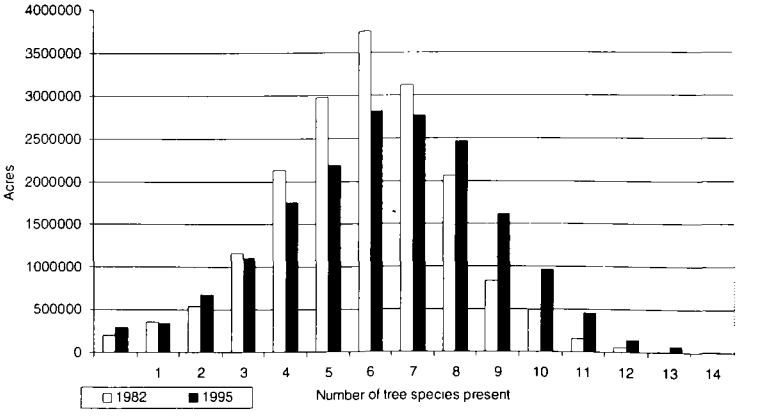

Figure 13. Acres of forest land in Maine, by number of different tree species 1"+ dbh, present on FIA plots, 1982 and 1995.

and the black points are plots with 10 or more different species. The greatest diversity of tree species occurs in an east-west band across the lower third of the state. In this region, the spruce-fir and northern hardwood forest type groups that dominate the northern two-thirds of the state overlap with the oak-pine and elm-ash-maple forest type groups that are found in the southern regions of Maine. A study by Boone (1996) finds that this region supports the greatest numbers of breeding birds.

Figure 15 shows the changes in the numbers of live trees on Maine forest land between 1982 and 1995, by diameter class. It indicates a fairly consistent trend among trees 5.0 inches dbh and greater, where the greatest declines occurred among the smaller size trees and the largest increases occurred among the larger size trees. This is not the case among individual species. In appendix Figures C1 to C21, we report the percentage changes in the number of live trees by diameter and species. It should be noted that these charts depict percentage changes and that in instances where the numbers of trees are small, large percentage changes do not necessarily indicate large absolute changes. A table with absolute changes associated with each of these charts is also found in the appendix Table C2.

The four most numerous tree species in the Maine forest are balsam fir, red spruce, northern white cedar, and red maple. The percentage changes by size class for these four species show substantial variation from the pattern in Figure 15, and from each other (Appendix Figures C1 to C21). The number of balsam fir trees over 5 inches dbh declined by more than 40% in every size category except one. The number of live red spruce trees declined in every size category over 1 inch dbh. The changes in northern white cedar trees resembles the pattern in Figure 15 except for negative changes in the three largest size categories. Red maple trees increased in number in every size category except those 5 to 6.9 inches dbh, which saw a very slight decline.

D. Mast

Proposed FIA measure: Number of trees or volume per acre of important mast producing species

Mast is the seed produced by woody stemmed, perennial plants and includes both fruits (soft mast) and nuts (hard mast). Mast is valuable for the food source it provides to birds and mammals. The FIA database includes a species-specific mast variable that indicates if tree or shrub species produce nuts, seed, or berries. Discussion among FIA committee members narrowed the focus to the most important mast producing trees: oak, beech, and conifers.

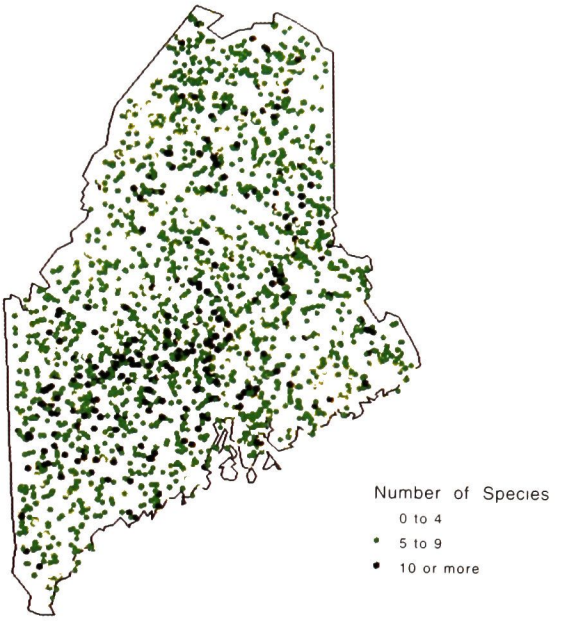

Figure 14. Number of tree species on Maine forest lands. Number of different tree species, 1+ dbh, present on FIA plots, 1995.

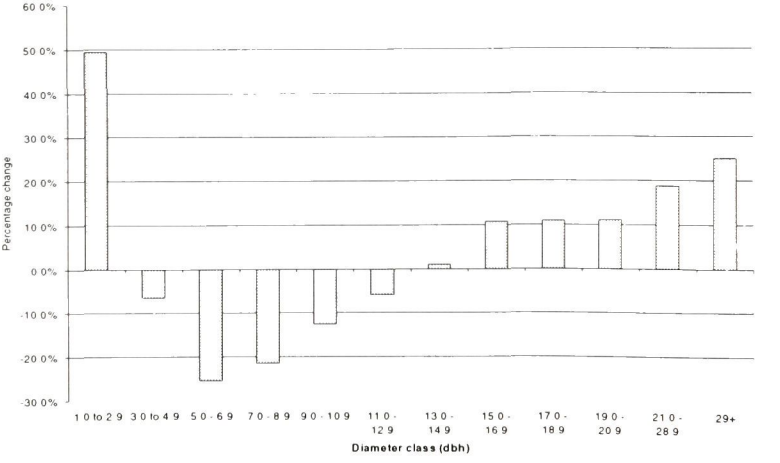

Figure 15. Change in number of live trees on timberland, by diameter class, Maine, 1982 to 1995.

There are several factors that affect the mast production of trees, including age, vigor, and site conditions. Since the FIA inventory does not contain any data that indicates the amount of mast being produced by an individual tree, we chose to examine the numbers of trees that have the potential to produce mast. The age variable in the FIA data is largely missing, and, therefore, size is used as a proxy for age, recognizing that other factors besides age can determine the size of individual trees. Trees with less competition, and crowns that are well exposed to sunlight tend to be heavier producers of mast. We define mast-potential trees as live, open, dominant, or co-dominant trees that are at least 5 inches dbh. It has been suggested that crown ratio be applied as an additional criteria for the determination of mast-potential trees. On the basis that more vigorous trees (i.e., higher crown ratios) are better producers of mast, additional work might focus on determining appropriate crown ratio cut-off points for the various tree species examined here.

The FIA crown class variable indicates if a tree is open grown, dominant, codominant, intermediate, or overtopped. Open grown trees have no competition, and their crowns receive full light from above and from the sides throughout most of their lives. Dominant trees have crowns that extend above the forest canopy and receive full light from above and partly from the sides. Codominant trees have crowns that form the canopy and receive full sunlight from above, but little from the sides. Intermediate trees are shorter than dominants or codominants, but with crowns that are either below or extend partly into the forest canopy. These trees receive little direct light from above and none from the sides. Overtopped trees are suppressed by the lack of direct light either from above or from the sides. Their crowns are entirely below the forest canopy.

As depicted in Figure 16, most mast-potential oak trees are found in the southern region of the state. The yellow points are plots with no mast-potential oak trees. The green points are plots where the basal area of mast-potential oak trees is between 1 and 25 square feet per acre, and the black points indicate plots with at least 25 square feet per acre of mast-potential oak trees.

Figures 17 and 18 show the changes that have taken place in the numbers of oak trees in Maine, by diameter size class of the trees. The initial examination of mast characteristics in Maine focused solely on looking at live trees, regardless of crown class (Figure 17). Although the analysis eventually incorporated crown class as a selection criteria (Figure 18), both charts are included in this report because they show an interesting pattern that also emerges with the other important mast-producing species. As oak trees declined slightly

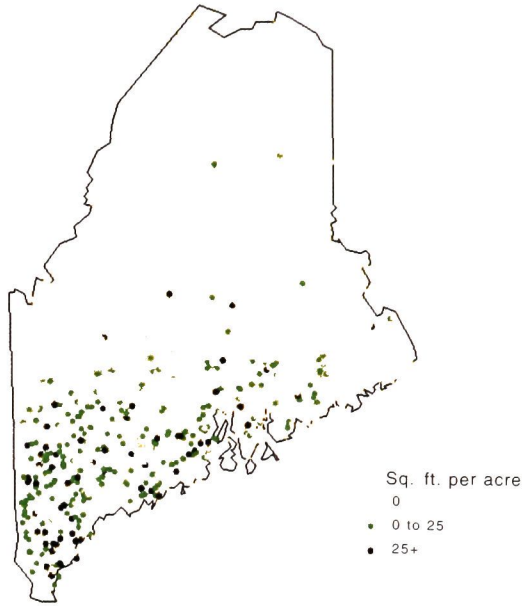

Figure 16. Mast-potential oak trees on Maine forest lands. Basal area of live, open, dominant and co-dominant, 5+ dbh trees, 1995.

among the smallest trees, those between 5.0 and 6.9 inches dbh, and exhibited generally larger percentage increases as tree size increases. When we limit the analysis to open, dominant, or co-dominant crown class trees, as in Figure 18, the number of trees in nearly all size classes exhibit higher percentage increases. The same pattern is found with beech trees and conifers. The numbers of mast-potential trees either declined less than, or increased more than, the numbers of live trees in corresponding size classes.

The mast-potential beech trees are found primarily in an east-west swath across the middle portion of the state, although plots with high basal area of mast-potential beech trees also occur in the northern reaches of Aroostook County and in some mid-coastal areas (Figure 19). Between 1982 and 1995, the number of smaller beech trees (those between 5.0 and 10.9 inches dbh) increased slightly, while the number of large-sized trees decreased. As with oak trees, mast-potential beech trees increased more than all live beech trees (Figures 20 and 21). Indeed, mast-potential beech trees of all sizes but the very largest increased in number between 1982 and 1995.

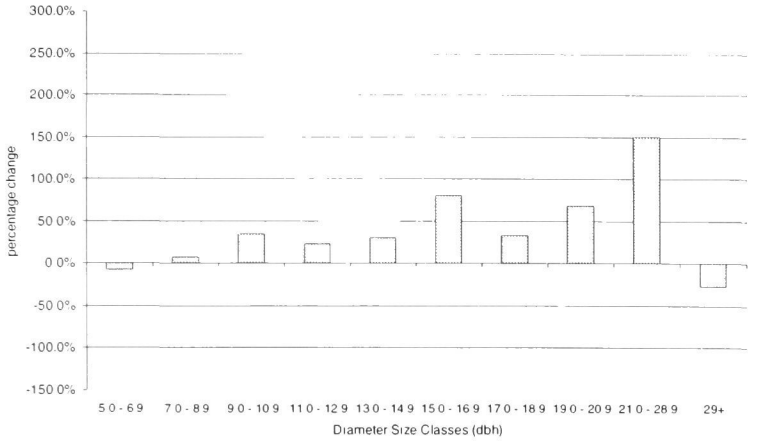

Figure 17. Percentage change in number of live oak trees on Maine timberland, by size class, from 1982 to 1995.

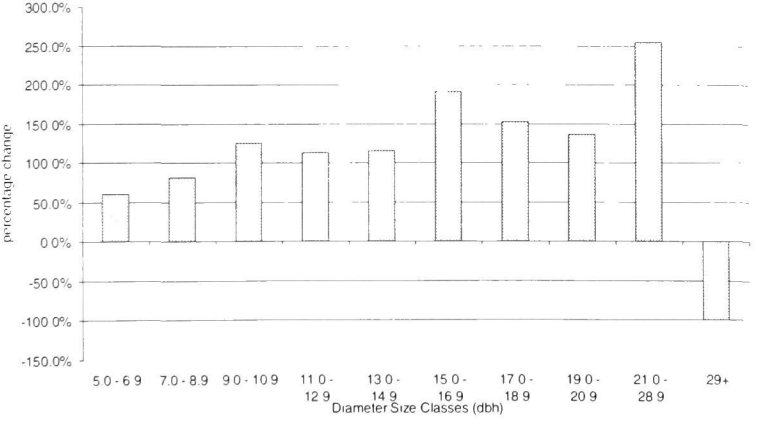

Figure 18. Percentage change in mast-potential oak trees on Maine timberland, by size class, from 1982 to 1995.

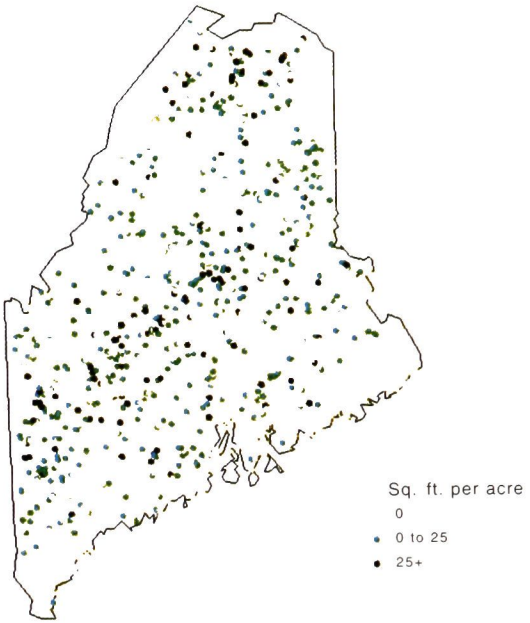

Figure 19. Mast-potential beech trees on Maine forest lands. Basal area of live, open, dominant and co-dominant, 5+ dbh trees, 1995.

As depicted in Figure 22, mast-potential coniferous trees are evenly spread across the state. Figures 23 and 24 show the percentage changes in the number of live and mast-potential coniferous trees, respectively. The numbers of live coniferous trees smaller that 15 inches dbh declined between 1982 and 1995, while the number of larger trees increased slightly (Figure 23). Mast-potential coniferous trees exhibited substantial percentage increases among trees greater the 9.0 inches dbh, and declined slightly among smaller trees.

In addition to the mast produced by tree species, many shrubs act as a food source for browsing animals. Numbers of tree seedlings and saplings, and number of shrub stems are counted in the FIA inventory. Figure 25 shows the change in the number of seedlings, saplings, and shrub stems between 1982 and 1995, by browse preference class. The readily and frequently browsed species exhibited substantial increase during that time period, while there was little change in the infrequently browsed species and a large decline in the species that are of questionable browse value. Species that are not classified for browse preference exhibited a large increase.

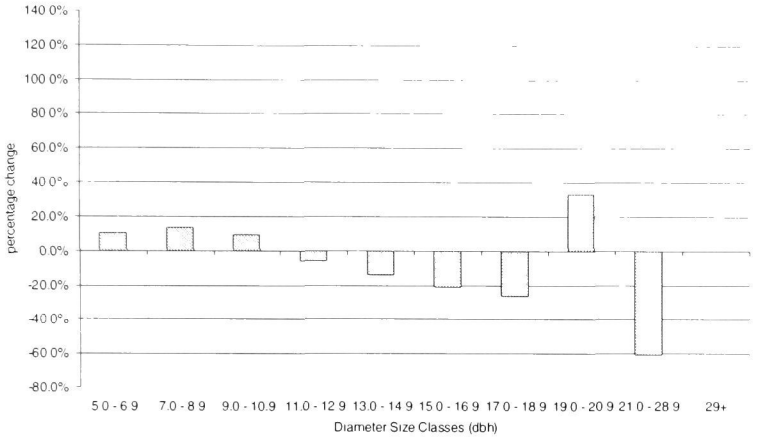

Figure 20. Percentage change in number of live beech trees on Maine timberlands, by size class, from 1982 to 1995.

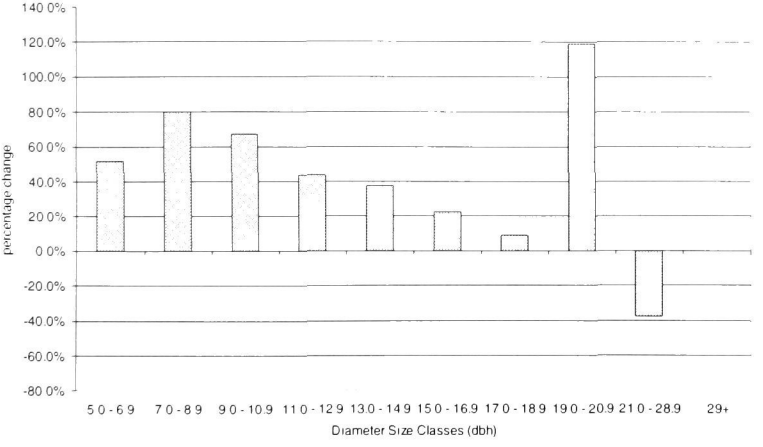

Figure 21. Percentage change in mast-potential beech trees in Maine forests, by size class, from 1982 to 1995.

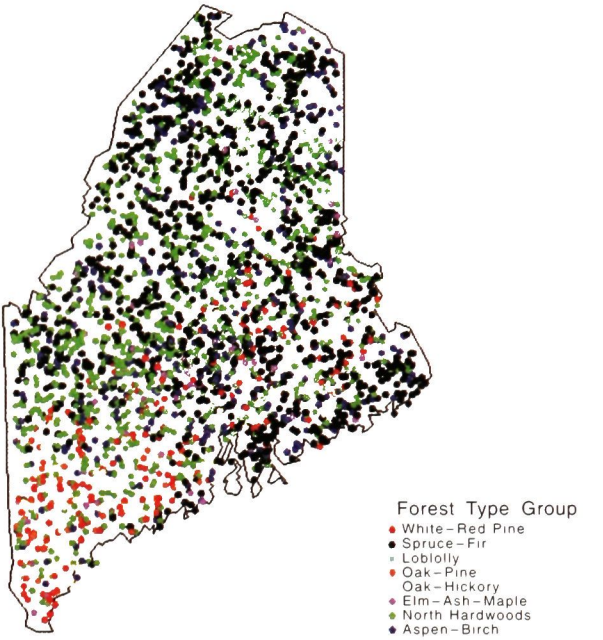

Figure 22. Mast-potential conifers on Maine forest lands. Basal area of live, open, dominant and co-dominant, 5+ dbh trees, 1995.

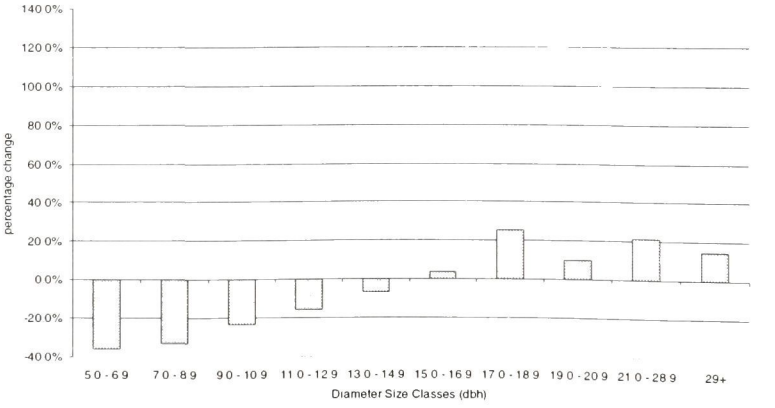

Figure 23. Percentage change in number of live conifer trees on Maine timberland, by size class, from 1982 to 1995.

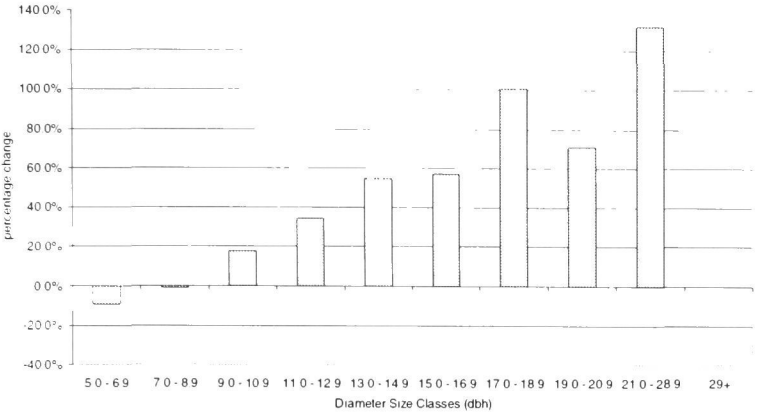

Figure 24. Percentage change in mast-potential conifer trees in Maine forests, by size class, from 1982 to 1995.

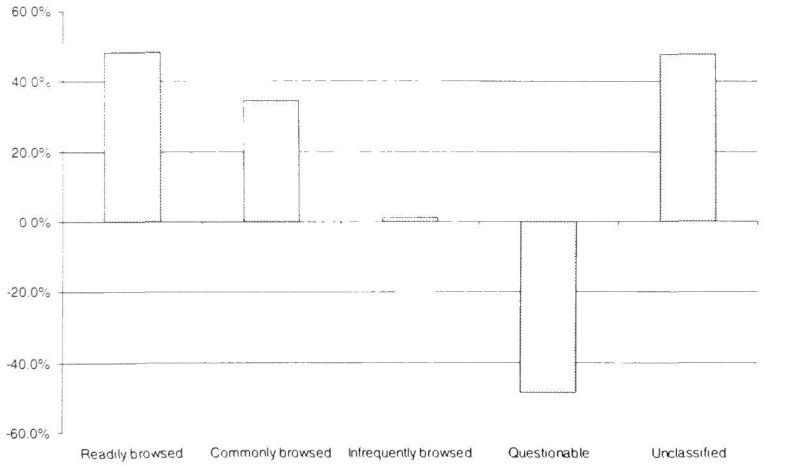

Figure 25. Percentage change number of shrubs, seedlings, and saplings, by browse preference class, Maine, 1982 to 1995.

The Maine Department of Inland Fisheries and Wildlife has identified the shrub species that white-tailed deer prefer for browse during the winter season in Maine. The density of readily browsed and commonly browsed species is shown in Figure 26. Generally, these species are found at higher density levels in the northern half of the state.

E. Vertical diversity and layering

Proposed FIA measure: Distribution of trees by crown class.

The vertical structure of the forest is important for biodiversity because of its role in defining niches (Hunter 1990). A well-stratified forest provides a variety of niches that can be occupied by a diverse array of plants and animals. In this subsection, we examine vertical structure in Maine's forest by exploring the use of crown class and tree height information. The crown class variable

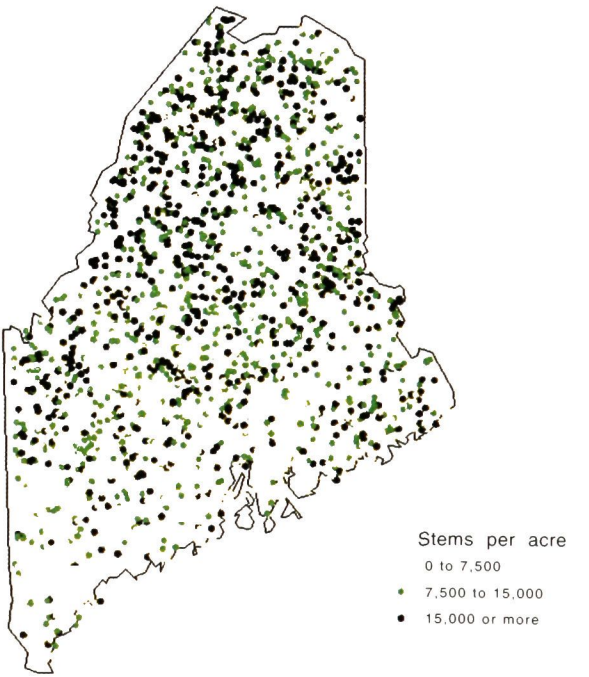

Figure 26. Browse density on Maine forest lands. Density of readily and commonly browsed species for deer, 1995.

in the FIA database reflects, to some extent, relative tree height, but its primary focus is on the degree to which individual trees compete for sunlight (see subsection D for definitions of the crown classes). Our tree height measures are presented only for the 1995 inventory because the source of our 1982 data, the Eastwide Data Base, does not contain this information.

More than 60% of the trees in Maine's forest are classed as codominant (Figure 27). Since these trees make up the general level of the forest canopy, there is likely to be little vertical variation among them. Approximately 18% of the trees are dominant, while roughly the same proportion are intermediate trees. Five percent of the trees are overtopped.

An alternative approach for more directly measuring vertical diversity is to examine the distances between the tallest and the shortest trees on the individual sample plots. The effect of a single large and/or short tree, however, might give a misleading picture of the vertical structure of the plot. One way to overcome this problem is to examine the distance between the tree at the 25th quartile of all tree heights on a plot and the tree at the 75th quartile of all tree heights on the plot.This provides a measure of the minimum vertical difference between the shortest one-fourth of the trees and the tallest one-fourth of the trees. The results of this analysis are presented in Figure 28. Because tree height data is

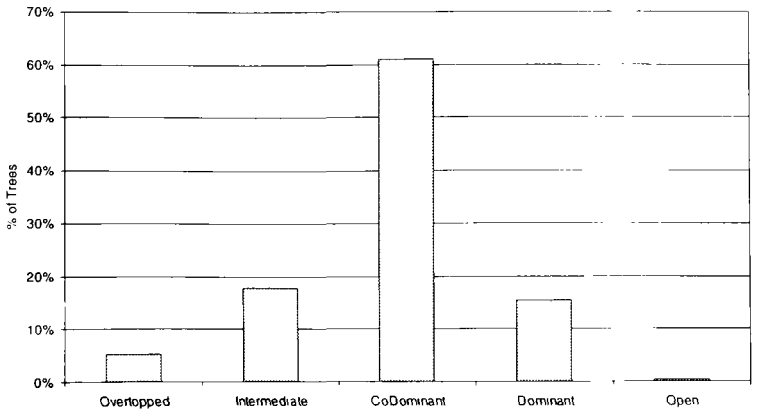

Figure 27. Crown classes in Maine's forests. Distribution of all live trees, 5.0+ dbh, 1995.

available in the FIA data only for trees 5.0 inches dbh and greater, this analysis excludes the smallest trees found on most plots.

On nearly 10.5 million acres of forest lands, the distance between the 25th and 75th percentiles of tree height is less that 15 feet, and on more than one million acres the difference is less than 5 feet. Conversely, there is a height difference of at least 21 feet between the bottom quartile of trees and the top quartile of trees on more than 2.5 million acres of forest land.

F. Degree of crown closure

Proposed FIA measure: Basal area by species over 1.0 inch dbh

Crown closure refers to the extent to which the forest canopy covers the ground below it. The canopy provides protective cover for many species of birds and mammals, and as a thermal cover, reduces solar heating during the day and radiational cooling at night. The FIA committee suggested total basal area of live trees as an indicator of crown cover. In later discussions, the emphasis shifted to open, dominant and codominant trees as they are the more important components of the general forest canopy.

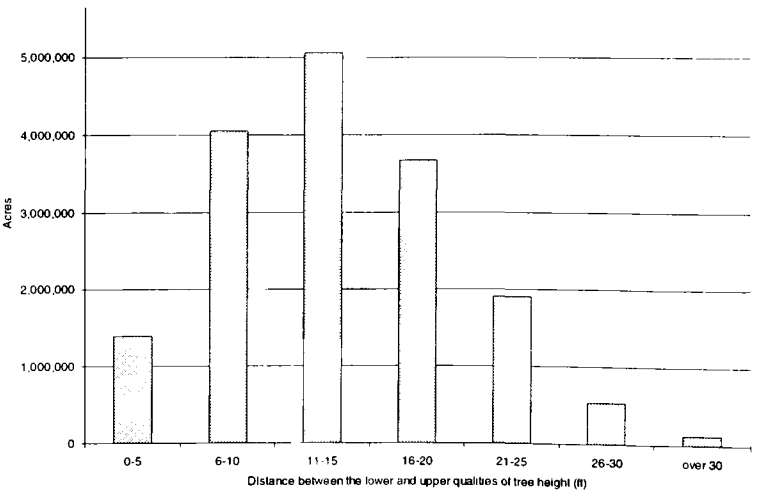

Figure 28. Vertical diversity of Maine's forests. Acres of forest land, by vertical distance between the 25th and 75th percentile tree heights, 1995.

Figure 29 shows the acres of forest land in 1982 and 1995, by the total basal area of all live trees 5.0 inches dbh and greater. The two distributions show that there was more acreage in 1995 at the lower basal area levels than there was in 1982. On a statewide basis, this indicates a decline in acres with higher basal areas. A similar analysis of basal area among open, dominant and codominant trees produces a different result (Figure 30). Among those trees that form the general forest canopy, there appears to have been a substantial increase in acreage between 1982 and 1995 among forest plots that have 75 square feet or more of basal area. At lower basal area levels, there were declines in acreage. Figure 31 shows no apparent geographic pattern in basal area levels.

Figure 32 examines the Maine forest by basal area categories, which are further disaggregated by forest type groups. With two exceptions, the acreage for individual forest type groups appears to remain a constant proportion of total acreage in the basal area category. One difference is that the acreage of aspen-birch forests, represented by the top segment of the bars, generally decreases as the level of basal area increases. Conversely, the acreage of white-red pine forests, the bottom segment of each bar, increases quite steadily as the basal area level increases.

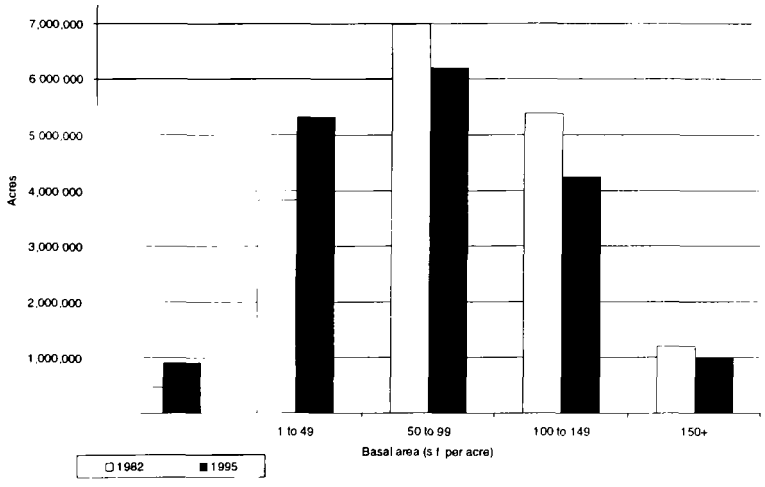

Figure 29. Basal area in Maine's forests. Acres of forest land, by basal area of all live trees 5.0+ dbh.

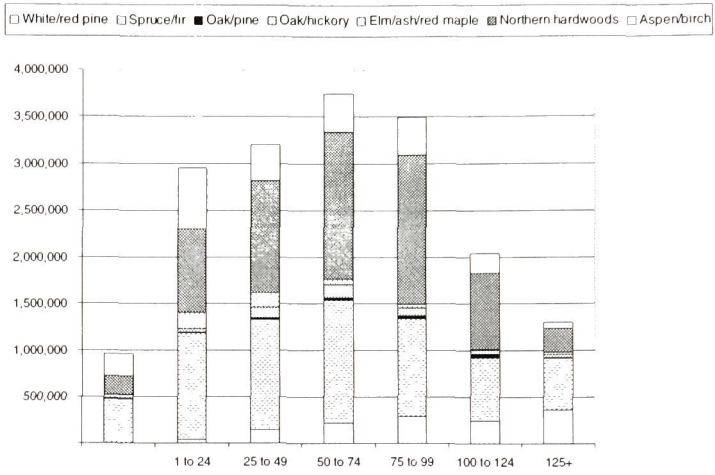

Figure 30. Basal area in Maine forests. Acres of forest land, by basal area of all live, open, dominant and codominant trees, 5.0+ dbh, Maine.

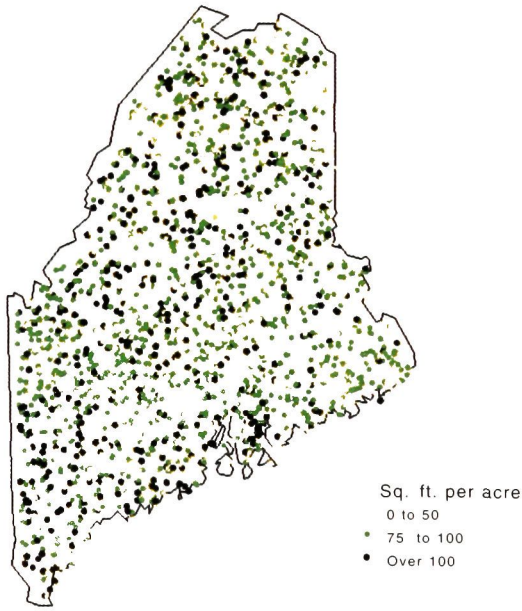

Figure 31. Crown closure on Maine forest lands. Basal area of live, open, dominant and codominant trees, 5.0+ dbh, 1995

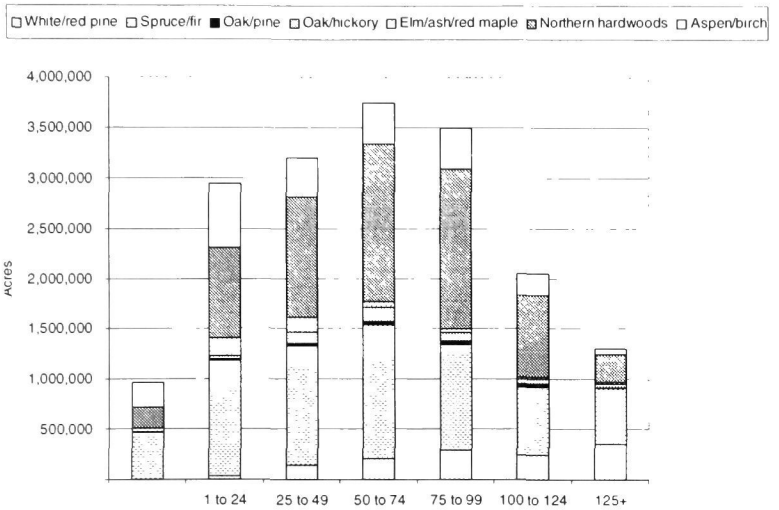

Figure 32. Basal area in Maine's forests. Acres of forest, by basal area of live trees, 5.0+ dbh, by forest-type group, 1995.

G. Tree Size

Proposed FIA measure: Diameter distribution of trees by species

Stand structure and tree species composition are two important factors affecting habitat quality. Variations in the vertical dimension and tree species diversity have been addressed in previous sections. The distribution of tree sizes is an additional consideration because larger trees, usually corresponding to taller and older trees, provide different habitat from smaller trees. Ecologists have reached different conclusions on the matter of when in the successional stage species diversity is the greatest (Hunter 1990). One perspective is that representation of different successional stages across the forest landscape will allow for the greatest species diversity.

Unfortunately, most of the data on stand ages is missing from the FIA databases. We have chosen to use tree size as a surrogate for age, recognizing the limitations of this approach (e.g., an old stand could have small diameter trees because of site conditions or stagnant growth). Diameter class distributions are presented for each of the tree species in Maine for 1982 (Figure 33) and 1995 (Figure 34). As shown in an earlier chart (Figure 12), the most

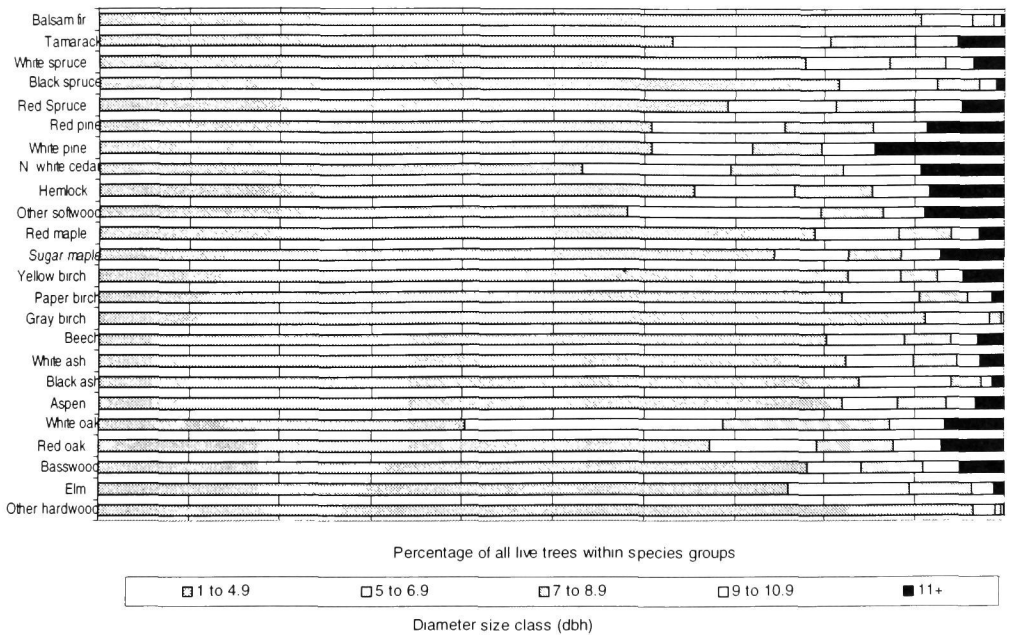

Figure 33. Size of trees in Maine's forests. Diameter distribution of live trees, by species, Maine, 1982.

numerous tree species in Maine are balsam fir, red spruce, white cedar, and red maple. With respect to balsam fir and red spruce, the period from 1982 to 1995 saw an increase in the proportion of smaller trees and a decrease in the proportion of larger trees. The reverse is true for white cedar, while there was little change in the size distribution of red maple.

In 1982, there were three tree species for which more than 80% of the trees were less than 5.0 inches dbh: gray birch, beech, and basswood. By 1995, the number of species meeting this criterion tripled to nine species: balsam fir, black spruce, yellow birch, paper birch, gray birch, beech, white ash, black ash, and aspen.

H. Forest Floor Characteristics

Proposed FIA measure: Thickness of organic layer, and depth to water

The forest floor plays an important role in influencing forest biodiversity, as habitat for numerous species of insects and microscopic organisms and as a source of soil nutrients for forest plants. Forest soils data are collected as part of the FIA inventory; however, the data were not included in the FIA data sets. The soils data were provided separately and linked to the FIA plots by plot number. Unlike the forest inventory data, the soils information is not collected on re-measured plots. Presumably, this is because soil profiles do not change appreciably over short periods of time. The soils information for some plots was recorded in 1982, while the information for the most recently inventoried plots was recorded in 1995. The complete soils database, then, is a mixture of 1982 and 1995 data. Therefore, we make no attempt to assess changes in forest floor characteristics over time.

Figure 35 shows spatial differences in the depth of the organic layer defined as the thickness of decayed plant material not including unincorporated matter that is identifiable as leaves and twigs. Approximately 35% of the forested land has an organic layer that is less than 2 inches thick. This acreage is more or less uniformly spread across the state, with a slightly higher concentration of such soils in the central region. At the other end of the spectrum, approximately 14% of the forested land has an organic layer that is more than 6 inches deep. These soils are found primarily in the northern two-thirds of the state.

Soils that are continually wet develop a spotted appearance called mottling. The presence of mottling is generally used as an indicator of poorly drained soils. The shorter the depth to mottling, the more poorly drained is the soil. Figure 36 shows that most soils

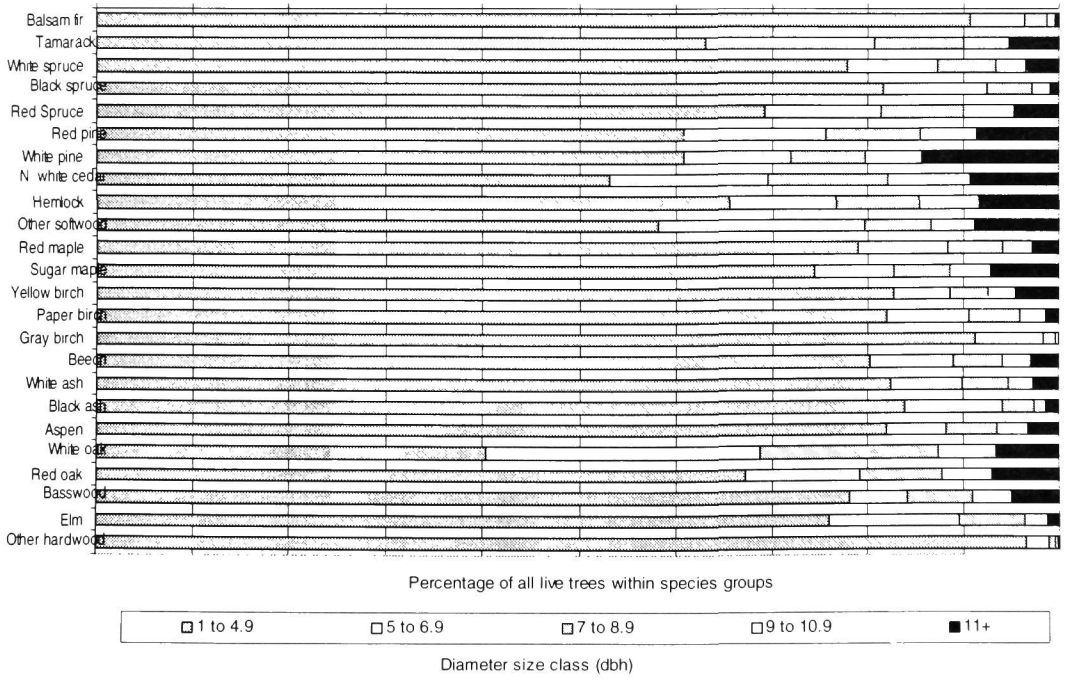

Figure 34. Size of trees in Maine's forests. Diameter distribution of live trees, by species, Maine, 1995.

in Maine's forests show no mottling at a depth of at least 20 inches. Of the plots that do show mottling, less than 5% (903,000 acres) exhibit mottling near the suface (less than 5 inches deep). Most of the plots exhibit mottling at a depth greater than 20 inches.

I. Frequency of Old Stands and Structures

Proposed FIA measure: Combined basal area and tree vigor.

Old growth forests are valued for the particular habitat elements and structural characteristics that they provide. The presence of large den trees, snags, and fallen logs, and a mature canopy with its gaps and complex vertical structure represent a community-level ideal for biological diversity. Individual characteristics of old-growth forests can be created through management practices, but the intricate interrelationships that define old-growth forests develop naturally 150 to 250 years after a major disturbance. In their assessment of non-marine biodiversity in Maine, Gawler et al. (1996) find that natural forests are not well represented in Maine and that older forests of all types are becoming uncommon.

The FIA database contains an age variable that applies to individual stands of trees; however, as noted above, these data are missing for most (80%). To measure tree vigor, we examined crown ratios as an indicator of tree vigor. In addition, discussions within the FIA committee led to other indicators that might help to identify old structures.

Figure 37 shows the total basal area of trees within varying crown ratio categories. Crown ratio indicates the percentage of total tree height that supports a full, live, green, healthy foliage that is contributing to tree growth. Generally, plots with a lower average crown ratio tend to have larger average tree diameters and a higher density of dead trees per acre.

The greatest amount of basal area is found in those trees with a crown ratio of 30% to 39%. Trees with less than 40% crown ratio account for nearly two-thirds of the total basal area among trees greater than 5 inches dbh. The amount of basal area at lower crown ratios drops off sharply. Less than 6.5% of total basal area occurs in trees with less than 20% crown ratio.

Crown ratio is a characteristic of individual trees. To portray this information on a plot level basis, the average crown ratio weighted by basal area was calculated. The result is shown geographically in Figure 38. Very few plots exhibit an average crown ratio greater than 66%. Those with an average crown ratio between 33% and 66% occur evenly across the state, as shown by the green points on the map. Plots with an average crown ratio less than 33% are shown as yellow points and are not as evenly dispersed.

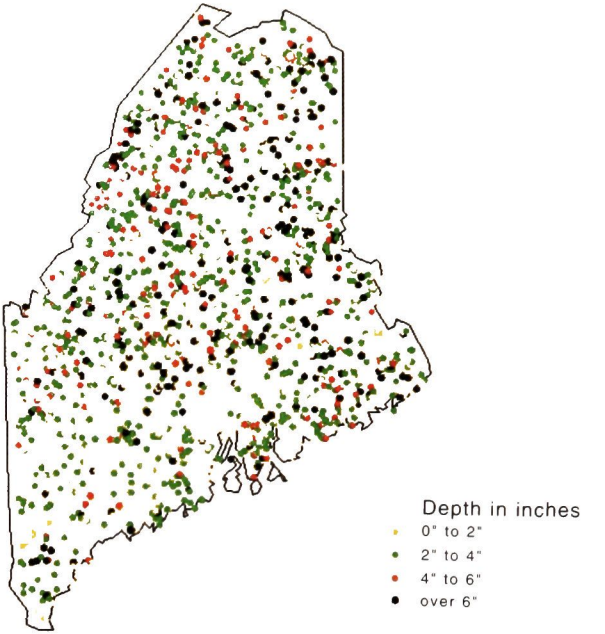

Figure 35. Forest floor characteristics in Maine. Depth of the organic layer.

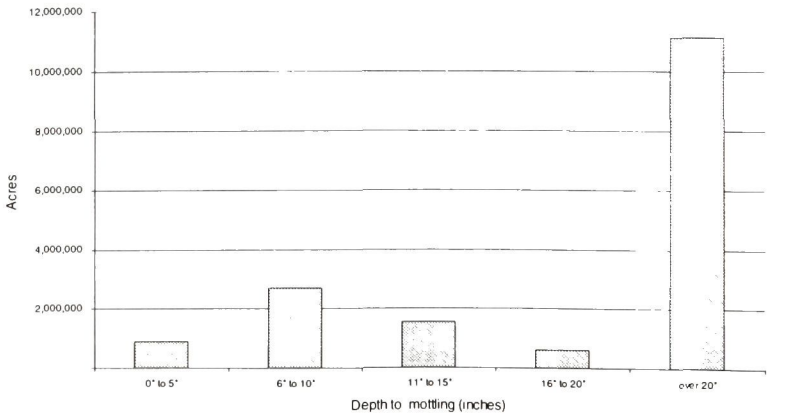

Figure 36. Forest floor characteristics in Maine. Depth to water.

In addition to identifying characteristics of older trees, members of the FIA committee recommended measures that might serve to locate older stands. Among the suggested stand characteristics were higher levels of total basal area, higher densities of dead trees, presence of large trees from selected species, and designation as a sawtimber stand. The selected species included white spruce, hemlock, yellow birch, sugar maple, white ash, and black ash. Old growth forests are among the most complex of forest structures and the measures presented here represent a preliminary effort to use indicators available in the FIA database.

Two sets of criteria were applied to the data to identify "older" and "oldest" stands. The "older" stands were defined as plots that meet all of the following three conditions: (1) have a total basal area of at least 100 square feet per acre; (2) have five or more total trees per acres that include white spruce or hemlock trees at least 18 inches dbh and yellow birch, sugar maple, white ash or black ash trees that are least 20 inches dbh; (3) have five or more dead trees per acre that are least 15 inches dbh.

The stands defined as being "oldest" were identified using the same criteria but with these more stringent thresholds: (1) a total basal area of at least 150 square feet per acre; (2) have five or more total trees per acres that include white spruce or hemlock trees at least 20 inches dbh and yellow birch, sugar maple, white ash or black ash trees that are least 24 inches dbh; (3) have five or more dead trees per acre that are least 15 inches dbh.

Figure 39 shows the location of the plots identified using these criteria. The "older" plots are shown as the green points and the "oldest" plots are represented by the black points. The plots identified by the "older" criteria correspond to 473,028 acres; the "oldest" plots represent 189,635 acres. These plots are more or less evenly dispersed across the state, but differences do emerge with regard to other stand characteristics that have been examined throughout this report. As shown in Table I1 in the appendix, old forest structures tend to have larger average tree diameters; represent a disproportionately large share of northern hardwood forests, and a disproportionately small share of spruce-fir forests; have a smaller proportion of codominant trees, and higher proportions of intermediate and overtopped trees. Figure 40 shows that old stands as defined in this study have a higher species richness.

The criteria applied to the definition of "older" and "oldest" clearly need additional refinement. Without an explicit variable in the FIA databases to indicate tree age or even stand age, we were left with a constructed measure to approximate the characteristics

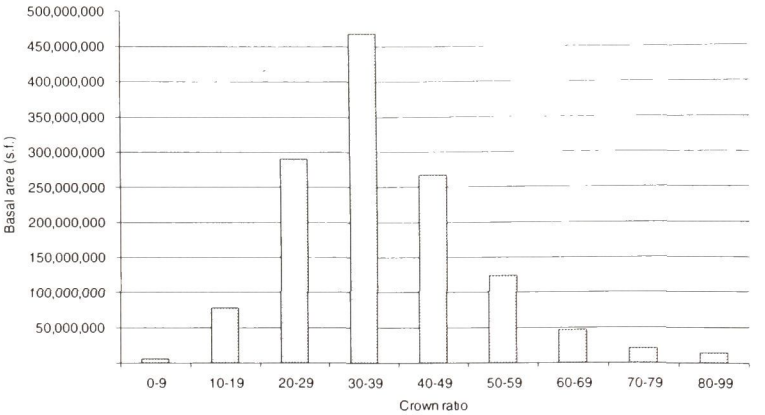

Figure 37. Individual tree vigor in Maine's forests. Basal area of live trees, 5.0+ dbh, by crown ratio, 1995.

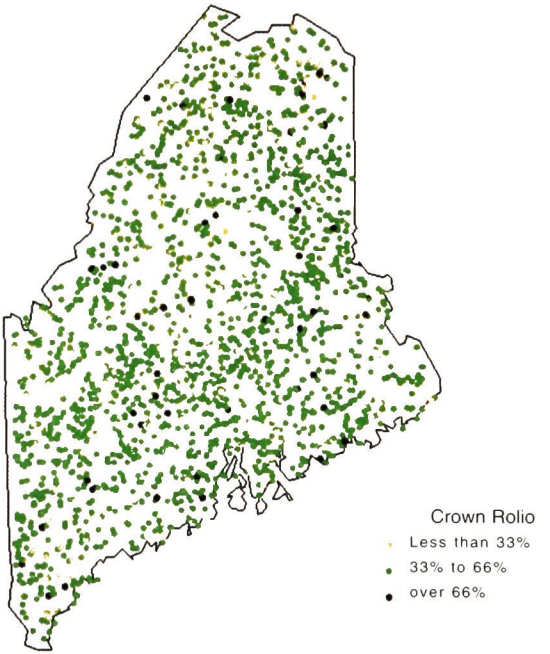

Figure 38. Tree vigor in Maine's forests. Weighted average crown ratio among live trees, 5.0+ dbh, 1995.

of older stands. The criteria used in this study represents at least two iterations of development with input from the FIA committee members. Additional refinements suggested by the FIA committee members and not part of this preliminary effort include the addition of selected tree species, adjusting minimum tree sizes, reviewing basal area and stocking thresholds with respect to forest type, and comparing FIA-based measures with characteristics of known old growth stands.

J. Conversion to Forest and Non-Forest Uses

Proposed FIA measure: Conversion rates by end use and landowner class

Although not direct indicators of forest biodiversity, changes in forest ownership and uses of forest land have implications for the extent and nature of forest biodiversity. The 17.7 million acres of forest land in Maine represent nearly 90% of the state's land area. Approximately 96% of the timberland in Maine is privately owned. In 1982, the privately owned lands were nearly evenly split between the forest industry and other private owners (47% industry; 49% other private). While the total timberland in private ownership did not change substantially between 1982 and 1995, the acreage of industry holdings declined to 43% and acres held by other private owners increased to 53%. Figure 41 shows that most of the industry owned lands are located in northern and eastern Maine.

Since the 19th century, the largest changes in land use in Maine, and throughout the northeastern U.S., have involved shifts of agricultural land to forest. Losses of forest to non-forest uses are mostly tied to land development and natural disturbances (e.g., beaver dams).

Net change in acreage by land use from one time period to the next does not provide a clear indication of the degree of change taking place as some forest stands are converted to non-forest uses and non-forest parcels revert to forest land. Changes in the sampling procedure for the FIA inventory preclude measuring changes over time at the plot level for all plots in the inventory. There are, however, enough remeasured plots in the 1995 inventory to give an indication of the degree of change taking place. The remeasured plots in the 1995 inventory represent 14.5 million acres. Of those, approximately 89% were forest land in 1982 and in 1995; 8.3% were non-forest land in 1982 and 1995; 1.6% were converted from forest to non-forest uses; and 1.4% reverted from non-forest uses to forest land (Figure 42).

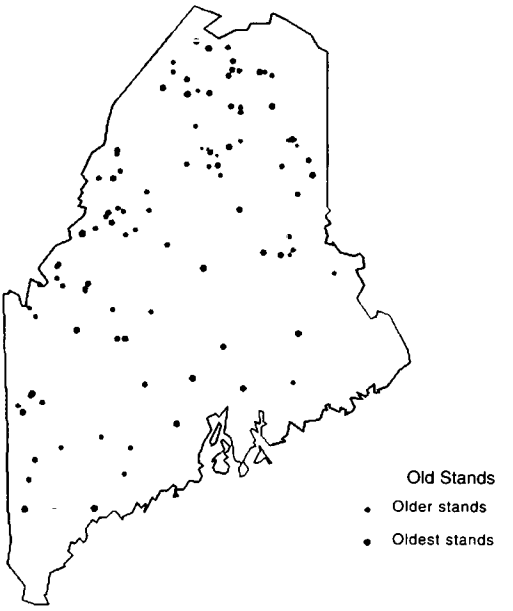

Figure 39. Old stands and structures in Maine's forests. Stands with large old trees, large dead trees, and 100+ sf/ac basal area, 1995.

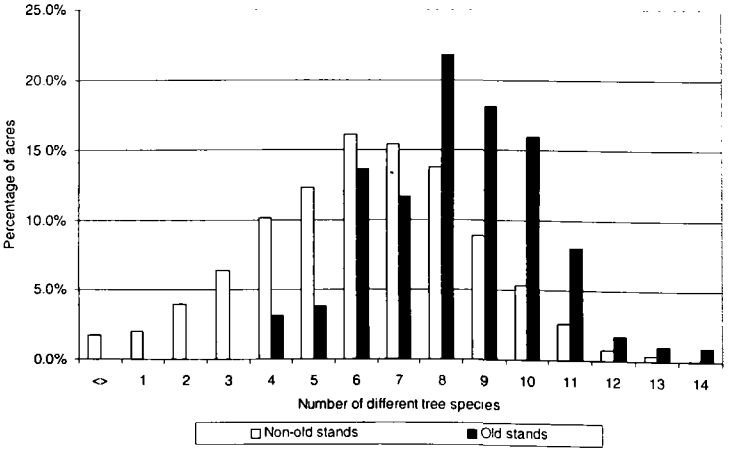

Figure 40. Number of species by stand age. Distribution of acres in old and non-old stands, by number of tree species, 1.0+ dbh, present on FIA plots, Maine, 1995.

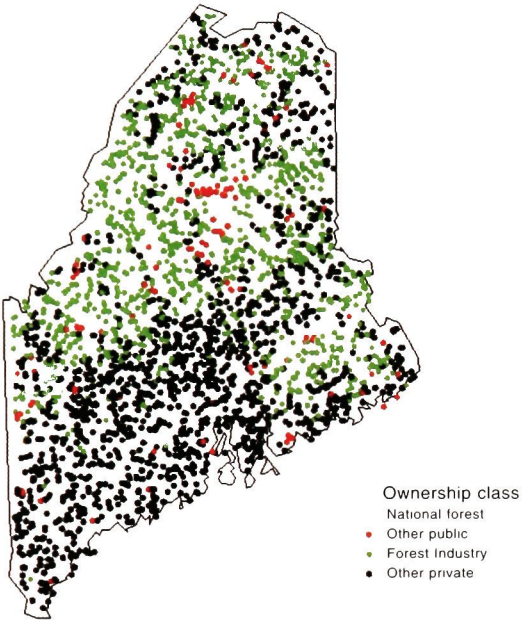

Figure 41. Ownership of Maine forest lands, by ownership class, FIA plots, 1995.

IV SUMMARY AND CONCLUSIONS

In this report, we present the results of an exploratory effort to use Forest Inventory and Analysis (FIA) data to develop biodiversity measures for Maine's forests. We worked on 11 measures of forest characteristics and examined six of these in considerable detail. While we cannot draw firm conclusions from this analysis regarding the status of biodiversity in Maine's forests, we can begin to make some progress in quantifying the current status of and trends in key forest characteristics. Moreover, we can gain insights into the potential uses of FIA data for analyzing forest biodiversity.

In part A of the previous section, we provide an overview of the Maine forest. Perhaps the most striking finding is the change in the forest types observed between 1982 and 1995. During this period, the area of spruce-fir forest declined by approximately 1.5 million acres, while the area of the northern hardwood type increased by almost 1 million acres. In 1995, 73% of the area of Maine's forest

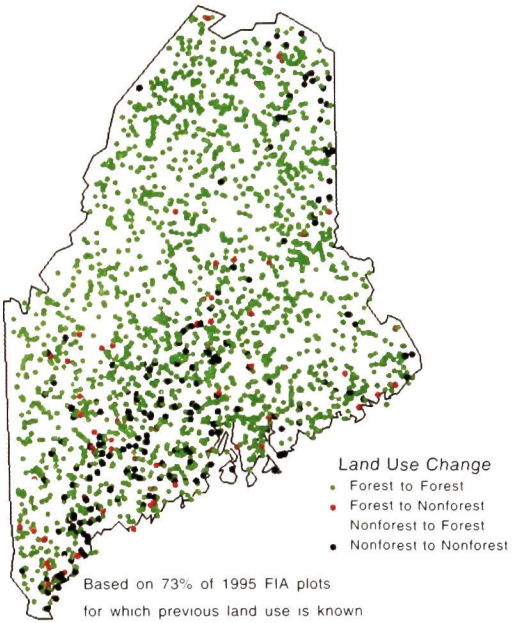

Figure 42. Land use trends in Maine. Changes in forest and nonforest uses in Maine, 1982 to 1995.

was evenly divided between spruce-fir and northern hardwood types.

In part B, we examine numbers of dead trees in Maine's forest. In 1995, dead trees at least 5.0 inches dbh were found on roughly 85% of forest land in the state and almost one-half the forest had between 1 and 25 dead trees per acre. Most of the dead trees were between 5 and 10 inches dbh and classified as snags with broken tops. Snags are standing dead trees considered to provide important wildlife habitat. Between 1982 and 1995, the number of standing dead trees increased; however, there was a 17% decline in large-diameter (>15 inches dbh) dead trees.

The density of trees by species and diameter class is analyzed in part C. Considering all species together, there was a decline between 1982 and 1995 in the number of trees in lower diameter classes (3 to 13 inches dbh) and increases in the lowest (1 to 3 inches dbh) and highest (>13 inches) diameter classes. While gains in the numbers of large diameter trees were relatively large in percentage

terms, the absolute increases were small. In addition, changes in diameter class distributions varied greatly across species. The most notable trend, described in part G, is the increase in the proportion of small-diameter balsam fir and red spruce trees and large-diameter white cedar trees.

In Part C, we also tally the tree species on each plot to produce a tree species richness distribution. We find that tree species richness increased between 1982 and 1995. This result may be due in part to the increase in the northern hardwood type and the decline in spruce-fir. On average, a higher number of tree species are represented in the northern hardwood than the spruce-fir forest.

In part D, we consider mast-potential trees, defined as trees in the open, dominant, and codominant crown classes. We find that between 1982 and 1995 the number of mast-potential oak, beech, and conifer trees increased across almost all diameter classes. Similarly, in part F we use the basal area per acre of open, dominant, and co-dominant trees to measure the degree of crown closure in the forest. We find an increase between 1982 and 1995 in the area of stands with higher basal area, suggesting an increase in crown closure during this period.

Vertical diversity and layering are analyzed in part E by examining differences in tree heights at the plot level. On most acres in 1995, the distance between the lower and upper quartiles of tree heights was 11 to 15 feet. This means that the distance between the shortest and the tallest trees is at least 11 to 15 feet. For almost three-quarters of the Maine forest, the distance between the lower and upper quartiles of tree heights is between 6 and 20 feet.

Our analysis of land use change reveals that the majority of plots remained forested between 1982 and 1995. Less than 2% of plots changed from forest to a non-forest use during this period, and a similar percentage of non-forested plots changed to forest. We made limited progress in developing measures of forest floor characteristics and old stands and structures, primarily because of time constraints. In addition, we made no headway in analyzing soil productivity and the age structure of the forest due to missing variables in the FIA database.

Our overall conclusion is that the FIA data offers some promise for examining forest biodiversity. In many states, the FIA data is the most comprehensive and complete record of the forest currently available. While much of the data is geared toward assessing the timber resource, there are many opportunities to use the data to

examine characteristics of the forest indicative of biodiversity. In our work on Maine, we have made much progress refining the proposed biodiversity measures, but additional work remains to be done in terms of analyzing the data.

It would be valuable to explore more fully the reference case approach mentioned in Section II. In particular, it would be useful to identify plots with old stands and structures, and use these plots to establish a reference case. From there, the FIA measures for all plots could be compared to those for the plots defining the reference case. In part I of the previous section, we make some attempt to identify plots with old stands and structures. Our efforts are hampered by the lack of a stand age variable in the FIA database and the difficulty of defining suitable criteria with the remaining data. One possibility is to define the reference case with information on known old stands. Members of the FIA committee suggested one avenue for this approach is cooperation the Natural Areas Program of the Maine Department of Conservation. It is the agency charged with monitoring and promoting conservation of natural areas, which are those lands in Maine that support rare, threatened, and endangered plants and animals, exemplary natural communities, and unique geological or hydrological features.

We conducted some preliminary analysis using average characteristics across all plots to define a reference case. For instance, we used the crown class distribution for all trees in the state (Figure 27) to define the reference case. Distributions on individual plots were then compared to the reference case using the cross-entropy measure discussed in Section II. This analysis identifies the extent to which distributions on individual plots vary from the state-level reference distribution. This approach provided a useful perspective; however, it is sometimes difficult to interpret the results. Does a particular value of the cross-entropy measure represent large or small differences between distributions?

It is clear that one of the the most valuable uses of the data is the examination of trends in forest characteristics over time. Unfortunately, in our application to Maine we encountered numerous difficulties trying to use data from earlier inventories. A major problem was simply locating the earlier data in a usable form. The 1982 data for Maine was readily available only in the Eastwide Data Base format, which provides only a limited subset of the variables in the Full Data Base. The status of the data from 1971 and 1959 remains uncertain. A second issue is that the Forest Service often changes sampling design and internal algorithms

with each inventory. This makes it difficult—and, in some instances, impossible—to compare data across inventories. This was the case with forest type designations in the 1982 and 1995 inventories. In addition, there were complications with resampled plots between 1982 and 1995 that may make it impossible to assemble data from plots sampled during each of the four inventories.

A shortcoming of the FIA data is that it is plot-based and, therefore, does not provide spatially explicit information. This limits the use of the data in conjunction with other databases that, increasingly, are available in GIS format. As a near-term solution, krigging techniques could be applied to the FIA data to turn sample points into spatially explicit metrics. Krigging employs smoothing algorithms to, in effect, fill in the missing data points. One potential problem with this approach is that the FIA does not reveal the precise location of plots. In the longer term, analyses with FIA data would greatly benefit from the integration of FIA sampling into mapped-based inventories.

As suggested above, the FIA data are not available in a format that facilitates the type of detailed analyses conducted during this study. One option discussed by the FIA Committee is to develop a new database with the raw inventory data. This would allow database users to perform analyses tailored to their particular interests. While the construction of a new database would be a significant undertaking, it would make the data accessible to many more users as well as increase the range of potential uses of the data. The FIA Committee also raised the issue of the statistical accuracy of the results. In principle, confidence intervals can be constructed for measures developed with the FIA data, though we did not pursue this analysis. In the event that a useable data set containing the four inventories back to 1959 is constructed, it will be critical to specify confidence intervals for the measures developed from these data. Confidence intervals will indicate whether changes in the measures over time are real, or simply the result of sampling errors. A related matter is the possibility of conducting formal statistical tests in connection to the reference case approach. For instance, plot-level distributions of interest could be analyzed using parametric analysis and then compared to reference distributions using formal statistical tests.

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APPENDICES

Table A1. Area of timberland by forest-type group, Maine, 1982 and 1995. Thousands of acres.

Forest-type Group	1982*	1995*	inc./(dec.)	% change
White/red pine	1,158.0	1,245.9	87.9	7.6
Spruce/fir	7,563.7	6,011.2	(1,552.5)	-20.5
Loblolly		6.7	6.7	0.0
Oak/pine	155.3	127.5	(27.8)	-17.9
Oak/hickory	378.5	453.3	74.8	19.8
Elm/ash/red maple	307.3	434.7	127.4	41.5
Northern hardwoods	5,505.7	6,408.9	903.2	16.4
Aspen/birch	2,065.5	2,249.7	184.2	8.9
Total	**17,134.0**	**16,937.9**	**(196.1)**	**-1.1**

*Source: Forest Statistics for Maine, 1995.

Area of timberland by forest-type group, Maine, 1982 and 1995. Percentage of total forest acreage.

Forest-type Group	1982	1995
	---------- % ----------	
White/red pine	6.8	7.4
Spruce/fir	44.1	35.5
Loblolly	0.0	0.0
Oak/pine	0.9	0.8
Oak/hickory	2.2	2.7
Elm/ash/red maple	1.8	2.6
Northern hardwoods	32.1	37.8
Aspen/birch	12.1	13.3
Total	**100.0**	**100.0**

Table A2. Number of live trees 5+ dbh per acre on Maine forest lands, by species group, by forest-type group, 1995.

Species group	wht/red pine	spruce/fir	loblolly	oak/pine	oak/hickory	elm/ash/maple	north hardwood	aspen/birch	All forests
Balsam fir	13	41		16	8	10	17	23	26
Tamarack	1	3			0	1	0	1	1
White spruce	1	6		0	0	1	1	4	3
Black spruce	-	8	-			1	0	1	3
Red Spruce	14	42		8	3	1	13	10	23
Red pine	4	0			0		0	0	0
White pine	71	3	55	73	13	1	3	4	9
N. white cedar	6	46		4	1	14	4	4	20
Hemlock	54	4	-	7	9	1	8	1	9
Other softwood	2	0	170	2	0		0	0	0
Total softwood	**165**	**154**	**225**	**110**	**34**	**31**	**45**	**50**	**94**
Red maple	22	13		30	40	70	31	18	23
Sugar maple	2	1	-	1	4	1	23	2	9
Yellow birch	4	4	-	0	2	3	15	3	8
Paper birch	7	8	15	7	8	1	8	36	11
Gray birch	3	1	-	4	1	2	1	3	1
Beech	3	0		3	11	1	24	2	10
White ash	2	1		4	4	2	5	2	3
Black ash	0	1			-	10	1	1	1
Aspen	4	3	-	15	3	1	3	42	8
White oak	0	-		1	3	0	0	0	0
Red oak	6	0	-	23	70	1	2	2	3
Basswood	0	0		1		0	1	0	0
Elm	0	0	-	1	0	1	0	0	0
Other hardwood	2	1		3	4	1	5	2	3
Total hardwood	**55**	**32**	**15**	**92**	**149**	**95**	**118**	**114**	**82**
Total Trees	**221**	**186**	**240**	**202**	**184**	**126**	**163**	**163**	**175**
Total Acres	**1,287,178**	**6,413,237**	**6,709**	**130,434**	**462,050**	**487,932**	**6,559,841**	**2,352,031**	**17,699,412**

Table A3. Percentage of live trees 5+ dbh on Maine forest lands, by species group, by forest-type group, 1995.

Species Group	wht/red pine	spruce/fir	loblolly	oak/pine	oak/hickory	elm/ash/maple	north hardwood	aspen/birch	All forests
Balsam fir	5.9	21.9	0.0	8.0	4.4	7.8	10.4	14.0	14.6
Tamarack	0.2	1.7	0.0	0.0	0.1	0.9	0.1	0.8	0.8
White spruce	0.4	3.3	0.0	0.1	0.1	1.0	0.7	2.5	1.9
Black spruce	0.0	4.5	0.0	0.0	0.0	1.1	0.1	0.4	1.8
Red Spruce	6.3	22.7	0.0	4.2	1.5	0.9	8.0	6.2	12.9
Red pine	1.9	0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.2
White pine	32.3	1.6	22.9	36.0	7.0	0.9	1.5	2.7	5.0
N. white cedar	2.8	24.7	0.0	1.8	0.3	10.9	2.4	2.7	11.2
Hemlock	24.5	2.0	0.0	3.7	5.2	0.9	4.7	0.9	4.9
Other softwood	0.7	0.0	70.8	0.9	0.0	0.0	0.0	0.0	0.1
Total softwood	**75.0**	**82.6**	**93.8**	**54.6**	**18.7**	**24.3**	**27.8**	**30.5**	**53.5**
Red maple	10.2	6.8	0.0	14.7	21.7	56.0	19.2	11.2	13.4
Sugar maple	0.8	0.4	0.0	0.5	2.3	0.6	14.2	1.4	5.4
Yellow birch	1.7	2.0	0.0	0.1	1.1	2.5	9.0	1.9	4.3
Paper birch	3.0	4.1	6.3	3.6	4.3	1.0	4.9	21.8	6.4
Gray birch	1.3	0.4	0.0	2.0	0.4	1.7	0.4	2.1	0.7
Beech	1.4	0.2	0.0	1.7	5.8	0.4	14.6	1.2	5.6
White ash	0.8	0.4	0.0	2.0	2.1	1.3	3.0	1.0	1.5
Black ash	0.1	0.6	0.0	0.0	0.0	7.9	0.4	0.4	0.6
Aspen	2.0	1.5	0.0	7.3	1.6	1.1	1.7	25.7	4.7
White oak	0.1	0.0	0.0	0.3	1.8	0.2	0.0	0.3	0.1
Red oak	2.6	0.2	0.0	11.3	37.9	0.8	1.1	1.1	2.0
Basswood	0.0	0.0	0.0	0.3	0.0	0.1	0.3	0.0	0.1
Elm	0.1	0.0	0.0	0.3	0.1	1.2	0.2	0.2	0.2
Other hardwood	1.0	0.5	0.0	1.4	2.2	1.0	3.1	1.3	1.6
Total hardwood	**25.0**	**17.4**	**6.3**	**45.4**	**81.3**	**75.7**	**72.2**	**69.5**	**46.5**
Total Trees	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Total Acres	**1,287,178**	**6,413,237**	**6,709**	**130,434**	**462,050**	**487,932**	**6,559,841**	**2,352,031**	**17,699,412**

Table A4. Number of trees 5.0+ dbh on timberland, by species and status, Maine, 1982 and 1995. Thousands of trees.

	1982			1995			% change		
Species Group	Live	Dead	Total	Live	Dead	Total	Live	Dead	Total
Balsam fir	816,312	212,184	1,028,496	445,741	211,108	657,059	-45.4	-0.5	-36.1
Tamarack	18,748	2,469	21,217	25,231	5,901	31,133	34.6	139.0	46.7
White spruce	87,078	4,584	91,662	56,170	6,447	62,618	-35.5	40.6	-31.7
Black spruce	88,691	6,405	95,096	55,842	6,428	62,271	-37.0	0.4	-34.5
Red spruce	631,261	43,353	674,614	381,746	41,189	422,939	-39.5	-5.0	-37.3
Red pine	6,314	157	6,471	7,438	298	7,737	17.8	89.8	19.6
White pine	145,974	14,021	159,995	149,148	13,386	162,503	2.2	-4.5	1.6
N. white cedar	342,163	49,174	391,337	340,053	47,780	387,837	-0.6	-2.8	-0.9
Hemlock	178,745	5,108	183,853	150,901	7,768	158,671	-15.6	52.1	-13.7
Other softwood	1,574	472	2,046	3,772	986	4,759	139.6	108.9	132.6
Total softwoods	**2,316,860**	**337,927**	**2,654,787**	**1,616,042**	**341,291**	**1,957,527**	**-30.2**	**1.0**	**-26.3%**
Red maple	377,886	19,762	397,648	405,608	31,688	437,296	7.3	60.3	10.0
Sugar maple	153,265	6,751	160,016	164,088	7,565	171,653	7.1	12.1	7.3
Yellow birch	126,984	20,241	147,225	131,984	13,203	145,187	3.9	-34.8	-1.4
Paper birch	215,158	23,488	238,646	192,792	28,872	221,664	-10.4	22.9	-7.1
Gray birch	34,292	8,518	42,810	22,310	9,791	32,101	-34.9	14.9	-25.0
Beech	157,875	18,944	176,819	169,002	27,771	196,773	7.0	46.6	11.3
White ash	34,749	1,951	36,700	45,249	1,788	47,037	30.2	-8.4	28.2
Black ash	28,715	8,620	37,335	16,978	6,631	23,609	-40.9	-23.1	-36.8
Aspen	189,047	22,778	211,825	140,506	24,075	164,581	-25.7	5.7	-22.3
White oak	4,561	43	4,604	3,206	497	3,703	-29.7	1055.8	-19.6
Red oak	52,901	1,039	53,940	59,687	2,066	61,753	12.8	98.8	14.5
Basswood	2,753	75	2,828	3,935	159	4,094	42.9	112.0	44.8
Elm	5,645	5,270	10,915	4,786	2,671	7,457	-15.2	-49.3	-31.7

Table A4. Continued.

Species Group	1982 Live	1982 Dead	1982 Total	1995 Live	1995 Dead	1995 Total	% change Live	% change Dead	% change Total
Other comm. hardwoods	10,482	1,699	12,181	20,748	4,840	25,588	97.9	184.9	110.1
Noncomm. hardwoods	47,168	12,212	59,380	27,828	8,229	36,057	-41.0	-32.6	-39.3
Total hardwoods	**1,441,481**	**151,391**	**1,592,872**	**1,408,707**	**169,846**	**1,578,553**	**-2.3**	**12.2**	**-0.9**
Total Trees	**3,758,341**	**489,318**	**4,247,659**	**3,024,749**	**511,137**	**3,536,080**	**-19.5**	**4.5**	**-16.8**

Table A5. Selected measures of all live trees 5+ dbh on Maine forest lands, 1995.

Density level	acres	live 5+ dbh	avg size	Tree Size (dbh) 5"–10"	10"–15"	15"–20"	20"+
0	921,150						
1 to 99	4,097,194	209,102,590	8.4	158,431,388	38,284,251	9,104,100	3,282,852
100 to 199	5,661,529	878,269,715	8.6	642,060,839	183,998,179	40,141,312	12,069,385
200 to 299	4,786,892	1,179,628,078	8.3	911,309,210	221,351,844	39,323,407	7,643,617
300 to 399	1,657,634	565,207,297	7.8	468,703,184	85,565,807	9,672,954	1,265,352
400 to 499	438,708	193,758,592	7.6	165,949,070	25,442,952	2,300,230	
500+	136,305	78,907,348	7.5	69,605,650	8,742,559	491,191	67,948
total	**17,699,412**	**3,104,873,620**		**2,416,059,340**	**563,385,592**	**101,033,195**	**24,329,153**

	acres	live 5+ dbh	avg size	density	Tree Size (dbh) 5"–10"	10"–15"	15"–20"	20"+
Forest type								
wht/red pine	1,287,178	283,887,769	9.2	220.6	192,938,745	67,734,195	18,245,020	4,969,809
spruce/fir	6,413,237	1,194,016,529	8.0	186.2	957,091,950	203,626,703	28,911,854	4,386,022
loblolly	6,709	1,607,742	10.3	239.6	837,365	535,914	234,462	
oak/pine	130,434	26,399,224	8.5	202.4	20,548,530	4,426,656	852,128	571,910
oak/hickory	462,050	84,820,912	8.4	183.6	65,868,377	14,041,203	3,712,825	1,198,507
elm/ash/maple	487,932	61,381,112	7.6	125.8	51,762,845	8,128,268	1,262,531	227,468
north hardwood	6,559,841	1,068,313,849	8.5	162.9	799,023,042	214,967,328	41,957,959	12,365,519
aspen/birch	2,352,031	384,446,483	7.6	163.5	327,988,485	49,925,324	5,856,415	676,258
Total	**17,699,412**	**3,104,873,620**			**2,416,059,340**	**563,385,592**	**101,033,195**	**24,395,493**
Stand size								
sawtimber	5,994,741	1,173,911,243	9.4	195.8	752,080,451	324,446,369	77,539,810	19,844,614
poletimber	7,040,689	1,709,125,028	7.6	242.7	1,470,642,502	214,410,166	20,340,802	3,731,557
seedling/sap	4,618,727	221,394,545	7.3	47.9	192,954,222	24,468,418	3,152,583	819,323
nonstocked	45,255	442,804	7.5	9.8	382,165	60,639		
Total	**17,699,412**	**3,104,873,620**			**2,416,059,340**	**563,385,592**	**101,033,195**	**24,395,493**

Table A5. Continued.

					Tree Size (dbh)			
		acres live 5+ dbh		avg size	density	5"–10"	10"–15"	15"–20" 20"+
Stocking class								
nonstocked	26,806	442,804	7.5	16.5	382,165	60,639		
poorly stocked	952,920	86,271,655	8.0	90.5	68,975,643	14,747,611	2,004,664	543,737
mod stocked	4,260,420	672,482,607	8.0	157.8	538,853,030	111,158,723	18,512,567	3,958,286
fully stocked	8,961,405	1,884,975,897	8.3	210.3	1,463,527,700	346,419,281	61,085,442	13,943,475
overstocked	3,497,861	460,700,657	8.6	131.7	344,320,802	90,999,338	19,430,521	5,949,995
Total	**17,699,412**	**3,104,873,620**			**2,416,059,340**	**563,385,592**	**101,033,195**	**24,395,493**
Stand origin								
100% natural	17,446,581	3,075,952,964	8.3	176.3	2,394,392,443	557,872,785	99,652,547	24,035,190
major natural	91,922	10,027,995	8.4	109.1	7,760,137	1,650,133	458,181	
100% artificial	47,017	8,344,448	8.5	177.5	6,314,976	1,860,486	134,847	
major artificial	113,892	10,548,213	8.8	92.6	7,591,785	2,002,188	787,620	166,619
Total	**17,699,412**	**3,104,873,620**			**2,416,059,340**	**563,385,592**	**101,033,195**	**24,201,809**

Table B1. Number of standing dead trees on timberland, by species, by diameter class, Maine, 1982 and 1995. Thousands of trees.

Species Group	1982—Diameter class (dbh) 5 to 10.9	11 to 14.9	15+	Total	1995—Diameter class (dbh) 5 to 10.9	11 to 14.9	15+	Total
Balsam fir	194,741	8,488	832	204,061	197,236	9,072	821	207,129
Tamarack	2,048	251	55	2,354	4,657	879	229	5,765
White spruce	4,140	223	69	4,432	5,531	392	100	6,023
Black spruce	5,914	166		6,080	5,879	140	68	6,086
Red Spruce	35,263	3,130	985	39,378	32,850	4,127	1,203	38,181
Red pine	156			156	220	34	-	254
White pine	11,242	1,821	940	14,003	9,944	1,955	1,282	13,181
N. white cedar	36,167	8,508	2,650	47,325	33,686	9,215	2,921	45,822
Hemlock	3,979	571	327	4,877	6,043	688	452	7,183
Other softwood	436	36		472	714	273		987
Total softwoods	**294,086**	**23,194**	**5,858**	**323,138**	**296,761**	**26,774**	**7,075**	**330,611**
Sugar maple	4,285	1,115	1,154	6,554	4,848	1,195	1,364	7,407
Red maple	16,913	1,857	582	19,352	25,439	4,299	1,457	31,195
Yellow birch	8,588	5,172	6,398	20,158	8,282	2,390	2,341	13,012
Paper birch	19,086	2,764	1,017	22,867	24,924	2,868	489	28,282
Gray birch	8,518			8,518	9,727			9,727
Beech	11,978	3,755	2,912	18,645	20,098	5,129	1,922	27,149
White ash	1,423	224	212	1,859	1,352	305	65	1,722
Black ash	7,508	850	168	8,526	5,818	485	199	6,501
Aspen	19,855	1,296	254	21,405	20,631	2,082	709	23,422
White oak	28	15		43	497			497
Red oak	896	60	40	996	1,784	115	66	1,966
Basswood	26	34		60	125	33	34	192
Elm	4,030	655	429	5,114	1,890	360	420	2,671
Other hardwood	12,859	244	496	13,599	11,199		61	11,261
Total hardwoods	**115,993**	**18,041**	**13,662**	**147,696**	**136,616**	**19,260**	**9,126**	**165,003**
Total, all species	**410,079**	**41,235**	**19,520**	**470,834**	**433,377**	**46,035**	**16,202**	**495,613**

Table B2. Selected measures of total dead trees 5+ dbh on Maine forest lands, 1982 and 1995.

Density group	acres	all dead trees	avg size	Tree Size (dbh) 5"-10"	10"-15"	15"-20"	20"+
1982							
0	3,072,330						
1 to 25	7,534,032	95,655,897	9.1	66,156,104	20,689,718	6,749,500	2,060,575
25 to 50	4,043,363	144,626,157	8.1	115,072,320	22,716,241	5,552,679	1,284,916
50 to 75	1,650,517	100,123,240	7.7	83,454,268	13,611,488	2,721,892	335,593
75 to 100	773,918	66,027,386	7.1	60,323,830	4,986,610	616,719	100,226
100+	790,460	104,056,971	7.3	93,052,008	9,526,383	1,171,440	307,140
Total	**17,864,620**	**510,489,650**		**418,058,529**	**71,530,440**	**16,812,230**	**4,088,451**
1995							
0	2,631,422			-	-		-
1 to 25	7,932,969	109,146,935	8.4	83,997,766	18,726,910	4,605,352	1,816,907
25 to 50	3,917,495	150,021,274	8.1	119,488,613	24,818,671	4,515,642	1,198,347
50 to 75	1,718,738	108,872,547.	7.8	91,489,925	14,718,629	2,264,643	399,349
75 to 100	752,937	65,699,211	7.7	54,710,521	9,612,111	1,311,702	64,877
100+	745,851	100,655,508	7.6	86,693,625	12,284,626	1,459,619	217,638
Total	**17,699,412**	**534,395,476**		**436,380,451**	**80,160,947**	**14,156,959**	**3,697,119**

Table C1. Live trees on forest land, by species, by diameter size class, Maine, 1995.

Species	1 to 4 9	5 to 6.9	7 to 8.9	9 to 10.9	11 to 12.9	13 to 14.9	15 to 16.9	17 to 18.9	19 to 20.9	21 to 28.9	29+	Total
Balsam fir	4,380,374.4	268,373.5	117,422.7	42,599.3	12,865.4	3,433.9	745.1	65.3	33.5	0.0	0.0	4,825,913.2
Tamarack	42,550.3	11,883.4	6,357.9	3,129.7	2,132.4	723.3	395.3	132.7	130.4	65.6	0.0	67,500.9
White spruce	200,086.0	23,677.5	15,640.9	7,818.2	4,914.4	2,085.4	994.3	492.5	130.6	227.3	0.0	256,067.1
Black spruce	250,215.5	33,140.0	14,239.2	5,850.2	1,936.3	609.8	155.1	33.2	0 0	0.0	0.0	306,179.4
Red spruce	888,186.7	154,230 0	112,578.7	67,507.2	35,869.7	15,250.9	6,842.6	2,178.3	675.5	355.6	0.0	1,283,675.3
Red pine	11,719.7	2,769.2	1,914.8	1,145.6	561.7	615.3	268.4	216.4	33.6	0.0	0.0	19,244.7
White pine	226,803.8	41,895.3	29,238.2	22,054.1	17,117.0	13,038.7	8,315.6	6,705.6	3,915.0	5,302.3	757.5	375,143.2
N white cedar	387,460 5	118,851.3	92,580.0	62,613.3	35,327.5	17,870.5	8,896.3	3,752.5	1,084.1	888.7	33.0	729,357.8
Hemlock	280,691.3	48,248.7	38,052.4	27,417.8	16,635.6	10,404.3	5,068.4	2,334.7	1,060.2	1,050.3	49.5	431,013.1
Other softwood	5,685.0	2,021.9	740.8	419.6	384.3	320.0	166.4	67.0	0.0	0.0	0.0	9,805.0
Total softwood	**6,673,773.3**	**705,090.8**	**428,765.5**	**240,555.0**	**127,744.4**	**64,352.2**	**31,847.6**	**15,978.0**	**7,062.9**	**7,889.9**	**840.0**	**8,303,899.7**
Red maple	1,526,282.2	183,897.3	110,403.2	59,846.2	28,812.1	13,603.5	6,494.0	2,946.2	1,765.6	1,651.4	132.2	1,935,833.9
Sugar maple	481,278.0	53,294.9	38,250.6	27,296.4	17,965.3	11,751.8	6,437.5	3,653.4	2,596.4	3,722.5	261.1	646,508.0
Yellow birch	633,368.6	45,463.5	31,252.7	21,450.7	15,565.0	8,396.8	5,252.8	2,943.0	1,623.0	1,492.9	101 4	766,910.4
Paper birch	889,275.8	94,196.8	58,603.4	28,637.0	10,313.5	3,648.0	993.7	304.7	99.8	97.4	0.0	1,086,170.2
Gray birch	228,026.7	17,968.8	3,585.3	619.7	33.1	0.0	0.0	0.0	0.0	0.0	0.0	250,233.5
Beech	693,560.2	76,140.9	43,939.8	26,006.7	12,983.7	7,004.2	3,217.5	1,211.8	589.7	154.8	0.0	864,809.4
White ash	208,081.4	19,405.9	12,494.1	6,402.0	3,697.5	1,708.2	779.8	269.4	117.7	192.5	68.4	253,216.9
Black ash	94,632.0	11,496.9	3,844.9	1,393.2	955.4	273.3	164.1	32.2	32.2	0.0	0.0	112,824.1
Aspen	637,674.2	48,048.6	41,687.8	25,468.2	13,787.0	7,294.8	3,294.5	853.3	412.8	240.7	30.6	778,792.5
White oak	2,177.8	1,510.9	1,001.5	327.2	80.3	121.2	74.3	0.0	36.0	0.0	39.2	5,368.4
Red oak	120,136.7	21,573.2	15,610.4	9,457.0	5,611.8	3,028.6	2,246.6	777.9	620.3	622.0	0.0	179,684.6
Basswood	14,126.6	1,079.5	1,235.9	743.0	361.5	166.1	229.3	61.3	63.4	0.0	0.0	18,066.7
Elm	15,570.4	2,695.9	1,289.3	473.4	95.6	62.8	65.9	0.0	0.0	0.0	0.0	20,253.2
Other hardwood	**1,351,102.8**	**33,979.9**	**9,191.9**	**2,883.3**	**967.6**	**399.1**	**275.7**	**102.4**	**0.0**	**8.5**	**33.2**	**1,398,944.5**
Total hardwood	**6,895,293.5**	**610,753.0**	**372,390.6**	**211,004.1**	**111,229.4**	**57,458.4**	**29,525.5**	**13,155.7**	**7,957.0**	**8,183.0**	**666.1**	**8,317,616.3**
Total live trees	**13,569,066.9**	**1,315,843.8**	**801,156.1**	**451,559.1**	**238,973.9**	**121,810.7**	**61,373.1**	**29,133.7**	**15,019.8**	**16,072.9**	**1,506.1**	**16,621,516.0**

Table C2. Change in number of live trees, by diameter class, by species, 1982 to 1995.

Species Group	1 to 4.9	5 to 6.9	7 to 8.9	9 to 10.9	11 to 12.9	13 to 14.9	15 to 16.9	17 to 18.9	19 to 20.9	21 to 28.9	29+	Total
Balsam fir	1,236,487.3	-209,098.4	-121,828.4	-47,674.1	-12,918.5	-2,429.0	-751.8	-136.8	4.1	-16.0	0.0	841,638.3
Tamarack	-1,433.9	2,638.2	2,321.8	110.1	527.5	-31.5	95.5	-131.8	71.1	40.2	0.0	4,207.3
White spruce	53,455.8	-20,516.8	-8,709.3	-4,463.2	-5.5	184.9	371.3	253.2	37.3	185.6	0.0	20,793.4
Black spruce	21,007.1	-24,778.1	-7,375.1	-2,677.9	-11.6	-370.4	29.4	4.2	-28.7	0.0	0.0	-14,201 2
Red Spruce	-86,191.5	-130,290.5	-74,523.0	-32,148.2	-12,211.1	-6,913.9	-1,319.6	-1,240.5	-519.2	-464.2	-16.7	-345,838.2
Red pine	8,051.3	1,627.6	586.4	-348.5	-767.8	60.1	-100.6	149.8	14.5	-14.6	0.0	9,258.0
White pine	8,002.9	-6,056.0	-2,325.5	-645.8	724.0	2,389.8	1,029.5	2,199.8	1,219.8	2,023.2	64.9	8,626 6
N. white cedar	-62,436.9	-13,131.2	-5,146.5	6,215.2	1,472.3	1,914.2	1,719.6	1,420.3	-177.7	-48.5	-3.3	-68,202.6
Hemlock	34,094.8	-19,951.3	-7,297.0	-1,101.0	-2,028.2	990.3	-227.2	625.1	1.1	-64.7	30.4	5,072.2
Other softwood	759.4	1,692.4	86.5	6.1	225.5	143.0	115.1	56.8	0.0	0.0	-0.7	3,084.2
Total softwoods	**1,211,796.2**	**-417,864.1**	**-224,210.0**	**-82,727.4**	**-24,993.3**	**-4,062.5**	**961.2**	**3,200.0**	**622.3**	**1,641.0**	**74.6**	**464,438.1**
Red maple	293,207.9	-1,079.4	7,826.7	8,603.3	4,272.7	2,773.3	1,912.0	310.0	563.8	864.1	46.1	319,300 6
Sugar maple	49,262.0	-2,019.5	-686.9	5,106.6	3,560.9	2,430.3	1,277.4	-66.8	-238.2	869.0	87.5	59,582.2
Yellow birch	291,203.7	3,485.8	-804.0	-1,054.3	1,516.7	870.9	260.1	107.3	291.0	-661.9	2.5	295,217.9
Paper birch	365,280.6	-17,117.6	-6,092.4	0.3	-24.1	125.5	-402.3	-199.3	-123.0	22.4	-8.1	341,462.0
Gray birch	-17,107.0	-10,841.8	-872.2	-108.3	-255.5	-107.2	-63.3	-9.2	0.0	0.0	0.0	-29,364.5
Beech	51,315.6	7,999.1	5,104.1	2,117.9	-1,001.2	-959.2	-936.3	-389.8	133.0	-239.4	0.0	63,143 9
White ash	104,731.7	5,893.4	2,086.9	264.3	1,061.4	632.9	304.2	68.2	-45.1	75.1	67.0	115,140 1
Black ash	6,428.5	-3,566.8	-3,712.6	-1,919.4	-790.2	-523.0	-79.6	-59.5	-60.8	-29.4	0.0	-4,312.9
Aspen	333,281.2	-26,979.5	-14,194.2	-8,611.4	-1,639.1	332.7	1,164.8	6.9	-19.6	28.0	1.2	283,370.9
White oak	-14,807.7	-1,431.6	-58.0	71.3	23.0	31.1	-0.1	-49.6	-7.8	-10.6	7.5	-16,232.4
Red oak	9,502.4	-736.2	911.6	2,321.9	1,177.8	708.9	1,077.8	238.1	291.4	313.8	-21.0	15,786.4
Basswood	206.2	232.9	431.5	442.0	1.8	5.8	132.3	-77.4	26.0	-3.5	0.0	1,397.6
Elm	-1,442.7	189.5	-319.6	36.3	-156.5	-353.1	-3.7	-143.3	-18.2	-85.7	-33.1	-2,330.2
Other hardwood	**456,591.3**	**-10,072.9**	**-662.5**	**1,094.0**	**353.0**	**110.4**	**92.0**	**70.5**	**-16.5**	**-47.4**	**30.8**	**447,542.8**
Total hardwoods	**1,927,653.7**	**-56,044.5**	**-11,041.6**	**8,364.5**	**8,100.7**	**6,079.3**	**4,735.4**	**-194.0**	**776.0**	**1,094.4**	**180.4**	**1,889,704.2**
Total live trees	**3,139,449.9**	**-473,908.5**	**-235,251.7**	**-74,362.9**	**-16,892.6**	**2,016.8**	**5,696.6**	**3,006.0**	**1,398.3**	**2,735.4**	**255.0**	**2,354,142.3**

Table C3. Percentage change in number of live trees, by diameter class, by species, 1982 to 1995.

Species Group	1 to 4.9	5 to 6.9	7 to 8.9	9 to 10.9	11 to 12.9	13 to 14.9	15 to 16.9	17 to 18.9	19 to 20.9	21 to 28.9	29+	Total
Balsam fir	39.3	-43.8	-50.9	-52.8	-50.1	-41.4	-50.2	-67.7	13.9	-100.0		21.1
Tamarack	-3.3	28.5	57.5	3.6	32.9	-4.2	31.9	-49.8	120.0	158.3		6.6
White spruce	36.5	-46.4	-35.8	-36.3	-0.1	9.7	59.6	105.8	40.0	445.3		8.8
Black spruce	9.2	-42.8	-34.1	-31.4	-0.6	-37.8	23.4	14.4	-100.0			-4.4
Red Spruce	-8.8	-45.8	-39.8	-32.3	-25.4	-31.2	-16.2	-36.3	-43.5	-56.6	-100.0	-21.2
Red pine	219.5	142.6	44.1	-23.3	-57.8	10.8	-27.3	224.7	75.5	-100.0		92.7
White pine	3.7	-12.6	-7.4	-2.8	4.4	22.4	14.1	48.8	45.3	61.7	9.4	2.4
N. white cedar	-13.9	-9.9	-5.3	11.0	4.3	12.0	24.0	60.9	-14.1	-5.2	-9.2	-8.6
Hemlock	13.8	-29.3	-16.1	-3.9	-10.9	10.5	-4.3	36.6	0.1	-5.8	159.3	1.2
Other softwood	15.4	513.6	13.2	1.5	142.0	80.8	224.5	558.4			-100.0	45.9
Total softwoods	**22.2**	**-37.2**	**-34.3**	**-25.6**	**-16.4**	**-5.9**	**3.1**	**25.0**	**9.7**	**26.3**	**9.7**	**5.9**
Red maple	23.8	-0.6	7.6	16.8	17.4	25.6	41.7	11.8	46.9	109.8	53.6	19.8
Sugar maple	11.4	-3.7	-1.8	23.0	24.7	26.1	24.8	-1.8	-8.4	30.5	50.4	10.2
Yellow birch	85.1	8.3	-2.5	-4.7	10.8	11.6	5.2	3.8	21.8	-30.7	2.5	62.6
Paper birch	69.7	-15.4	-9.4	0.0	-0.2	3.6	-28.8	-39.5	-55.2	29.8	-100.0	45.9
Gray birch	-7.0	-37.6	-19.6	-14.9	-88.5	-100.0	-100.0	-100.0				-10.5
Beech	8.0	11.7	13.1	8.9	-7.2	-12.0	-22.5	-24.3	29.1	-60.7		7.9
White ash	101.3	43.6	20.1	4.3	40.3	58.9	64.0	33.9	-27.7	63.9	4584.2	83.4
Black ash	7.3	-23.7	-49.1	-57.9	-45.3	-65.7	-32.7	-64.9	-65.3	-100.0		-3.7
Aspen	109.5	-36.0	-25.4	-25.3	-10.6	4.8	54.7	0.8	-4.5	13.2	4.0	57.2
White oak	-87.2	-48.7	-5.5	27.9	40.2	34.4	-0.1	-100.0	-17.9	-100.0	23.7	-75.1
Red oak	8.6	-3.3	6.2	32.5	26.6	30.6	92.2	44.1	88.6	101.8	-100.0	9.6
Basswood	1.5	27.5	53.6	146.8	0.5	3.6	136.6	-55.8	69.2	-100.0		8.4
Elm	-8.5	7.6	-19.9	8.3	-62.1	-84.9	-5.3	-100.0	-100.0	-100.0	-100.0	-10.3
Other hardwood	51.0	-22.9	-6.7	61.1	57.4	38.2	50.1	220.8	-100.0	-84.8	1244.5	47.0
Total hardwoods	**38.8**	**-8.4**	**-2.9**	**4.1**	**7.9**	**11.8**	**19.1**	**-1.5**	**10.8**	**15.4**	**37.1**	**29.4**
Total live trees	**30.1**	**-26.5**	**-22.7**	**-14.1**	**-6.6**	**1.7**	**10.2**	**11.5**	**10.3**	**20.5**	**20.4**	**16.5**

Table C4. Density of trees 1.0+ dbh on forest lands, by diameter class, by species, Maine, 1995. Trees per acre.

Species Group	Diameter size class											
	0 to 0.9	1 to 4.9	5 to 6.9	7 to 8.9	9 to 10.9	11 to 12.9	13 to 14.9	15 to 16.9	17 to 18.9	19 to 20.9	21 to 28.9	29+
Balsam fir	2,122.2	251.4	22.2	10.2	3.9	1.2	0.3	0.1	0.0	0.0	-	
Tamarack	15.0	2.4	0.8	0.5	0.2	0.2	0.1	0.0	0.0	0.0	0.0	-
White spruce	33.4	11.6	1.6	1.0	0.5	0.3	0.1	0.1	0.0	0.0	0.0	-
Black spruce	85.3	14.3	2.1	0.9	0.4	0.1	0.0	0.0	0.0	-	-	
Red Spruce	425 3	51.1	10.1	7.0	4.2	2.2	1.0	0.4	0.1	0.0	0.0	
Red pine	0.4	0.7	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0		
White pine	48.9	13.4	2.8	1.9	1.4	1.1	0.8	0.5	0.4	0.2	0.3	0.1
N. white cedar	299.0	22.2	7.7	6.0	4.2	2.4	1.2	0.6	0.3	0.1	0.1	0.0
Hemlock	113.5	16.3	3.0	2.3	1.6	1.0	0.6	0.3	0.1	0.1	0.1	0.0
Other softwood		0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0			-
All softwood	**3,143.2**	**383.7**	**50.6**	**30.0**	**16.6**	**8.5**	**4.2**	**2.1**	**1.0**	**0.5**	**0.5**	**0.1**
Red maple	789.6	87.6	11.3	6.8	3.7	1.8	0.9	0.4	0.2	0.1	0.1	0.0
Sugar maple	567.1	27.6	3.2	2.3	1.6	1.1	0.7	0.4	0.2	0.2	0.2	0.0
Yellow birch	329.4	36.2	2.8	1.9	1.3	1.0	0.5	0.4	0.2	0.1	0.1	0.0
Paper birch	338.4	51.6	6.3	3.8	1.8	0.7	0.3	0.1	0.0	0.0	0.0	
Gray birch	106.5	13.2	1.5	0.3	0.0	0.0		-				
Beech	303.6	39.5	4.9	2.9	1.7	0.9	0.5	0.2	0.1	0.1	0.0	-
White ash	101.9	12.1	1.2	0.8	0.4	0.2	0.1	0.1	0.0	0.0	0.0	0.0
Black ash	37.8	5.4	0.9	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	
Aspen	241.5	37.3	3.4	2.8	1.7	0.9	0.4	0.2	0.1	0.0	0.0	0.0
White oak	4.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0		0.0	-	0.0
Red oak	38.5	7.0	1.3	0.9	0.6	0.3	0.2	0.1	0.0	0.0	0.0	
Basswood	9.5	0.8	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0		
Elm	5.9	0.9	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other hardwood	1,178.3	77.3	2.5	0.7	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
All hardwood	**4,052.0**	**396.7**	**39.7**	**23.7**	**13.3**	**7.1**	**3.7**	**1.9**	**0.9**	**0.5**	**0.5**	**0.0**
Total trees	**7,195.1**	**780.3**	**90.3**	**53.7**	**29.9**	**15.6**	**7.9**	**4.0**	**1.9**	**1.0**	**1.0**	**0.1**

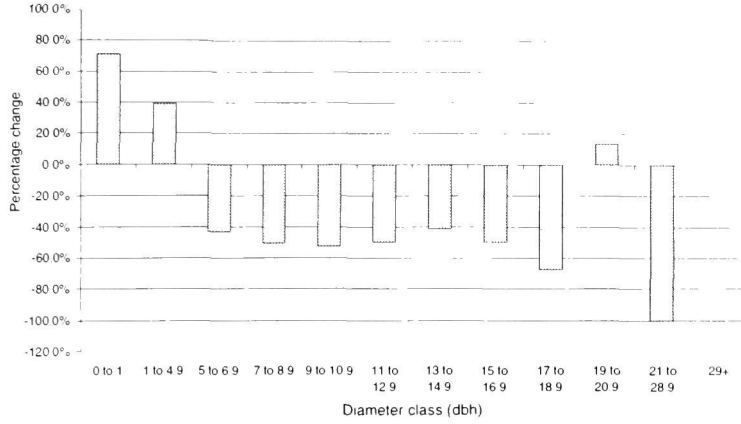

Figure C1. Change in number of live balsam fir trees on forest land, by diamter class, Maine, 1982 to 1995.

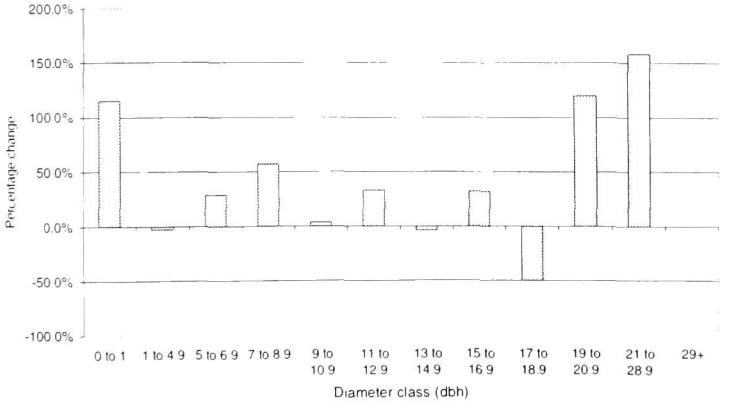

Figure C2. Change in number of live tamarack trees on forest land, by diameter class, Maine, 1982 to 1995.

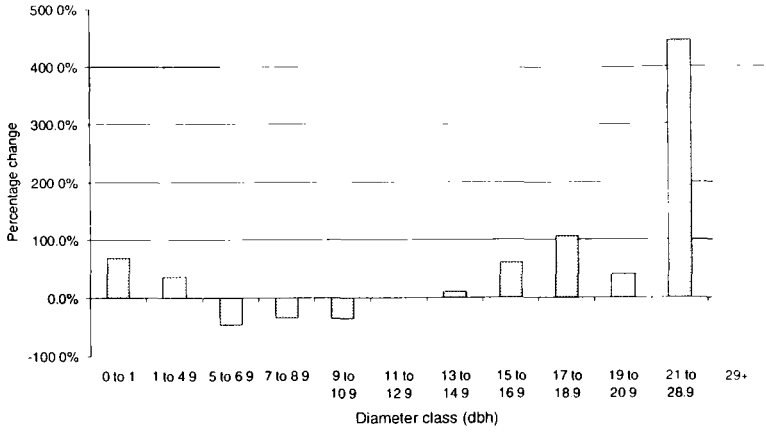

Figure C3. Change in number of live white spruce trees on forest land, by diameter class, Maine, 1982 to 1995.

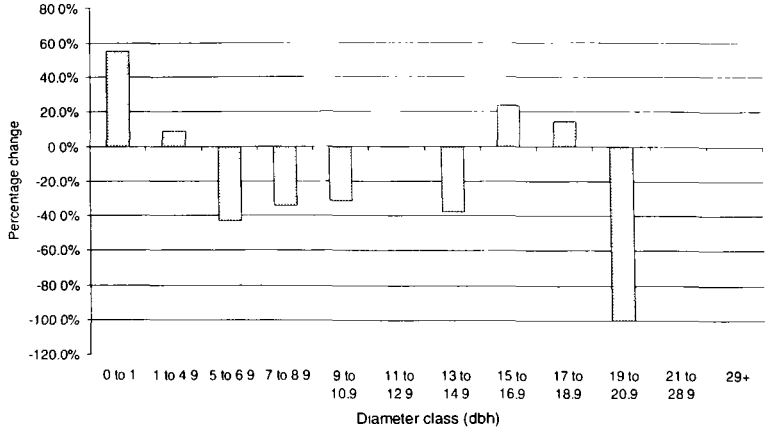

Figure C4. Change in number of live black spruce trees on forest land, by diameter class, Maine, 1982 to 1995.

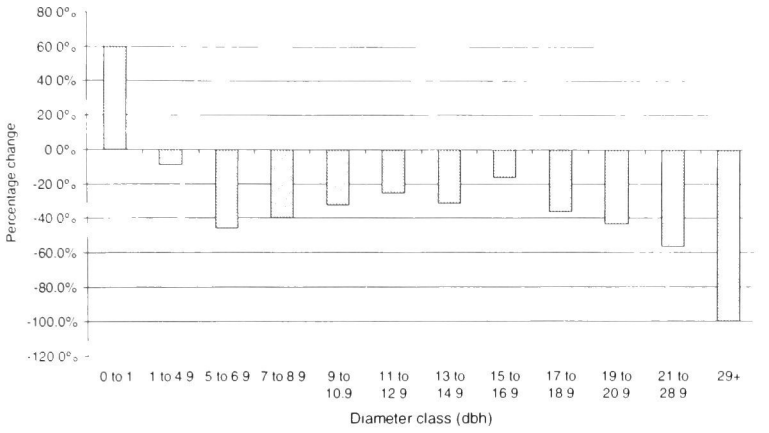

Figure C5. Change in number of live red spruce trees on forest land, by diameter class, Maine, 1982 to 1995.

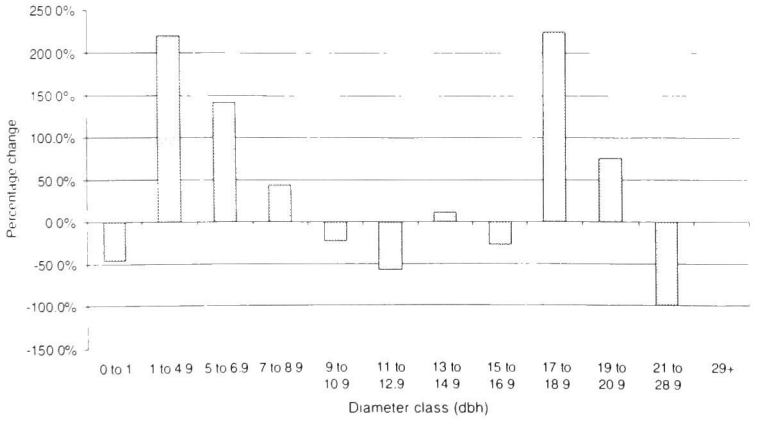

Figure C6. Change in number of live red pine trees on forest land, by diameter class, Maine, 1982 to 1995.

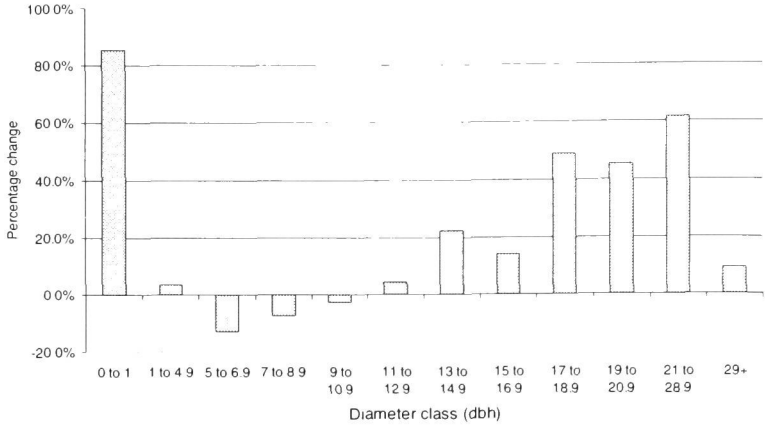

Figure C7. Change in number of live white pine trees on forest land, by diameter class, Maine, 1982 to 1995.

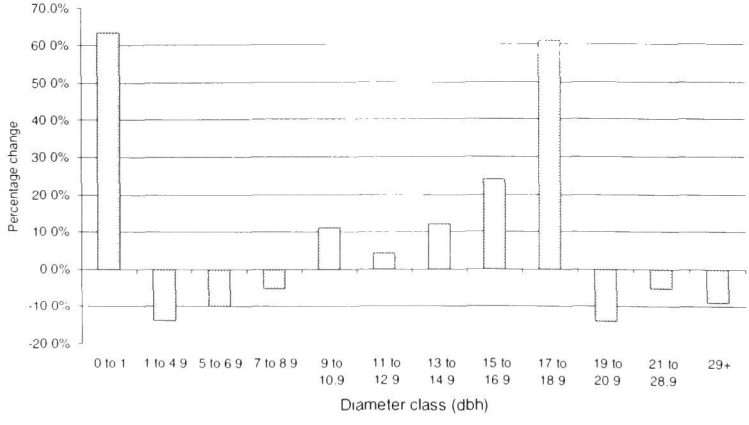

Figure C8. Change in number of live white cedar trees on forest land, by diameter class, Maine, 1982 to 1995.

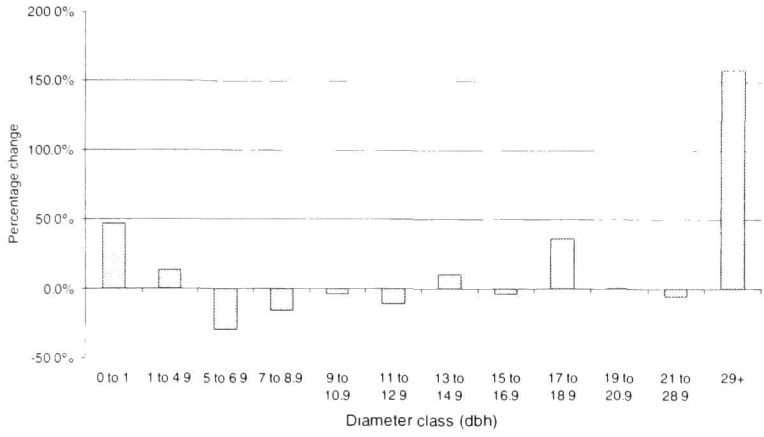

Figure C9. Change in number of live hemlock trees on forest land, by diameter class, Maine, 1982 to 1995.

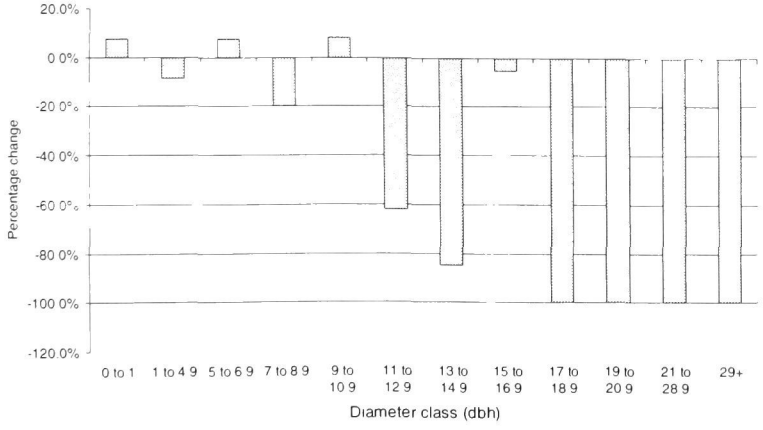

Figure C10. Change in number of live red maple trees on forest land, by diameter class, Maine, 1982 to 1995.

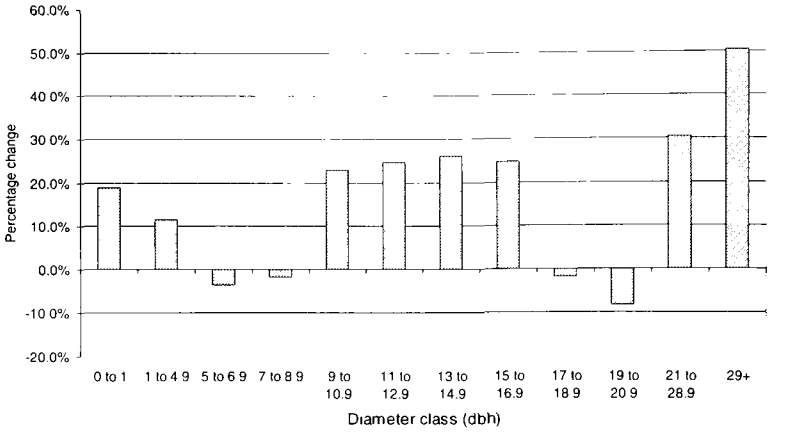

Figure C11. Change in number of live sugar maple trees on forest land, by diameter class, Maine, 1982 to 1995.

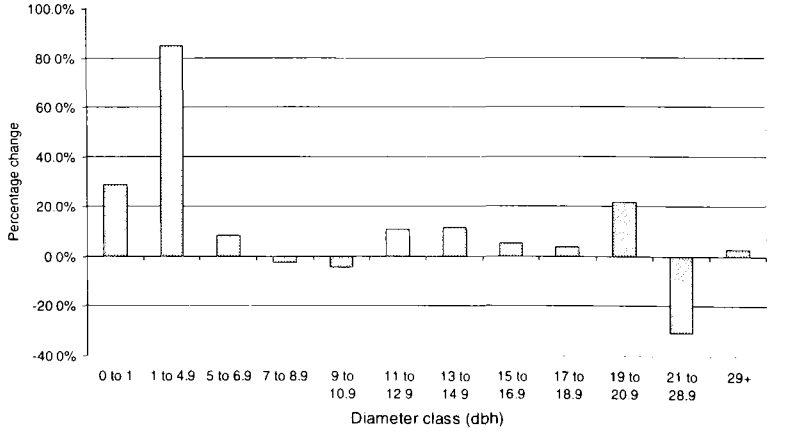

Figure C12. Change in number of live yellow birch trees on forest land, by diameter class, Maine, 1982 to 1995.

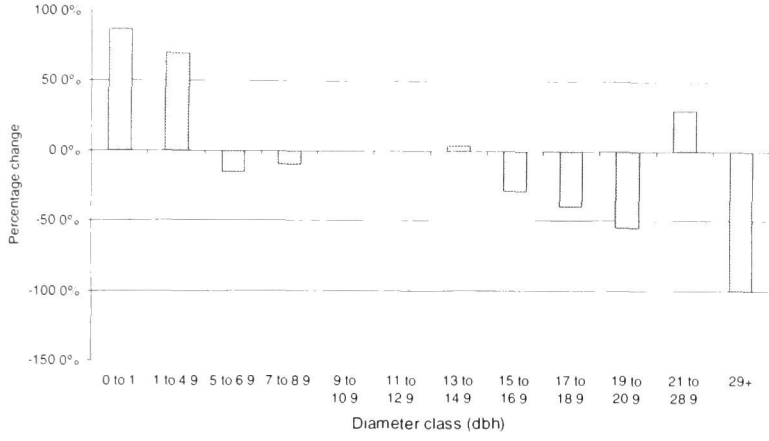

Figure C13. Change in number of live paper birch trees on forest land, by diameter class, Maine, 1982 to 1995.

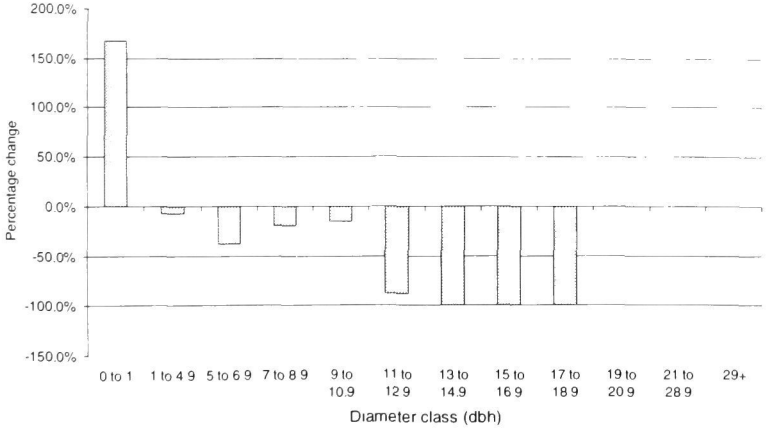

Figure C14. Change in number of live gray birch trees on forest land, by diameter class, Maine, 1982 to 1995.

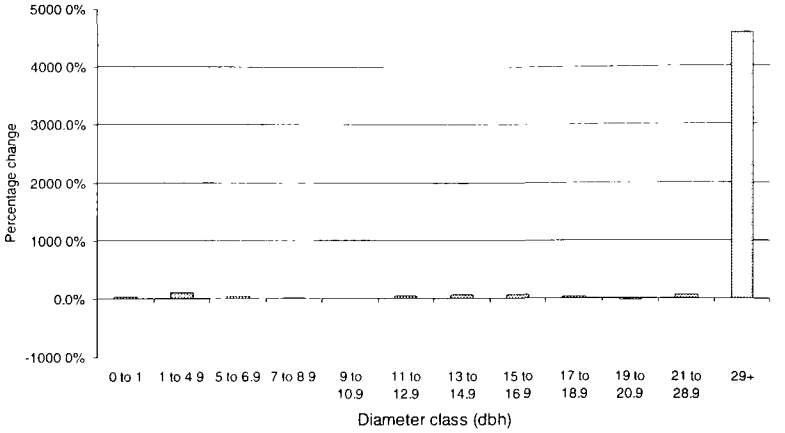

Figure C15. Change in number of live white ash trees on forest land, by diameter class, Maine, 1982 to 1995.

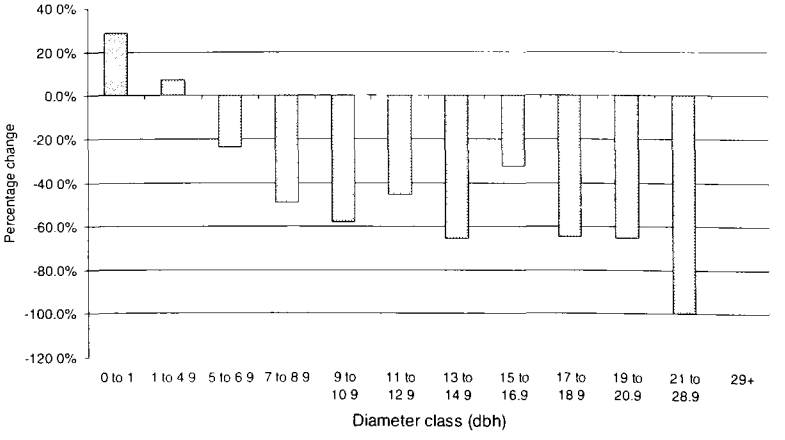

Figure C16. Change in number of live black ash trees on forest land, by diameter class, Maine, 1982 to 1995.

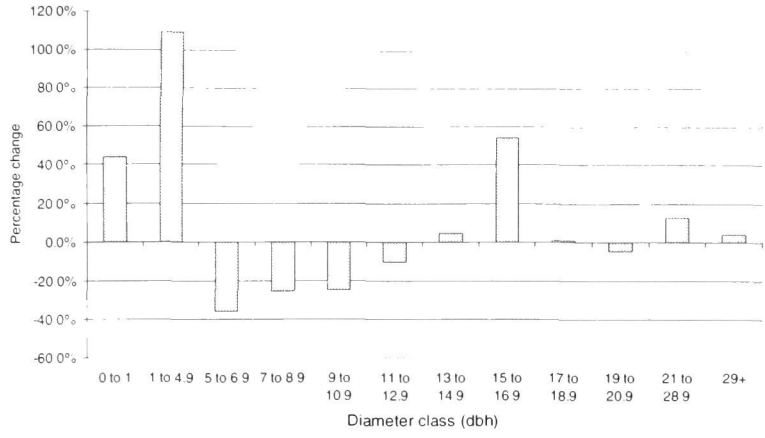

Figure C17. Change in number of live aspen trees on forest land, by diameter class, Maine, 1982 to 1995.

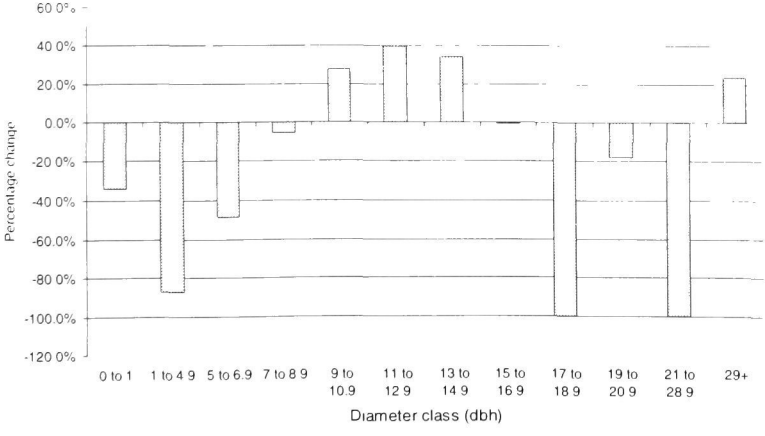

Figure C18. Change in number of live white oak trees on forest land, by diameter class, Maine, 1982 to 1995.

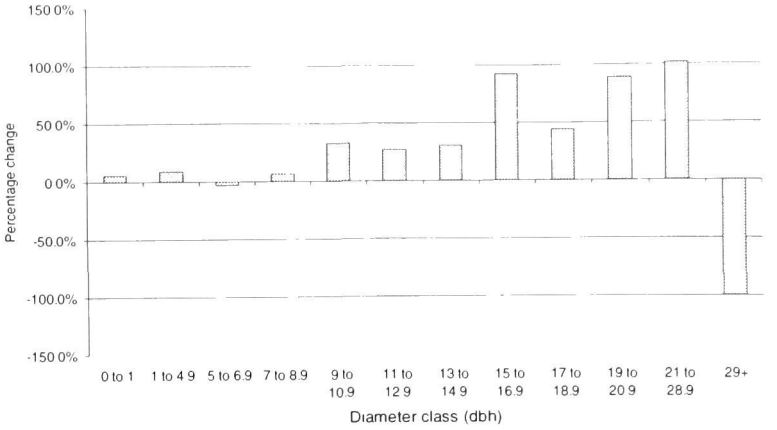

Figure C19. Change in number of live red oak trees on forest land, by diameter class, Maine, 1982 to 1995.

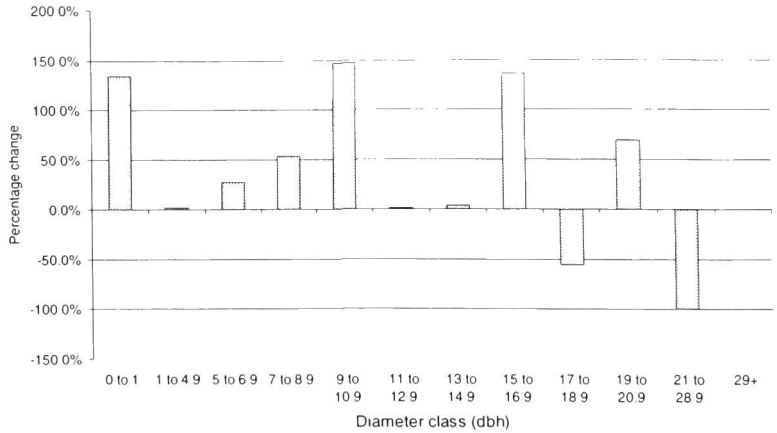

Figure C20. Change in number of live basswood trees on forest land, by diameter class, Maine, 1982 to 1995.

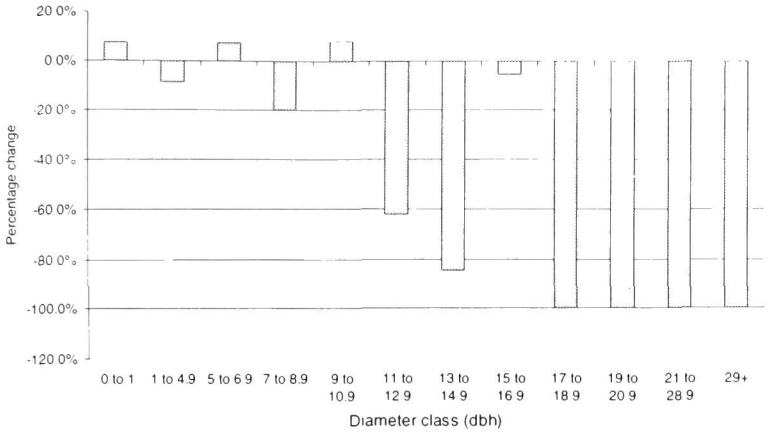

Figure C21. Change in number of live elm trees on forest land, by diameter class, Maine, 1982 to 1995.

Table D1. Live, open, dominant and co-dominant, nut- and fruit-producing trees on forest lands, by species, by diameter class, 1995. Thousands of trees.

Diameter Size Class Species	5.0– 6.9	7.0– 8.9	9.0– 10.9	11.0– 12.9	13.0– 14.9	15.0– 16.9	17.0– 18.9	19.0– 20.9	21.0– 28.9	29+	Total
Ohio buckeye	30.4	36.9	-	-		-	-	-	-	-	67.3
Serviceberry	156.7	59.3	-	-	-	-	-	-	-	-	216.0
Hickory	30.6	-	36.9	-		-	-	-	-	-	67.5
Chestnut	32.1	-				-	-	-	-	-	32.1
Hackberry		36.0		-	-	-	-	-	-	-	36.0
Beech	39,656.8	32,377.1	22,368.5	11,890.4	6,446.9	3,101.5	1,041.5	556.5	154.8	-	117,594.1
Butternut	-	-	33.1		34.1			-		-	67.3
Apple	440.2	301.7	158.9	90.6	31.5	-	-	-		-	1,023.0
E. hophornbeam	4,907.0	1,936.8	616.2	202.6	-	67.7	38.6	-	-	-	7,768.8
Plum cherry	-	33.2	-	-	-	-	-	-	-	-	33.2
Pin cherry	4,721.3	680.3	203.4	33.0	-	-			-	-	5,638.0
Black cherry	2,698.0	2,155.1	1,121.0	422.6	106.8	62.3	31.0	-	33.8		6,630.6
Chokecherry	99.1	32.2			-			-		-	131.2
White oak	1,318.7	965.4	329.4	80.3	121.2	41.0		36.0	39.2	-	2,931.4
Bear oak	32.6		-	-	-		-	-		-	32.6
Bur oak		-	-	-	-	33.2		-	-		33.2
N. red oak	17,788.6	14,496.9	8,986.7	5,300.8	2,883.3	2,351.1	772.3	656.6	707.6		53,943.8
Black oak	673.1	627.0	468.7	255.0	174.2	-	78.4	-			2,276.4
Mountain ash	511.8	384.5	29.7	-	31.0	-	-	-			957.1
Total	**73,096.9**	**54,122.4**	**34,352.5**	**18,275.4**	**9,829.1**	**5,656.7**	**1,961.8**	**1,249.1**	**935.4**	**-**	**199,479.4**

Table D2. Live, open, dominant and co-dominant coniferous trees on forest lands, by species, by diameter size class, 1995. Thousands of trees.

	Diameter Size Class									
Species	5 to 6.9	7 to 8.9	9 to 10.9	11 to 12.9	13 to 14.9	15 to 16.9	17 to 18.9	19 to 20.9	21+	Total
Balsam fir	149,682.8	96,032.9	40,048.8	12,444.0	3,362.5	765.8	65.3	33.5	-	302,435.6
E. red cedar	36.3					-	-			36.3
Tamarack	10,882.9	6,191.6	3,182.7	2,033.6	744.8	395.5	132.7	130.4	65.6	23,759.9
White spruce	13,630.6	12,869.8	7,558.6	4,846.6	2,141.4	1,080.2	508.8	130.6	258.1	43,024.6
Black spruce	28,275.4	13,776.1	5,908.6	1,998.4	582.7	161.0	33.2	-	-	50,735.4
Red spruce	84,025.7	94,656.2	64,045.8	35,473.9	15,250.1	6,738.0	2,199.2	703.5	355.6	303,448.1
Jack pine	1,515.1	161.6	-	-	-			-		1,676.7
Red pine	1,992.9	1,665.8	1,094.5	498.9	619.4	271.6	216.4	33.6		6,393.1
Pitch pine		320.6	412.4	391.4	321.6	166.4	67.0	-		1,679.3
E. white pine	22,431.4	22,475.3	20,346.5	17,011.7	13,300.3	8,705.1	6,852.5	3,927.8	6,189.4	121,240.0
Scoth pine	-	-	34.8	-		-	-	-		34.8
N. white cedar	50,244.2	60,672.8	50,990.2	31,898.1	16,491.6	8,309.5	3,672.4	1,080.9	861.1	224,220.8
E. hemlock	14,540.6	19,753.3	19,995.0	14,166.0	9,753.0	4,812.6	2,244.7	1,044.9	1,093.8	87,404.0
Total	**377,257.9**	**328,576.1**	**213,618.0**	**120,762.5**	**62,567.5**	**31,405.7**	**15,992.1**	**7,085.2**	**8,823.6**	**1,166,088.7**

Table F1. Basal area of live, open, dominant & codominant trees 5.0+ dbh on forest lands, 1995.

Forest Type Group	Basal Area (sq. ft. per acre)							
		1 to 24	25 to 49	50 to 74	75 to 99	100 to 124	125+	Total
	Acres							
White/red pine	3,152	33,285	144,931	212,952	287,172	245,971	359,715	1,287,178
Spruce/fir	464,509	1,153,554	1,189,855	1,323,390	1,050,465	677,185	554,279	6,413,237
Oak/pine	1,280	11,561	14,279	26,675	35,168	35,008	6,463	130,434
Oak/hickory	6,586	28,947	114,394	147,481	83,792	45,669	35,181	462,050
Elm/ash/red maple	38,256	171,341	153,060	58,222	34,259	13,055	19,739	487,932
Northern hardwoods	205,739	903,583	1,201,634	1,568,208	1,600,040	812,029	268,608	6,559,841
Aspen/birch	243,073	644,266	384,415	405,891	399,677	216,903	57,806	2,352,031
Total	**962,595**	**2,946,537**	**3,202,568**	**3,742,819**	**3,490,573**	**2,045,820**	**1,301,791**	**17,692,703**
	Percentage of Acres							
White/red pine	0.2	2.6	11.3	16.5	22.3	19.1	27.9	100
Spruce/fir	7.2	18.0	18.6	20.6	16.4	10.6	8.6	100
Oak/pine	1.0	8.9	10.9	20.5	27.0	26.8	5.0	100
Oak/hickory	1.4	6.3	24.8	31.9	18.1	9.9	7.6	100
Elm/ash/red maple	7.8	35.1	31.4	11.9	7.0	2.7	4.0	100
Northern hardwoods	3.1	13.8	18.3	23.9	24.4	12.4	4.1	100
Aspen/birch	10.3	27.4	16.3	17.3	17.0	9.2	2.5	100
Total	**5.4**	**16.7**	**18.1**	**21.2**	**19.7**	**11.6**	**7.4**	**100**

Table F2. Basal area (sq. ft. per acre) of live trees 1+ dbh per acre on Maine forest lands, by species group, by forest-type group, 1995.

Species group	wht/red pine	spruce/fir	loblolly	oak/pine	oak/hickory	elm/ash/maple	north hardwood	aspen/birch	All forests
Balsam fir	6.6	23.0	2.0	8.4	5.4	6.4	8.6	12.3	14.0
Tamarack	0.3	1.5			0.1	0.5	0.1	0.4	0.7
White spruce	0.5	3.5		0.1	0.0	0.5	0.6	2.0	1.8
Black spruce	0.0	3.9				0.5	0.0	0.2	1.5
Red Spruce	6.4	20.8		4.7	1.3	1.0	6.5	4.6	11.1
Red pine	2.1	0.1			0.0		0.1	0.3	0.2
White pine	55.9	2.6	28.6	51.2	10.9	0.6	2.3	2.8	6.9
N. white cedar	2.8	23.7		1.2	0.3	5.7	2.2	1.9	10.0
Hemlock	32.2	2.1		3.6	6.2	0.4	4.4	0.7	5.0
Other softwood	0.6	0.0	134.0	1.2	0.1		0.0	0.0	0.1
Total softwood	**107.5**	**81.3**	**164.6**	**70.2**	**24.6**	**15.6**	**24.7**	**25.3**	**51.4**
Red maple	11.0	6.4		13.0	20.6	33.2	17.0	8.5	12.1
Sugar maple	1.2	0.4		2.5	2.3	0.5	16.0	1.3	6.4
Yellow birch	2.2	2.3		0.3	1.0	1.4	10.3	1.7	5.1
Paper birch	3.4	4.2	2.7	4.3	5 2	0.4	4.0	15.0	5.4
Gray birch	1.4	0.4		2.2	0.4	0.9	0.3	2.0	0.7
Beech	1.9	0.2		1.5	5.7	0.3	12.4	0.9	5.1
White ash	1.1	0.4		2.8	2.1	1.5	2.6	0.9	1.4
Black ash	0.1	0.6		0.2	-	4.9	0.4	0.3	0.5
Aspen	2.3	1.7		5.9	1.4	0.6	1.9	22.4	4.5
White oak	0.1			0.2	1.9	0.1	0.0	0.1	0.1
Red oak	3.8	0.2		11.9	39.8	0.5	1.1	0 9	2.0
Basswood	0.0	0.0		0.3	-	0.0	0.3	0.0	0.1
Elm	0.1	0.0		0.1	0.1	0.6	0.1	0.2	0.1
Other hardwood	1.5	1.2		2.9	3.4	1.9	4.0	2.0	2.4
Total hardwood	**30.1**	**18.0**	**2.7**	**48.2**	**83.7**	**46.9**	**70.3**	**56.3**	**46.1**
Total Trees	**137.6**	**99.4**	**167.3**	**118.4**	**108.3**	**62.5**	**94.9**	**81.6**	**97.5**
Total Acres	**1,287,178**	**6,413,237**	**6,709**	**130,434**	**462,050**	**487,932**	**6,559,841**	**2,352,031**	**17,699,412**

Table G1a. Number of live trees on timberland, by diameter class, Maine, 1982 and 1995. Thousands of trees.

Diameter class	1982	1995	inc./(dec.)	% change
1.0 to 2.9	7,162,086	10,696,433	3,534,347	49.3
3.0 to 4.9	2,878,863	2,693,084	(185,779)	-6.5
5.0 - 6.9	1,753,340	1,304,864	(448,476)	-25.6
7.0 - 8.9	1,014,948	795,749	(219,199)	-21.6
9.0 - 10.9	513,859	449,060	(64,799)	-12.6
11.0 - 12.9	250,828	235,587	(15,241)	-6.1
13.0 - 14.9	117,825	119,166	1,341	1.1
15.0 - 16.9	54,437	60,300	5,863	10.8
17.0 - 18.9	25,585	28,383	2,798	10.9
19.0 - 20.9	13,198	14,653	1,455	11.0
21.0 - 28.9	13,086	15,541	2,455	18.8
29+	1,236	1,545	309	25.0
Total	**13,799,291**	**16,414,365**	**2,615,074**	**19.0**
Total 5+ dbh	**3,758,342**	**3,024,848**	**(733,494)**	**-19.5**

Table G1b. Number of live trees on timberland, by diameter class, Maine, 1982 and 1995. Percentage of total trees.

Diameter class	1982	1995
1.0–2.9	51.9	65.2
3.0–4.9	20.9	16.4
5.0–6.9	12.7	7.9
7.0–8.9	7.4	4.8
9.0–10.9	3.7	2.7
11.0–12.9	1.8	1.4
13.0–14.9	0.9	0.7
15.0–16.9	0.4	0.4
17.0–18.9	0.2	0.2
19.0–20.9	0.1	0.1
21.0–28.9	0.1	0.1
29+	0.0	0.0
Total	**100.0**	**100.0**

Table G1c. Number of live trees 5.0+ dbh on timberland, by diameter class, Maine, 1982 and 1995. Percentage of total trees.

Diameter class	1982	1995
5.0–6.9	46.7	43.1
7.0–8.9	27.0	26.3
9.0–10.9	13.7	14.8
11.0–12.9	6.7	7.8
13.0–14.9	3.1	3.9
15.0–16.9	1.4	2.0
17.0–18.9	0.7	0.9
19.0–20.9	0.4	0.5
21.0–28.9	0.3	0.5
29+	0.0	0.1
Total	**100.0**	**100.0**

Table H1. Selected characteristics of the forest floor, Maine, 1995.

	Acres
Depth of organic layer	
< 1"	2,185,879
1 to 1.9"	3,802,071
2 to 2.9"	4,023,319
3 to 3.9"	2,673,891
4 to 4.9"	1,270,053
5 to 9.9"	1,760,537
10+	1,198,805
Total	**16,914,555**
Depth to mottling	
0 to 5"	903,097
6 to 10"	2,690,542
11 to 15"	1,571,253
16 to 20"	611,401
over 20	11,138,262
Total	**16,914,555**
Depth to bedrock	Acres
0 to 10"	359,917
11 to 20"	1,232,252
21 to 30"	2,536,562
31 to 40"	12,354,330
Total	**16,483,061**
Moisture class	
Very dry	19,066
Dry	1,024,077
Mesic	11,132,808
Wet	3,293,580
Very wet	1,014,215
Total	**16,483,746**

Table I1. Selected measures of live trees 5.0+ dbh on forested land, by stand age structure, Maine 1995.

	acres	trees	avg. size	density	Size categories (dbh) 5 to 9	10 to 14	15 to 19	20+	Total
all other	17,036,749	2,934,780,070	8.2	172.3	78.4%	17.9%	3.1%	0.7%	100%
older	473,028	78,637,329	9.7	166.2	62.7%	25.6%	8.3%	3.5%	100%
oldest	189,635	39,128,536	10.0	206.3	59.6%	28.0%	7.8%	4.6%	100%

Selected measures of dead trees 5.0+ dbh on forested land, by stand age structure, Maine 1995.

	acres	trees	avg. size	density	Size categories (dbh) 5 to 9	10 to 14	15 to 19	20+	Total
all other	17,036,749	503,878,206	7.8	29.6	82.6%	14.8%	2.2%	0.4%	100.00%
older	473,028	14,962,572	10.9	31.6	55.5%	22.9%	13.5%	8.1%	100.00%
oldest	189,635	7,522,120	10.0	39.7	65.1%	16.8%	11.4%	6.7%	100.00%

Acres of forested land, by stand age structure, by forest-type group, Maine, 1995.

	White/red pine	Spruce/fir	Oak/pine	Oak/hickory	Elm/ash/maple	N. hardwoods	Aspen/birch	Total
all other	1,227,384	6,343,762	123,823	462,050	487,932	6,033,058	2,352,031	17,030,040
older	26,163	36,423	6,611			403,831	-	473,028
oldest	33,631	33,052	-	-	-	122,952	-	189,635
Total	1,287,178	6,413,237	130,434	7,830,849	487,932	6,559,841	2,352,031	25,061,502

Acres of forested land by number of tree species 1.0+ dbh present on FIA plots, Maine, 1995.

	Number of species							
	0 to 2	3 to 4	5 to 6	7 to 8	9 to 10	11 to 12	13 to 14	Total
all other	9.3%	19.7%	14.7%	34.8%	17.0%	4.1%	0.5%	100%
older	0.0%	8.0%	20.2%	43.0%	24.0%	3.2%	1.6%	100%
oldest	0.0%	7.8%	3.6%	50.4%	35.0%	3.1%	0.0%	100%

Distribution of live trees 5.0+ dbh on forested land, by crown class, by stand age structure, Maine, 1995.

	Crown Class					
	Open	Dominant	CoDominant	Intermediate	Overtopped	Total
all other	0.3%	15.5%	61.2%	17.9%	5.2%	100%
older	0.0%	14.0%	60.0%	19.8%	6.2%	100%
oldest	0.0%	16.8%	54.7%	21.5%	7.1%	100%

Live trees on forested land by crown ratio, by stand age structure, Maine, 1995.

	Crown ratio (%)					
oldstand	0 to 19	20 to 39	40 to 59	60 to 79	80 to 100	Total
all other	8.9	60.0	24.9	4.9	1.2	100
older	6.5	55.9	31.9	5.4	0.4	100
oldest	9.8	59.6	24.5	5.9	0.3	100

Mast-potential oak & beech trees as percentage of all trees 5.0+ dbh, by size category, by stand age structure, Maine, 1995.

	Size category (dbh) %									
	5 to 6.9	7 to 8.9	9 to 10.9	11 to 12.9	13 to 14.9	15 to 16.9	17 to 18.9	19 to 20.9	21 to 28.9	29+
all other	3.7	5.0	6.0	6.1	6.7	7.6	5.9	7.5	5.3	2.3
older	4.6	7.5	6.8	10.0	11.1	7.7	4.7	4.4	2.5	0.0
oldest	3.6	6.3	7.3	10.7	4.8	9.7	2.4	6.8	2.1	0.0

Mast-potential conifer trees as percentage of all trees 5.0+ dbh, by size category, by stand age structure, Maine, 1995.

	Size category (dbh) %									
	5 to 6.9	7 to 8.9	9 to 10.9	11 to 12.9	13 to 14.9	15 to 16.9	17 to 18.9	19 to 20.9	21 to 28.9	29+
all other	24.0%	34.8%	41.0%	44.4%	45.5%	45.4%	51.6%	45.3%	49.7%	45.4%
older	9.0%	24.1%	23.5%	25.6%	23.2%	22.6%	18.8%	12.2%	12.3%	0.0%
oldest	12.1%	26.7%	32.9%	44.9%	47.5%	41.8%	29.6%	26.4%	31.5%	39.5%

Table 12. Stocking class of all live trees, by stand size class, by forest type group, Maine, 1995.

Forest Type Group	STDSIZE	acres	Nonstocked	Poorly stocked	Moderately stocked	Fully stocked	Over stocked
White/red pine	Sawtimber	964,599	-	50,422	228,393	510,467	175,317
	Poletimber	267,628	-	13,613	78,732	141,540	33,743
	Seedling/sapling	52,704	-			38,600	14,104
	Nonstocked	2,247	2,247	-	-	-	-
Spruce/fir	Sawtimber	2,012,740	-	140,022	716,337	1,058,368	98,013
	Poletimber	2,328,665		195,270	979,104	1,106,614	47,677
	Seedling/sapling	2,044,136		61,552	229,334	893,557	859,693
	Nonstocked	27,696	14,537	6,695	6,464	-	-
Oak/pine	Sawtimber	49,279			7,876	41,403	-
	Poletimber	68,148		12,086	22,054	27,545	6,463
	Seedling/sapling	13,007	-			6,145	6,862
Oak/hickory	Sawtimber	134,259	-	8,859	13,468	76,400	35,532
	Poletimber	287,712	-	5,428	92,580	169,319	20,385
	Seedling/sapling	40,079	-		5,329	6,586	28,164
Elm/ash	Sawtimber	45,776	-	19,788	12,496	13,055	437
	Poletimber	232,991		49,996	106,565	56,691	19,739
	Seedling/sapling	202,640	-	19,435	19,466	80,137	83,602
	Nonstocked	6,525	6,525		-	-	-
Northern hardwood	Sawtimber	2,559,661	-	77,717	493,496	1,577,134	411,314
	Poletimber	2,721,005	-	127,841	832,343	1,604,396	156,425
	Seedling/sapling	1,275,678	-	54,665	80,455	388,810	751,748
	Nonstocked	3,497	3,497			-	
Aspen/birch	Sawtimber	221,718	-	24,996	64,435	132,287	-
	Poletimber	1,134,540		73,324	230,588	610,374	220,254
	Seedling/sapling	990,483	-	5,921	40,905	415,268	528,389
	Nonstocked	5,290		5,290	-		

Table I3 Stocking class of all live trees, by stand size class, by forest type group, Maine, 1995.

Forest Type Group	STDSIZE	acres		Nonstocked	Poorly stocked	Moderately stocked	Fully stocked	Over stocked
				%				
White/red pine	Sawtimber	964,599	100	0.0	5.2	23.7	52.9	18.2
	Poletimber	267,628	100	0.0	5.1	29.4	52.9	12.6
	Seedling/sapling	52,704	100	0.0	0.0	0.0	73.2	26.8
	Nonstocked	2,247	100	100.0	0.0	0.0	0.0	0.0
Spruce/fir	Sawtimber	2,012,740	100	0.0	7.0	35.6	52.6	4.9
	Poletimber	2,328,665	100	0.0	8.4	42.0	47.5	2.0
	Seedling/sapling	2,044,136	100	0.0	3.0	11.2	43.7	42.1
	Nonstocked	27,696	100	52.5	24.2	23.3	0.0	0.0
Oak/pine	Sawtimber	49,279	100	0.0	0.0	16.0	84.0	0.0
	Poletimber	68,148	100	0.0	17.7	32.4	40.4	9.5
	Seedling/sapling	13,007	100	0.0	0.0	0.0	47.2	52.8
Oak/hickory	Sawtimber	134,259	100	0.0	6.6	10.0	56.9	26.5
	Poletimber	287,712	100	0.0	1.9	32.2	58.9	7.1
	Seedling/sapling	40,079	100	0.0	0.0	13.3	16.4	70.3
Elm/ash	Sawtimber	45,776	100	0.0	43.2	27.3	28.5	1.0
	Poletimber	232,991	100	0.0	21.5	45.7	24.3	8.5
	Seedling/sapling	202,640	100	0.0	9.6	9.6	39.5	41.3
	Nonstocked	6,525	100	100.0	0.0	0.0	0.0	0.0
Northern hardwood	Sawtimber	2,559,661	100	0.0	3.0	19.3	61.6	16.1
	Poletimber	2,721,005	100	0.0	4.7	30.6	59.0	5.7
	Seedling/sapling	1,275,678	100	0.0	4.3	6.3	30.5	58.9
	Nonstocked	3,497	100	100.0	0.0	0.0	0.0	0.0
Aspen/birch	Sawtimber	221,718	100	0.0	11.3	29.1	59.7	0.0
	Poletimber	1,134,540	100	0.0	6.5	20.3	53.8	19.4
	Seedling/sapling	990,483	100	0.0	0.6	4.1	41.9	53.3
	Nonstocked	5,290	100	0.0	100.0	0.0	0.0	0.0

Table I4. Crown ratio of live trees, 5.0+ dbh, on forested land, 1982 and 1995.

Crown Ratio	No. of trees	Basal area	% of trees	% of Basal area
1995				
0–9	15,101,473	5,844,957	0.5	0.4
10–19	259,176,067	77,816,978	8.3	5.9
20–29	814,211,035	289,667,457	26.2	22.0
30–39	1,046,504,476	468,862,979	33.7	35.6
40–49	530,696,575	266,875,467	17.1	20.3
50–59	248,855,177	124,547,055	8.0	9.5
60–69	100,937,564	47,054,932	3.3	3.6
70–79	52,420,246	21,979,317	1.7	1.7
80–99	36,971,006	14,868,636	1.2	1.1
Total	**3,104,873,620**	**1,317,517,778**	**100.0**	**100.0**
1982				
0–9	1,519,161,118	583,201,271	39.6	39.2
10–19	200,430,629	52,697,716	5.2	3.5
20–29	570,945,406	172,966,146	14.9	11.6
30–39	846,918,300	335,653,543	22.1	22.6
40–49	409,341,803	201,831,304	10.7	13.6
50–59	169,707,824	84,989,838	4.4	5.7
60–69	69,161,306	33,173,886	1.8	2.2
70–79	31,701,742	14,130,390	0.8	0.9
80–99	21,257,355	8,830,274	0.6	0.6
Total	**3,838,625,482**	**1,487,474,368**	**100.0**	**100.0**

Table J1. Area of timberland by ownership class, Maine, 1982 and 1995. Thousands of acres.

Ownership class	1982*	1995**	inc./(dec.)	% change
National forest	45.6	33.5	(12.1)	-26.5
Other public	644.5	598.7	(45.8)	-7.1
Forest industry	8,016.9	7,297.8	(719.1)	-9.0
Other private	8,353.2	9,007.6	654.4	7.8
Total	**17,060.2**	**16,937.6**	**(122.6)**	**-0.7**

*Source: Forest Statistics for Maine 1971 and 1982.
**Source: Forest Statistics for Maine, 1995.
Note: Differences in total land area may be due partially to changes in estimating procedures.

Land area in Maine, by land use class, 1982 and 1995. Thousands of acres.

Ownership class	1982*	1995**	inc./(dec.)	% change
Timberland	17,060.2	16,937.7	(122.5)	-0.7
Reserved forest	272.0	334.2	62.2	22.9
Urban forest	2.1	43.4	41.3	1966.7
Unproductive forest	262.1	367.6		
Unproductive reserved	11.0	6.2	(4.8)	-43.6
Total	**17,607.4**	**17,689.1**	**81.7**	**0.5**

*Source: Forest Statistics for Maine 1971 and 1982.
**Source: Forest Statistics for Maine, 1995.
Note: Differences in total land area may be due partially to changes in estimating procedures.

Plot-level view of land use change, 1995 FIA plots.* Thousands of acres.

Land use change	acres	%
Forest to Forest	12,817,146	88.7
Forest to Non-Forest	231,412	1.6
Non-Forest to Forest	200,709	1.4
Non-Forest to Non-Forest	1,203,024	8.3
Total	**14,452,291**	**100.0**

*Based on 2,192 remeasured plots in 1995 for which previous land use is known.

Table K1. Comparison of acreage on linked and non-linked plots. 1995 data for forested plots

	linked	%	not linked	%
Land Use				
Forested	7,786,975	91.3	9,912,437	87.5
Non-forested	1,114,511	8.7	939,495	12.5
Total acres	**8,901,486**	**100**	**10,851,932**	**100**
Owner				
National forest	20,308	0.2	19,766	0.2
Other public	440,865	5.0	542,568	5.0
Forest industry	2,829,569	31.8	4,744,263	43.7
Other private	5,610,744	63.0	5,545,335	51.1
Total acres	**8,901,486**	**100.0**	**10,851,932**	**100.0**
Forest type group				
White-Red Pine	625,651	8.0	661,527	6.7
Spruce-Fir	2,570,126	33.0	3,843,111	38.8
Loblolly		0.0	6,709	0.1
Oak-Pine	77,359	1.0	53,075	0.5
Oak-Hickory	210,504	2.7	251,546	2.5
Elm-Ash-Maple	205,684	2.6	282,248	2.8
North H'dwoods	2,945,349	37.8	3,614,492	36.5
Aspen-Birch	1,152,302	14.8	1,199,729	12.1
Total acres	**7,786,975**	**100.0**	**9,912,437**	**100.0**
Stand size class				
Sawtimber	2,588,570	33.2	3,406,171	34.4
Poletimber	3,100,819	39.8	3,939,870	39.7
Seedling/sapling	2,082,274	26.7	2,536,453	25.6
Non-stocked	15,312	0.2	29,943	0.3
Total acres	**7,786,975**	**100.0**	**9,912,437**	**100.0**
Stocking class				
Nonstocked	10,022	0.1	16,784	0.2
Poorly stocked	439,030	5.6	513,890	5.2
Mod. Stocked	2,064,962	26.5	2,195,458	22.1
Fully stocked	3,681,972	47.3	5,279,433	53.3
Overstocked	1,590,989	20.4	1,906,872	19.2
Total acres	**7,786,975**	**100.0**	**9,912,437**	**100.0**

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