The 2005 Biennial Report on the State of the Forest and Progress Report on Forest Sustainability Standards

Report to the
Joint Standing Committee of the
122nd Legislature on
Agriculture, Conservation and Forestry
29 December 2005

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We help you make informed decisions about Maine's forests

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Note to readers: The information in this report is believed to be accurate as of 31 December 2005. New information received after this date may not be reflected in the report.

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Dear Reader:

I'm pleased to present the 2005 State of the Forest Report. I hope you find the report interesting and informative.

The report reflects progress on a number of important issues, including increasing the amount of third-party certified land in Maine, planning what the state government can do to support the forest industry, and other issues as well.

Beyond status reports on specific issues, we have made a concerted effort to boil down the mountain of data on Maine's forests into a summary. Developing a meaningful and accurate summary on the condition of Maine's forests has been particularly challenging. Many facets of the forest condition must all be considered in concert to have an accurate picture; fitting the pieces of the puzzle together to form a coherent whole is exceedingly complex. In addition, different segments of Maine society have deep differences of opinion about the criteria by which to assess the meaning of specific facts. In this regard, persons of good will, but with different perspectives on what constitutes "good forestry," can interpret the information on our forests very differently. Examples of these differences are included in the introduction to this report. I encourage you to read the introduction and consider these different perspectives as you read the report itself. Despite the fact that people come to the discussion on forestry issues from very different perspectives; nonetheless, it is important for us all to be working from the same set of facts as we debate what they mean.

Disagreements on forestry issues have proven extremely divisive and have consumed large amounts of time and effort over the past 20 years. While I suffer no illusions as to the prospects for quick and easy progress in resolving these differences, those of us who care about our forests need to find ways to work collaboratively to resolve forestry issues if we are to maximize our effectiveness, achieve the benefits of a stable public policy (which financiers cite as a major factor influencing the investments needed to keep Maine's forest products industry competitive), and avoid divisive debates. This will involve improving our understanding of the issues and of one another's perspectives, as well as engaging in an open and constructive dialogue.

We intend to replicate the format of the summary in the future so that we can identify trends by consistently tracking a given set of metrics. However,

we do not anticipate that this summary will be entirely static in format. We invite your comments on how to improve it over time. We do not claim to have a monopoly on wisdom regarding how to interpret the complex information available on this topic.

After over two years in the position of State Forester, I have been struck by how distinguished Maine's forest resources truly are in comparison to other parts of our region, never mind other parts of the country. For example, did you realize that Vermont has no (zero) nesting pairs of bald eagles, while Maine has over 300 nesting pairs? Did you realize that Maine's forest products industry accounts for more than half of the output of the industry in the northern forest region? The importance of Maine's forest resources in these regards are not isolated aberrations. Many other statistics lead to the conclusion that Maine's forests are especially important. Even those of us who work in natural resources tend to underestimate the significance of Maine's forest resources.

It truly has been an honor to serve as State Forester. Once again I hope you find this report both interesting and informative.

My thanks to the many people who worked on sections of this report, but particularly Donald Mansius and the staff of the Forest Policy & Management Division who were the principal authors of the report.

Yours truly,

R. Alec Giffen
Director, Maine Forest Service

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INTRODUCTION

Around 300 BC, King Ptolemy I of Egypt aspired to learn the new mathematics of geometry. Frustrated by the complexities of the subject, he inquired of no less a personage than the father of geometry himself, Euclid, if there wasn't an easier way to master the subject. Euclid replied that there was no "royal road to geometry." Just as there is no easy way to understand geometry, there is no easy way to understand the complexities of the condition of Maine's forests.

The current assessment of growth vs. drain in Maine illustrates the complexity of these issues. In this regard, it is encouraging to note that the USDA Forest Service has concluded that growth equals harvest for pulpwood or better quality trees and that the volumes of these trees have been stable since 1995. Previous data had indicated that harvests slightly exceeded growth for this period and that as a result pulpwood quality volumes had been declining slightly each year (approximately 1% per annum). Therefore, the conclusion that growth now equals harvest for these trees and that timber volumes have been stable for the last decade is encouraging. However, other information in the report indicates that not all of the timber we are growing will be available for harvest. For example, approximately 132,000[1] individuals own less than 10 acres of forest land; another 57,000 own between 10 and 49 acres. Research indicates that owners of small parcels of forest land usually own it for purposes other than timber production, and hence the timber on these lands is unlikely to be actively managed and a portion of it may not be available for harvest in the future. This argues that our data are likely to paint too rosy a picture of future timber supplies (sobering). At the same time, we are monitoring the development of young stands resulting from the combined impacts of the 1970 – 1990 spruce budworm epidemic and extensive harvesting. Trees in these stands are nearing merchantable size. If harvesting levels remain stable, we would expect that timber volumes would increase in the decades ahead as these stands reach merchantability (encouraging). However, inventory data recently analyzed indicates that balsam woolly adelgid, previously confined to coastal Maine, is now expanding inland and killing large numbers of balsam fir trees. Preliminary analysis indicates that approximately 16% of the balsam fir trees in a band approximately 15 miles inland from the coast in eastern Maine died in the last 5 year period. Further, mortality from balsam woolly adelgid was detected as far north as the Greenville area, and it is not clear what the course of this outbreak will be (worrisome). The bottom line is that, as for many forestry metrics, assessing the relationship between growth and harvest, and looking to the future of supply, turns out to have several parts and some parts are only partially understood.

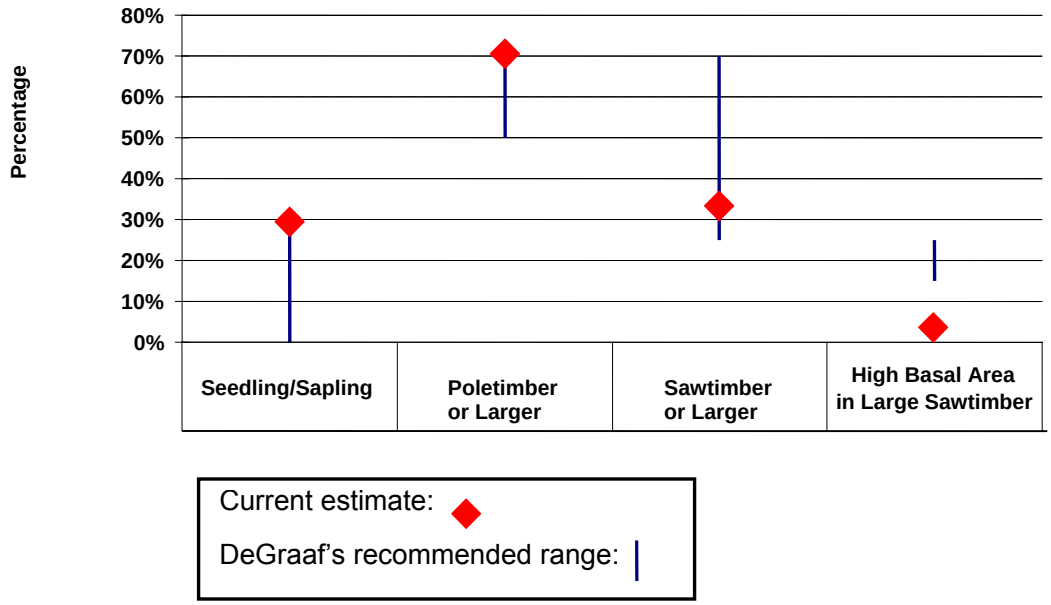
This situation is made more difficult by the fact that, even if we understood the situation completely and could predict the future perfectly, persons with different perspectives can view a single metric from very different vantage points. For example, consider the issue of stand size class distribution, another fundamental metric in assessing forest condition. Maine currently has approximately equal acreages in seedling and sapling, poletimber, and sawtimber sized stands, but what does this mean? Proponents of a regulated forest (meaning one where management is intended to produce a stand size class distribution that can support relatively consistent levels of harvest on a regular basis) are likely to see this as positive. On the other hand, persons interested in maximizing habitat values for

[1] McWilliams *et al*, 2005.

vertebrate wildlife would note that it deviates from both DeGraaf's idealized stand size class distribution and the distribution identified in the biodiversity benchmarks later in this report (Figure 1). Still others who believe that our management should more closely mimic natural processes might view it with alarm, as it deviates from what we know about conditions in Maine's forest at the time of European settlement. Thus, a single set of facts can be viewed from several very different perspectives. The effort to identify forest sustainability benchmarks as outlined later in this report is intended to provide a set of standards that Maine's forest conditions can be measured against, and thus help bring divergent perspectives together – but we are in the early stages of that effort.

Many other examples of the complexities of this information and the difficulties of interpreting it objectively are possible. Please keep these thoughts in mind as you review the 2005 State of the Forest report.

Figure 1. Idealized forest stand structure and current statewide timberland structure. (K. Laustsen, 2005, personal communication. Adapted from DeGraaf, 1992)



EXECUTIVE SUMMARY

The 2005 State of the Forest Report is a keystone of the Maine Forest Service's efforts to inform Maine citizens about the condition of and trends in Maine's forests and forest economy. Pursuant to legislative direction, the report covers a number of issues including forest sustainability benchmarking, forest land ownership changes, and forest condition.

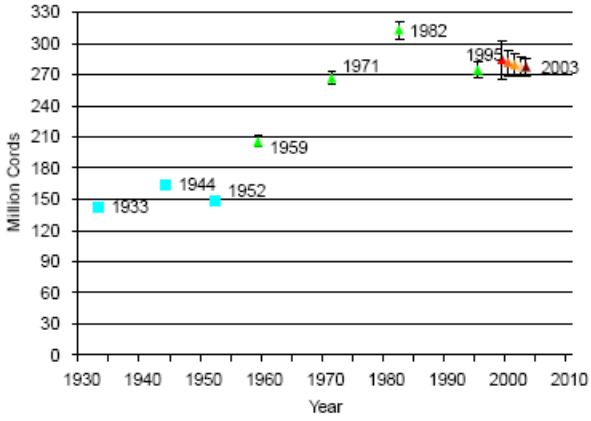
The Significance of Maine's Forests

Several things distinguish Maine's forests from others in the eastern U.S. Individually, these features are significant. In combination, they make Maine's forests unique.

- The resilience of our forest ecosystems: Maine's forests have been harvested for wood products for over 200 years, yet 90% of the state remains forested - the highest percentage in the country. Analysis of historical records indicates that Maine has approximately 2/3 of the stocking that it did at the time when commercial harvesting began. Further, Maine has largely maintained its forest biodiversity, with a few exceptions (e.g., caribou).
- The dominance of private ownership of forestland: 95% of Maine's forests are privately owned, one of the highest percentages in the country.
- The diversity and significance of our forest resources: In addition to a diverse timber resource, Maine's forests support many public resources, including 6,000 lakes and ponds and 32,000 miles of rivers and streams and abundant fish and wildlife resources.
- Maine has the largest contiguous block of undeveloped forestland east of the Mississippi: This includes approximately 10.5 million acres of unorganized territory which remain largely undeveloped forestland, most of which is actively managed for timber production.
- The strength and diversity of Maine's forest products industry: Maine's forest products industry accounts for approximately half of the output of the four-state region of northern New England and New York. Maine's forest landowners have markets – somewhere – for every stick of wood they harvest.
- A long history of multiple-use management on private land and a tradition of free public access to private land: This tradition dates to colonial times and is established in Maine common law for access to Great Ponds, navigable waters, and the coast.
- The special connection Maine citizens have with our forests: This heritage includes traditions of both consumptive and nonconsumptive use. Maine people care about the forests and how they are managed.

Forest Condition

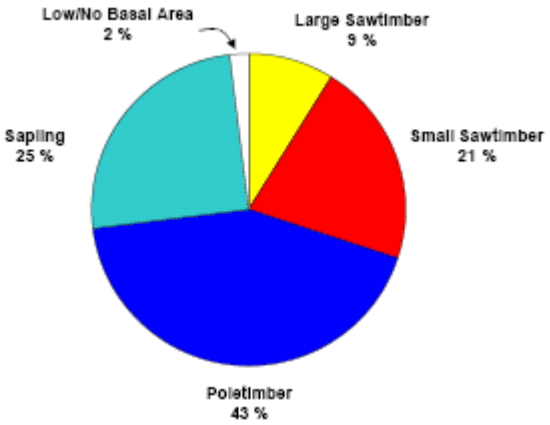
- Maine's forest inventory (chart below) has stabilized over the last several years at 275 million cords – 87% more than the 1950s.



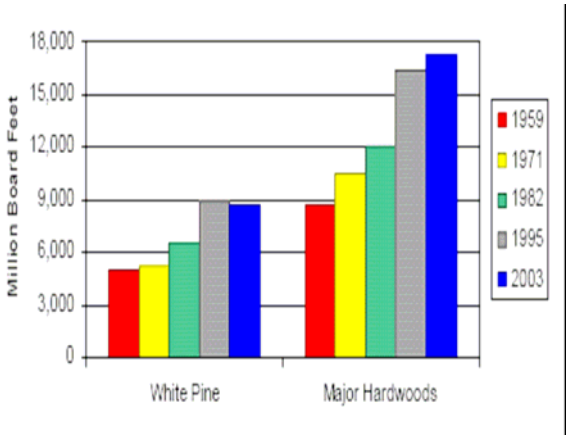
- Harvesting has stabilized at just over 500,000 acres per year, with a total

harvest of just over 6 million cords per year. Harvest and growth are currently in balance at around 0.35 cords per acre per year; however, Maine's forests have the potential to grow 0.5 cords per acre per year under improved management, and some intensively managed lands can and do produce more.

- Partial harvest methods dominate forest management, accounting for just under 60% of harvest acreage. Shelterwood harvesting accounts for 36% of harvest acreage. Clearcutting now accounts for less than 5% of harvest acreage, a significant decline over the last 15 years.
- The composition of Maine's forest stands is approximately 1/3 softwood and 2/3 hardwood, while the underlying habitats are 2/3 softwood and 1/3 hardwood. This difference between habitat type and stand type is a legacy of the last spruce budworm epidemic and harvesting.



- Maine's forest stands are roughly evenly divided between sawtimber, poletimber and seedlings/sapling size stands (chart above).
- With the exception of spruce and fir, sawtimber volumes of major species have steadily increased over the years (following chart).



- MFS continues to monitor the development of young stands resulting from the combined impacts of the 1970 – 1990 Spruce Budworm Epidemic and extensive harvesting. Efforts to predict the timing and initial merchantability of these young stands is underway. Over the last 5 years of data collection under the new annualized inventory design (1999 – 2003), annual estimates of ingrowth (new merchantable trees since 1995) have improved from 1.53 million cords in 1999 to 1.86 million cords in 2003. If current trends continue, ingrowth is expected to increase to 2.2 - 2.3 million cords per year in 2010.

Forest Economy

- Maine has a highly diverse forest industry "cluster" (a mix of mutually supportive manufacturing facilities). Maine's forest products cluster provides markets for waste products from manufacturing facilities, as well as high-grade material. Landowners have markets for everything they harvest, from the lowest grades of wood that go to biomass generation to dimension lumber and high end furniture products.
- Despite a very challenging global situation, Maine is still the #2 paper producing state in the U.S.; further, Maine's lumber production from over 200 sawmills has more than doubled since the mid-1970's.

- The forest products industry is still a key player in the state's economy. Its direct annual contributions amount to $6.2 billion; with indirect contributions, the industry's total impact is $10.2 billion. The industry provides over 18,000 jobs for Maine people. Forest products represent 36% of the state's total manufacturing output.
- Maine is also a major player in the regional forest products industry. Maine produces over ½ of the wood output of the four-state region that includes New Hampshire, Vermont, and New York. Our forest products industry accounts for 40% of the value of shipments in this same region.
- Employment in the forest products industry has declined steadily (following table), as mills and harvesting technology become more efficient. While employment is down, worker productivity, average wage, and capital expenditures have all increased. This is the natural evolution of a mature industry going through transition and taking steps to remain competitive in the global marketplace.

	1997	2002	% Change
Employees	23,430	18,130	-23%
Payroll ($1,000)	$ 900,957	$ 838,552	-7%
Value Added ($1,000)	$ 2,563,869	$ 2,526,752	-1%
Value of Shipments ($1,000)	$ 5,552,376	$ 5,263,591	-5%
Capital Expenditures ($1,000)	$ 296,965	$ 368,454	24%
Productivity ($ shipments / employee)	$ 236,977	$ 290,325	23%
Average wage	$ 38,453	$ 46,252	20%

Challenges

Maine's forests, its landowners, and its industry all face significant challenges as we look to the future. MFS has identified several critical and interrelated issues that are key to the future of our forests:

- Maintaining a sustainably managed, economically viable working forest land base. This is critical to maintaining the many public values provided by Maine's privately-held forests. For example, the habitat for many wildlife species is dependent upon active management.
- Conversion of forest land to development and parcelization. Parcelization makes good forest management less likely and more difficult, even if the land remains forested. Parcelization and forest land conversion are significant issues in southern and central Maine.
- Inadequate returns from long term forest management. The financial returns on long term forest management do not justify either retaining forest land, if other uses (e.g., development) are possible, or practicing long-term silviculture. Research at the Penobscot Experimental Forest indicates that the present value of stands managed for long-term value is about half that of stands subjected to diameter limit cutting, even though this practice diminishes the long-term productivity of the land.
- Maintaining and improving the long-term viability of the forest based economy. The state has faced the loss of mills, declining industry employment, fewer loggers, and consequent impacts on forest-based communities. At the same time, Maine excels in some sectors, and the industry has significant opportunities.
- Insect and disease threats. A number of exotic insects and diseases, some established, some not yet here, threaten significant components of Maine's forests. Existing threats include beech bark disease, balsam woolly adelgid, browntail moth, and hemlock woolly adelgid. Potential threats include sudden oak death and emerald ash borer.

Opportunities

Maine's forest landowners and the forest products industry also have a number of significant opportunities. These include:

- Conserving large areas of Maine's forests in perpetuity by capitalizing on the interest of investors to maximize their returns and purchasing conservation easements that ensure retention of undeveloped forest lands, public access, and sustainable management.
- Capitalizing on Maine's reputation for sustainable management to distinguish Maine's forest products industry in the global marketplace. In addition to demonstrated evidence that Maine's forests are sustainably managed, Maine has the largest percentage of certified land and possibly the largest percentage of certified harvests conducted of any state in the nation. These facts can be used to create a special niche for Maine's forest products among consumers who value sustainability – demand for such products is growing. This will require Maine to remain a leader in certification and addressing forest environmental issues, such as maintaining forest biodiversity.
- Increasing productivity. With improved management, Maine's forests have the potential to produce considerably more timber per acre while maintaining other forest values. On average, it should be possible to increase the productivity of Maine's forestland by approximately half over current levels.
- Diversifying Maine's forest products industry to be a leader in new products such as biofuels and those from biorefinery technology. With increases in fossil fuel prices, the opportunity exists to replace traditional sources of fuels and chemical feedstocks with wood and wood wastes.

Ownership Changes

Changes in ownership present both opportunities and challenges. Maine has experienced significant changes in who owns the forest since the mid-1990's. Most of Maine's large industrial forest landowners have exited the scene, replaced by a mix of corporate structures collectively known as timberland investment management organizations, or TIMO's. In general, these investors seek to maximize returns and generally plan on holding the land for 10-15 years.

Investor-owners now hold at least 3.75 million acres in Maine. This presents opportunities for unprecedented large-scale land conservation efforts, but there are also public concerns about the future of these large blocks of forest land; that is, will they remain as large unfragmented ownerships, will they remain undeveloped, will they be actively managed, and will they continue to be available for traditional public access?

The report concludes with a progress report on Criteria and Indicators of Sustainable Forest Management and proposes new indicators and benchmarks for the criteria of Aesthetics, Biodiversity, and Traditional Recreation. This is still a work in progress that will require more work, including a public process to validate the results of this effort.

LIST OF ACRONYMS USED IN THIS REPORT

BMP: Best Management Practices

CLP: Certified Logging Professional

DAFRR: Department of Agriculture, Food and Rural Resources

DBH: Diameter of a tree measured at 4-1/2 feet above the ground

DEP: Department of Environmental Protection

FIA: Forest Inventory and Analysis

FSC: Forest Stewardship Council

HWA: Hemlock woolly adelgid

LURC: Land Use Regulation Commission

MFS: Maine Forest Service

MLC: Master Logger Certification

NIPF: Non-industrial private forest landowner

SFI: Sustainable Forestry Initiative

SWOAM: Small Woodland Owners Association of Maine

TGTL: Tree Growth Tax Law

USDA: U.S. Department of Agriculture

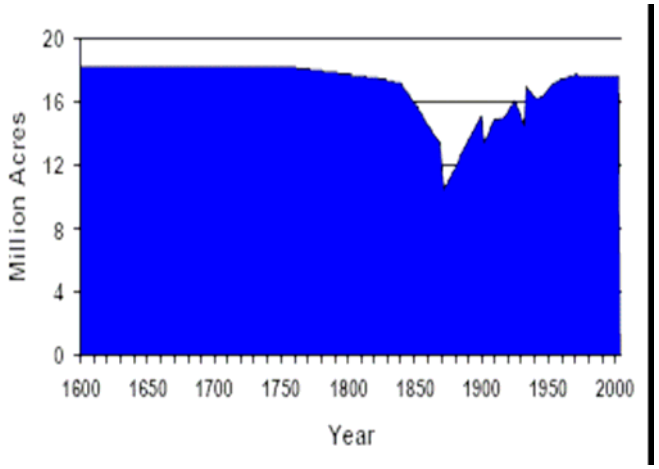
FOREST INVENTORY UPDATE

In 1997, the Legislature authorized MFS to participate with the USDA Forest Service to implement an annual inventory system (Public Law 1997, c. 720). Maine is the lead state in the Northeast to participate in this new inventory process and is the first state to utilize a nationally standardized protocol for collecting and analyzing forest information. The annual inventory measures 20% of the total inventory plots every year (approximately 700 samples). Maine has completed seven years of measurement, and recently reported on the results of 5 years of data, representing the first complete cycle through the annualized system. The annual inventories of Maine's forest resource have been extremely valuable and will continue to provide information needed for informed decision making on forestry issues. The diversity of forest stands resulting from recent forest practices and associated issues elevate the importance and complexity of these inventories. The data generated are particularly important in addressing both timber and nontimber values, for example, assessing wildlife habitat conditions and biodiversity and predicting the vulnerability of Maine's forests to invasive exotic pests.

The Forest Land Base

With 17.7 million acres of forest land, Maine is the most heavily forested state in the nation at 90 percent. The state's forest land base has remained essentially stable for the last several decades and is close to the estimated acreage of forest land present at the time of European settlement (Figure 2).

Figure 2. Area of forest land, Maine, 1660 – 2003 (Irland, 1998).

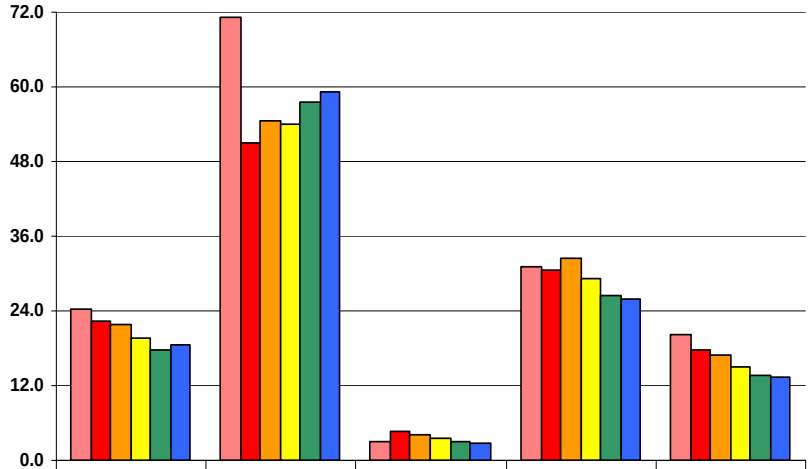


Data on conversion and reversion trends is still limited. As part of their required annual reporting to MFS on harvesting and silvicultural activities, landowners also provide annual data on land use changes. This reporting is a one-way accounting of timberland converted to other uses, but seems indicative of recent trends in Maine. In Southern Maine (Androscoggin, Cumberland, Franklin, Hancock, Kennebec, Knox, Lincoln, Oxford, Sagadahoc, Waldo, and York

Counties), the annual rate of reported land conversion doubled from an average of 1,600 acres in the 1991–1997 period to nearly 3,500 acres annually for the period 1998–2003. As defined here, southern Maine represents only one-third of the state's timberland acreage. In comparison, the remaining two-thirds of the state averaged 1,100 acres of timberland conversion annually for the first period and only 1,600 acres annually for the second period. The level of conversion is not as serious a concern[2] as the acceleration in the rate of conversion between periods, and what this means for the long-term.

Data sources (e.g. Forest Inventory and Analysis) that deal with compensating levels of land reverting to forestland from other uses are currently less precise and harder to quantify regionally. However, information derived from the forest inventory corroborates other available information to paint a picture that clearly demonstrates a forest land base in the process of fragmentation and conversion, at least in southern Maine. For example, Figure 3 shows that timberland acres per capita have declined statewide, and pronouncedly so in southern and western Maine.

Figure 3. Transition in timberland acres per capita by FIA mega-region, 1885, 1960, 1970, 1982, 1995, and 2001 (K. Laustsen, 2005, personal communication).



	Eastern	Northern	Southern	Western	Statewide
1885	24.2	71.3	2.9	31.0	20.1
1960	22.4	51.0	4.6	30.6	17.7
1970	21.9	54.6	4.1	32.5	17.0
1982	19.5	54.1	3.5	29.2	15.1
1995	17.7	57.5	3.0	26.5	13.7
2001	18.6	59.2	2.9	25.9	13.5

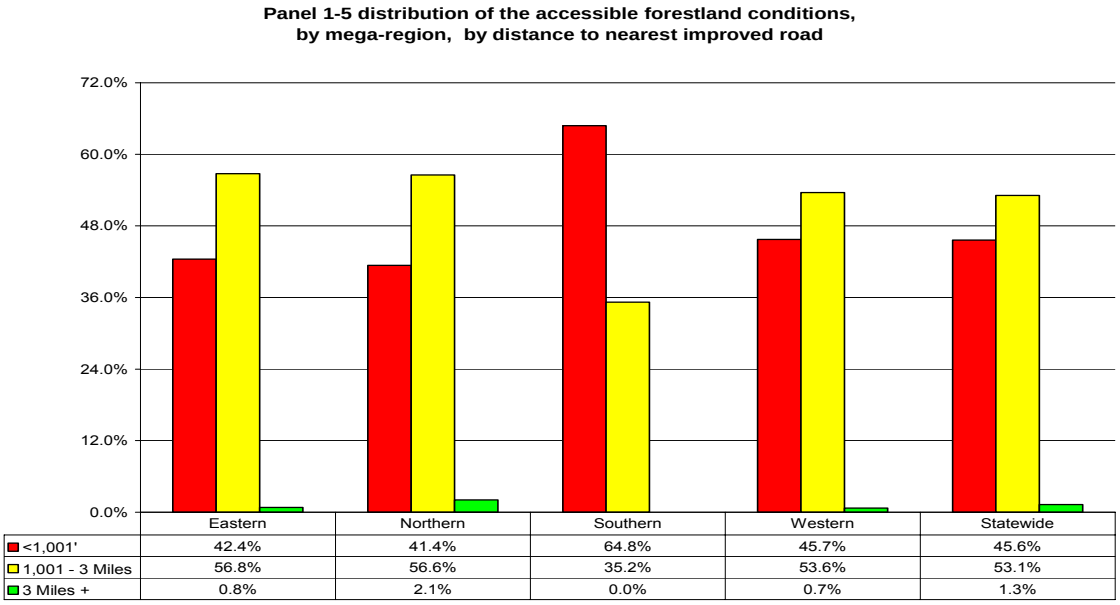
Mega-Region

Figure 4 shows a related trend, the distance to improved roads from forest inventory plot centers. Nearly two-thirds of forest land in southern Maine lies within 1,000 feet of an improved road, a sharp contrast with the statewide

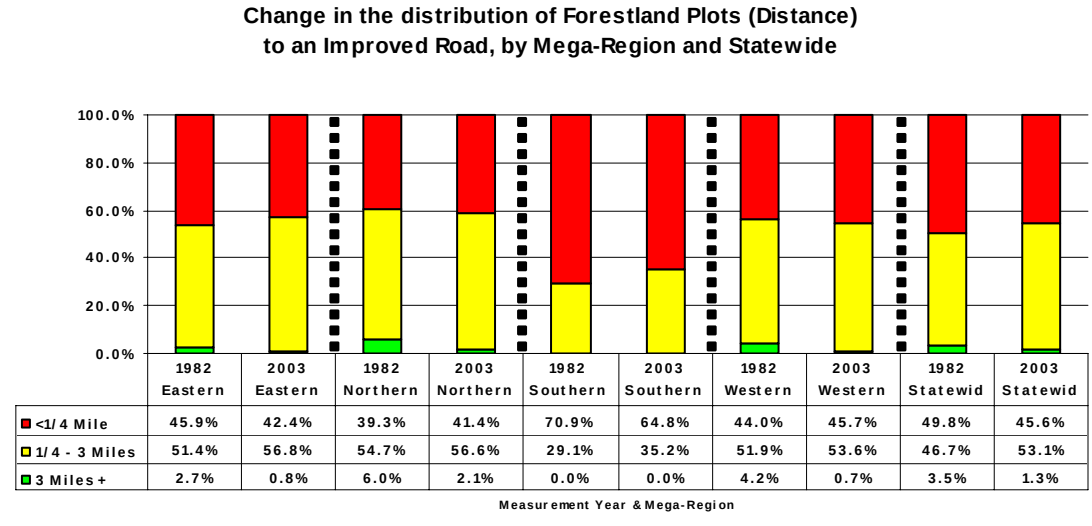
[2] The total acreage converted over the last 13 years represents 0.3% of all the forested area.

average of 46%. While some movement occurs into and out of improved road classifications on larger holdings in northern Maine, roads improved in southern Maine generally remain improved roads. As the proximity to improved roads increases, forest land becomes more prone to conversion to other uses, particularly development. This topic is discussed in more detail in the "Issues and Outlook" section.

Figure 4. Distance to improved roads from forest inventory plot centers, etc. (K. Laustsen, 2005, personal communication).



	Eastern	Northern	Southern	Western	Statewide
<1,001'	42.4%	41.4%	64.8%	45.7%	45.6%
1,001 - 3 Miles	56.8%	56.6%	35.2%	53.6%	53.1%
3 Miles +	0.8%	2.1%	0.0%	0.7%	1.3%



	1982 Eastern	2003 Eastern	1982 Northern	2003 Northern	1982 Southern	2003 Southern	1982 Western	2003 Western	1982 Statewid	2003 Statewid
<1/4 Mile	45.9%	42.4%	39.3%	41.4%	70.9%	64.8%	44.0%	45.7%	49.8%	45.6%
1/4 - 3 Miles	51.4%	56.8%	54.7%	56.6%	29.1%	35.2%	51.9%	53.6%	46.7%	53.1%
3 Miles +	2.7%	0.8%	6.0%	2.1%	0.0%	0.0%	4.2%	0.7%	3.5%	1.3%

Maine's forests have experienced several shifts in acreage among owner groups during the last 45 years. Public ownership has increased steadily, yet it still constitutes a small portion of Maine's forest land and remains one of smallest percentages in the country. Some view the small proportion of public ownership

as desirable, because they believe that private land ownership yields the greatest benefits (e.g. more working forests). Others view this situation as undesirable, because fewer acres are available to meet public needs not served by private lands (e.g. reserve areas and forests managed with different emphases). The ownership of Maine's large private forests is changing rapidly. Industrial owners have reduced their holdings significantly, particularly in the last decade, while a new category of investor owners that includes timber investment management organizations, real estate investment trusts, and limited liability corporations has increased their holdings substantially (Figure 5). Between 1995 and 2003, forest industry holdings declined at least 2 million acres (Figure 6).

Figure 5. Timberland acreage for the owner group/class "Non-Industrial and Corporate" (encompassing primarily Timberland Investment Management Organizations and similar corporate structures), Maine (K. Laustsen, 2005, personal communication).

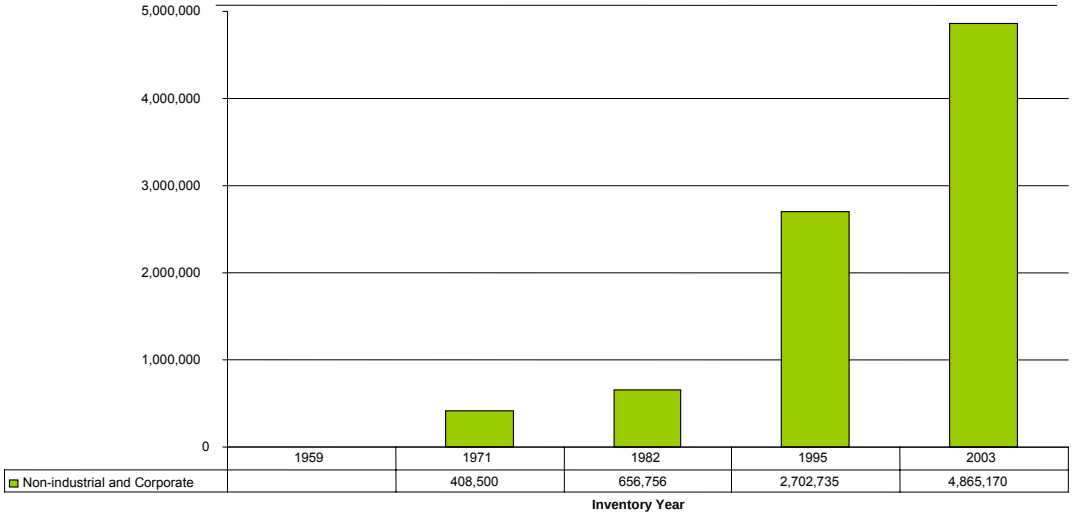
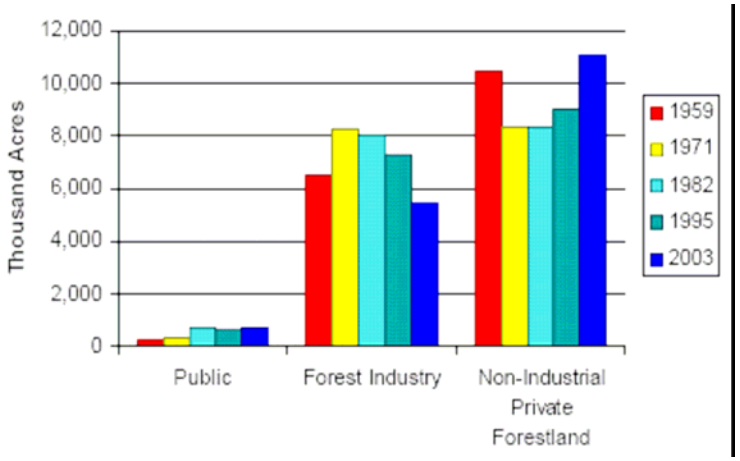


Figure 6. Timberland acreage by owner group, Maine (McWilliams *et al*, 2005).



Unlike forests in other timber-producing states, most of Maine's forests are extensively managed stands that originated from natural regeneration (Figure 7).

These stands include 44 commercial tree species. Species with the most trees 1 inch or larger in DBH are balsam fir (35 percent), red maple (12); red, white, and black spruce (11), and sugar maple, yellow birch, and American beech (11). The other 31% are made up of a variety of species, not one of which accounts for more than 1%. Some people are concerned with the number of balsam fir and red maple, because fir is shorter lived and more vulnerable than spruce to insects and disease, and because red maple has traditionally been less valuable than other hardwoods. Others appreciate the vigor of fir and believe that demand for species like red maple will increase in the future.

Maine's forest stands generally are diverse and more closely resemble "natural" forests than more intensively-managed forests in other parts of the world. A small portion of Maine's forest is managed intensively, including plantations, precommercial thinning (spacing), and conifer release (Figure 8).

Figure 7. Percent of timberland by stand origin, Maine, 2003 (K. Laustsen, 2004, personal communication).

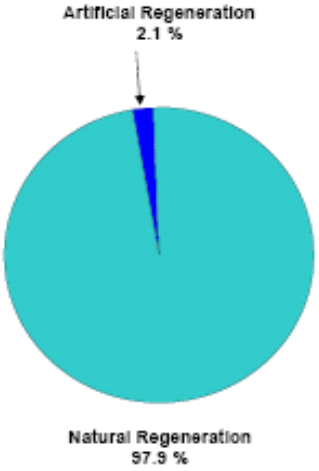
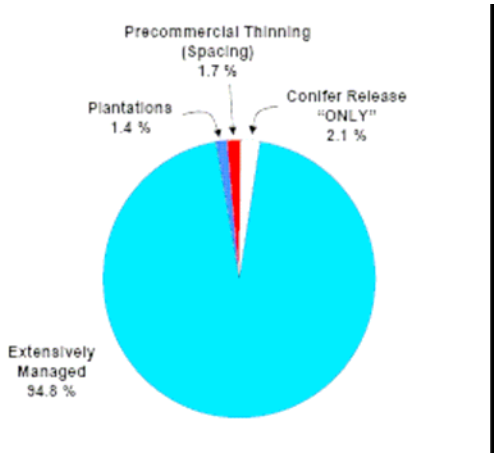


Figure 8. Percent of timberland by management practice, Maine, 2003 (K. Laustsen, 2004, personal communication).



As classified by the FIA, Maine's underlying forest habitat is 38 percent hardwood and 62 percent softwood types (Figure 9). However, this acreage currently is occupied by 59 percent hardwood and 41 percent softwood forest types. This discrepancy is an artifact of mixed-wood stands and stand recovery following spruce budworm outbreaks and reflects the difference between FIA estimates of existing vegetative cover and habitat classifications that represents the potential natural vegetation of a site. Some people are undoubtedly concerned with this discrepancy while others are not. Interestingly, some practices that could remedy this imbalance (e.g. precommercial thinning to favor softwoods) are viewed skeptically by people who favor noninterventionist approaches. In any case, over the long term, the vegetative composition of these stands will trend toward the underlying habitat type. The area of land by habitat is shown in Figure 10.

Figure 9. Distribution of softwood and hardwood habitat groups Maine, 2003 (McWilliams *et al*, 2005).

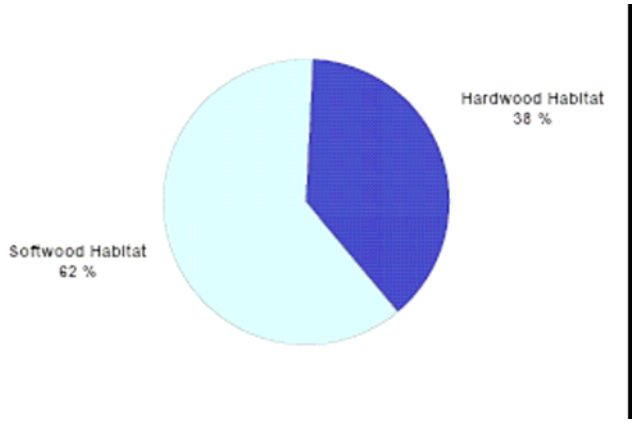
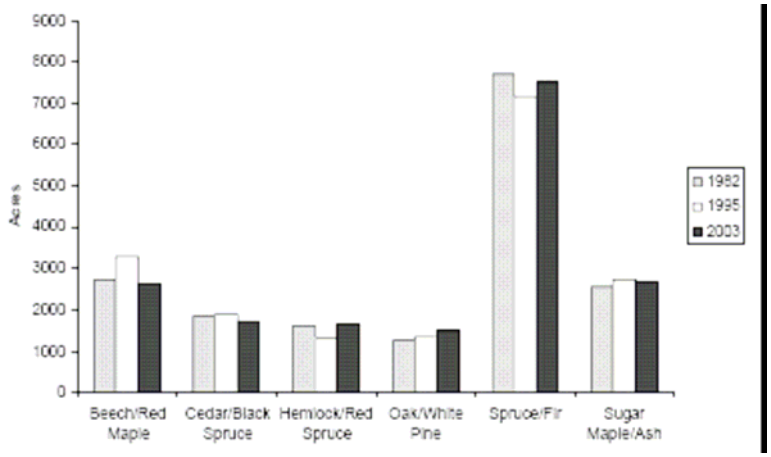


Figure 10. Area of land by habitat, Maine 2003 (McWilliams *et al*, 2005).



The volume of timber on Maine's forests is nearly double that in 1952 (Figure 11) and about 2/3 of the volume estimated to be present at the time of European settlement (Figure 12).[3] Current growth and harvest estimates are essentially equal (0.35 cords per acre per year). Regenerating forest stands in Maine generally is not a concern, as natural regeneration typically results in thousands of seedlings per acre within several years of a disturbance, including harvesting.

Timber harvesting currently occurs on approximately 550,000 acres per year, a substantial increase since the late 1980's. Most of this activity consists of partial harvesting or shelterwood cutting (Fig. 13). Terminal harvests[4] constitute a large share of the total harvest for white pine and northern red oak - 24 percent and 38 percent, respectively, of total annual removal.

[3] This may overstate the case somewhat, as minimum top diameters were much larger at the time of the first cruises, and trees considered merchantable now would not have been counted in those earlier surveys.
[4] Harvests from land use conversions.

Figure 11. Volume of pulpwood quality or better trees on timberland, Maine. 95% Confidence intervals shown for 1999- 2003 annual inventory results (McWilliams *et al*, 2005).

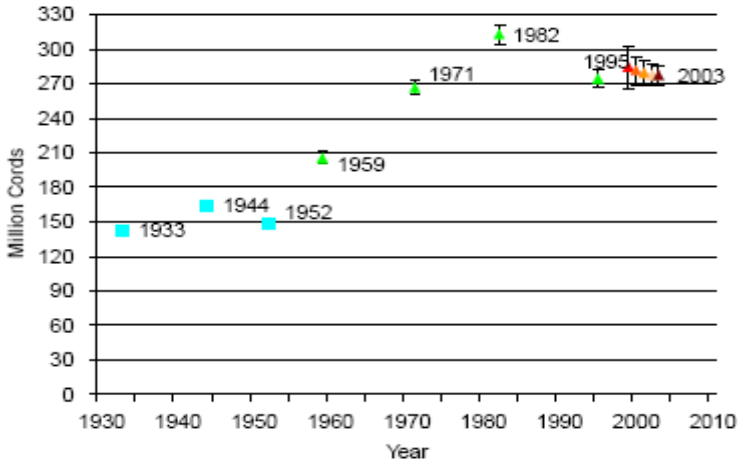


Figure 12. Historic inventory estimates for pulpwood, million cords (Coolidge, 1963, plus FIA reports).

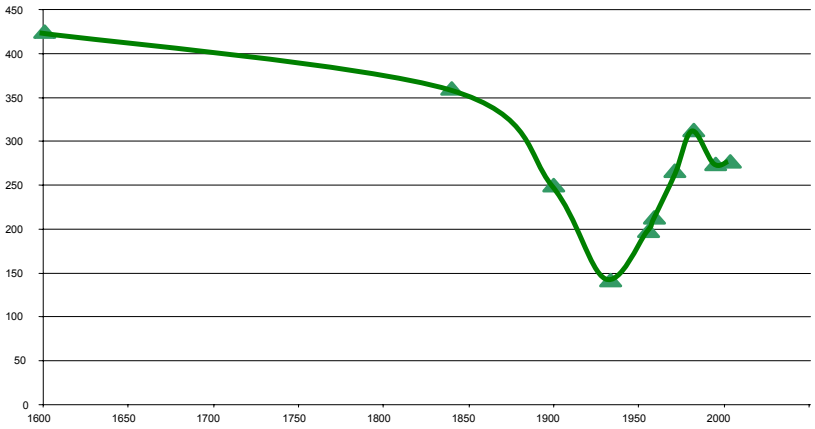


Figure 13. Percent of timberland by harvest type, Maine (MFS 1996-2003) (McWilliams *et al*, 2005).

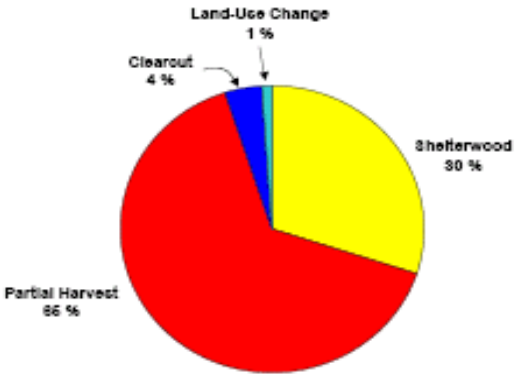
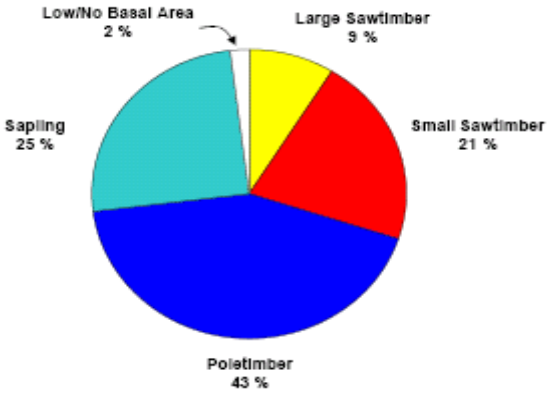


Figure 14. Percent of timberland by stand-diameter class, Maine, 2003 (McWilliams *et al*, 2005).

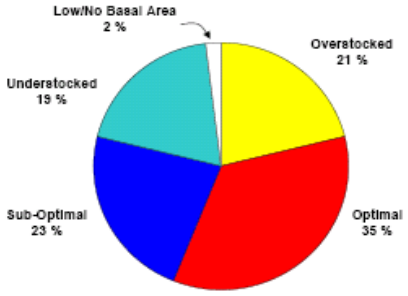


The major groupings and current distribution of Maine's timberland by stand diameter class reveal that one-fourth of Maine's timberland is in sapling-size stands (Figure 14)[5]. Poletimber and sawtimber-size stands account for 43 and 30 percent, respectively. Large sawtimber comprises 9 percent of timberland.

The introduction to this report discusses how persons with different perspectives could interpret this information. In brief, persons looking for a steady flow of timber from a regulated forest likely will be encouraged while those seeking to replicate "natural" conditions likely will be concerned.

According to accepted standards, about one-third of Maine's timberland is optimally stocked. Sub-optimally stocked and overstocked timberland account for 23 and 21 percent, respectively (Figure 15).

Figure 15. Percent of timberland by FIBER stocking category, Maine, 2003 (McWilliams *et al*, 2005).



Sawtimber volumes

Eastern white pine and six major hardwood species (sugar maple, red maple, yellow and white birch, aspen, and northern red oak) consistently comprise 90 percent of quality-graded sawtimber volume. The other large volume species – spruce and fir are not graded. Sawtimber volumes for the major, graded species have increased steadily over the 45-year inventory period (Figure 16).

The average size of white pine sawtimber trees has shown a small but steady increase over the inventory period, peaking at 14.8 inches during the last 8 years (Figure 17). The average diameter of major hardwoods declined slightly but then recovered during the same period. The current average, 14.4 inches, has remained stable over the last 8 years.

Volume of sawtimber per acre of timberland is a measure used to assess trends. Both white pine (73 percent) and the major hardwoods (93 percent) have shown steady increases over the inventory period (Figure 18).

[5] See glossary for definitions of these terms.

Figure 16. Volume of white pine and major hardwood sawtimber, Maine (McWilliams *et al*, 2005).

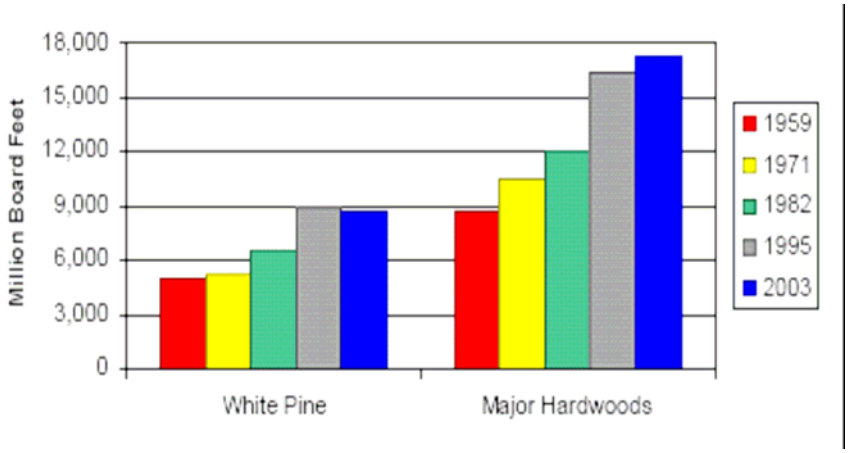


Figure 17. Quadratic mean diameter[6] of sawtimber trees for white pine and major hardwoods, Maine (McWilliams *et al*, 2005).

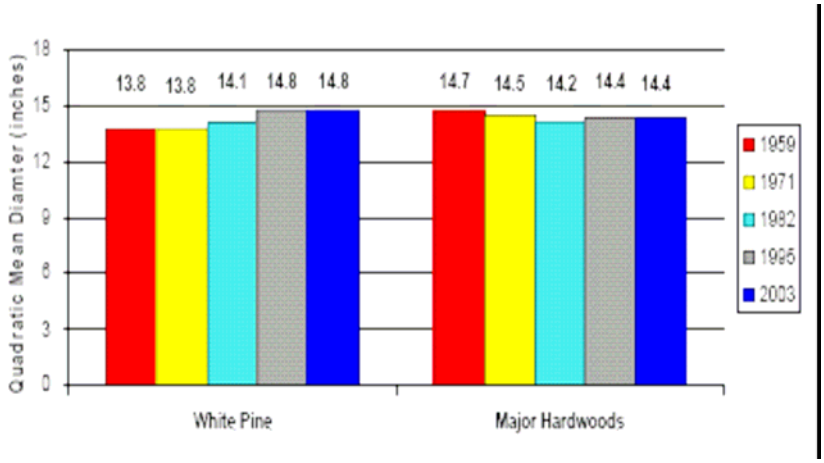
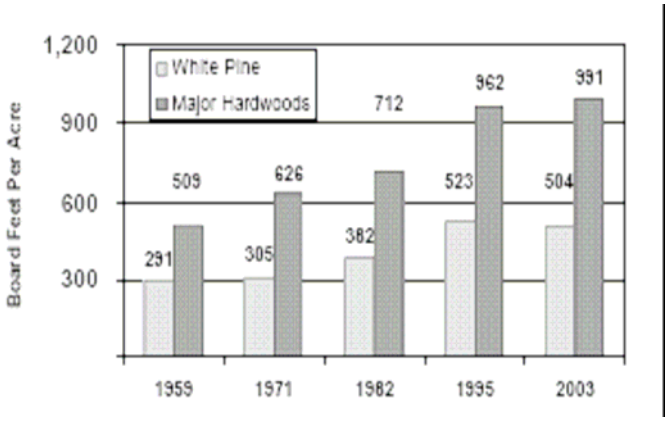


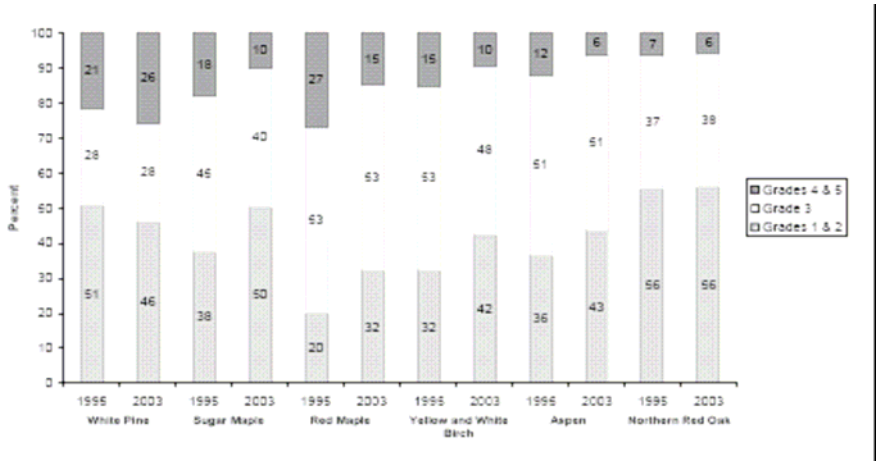
Figure 18. Average volume of sawtimber per timberland acre for white pine and major hardwoods (red and sugar maple, yellow and white birch, aspen, and northern red oak), Maine (McWilliams *et al*, 2005).



[6] See glossary for a definition of this term.

The distribution of sawtimber volume by tree grade (quality) for the two most recent inventories shows improvement for sugar and red maple, yellow and white birch, and aspen. This improvement is apparent from the increase in the percentage of grade 1 and 2 material. When all sawtimber size classes are considered, the quality of white pine decreased while northern red oak showed little change (Figure 19). However, the distribution is influenced heavily by tree size. When only trees at least 15 inches DBH are considered, white pine shows little change while northern red oak improves slightly.

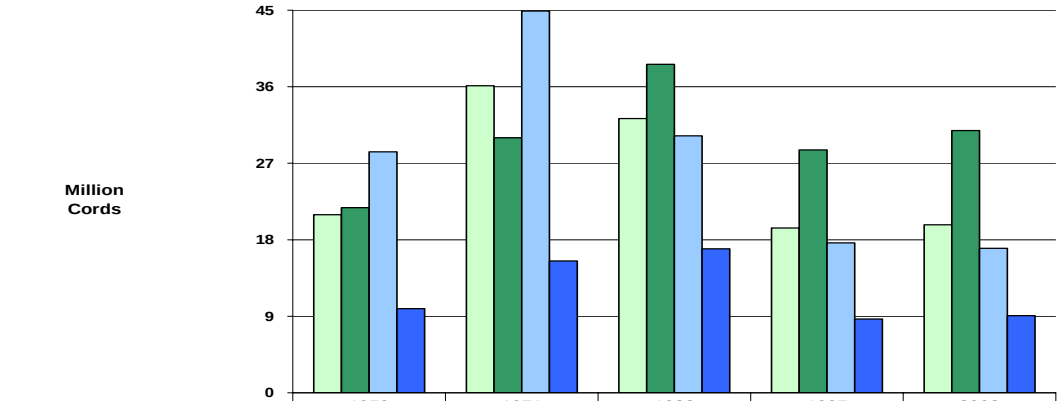
Figure 19. Percent of sawtimber volume on timberland by tree grade for white pine and major hardwood species, Maine (McWilliams *et al*, 2005).



Current spruce and fir sawtimber volumes are well below 1982 levels; however, volumes have rebounded slightly since 1995 (Figure 20). This is due in part to the spruce budworm outbreak of the 1970s and 1980s. Spruce and fir volumes are expected to increase as the sapling stands which replaced those killed by the budworm or salvaged in its wake grow into merchantable size classes. At some point in the near future, the budworm will return to Maine, and it is not clear if Maine's stands of spruce and fir will be any more resistant than they have been to previous outbreaks.

MFS continues to monitor the development of young stands resulting from the combined impacts of the 1970 – 1990 Spruce Budworm Epidemic and extensive harvesting. Efforts to predict the timing and initial merchantability of these young stands is underway. Over the last 5 years of data collection under the new annualized inventory design (1999 – 2003), annual estimates of ingrowth (new merchantable trees since 1995) have improved from 1.53 million cords in 1999 to 1.86 million cords in 2003. If current trends continue, ingrowth is expected to increase to 2.2 - 2.3 million cords per year in 2010.

Figure 20. Volume of spruce and fir growing stock, Maine (K. Laustsen, 2005, personal communication).



	1959	1971	1982	1995	2003
Spruce - Potential Sawtimber	20.96	36.11	32.27	19.38	19.76
Spruce - Sawtimber	21.78	30.01	38.64	28.57	30.86
Fir - Potential Sawtimber	28.33	44.91	30.24	17.63	17.00
Fir - Sawtimber	9.89	15.52	16.94	8.68	9.07

Forest Stand Structure and Large Trees

Maine's forests currently are distributed relatively evenly across broad stand size class groupings, with just under 30% in early development classes, about 40% in mid-development classes, and just over 30% in the sawtimber class (Table 1).

Table 1. 2003 Stand Structure (K. Laustsen, 2004, personal communication).

Stand Size Class	Stand Structure		
	Single-Storied	Two-Storied	Multi-Storied & Mosaic[7]
Stands with High Basal Area[8] in Large Sawtimber	0.9%	0.8%	
All Other Sawtimber Stands	11.3%	20.4%	
All Sawtimber	33.4		
Poletimber Stands	37.2%		
Seedling/Sapling/Nonstocked	29.4%		

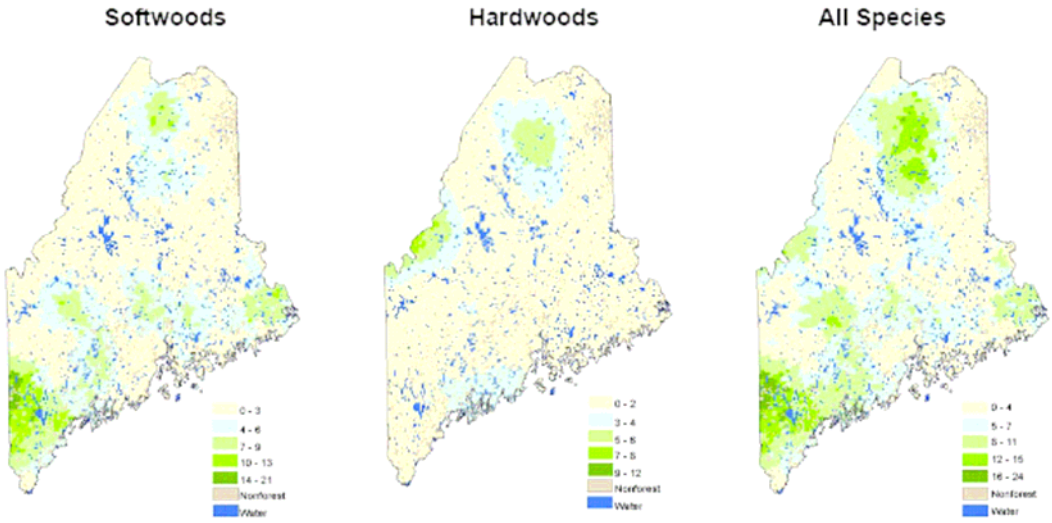
The stocking and distribution of large trees (at least 16 inches DBH) greatly affect wildlife habitat, biodiversity, and stand structure. The biodiversity benchmark section of this report provides more information comparing Maine's actual distribution of stand structures compared with an idealized structure for

[7] These breakdowns are important because Maine's forests evolved under disturbance patterns that "produced a finely patterned, diverse mosaic dominated by late successional species and structures." Large scale, catastrophic stand-replacing disturbances were rare (Seymour, R. *et al*. 2002).

[8] These stands are comprised of at least 100 square feet of basal area, of which at least half the basal area is trees 15.0 inches DBH or larger. This is a different way of characterizing such stands than the USDA Forest Service, Forest Inventory Analysis definition of large sawtimber stands.

maintaining forest biodiversity. In brief, adequate representation of stands dominated by large trees is well below what is considered "ideal," according to guidelines proposed by some wildlife biologists. In addition, the introduction to this report explains how persons with different perspectives are likely to view the overall distribution of Maine's forests by size class. The relative distribution of large trees in Maine's forests is shown in Figure 21.

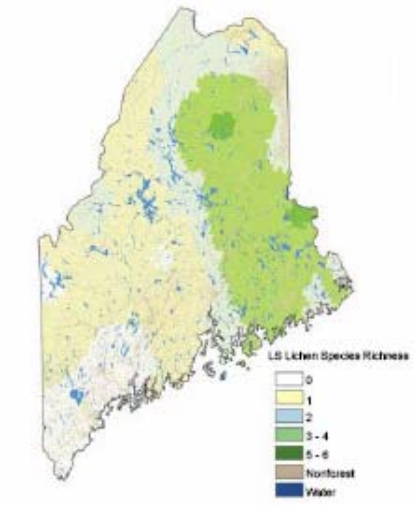
Figure 21. Estimated number of trees per acre greater than 16.0 inches in diameter at breast height, Maine, 2003 (McWilliams *et al*, 2005).



Lichens and shrubs

Certain species of lichens occur only on older trees. The known distribution of those species[9] is shown in Figure 22.

Figure 22. Number of late successional lichen species, Maine 2003 (McWilliams *et al*, 2005).



[9] Distribution based on USDA Forest Service, Forest Inventory Analysis data and A. Whitman, personal communication, 2004.

Forest Health Issues

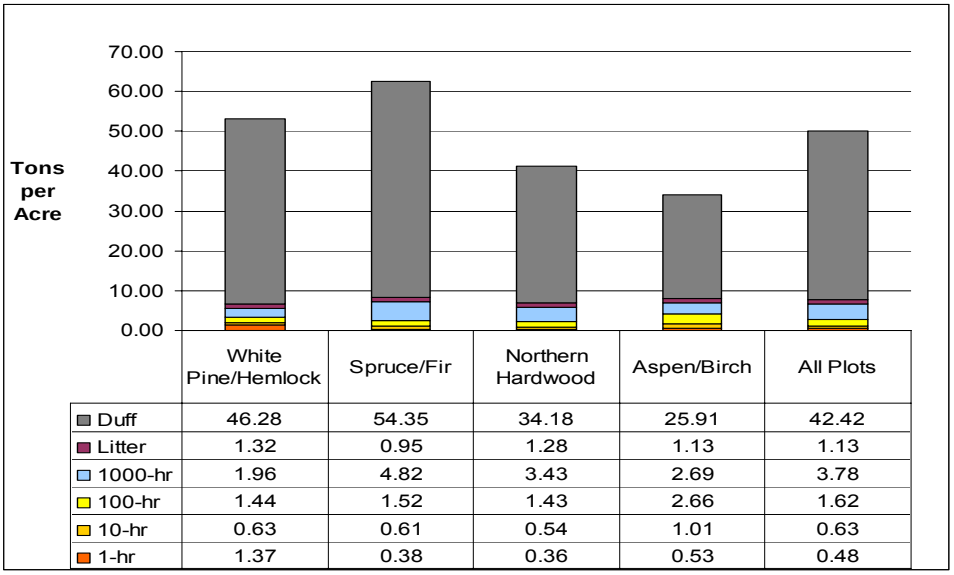
A number of pests (native and exotic) pose important threats to Maine's forests. These include spruce budworm, balsam woolly adelgid, beech bark disease, hemlock woolly adelgid, and others.

FIA data indicate that Maine's forests have a low diversity of shrub/vine species. Only 30 percent of the plots contain more than four of the species tallied, most of which are deciduous shrubs. Many deciduous shrub species have tremendous value to wildlife.

Forest Fuels

Some of Maine's forests carry significant fuel loads (Figure 23). At long intervals, prolonged droughts can create extremely high fire risks when organic material in soils dries to the point that it becomes flammable.

Figure 23. Fuel Loading by Forest Type, Maine, 2004 (K. Laustsen, 2005, personal communication).



	White Pine/Hemlock	Spruce/Fir	Northern Hardwood	Aspen/Birch	All Plots
Duff	46.28	54.35	34.18	25.91	42.42
Litter	1.32	0.95	1.28	1.13	1.13
1000-hr	1.96	4.82	3.43	2.69	3.78
100-hr	1.44	1.52	1.43	2.66	1.62
10-hr	0.63	0.61	0.54	1.01	0.63
1-hr	1.37	0.38	0.36	0.53	0.48

Maine's softwood types have significantly more fuel per acre than the hardwood types. By comparison, southeastern Piedmont pine-hardwood forests typically carry fuel loads of approximately 20 tons per acre (Waldrop *et al*, 2004); central hardwood types approximately 8 tons per acre (Hartman, 2004); and, closed jack pine types 10 to 15 tons per acre (The Nature Conservancy, USDA Forest Service, and Department of the Interior, 2005).

ISSUES AND OUTLOOK

There is a good deal to celebrate regarding the condition of Maine's forests -- total inventories have increased significantly over the last 50 years; sawtimber volumes for a number of species have increased; sawtimber quality is holding steady at the same time. A number issues or opportunities deserve attention, however. Additional information on noteworthy issues follows.

Changes in Stand Structure

The structural characteristics of forest land in Maine have undergone major changes. Currently, there are large blocks of forest in the early stages of succession; other areas contain one-, two-, and multistory stands. This more complex structure benefits certain nontimber values and may require new harvest and management strategies.

White Pine's Future: An Issue to Watch

The inventory and change analysis of Maine's white pine area and resource reveals some interesting trends that bear watching:

- Of the total white pine removal, 25% of the growing stock volume harvested comes from land use conversion harvests, a one-time flush from these terminal harvests.
- Although current inventory of growing stock and sawtimber volumes are stable and well distributed across the DBH range, only 11% of the Oak/White Pine Habitat acreage is in the sapling stand diameter class - down from 17% in 1995 and 21% in 1982, respectively. This continued decline in the regeneration component presents a concern for the future.
- The average volume per tree continues to increase, a further sign that white pine is a progressively maturing resource.
- The statewide growth: removal ratio for growing stock is 1.5:1. The same ratio for just sawtimber trees is 1.4:1. However, other evidence, such as the conversion of highly productive land to other uses and the declining share of regeneration acreage, indicate the need for continued monitoring.

White pine is an important contributor to the value-added portion of Maine's forest economy. Trends in the white pine inventory indicate the need for affirmative actions by landowners, pine manufacturers, and the state to protect white pine's status as Maine's state tree in the most literal sense.

Future Timber Volumes

If growth and harvest rates remain at current levels, timber volumes will remain stable and then likely increase as stands recovering from spruce budworm outbreaks and associated harvesting grow to merchantable size. Maine needs to update its growth and yield modeling to:

- predict when sapling-sized spruce-fir stands will grow to merchantable size;
- monitor species-specific inventory gains and declines and their effect on the timber supply, quality trends, wildlife habitat, and other ecosystem values;
- provide the analytical basis for targeted efforts to increase timber yields from Maine's forests through improved utilization and more intensive management; and,
- improve our understanding of the trends in the quality of timber for Maine's forest-products industry.

Changes in Species Composition

We also need to evaluate the impact on timber supply and other forest values from declining merchantable inventories of species such as beech and aspen,

increasing merchantable inventories of species such as sugar maple, white ash, northern red oak, and yellow birch, and the reliance on timber volumes from terminal harvests of white pine and red oak. These changes will influence not only the forest products inventory, but wildlife habitat and other resource values as well. Monitoring growth and harvest levels and predicting future growth rates will require careful attention, particularly for species like white pine and red oak, which account for a large portion of terminal harvests.

Understanding the Implications of Changes in Forest Practices

While the relative balance of growth and harvest is comforting, the long-term implications of the changes in harvesting practices are unclear. Timber harvesting has increased from nearly 250,000 to more than 500,000 acres annually, and has shifted from clearcutting to largely partial harvesting. Such partial harvesting may remove lower quality trees and leave a productive stand capable of increased growth in volume and value, or it may remove higher quality trees and leave a stand of inferior trees incapable of responding to release, reducing the production and quality of the next stand. The implications for timber supplies and other forest values of the sharply increased annual harvest acreage as well as the effect of the shift from clearcutting to partial harvesting should be evaluated.

Land Use Changes

Numerous sources indicate that forest land conversion, particularly in southern and central Maine, continues to erode the working land base - both farms and forests - at a disturbing pace. Based on its review of multiple sources of information (including the forest inventory), MFS estimates that between 5,000 and 10,000 acres of forest land are converted each year to developed uses. This estimate correlates closely with the Natural Resource Conservation Service's Natural Resource Inventory estimate of 9,440 acres per year (cited in Peterson, 2004). For example, the State Planning Office estimates that between 1970 and 1990, land development occurred at four times the rate of population increase in the state (Maine Development Foundation, 2002), with an average of 33,600 acres per year of rural land converted (both agriculture and forestry) (Maine State Planning Office, n.d.). Another State Planning Office source indicates that a very high percentage of the "very high growth" and "high growth" municipalities are located in the southern quadrant of the state (Della Valle, 2003). The Natural Resources Inventory (conducted by the USDA Natural Resources Conservation Service) shows that land in Maine is being converted from rural to developed uses at an increasing pace. Conversion of rural land has been happening at a faster rate in Maine than nationally, increasing by 29% in Maine between 1992 and 1997 compared to an increase of 18% nationwide (Maine State Planning Office, n.d.). The Brookings Institution reported in 2001 that the Portland Metropolitan Area was 8th on a list of the fastest growing metropolitan areas, by percent change in urbanized land between 1982 and 1997. The report found that "…Portland, Maine, had high population growth by

Northeastern standards (17 percent), yet increased its urbanized land by 108 percent - more than five times the percentage increase in population." (Fulton *et al*, 2001).

In addition, data from the Tree Growth Tax Law program suggests increasing parcelization of forest land. Figures 24 and 25 show that average size of parcels enrolled has declined steadily over the last two decades. The sharp decline in the unorganized towns between 2000 and 2004 is notable and worthy of further investigation. While average parcel sizes have not crossed the threshold where commitment to active forest management becomes less likely, the trends indicated in these figures are troubling. MFS's 2003 field study of liquidation harvesting further corroborates this trend. The 33 parcels originally selected for this study had been divided into 65 parcels following harvesting (Maine Forest Service, 2004a).

Figure 24. Tree Growth Tax Law average parcel size, 1977-2003, organized towns (D. LeDew, 2005, personal communication).

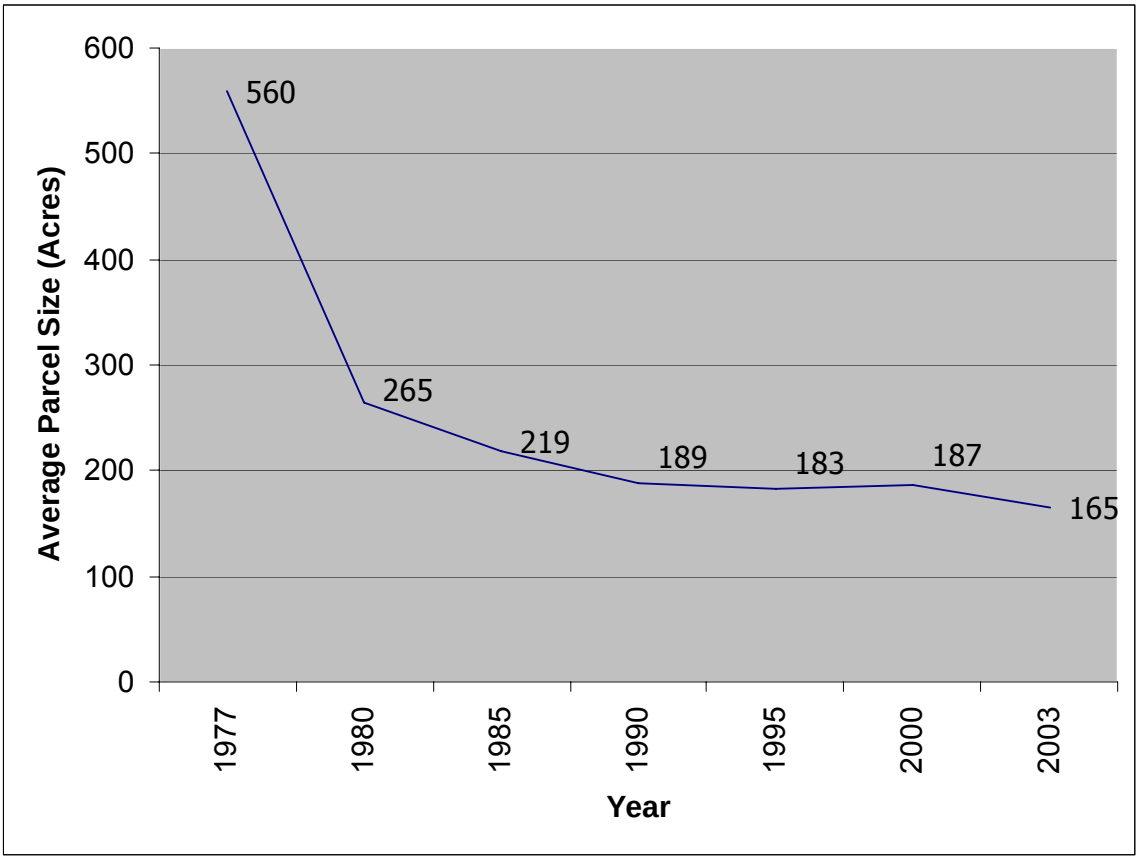
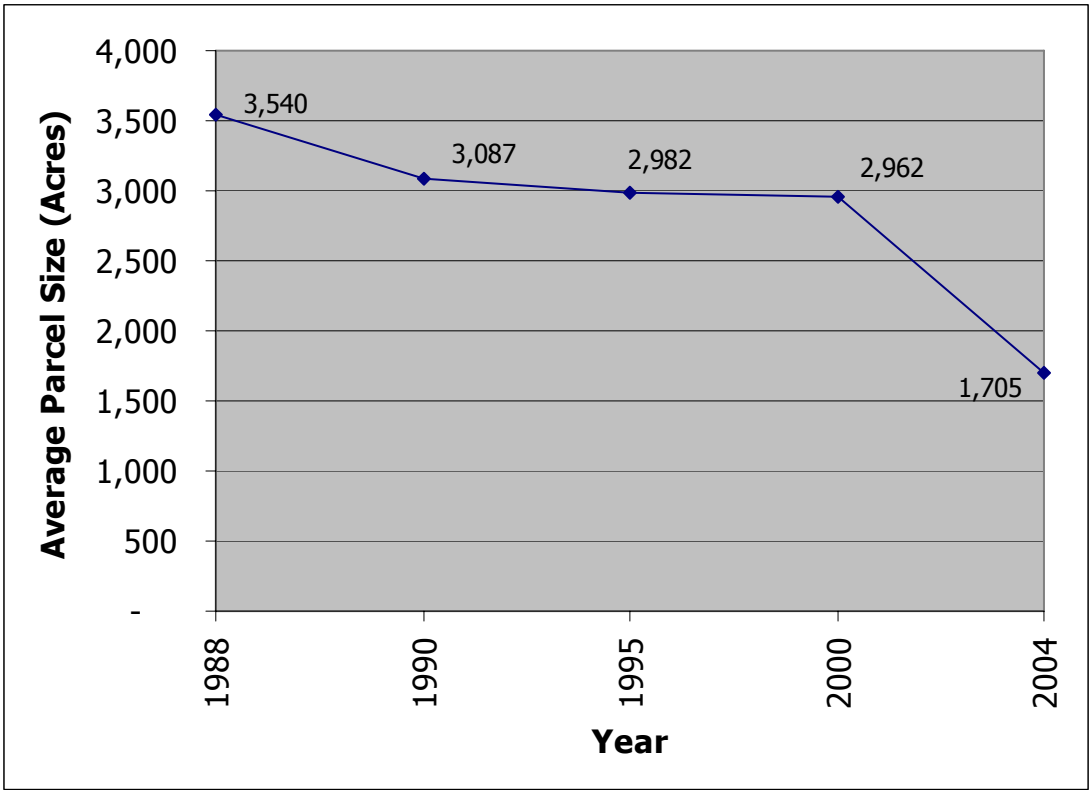


Figure 25. Tree Growth Tax Law average parcel size, 1988-2004, unorganized towns (D. LeDew, 2005, personal communication).

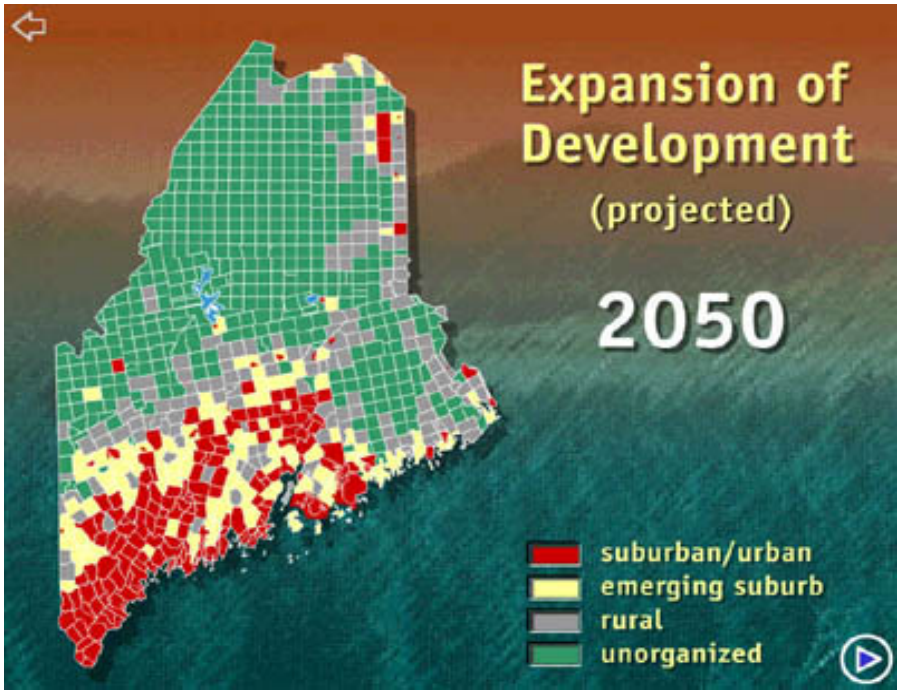


Land conversion is projected to continue apace for the next several decades, absent a shift in public policies and current trends (Figure 26).

A recent USDA Forest Service report (Stein, *et al*, 2005) identified the lower Penobscot, lower Androscoggin, and lower Kennebec watersheds as three of the top 15 relatively large watersheds in the eastern United States with significantly increased housing density projected over the next 25 years (the lower Penobscot rated number one).[10] While much of the current conversion appears to be happening on agricultural land, the forest land base is also being eroded.

[10] This study excluded smaller watersheds such as some of those in southwest Maine.

Figure 26. Projected expansion of development to 2050 (Maine State Planning Office 2005).



The conversion of forest land to other uses threatens future sustainability in the southern portion of the state. Monitoring and evaluation of this trend should continue. The fact that terminal harvests - primarily in southern Maine - account for 24 and 38 percent of the annual harvest for white pine and red oak, respectively, has implications for the future supply of these species.

Changes in Landownership

The importance of small nonindustrial private forest landowners to future timber supply continues to increase. Because of the large number of these owners, the fragmented spatial distribution of their forests, their widely varied ownership objectives, and reported reluctance to harvest, it is difficult for resource planners to coordinate management strategies.

The information presented in the previous section and in biodiversity sustainability indicator 5.5 together indicate that Maine's forests - particularly in southern Maine - are being divided into smaller parcels. This ongoing process of parcelization has serious implications for the future viability of the forest industry. Numerous studies clearly demonstrate that landowner commitment to active forest management decreases with decreasing parcel size, increasing land values, proximity to roads, and population density (Hodgdon and Tyrrell, 2003; Kittredge and Grogan, 2004; Kline, 2004; Wear and Newman, 2004; Wear, *et al*, 1999). In addition, the forest industry has largely divested itself of its holdings to investors with no mill holdings. Representatives of the new investor-owner class reportedly have indicated that they have a 10-15 year time horizon for achieving return targets. Further, a number of investor-owners have

demonstrated their interest in capitalizing on the development potential of their holdings.

It is not clear how recent changes in Maine's forest land ownership will affect long-term timber management and availability. These changes have created uncertainty among many interests about wood supplies, recreational access, and other values. We need to evaluate the effect of ownership changes on timber supply and availability and monitor the stability of the land base managed actively for forestry.

Invasive Exotic Pests

Invasive exotic pests likely will pose a greater threat in the future. For example:

- Balsam woolly adelgid, which in the past has been limited to the coastal area of Maine, has expanded to inland areas and is causing significant mortality of balsam fir.
- Hemlock woolly adelgid is now established in extreme southern Maine and is expanding northward.
- Maine's forests could be threatened by the emerald ash borer, which is expanding from Michigan, and *Phytophthora ramorum*, which causes sudden oak death. The latter is expanding from nursery stock in California, but it is not known whether *P. ramorum* can survive in Maine's climate.

The potential threats from invasive exotic pests will require increased monitoring. The effect of climate change on the spread of such pests also poses a huge unknown.

Size Class and Structural Distribution of Maine's Forest Stands

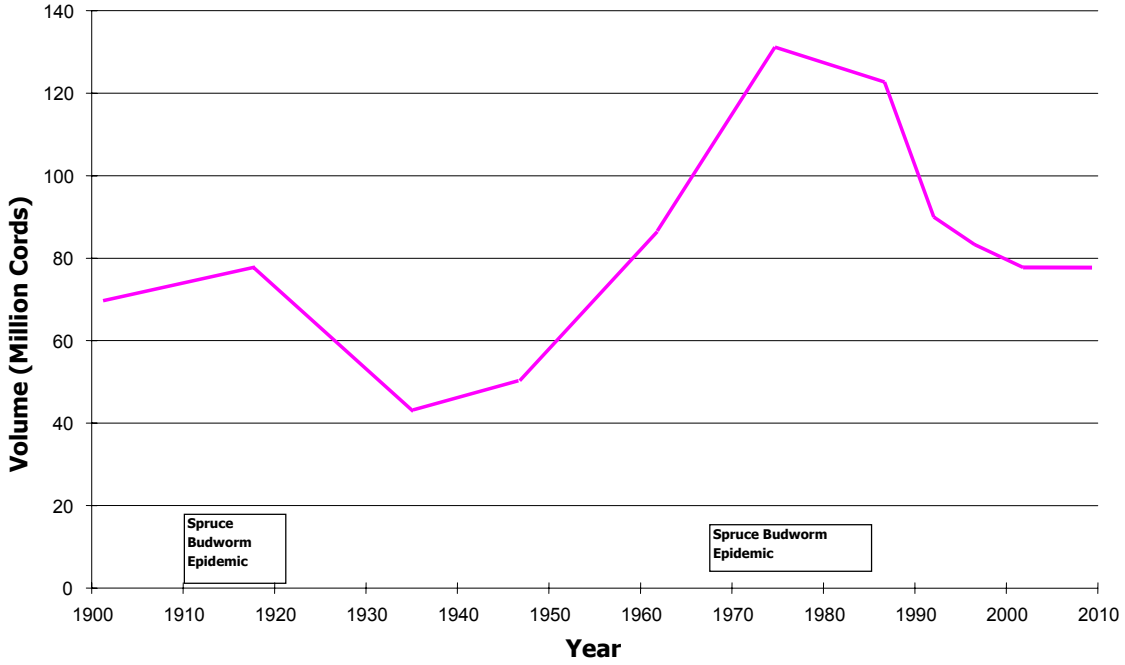
Maine's current forest stand structure can either be seen as comforting or troubling, depending on one's perspective. The interpretation of this information provides an object lesson in how different interests perceive, react to, and conflict over the same information in the forest policy arena. For example, some will find it comforting that Maine's forest stands are in a rough balance of size classes, with just under 1/3 in small size classes (regeneration), just over 1/3 in larger size classes (sawtimber), and about 1/3 in middle size classes (poletimber). Such proponents of a regulated working forest would view this size class distribution as evidence that Maine's forests are well managed and providing a sustained yield of timber. On the other hand, persons interested in certain wildlife species or in maintaining Maine's forests within the natural range of variation which would occur without active management would be concerned by this distribution. Still others will find it troubling that the size class with a high basal area in large sawtimber occupies a very small portion of the landscape (under 2%), and that much of Maine's forests are single-story (or cohort) stands. This issue in particular has led to emerging concerns over the relatively small

percentage of Maine's forest stands that can be classified as late successional or old-growth.

The Future of Maine's Young Spruce-Fir Resource

The impact of the spruce budworm epidemics in Maine rival that of other forest disturbances in the Eastern United States over the last century. While devastating and disturbing at the time, Maine's spruce-fir forests have begun to recover from the most recent outbreak (Figure 27). Merchantable-size stands will reemerge over the next 25 years as waves of young spruce-fir mature.[11] This will result in a large block of acreage in a relatively even-age condition, much like the condition of spruce-fir early in the last century.

Figure 27. Maine's Spruce-Fir Timber Supply Trends (K. Laustsen, 2005, personal communication).



As Maine's young forest grows, considerable spruce-fir acreage will offer opportunities for intensive management, including precommercial thinning in stands less than 20 years old and commercial thinning in older stands. These activities can increase yields while reducing risk and mortality. Unfortunately, MFS has documented a downward trend in such activities over the last several years (see MFS Silvicultural Activities Reports on the MFS website, www.maineforestservice.org). We need improved modeling capacity to better predict when the new sapling-size stands of spruce-fir will grow to merchantable

[11] Based on our assessment of available data, we believe that the most recent outbreak was less severe, and recovery more swift, than the 1920's outbreak.

size for harvesting. Management planners must consider whether the abundance of balsam fir in the next forest (currently more than two-thirds of sapling-size trees) could make Maine's forests vulnerable to another spruce budworm epidemic as they mature.

Potential Fire Danger

Maine's forests have high fuel loads and, at long intervals, pose an extremely high fire risk associated with prolonged drought. These conditions occur when organic material in soils dries to the point that it becomes flammable. Planning for wildfire suppression in Maine should take into account that, at long intervals, the threat of fire is extremely high when soil organic matter dries to the point that it can burn.

Many Forest Types Face Important Challenges

Maine's spruce-fir forests tend to dominate management and policy discussions because of the importance of this forest type (e.g. its special value in papermaking). However, there are many other forested ecosystems with important values and complex issues. For example, recent increases in demand for hardwoods for both pulp and sawlogs have created opportunities for managing and developing deciduous forests. Hemlock woolly adelgid could destroy hemlock across its range and the decline of beech affects the major source of hard mast for wildlife. Regeneration of the more valuable hardwoods is difficult in partially harvested stands with a high beech component in the understory as beech tends to dominate the regeneration under these conditions.

Forestry Issues Likely to Remain High Profile

Public concerns for nontimber resources such as noteworthy plant and wildlife habitats, sensitive areas, water quality, biodiversity, and providing public access and recreation opportunities likely will continue to be high-profile forest policy issues for the foreseeable future.

All annual inventory reports and their respective tables and charts can be obtained by contacting the Maine Forest Service, or at the MFS website: www.maineforestservice.org. Follow the links to "Current Publications."

The 2003 forest inventory report can be found at the USDA Forest Service website:

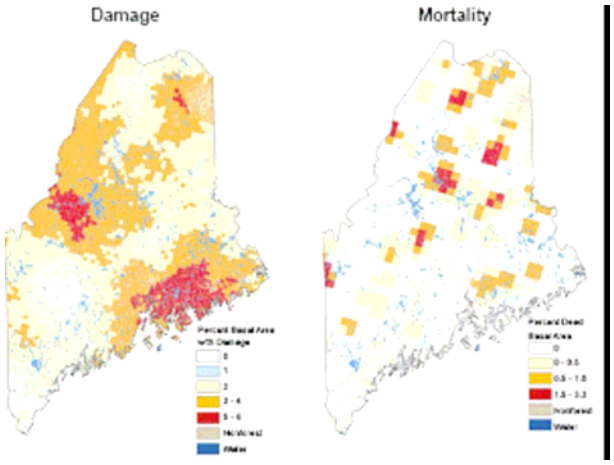
http://treesearch.fs.fed.us/pubs/20951

INVASIVE SPECIES THREATEN MAINE'S FORESTS

Maine's forests face increasing threats from the potential introduction, establishment, and expansion of foreign invasive pest species. Native insects like spruce budworm periodically kill vast numbers of trees in Maine's forests, but the ecosystem is adapted to these perturbations. Although it can take years, the forest and the forest-based economy can recover. Foreign pests can result in far more devastating and permanent situations.

Previously established nonnative pests like beech bark disease, chestnut blight, Dutch elm disease, and gypsy moth have already diminished the character and diversity of Maine's forests. The loss extends beyond just losing commercially valuable trees, also seriously impacting wildlife dependent on these trees for food and shelter. Although some of these pests (e.g. gypsy moth) appear to have attained equilibrium in the environment, some pests (e.g. beech bark disease), continue to damage and kill trees and degrade Maine's forest ecosystem. The most recent forest inventory shows that beech mortality - largely associated with beech bark disease and drought - exceeds growth, resulting in a 20% decline in beech volume since the 1995 inventory. Areas with the greatest impact are shown in dark red in Figure 28.

Figure 28. Beech damage and mortality, Maine, 2003 (McWilliams *et al*, 2005).



- Other foreign pests like browntail moth and balsam woolly adelgid, that had been endemic in Maine for years, are resurging, intensifying and expanding their range with concurrent impacts on the forest and forest-dependent communities.
- Although browntail moth infestations continue to spread inland, they are most concentrated within the Casco Bay area. The infestation has not yet caused a significant loss of trees. However, the extent to which this pest has stimulated specific pest response legislation provides evidence of the importance that local residents and businesses attach to the pest.

- While public concern over balsam woolly adelgid is minor, the current impact to Maine's forest resources is far broader. In the 5 years from 1999 to 2004, this pest killed 9% of the balsam fir basal area in 6.4 million acres of eastern and midcoast Maine (and 16% of the balsam fir basal area in the 1.4 million acres closest to the coast). An additional 49% of the fir displays visible balsam woolly adelgid injury, and may succumb in the near future.
- Hemlock woolly adelgid has begun to extend into Maine from established infestations to the south. It has been detected as low level spot populations in scattered native hemlock stands in the southern tip of York County. This population is established across 4,000 acres of Kittery, York, and Eliot. Although MFS appears to be succeeding in slowing the infestation's spread and minimizing loss of trees, there is no basis for assuming that this population can be eradicated.
- The organism causing sudden oak death, which has killed oak stands in California and Oregon, has been discovered in West Coast nurseries that have shipped stock into Maine. Although we have not yet detected this disease in Maine, diseased nursery stock has been intercepted elsewhere in New England. There is a real possibility that it is here - at least as a disease of outplanted ornamental nursery stock. Laboratory trials have shown northern red oak (which accounts for over 90% of Maine's oak trees) to be highly susceptible to this disease.
- Asian longhorned beetle and emerald ash borer, although further removed, are at least as serious. The USDA and state and local governments in the infested areas are spending millions of dollars to contain these pests. There is evidence that the effort is at least slowing the spread of asian longhorned beetle, for which the closest known infestations are in New York City and on Long Island.
- For emerald ash borer, the results are less reassuring. This pest was first detected in 6 counties in southeastern Michigan (surrounding Detroit) in 2002. Despite aggressive tree removal and quarantine efforts in the core infested area, emerald ash borer spread into new areas. By 2005, 20 counties and 19 partial counties in Michigan were infested, with additional infested areas in Ohio and Indiana. Currently over 8.8 million acres are under quarantine. Millions of trees are currently infested or are already dead (death occurs after 1-3 years). The only tools available to slow the spread of this pest are strict regulation of movement of potentially infested logs and nursery stock, and destruction of known and suspected infested material. In response to a shipment of infested ash trees into Maryland, that state destroyed all ash trees in a ½ mile radius around the nursery (more than 1,000 forest and shade trees). They are cautiously optimistic that they have eradicated all infested stock but continue to monitor actively the surrounding area. The state is prepared to condemn and destroy more trees if it detects any additional infested stock.

- There is no indication that the emerald ash borer infestation in the Midwest is under control, and where it has been intercepted in loads of firewood being transported by individuals from the infested area to their camps in uninfested areas, there is a good chance that there are additional as-yet undetected infestations. Whether established by firewood or nursery stock, if Maine were to detect an infestation, our only control option would be to replicate the Maryland response, as all of our ash species are vulnerable to this pest.
- The combination of a very mobile society and the rapid movement of goods and services around the world virtually assure that the flow of additional pest species inadvertently brought to North America will continue. The potential for climate change appears to increase the chances of successful establishment.

Recognizing the threat posed by nonnative pest species, MFS has focused increased attention and effort on this issue. The prime example of this dynamic is the effort expended on hemlock woolly adelgid over the past several years. However, the issue encompasses far more than just a single species.

As a strategic response, MFS has engaged a broad range of cooperators to improve survey and detection capacity. To date, providing training and assessment tools targeted to the various industrial commodity groups and public outreach through the media have proven successful for detecting and intercepting specific pests. However, the state of the science varies, and waiting until the pests are at the door is an irresponsible, risky approach.

Past experience demonstrates that the most effective and efficient intervention strategies are based on assessing the risk of various potential foreign pests and their avenues of introduction, and then focusing quarantine regulations and inspection and certification of regulated materials to disrupt those high priority pests' critical pathways - preferably long before they get close to Maine.

Although the USDA Animal & Plant Health Inspection Service (APHIS) has this responsibility, the magnitude of the task exceeds the resources provided to that agency. That forest product processors and their commodities are not traditional APHIS customers exacerbates the situation. Therefore, various state and federal agencies are working cooperatively in Maine to design seamless intervention and response mechanisms:

- The 120th Legislature gave the MFS Director clear, specific authority to order disposition of forest and shade trees infested with exotic pests. This authority is similar to that granted the Commissioner of Agriculture for agricultural commodities, crops and nursery stock.
- MFS and the USDA Forest Service are actively engaged on several cooperative projects to monitor for high priority foreign pests and manage those that get in. Current efforts include:

  - Early detection monitoring for sudden oak death and hemlock woolly adelgid;
  - Development of hazard rating systems and risk maps for balsam woolly adelgid; and,
  - A cooperative Slow-The-Spread project to contain and mitigate the hemlock woolly adelgid infestation in southern York County.
- An effort by the Maine Department of Agriculture, APHIS, and MFS to retool APHIS's local Cooperative Agricultural Pest Survey to better focus on serious invasive threats and forest pest species shows great promise as a tool to coordinate effort and secure funding.

MFS is currently developing a uniform strategy for monitoring and addressing nonnative forest pests. Any effective response to a foreign pest will require regulatory restriction and may involve condemnation and destruction of private property. If MFS is to maintain public and industry support and assure long term success, it is critical to have the decision processes publicly reviewed and in place before MFS has to invoke them.

MAINE'S FOREST ECONOMY[12]

Highlights of Maine's Forest Economy[13]

- Maine is the major timber producer of the four-state region that includes New Hampshire, New York, and Vermont, accounting for roughly half of wood production.
- The direct annual contribution of forest-based manufacturing and forest-related recreation and tourism to the Maine economy is over $6.2 billion. The total economic impact is estimated at $10 billion.

Important questions for Maine's future

➔ What kind of forest and forest economy do we want to have in 2020?

➔ What do we need to do now to ensure we get there?

- Forest-based manufacturing is the largest manufacturing industry in Maine, contributing $5.2 billion in value of shipments to the economy in 2001, or 36% of Maine's total manufacturing sales.
- The forest-based manufacturing industry provides employment for 21,692 people and generates a payroll of over $1.0 billion, the largest payroll in Maine's manufacturing sector. Forest-based recreation and tourism provides employment for over 12,000 and generates payrolls of $145 million.
- In 2002, forest-based manufacturing contributed $1.6 billion in Gross State Product (GSP) to the state economy, or 34% of the manufacturing GSP for Maine (value added is a common surrogate for GSP).
- Revenues from forest-related recreation and tourism activities totaled $1.02 billion in 2001.
- Maine landowners received estimated stumpage revenue in 2002 of $225 million.
- The sale of Christmas trees, wreaths, and maple syrup contributed $13 million in 2001.
- Wood provides the energy for approximately 24% of electrical use in Maine. Revenues from the sales of biomass chips in 2002 totaled $13 million. The most current data indicates that in 1998, 470,000 cords of firewood were harvested and processed in Maine, contributing $44 million to the state's economy.
- Each 1,000 acres of forest land in Maine supports 1.2 forest-based manufacturing jobs and .6 forest-related tourism and recreation jobs.

A Critical Juncture

Maine's forest economy - a major portion of the state's overall economy and a foundation of our rural areas, is at a turning point. Globalization has brought

[12] Portions of this section are substantially informed by Innovative Natural Resources Solutions, LLC. 2005. Maine Future Forest Economy Project: Current Conditions and Factors Influencing the Future of Maine's Forest Products Economy. Report prepared for the Maine Department of Conservation and Maine Technology Institute. 472 pages.

[13] North East State Foresters Association. 2004. The economic importance of Maine's forests. 8 pp.

opportunity and challenge: opportunity in the form of expanded markets for many of our products, and challenge in the form of competitive pressures exerted by lower-cost sources of timber, labor, and business regulation. While some facilities have undertaken substantial expansions and upgrades, recent mill closures at less efficient mills, capacity reductions, and temporary shutdowns of wood processing facilities in Maine and neighboring states are indicators of the changing environment. Employment levels have declined as mills become more efficient; nonetheless, production levels in some sectors have increased significantly. For example, both softwood and hardwood lumber production have increased significantly over the last few decades. To thrive in this new economy, Maine's forest products industry must maintain and expand markets and invest in the latest technologies to remain competitive.

The Maine Future Forest Economy Project is a Department of Conservation initiative to: "[Identify] what is needed to maintain Maine's existing wood using industries, to identify growth opportunities in existing and potential new wood using industries, and to identify what Maine State Government and the industry itself could do to improve the prospects for Maine's forest products industries." This project is part of Maine state government's ongoing effort to better understand and support the state's forest products industry. The project focuses on the manufacturing firms that comprise part of Maine's forest products industry. [14]

[14] Funding for this project provided by the USDA Forest Service with additional funding from the Maine Technology Institute.

Summary of Maine's Future Forest Economy Project

Maine's Future Forest Economy Project is a year-long analysis of the state's forest products manufacturing industry, funded by the Department of Conservation – Maine Forest Service (with funding from the USDA Forest Service) and the Maine Technology Institute. This effort, led by Innovative Natural Resource Solutions LLC, benefited from the advice of a 12-member advisory committee and the input of hundreds of members of Maine's forest products manufacturing industry.

Maine's forest products industry has entered a period of rapid change. The industry is consolidating, diversifying, and becoming more efficient in the face of ever-increasing global competition. Part of this change includes a decline in the number of employees. While employment numbers are down, Maine mills have strived to increase productivity. For example, between 1997 and 2002 five thousand jobs were lost in the forest products manufacturing sector, while output per worker rose by 23%. Far from the "dying industry" some outside observers see, Maine's pulp and paper industry has enjoyed stable production over the last decade, and the volume of lumber produced in Maine has increased by roughly 250% since 1975.

Maine forest product manufacturers have significant strengths, and these present opportunities. Maine's forest products "cluster" – the depth and variety of manufacturers – provides opportunities to find profitable niches and adapt to changing markets. Maine is physically close to the largest market of consumers in the world, an advantage that cannot be replicated by other regions. Maine's white pine lumber industry has enjoyed strong demand, and mills have been making continued investments in productivity. The state's spruce-fir resource is unusual in the U.S., is not available in most other parts of the world, and positions Maine mills to exploit certain market niches for lightweight papers. With increasing postage rates, demand for these grades is likely to rise.

The state's world-class research and development capacity, centered in Orono at the University of Maine, provides opportunities to develop and deploy the latest technology in-state. Maine enjoys a diverse forest resource, with white pine, northern hardwood and spruce-fir forests. The state's resilient ecosystem, coupled with a growing base of certified wood volumes and forestland, presents Maine forest product manufacturers with opportunities to identify profitable markets and build upon the state's existing manufacturing infrastructure.

Of course, Maine forest products manufacturers face very real challenges. The past five years have seen a number of forest products manufacturing facilities close, from paper mills to dowel manufacturers. During this same time period, new forest products have come to Maine, and existing facilities have added capacity and product lines. More changes can be anticipated in the future – some of them challenges, some of them opportunities.

Recommendations

To best position Maine and its forest products manufacturers for the future, the *Maine Future Forest Economy Project* report makes a number of recommendations. These recommendations are designed to help state government, forest product manufacturers and other stakeholders develop the conditions necessary for the forest industry to prosper in a changing economy. They are not focused on individual manufacturing facilities, bur rather seek to improve the underlying economic system that Maine mills operate in while safeguarding public values.

For most of Maine's forest product manufacturers, continued investment in manufacturing technology will be necessary to retain competitiveness. Maine state government can send a clear and unmistakable signal to the marketplace that investment in Maine is welcome by prospectively eliminating property tax on new manufacturing equipment. By providing tax treatment of manufacturing equipment that is competitive with other

states and countries, Maine can help encourage existing and new manufacturing facilities to bring the latest technologies to Maine.

Maine forest products manufacturers and state government can work together to promote a predictable and stable policy environment for Maine forest industries. By collaborating with a wide variety of stakeholders, parties can create a business environment that allows manufacturers to innovate, protects public values, and shares information so that policy leaders understand the opportunities and challenges faced by forest products manufacturers.

Opportunities exist to move cutting-edge technologies into Maine's forest products sector. Efforts should be increased to commercially develop the high-quality research that is conducted at UMO's *Advanced Engineered Wood Composite (AEWC) Center* and the *Pulp & Paper Process Development Center*. New opportunities exist to develop "bio-products," wood-based substitutes for fuels, chemicals, or other substances, and Maine is pursuing opportunities in this area.

Encouraging entrepreneurship can help provide new opportunities for Maine. By developing forums for idea sharing and business development, Maine manufacturers can learn from the success and failures of one another and recognize market opportunities as they develop. Maine forest products manufacturers can also capitalize on its earned reputation as an environmental leader to help position some products for some consumers and markets.

Finally, efforts to address challenges faced by Maine industries can be continued. Existing business assistance and development programs can become better connected to forest industries, challenges in the region's high cost of energy can be addressed, and transportation systems for freight can be improved.

Public Support

As these challenges are addressed, Maine can harness public support for the forest products industry. In a poll of Maine residents conducted by SMS Marketing Services of Portland, Maine, 93% of respondents indicated that it is important to maintain the forest products economy as a significant component of the Maine economy. Sixty-four percent of respondents support changes to the state's tax policy to help forest industries become more competitive, and 58% support investment of public dollars to improve the health of the forest economy.

More information

The text of the full report, an executive summary and individual chapters can be found at the Maine Forest Service website.

Source: Innovative Natural Resource Solutions LLC, 2005. Maine Future Forest Economy Project: Current Conditions and Factors Influencing the Future of Maine's Forest Products Industry. 474 pp. www.state.me.us/doc/mfs/fpm/ffe/. Last accessed 04 May 2005.

Imports and Exports of Forest Products from Maine[15]

The diversity of markets for various species and product types offers many opportunities for Maine's forest landowners. Landowners and loggers generally seek the best markets for the trees they harvest; those markets may be in the Northeastern or Midwestern states, in Canada, and even overseas. The bulk of wood exported goes to Canada (largely spruce and fir sawlogs). Similarly, Maine's wood using industries draw on wood supplied not only from Maine, but from much further afield, generally the Northeastern states and Canada.

Until 2000, Maine generally was characterized as a net importer of wood. While a substantial portion of the sawlogs harvested, primarily spruce and fir, were exported to Canada, a much larger quantity of pulpwood was imported from neighboring states to support Maine's pulp and paper mills. Since then, the situation has changed, as Maine has been a net exporter of wood[16]. While the sawlog export balance remains negative, the pulpwood export balance has trended neutral.

The following tables, extracted from the 2003 Wood Processor Report (the most recent year available) show wood flows into and out of Maine for sawlogs, pulpwood, and biomass, as well as the destinations of exports and sources of imports.

Table 2. Summary of Wood Flows in Maine, 2003

SUMMARY 2003 Wood flow in Maine as reported to the Maine Forest Service

Product	Harvest, Export, Import, Instate Processing	Total Volume in 2003	Total Volume converted to cords
Sawlogs (in MBF) 1 MBF = 1,000 board feet	a. Maine wood processed	836,260	1,672,520
	b. Exported from Maine without processing	449,071	898,142
	c. Total harvested from Maine forests (a+b=c)	1,285,331	2,570,662
	d. Imported from out of state	149,560	299,120
	f. Total processed by Maine Forest Products Industry (a+d=e)	985,820	1,971,640
Pulpwood (in cords)	a. Maine wood processed	2,496,510	2,496,510
	b. Exported from Maine without processing	534,015	534,015
	c. Total harvested from Maine forests (a+b=c)	3,030,525	3,030,525
	d. Imported from out of state	742,647	742,647
	f. Total processed by Maine Forest Products Industry (a+d=e)	3,239,157	3,239,157
Biomass Chips (in green tons)	a. Maine wood processed	916,393	366,557
	b. Exported from Maine without processing	73,170	29,268
	c. Total harvested from Maine forests (a+b=c)	989,563	395,825
	d. Imported from out of state	65,079	26,032
	f. Total processed by Maine Forest Products Industry (a+d=e)	981,472	392,589
Totals (in cords)	a. Maine wood processed		4,535,587
	b. Exported from Maine without processing		1,461,425
	c. Total harvested from Maine forests (a+b=c)		5,997,013
	d. Imported from out of state		1,067,799
	f. Total processed by Maine Forest Products Industry (a+d=e)		5,603,386

Note on conversions: *For sawlogs:* 1 MBF = 2 cords *For Biomass Chips:* 1 cord = 2.5 green tons

[15] Required by 12 MRSA §8879. Data drawn from Maine Forest Service Wood Processor Reports.
[16] Exports exceeded imports by 394 thousand cords.

Table 3. Import Origins and Export Destinations for Wood Harvested in Maine, 2003.

Wood Imports and Exports	
Import Origins	**Export Destinations**
States:	**States:**
Connecticut	Connecticut
Massachusetts	Massachusetts
New Hampshire	Michigan
New York	New Hampshire
Rhode Island	New Jersey
Vermont	New York
Provinces:	Pennsylvania
New Brunswick	Rhode Island
Nova Scotia	Vermont
Prince Edward Island	**Provinces:**
Quebec	New Brunswick
	Ontario
	Quebec
	Countries:
	Italy

FOREST CERTIFICATION

Independent, third party certification of forest management is a rapidly evolving, voluntary, market-driven tool that has the potential to change the face of Maine's forest products industry and forest landscape. Independent third party auditors assess whether the management practices of a landowner are in accordance with specific standards of sustainable forestry. Depending on the system chosen, either the land or the land manager may be certified.

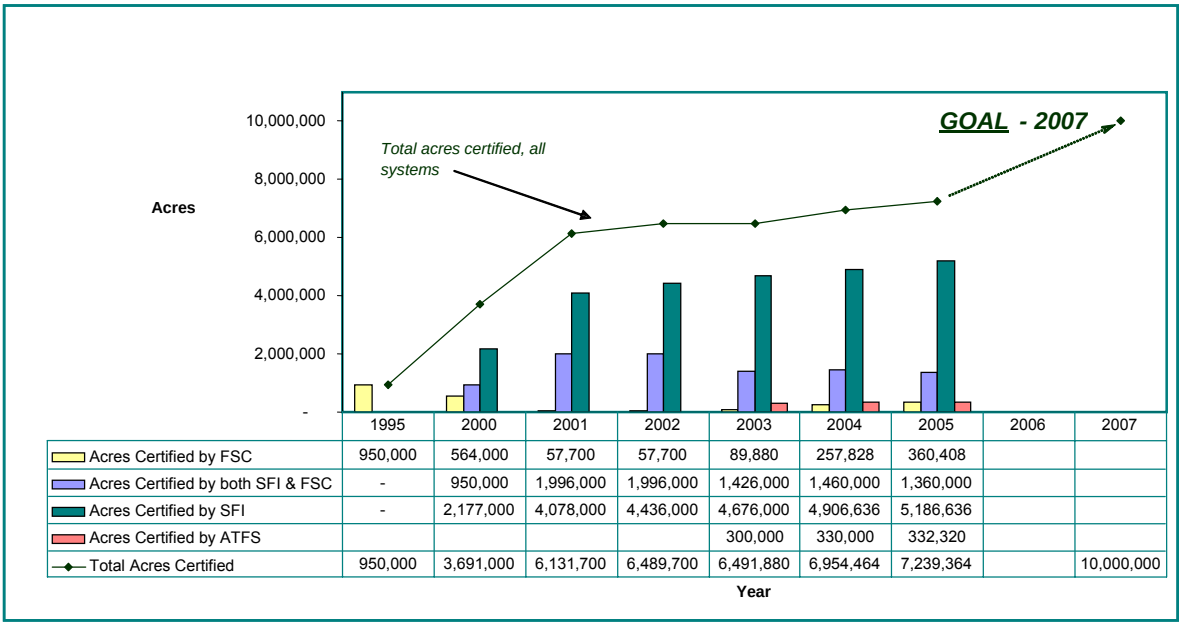
In June 2003, Governor Baldacci launched the Maine Forest Certification Initiative to "help grow Maine's forest industry by distinguishing Maine products in the marketplace while improving forest management on-the-ground." Specifically, Governor Baldacci desired to explore whether Maine might achieve this through increased use of forest certification.

The Governor observed that "certification has been a significant force for improving forest management in Maine, increasing the attention paid to balancing harvest with growth, maintaining water quality, and achieving other environmental objectives." The Governor also recognized the potential for certification to complement regulations by providing "a positive, market-based approach to improving forest management."

To focus the initiative, Governor Baldacci issued the following challenge to Maine's forest landowners and the industry:

"To maintain and strengthen our leadership position regarding certification, the goal of this initiative is to increase the amount of certified forestland in Maine from 6.5 million acres to at least 10 million acres by the end of 2007."

Figure 29. Maine Certified Forestlands 1995 - 2005 (H. Whittemore, 2005, personal communication).



	1995	2000	2001	2002	2003	2004	2005	2006	2007
Acres Certified by FSC	950,000	564,000	57,700	57,700	89,880	257,828	360,408		
Acres Certified by both SFI & FSC	-	950,000	1,996,000	1,996,000	1,426,000	1,460,000	1,360,000		
Acres Certified by SFI	-	2,177,000	4,078,000	4,436,000	4,676,000	4,906,636	5,186,636		
Acres Certified by ATFS					300,000	330,000	332,320		
Total Acres Certified	950,000	3,691,000	6,131,700	6,489,700	6,491,880	6,954,464	7,239,364		10,000,000

The Governor identified several actions that the state could take to help the industry meet this challenge, including:

1. Certifying actively managed state lands;
2. Giving preference in state purchasing to certified wood and paper whenever practicable;[17]
3. Providing technical assistance, outreach, and encouragement for owners of both large and small landholdings who seek to become certified;
4. Providing preference in Maine Forest Service cost-share programs for landowners, resource managers, and loggers entering certification systems;
5. Paying part of the cost for foresters to become certified resource managers, and
6. Encouraging the expansion of the Master Logger Certification Program and the Small Woodland Owners Association of Maine's Pilot Tree Farm group certification.

To guide the certification initiative, Governor Baldacci formed the Maine Forest Certification Advisory Committee. The committee was charged with developing recommendations in four areas:

1. What can be done to increase the amount of land and wood products that are certified in Maine?
2. What can be done to increase the number of businesses producing certified wood products in Maine?

[17] Executive order 8 FY 04/05, An Order Regarding the Use of "LEED" Building Standards for State Buildings.

3. What can be done to enhance the markets for certified forest products from Maine and distinguish Maine in the global marketplace for certified products?
4. Reviewing the certification systems in use in Maine and recommending changes to make them more effective in achieving sustainable forestry.

The Certification Advisory Committee issued its report in February 2005. The report is posted on the Maine Forest Service's website: www.state.me.us/doc/mfs/fpm/forcert.htm.

The committee also recommended a supplementary goal:

> To complement and supplement the goal of 10 million acres of certified forestland, the state Maine and forest industry should seek to increase the volume of wood from certified sources to 60 percent of the statewide total by the end of 2009 and ensure that buyers desiring to secure even higher percentages from Maine sources are able to do so.

Over 7 million acres of forestland currently are certified through one of the three major systems. This includes approximately 500,000 acres of public land, 6 million acres of large-parcel private lands, and 350,000 acres of small-parcel private lands. Meeting the challenge will require adding 3 million acres of certified land. The committee recommended achieving this by adding 2.5 million acres of large parcels (parcels over 5,000 acres), 500,000 acres of smaller parcels, and 100,000 acres of public timberlands. Meeting the challenge will mean a 33% increase in large parcel acres and a 250% increase in small parcel acres certified.

Meeting the 10 million acre goal will significantly increase the volume of wood originating from certified sources. This will aid in reaching the 60 percent volume goal, but will not achieve it completely. In addition to increasing the amount of certified acreage, Maine must also identify ways to certify volume from lands where land certification is not possible in the near-term. The most realistic, credible way to do this seems to be harvest practices certification, whereby foresters and loggers are certified, and the volume originating from harvests overseen or conducted by these certified practitioners would contribute to meeting the state's volume goal.

The report made recommendations in four areas: (1) achieving the acreage and volume goals; (2) strengthening treatment of biological resources; (3) improving certification systems; and, (4) a final recommendation for the public. These recommendations are as follows:

Recommendations for Achieving Maine's Certification Goals

- Recommendation 1: Create a Maine Forest Certification Information System
- Recommendation 2: Expand Harvest Practices Certification
- Recommendation 3: Motivate Owners of Private Forests to Certify Their Lands
- Recommendation 4: Motivate Owners of Public Forests and Private Conservation Areas to Certify Their Lands

- Recommendation 5: Track Wood from Certified Sources
- Recommendation 6: Market Maine's Certified Wood Products

The report also discussed implementation of the recommendations, suggesting that private and public sector forest certification interests should collaborate in the implementation of the recommendations. Specifically, these interests should:

1. Establish a leadership team to coordinate actions,
2. Identify funding and staffing requirements,
3. Establish implementation priorities,
4. Work with forest certification systems to integrate the Committee recommendations into their procedures, and
5. Develop and implement a strategy for monitoring progress.

The report makes several specific recommendations regarding the various certification systems operating in Maine. Finally, the report makes a recommendation to the public:

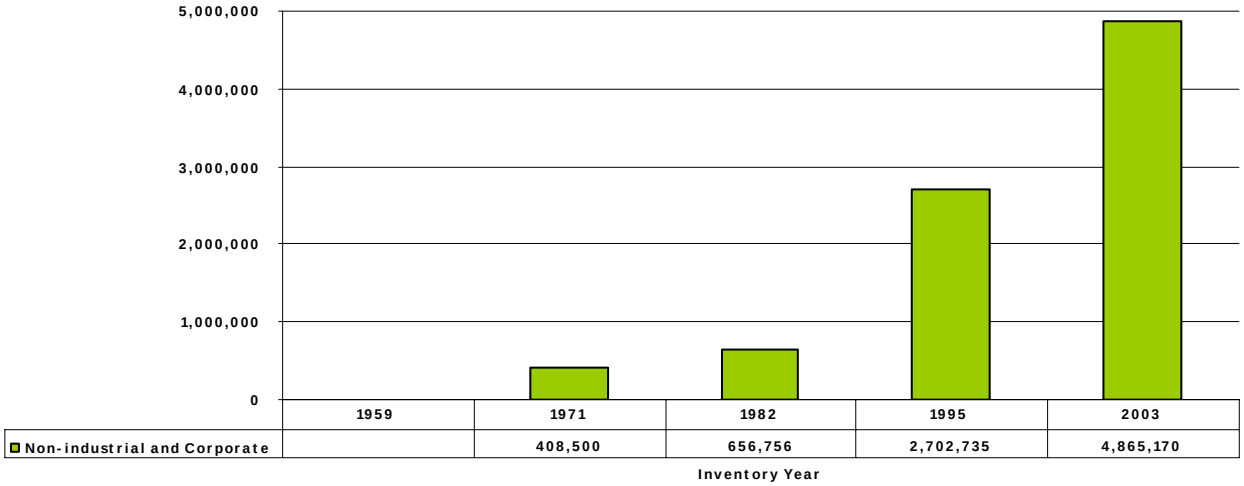
> **"Certification is, and should remain, market driven. To the extent that customers – both high volume purchasers of wood products and end consumers – demand and seek out wood products that come from well-managed forests, and are willing to pay an appropriate price for these products, forest landowners and the forest products industry will respond."**

In Maine, the total acreage certified continues to grow. New opportunities have opened up for small landowners, although challenges remain ahead for this landowner class.

LAND OWNERSHIP CHANGES

Nearly 7 million acres of Maine forest land have changed hands since 1998. Whereas industry ownerships (e.g. International Paper, Boise-Cascade, SD Warren, and Georgia-Pacific), once dominated the landscape, nearly all large forest industry holdings - with the notable exceptions of JD Irving and Katahdin Timberlands - are now in the hands of investor-owners, real estate investment trusts, and similar ownership structures (Figure 30). Interestingly, some logging contractors reportedly have begun to accumulate a land base, although hard data are not easily available to confirm this trend.

Figure 30. Timberland areage for the Owner group/class, Non-Industrial and Corporate, encompassing primarily Investor Owners by inventory year (K. Laustsen, 2005, personal communication).



Investor-owners now hold several million acres of commercial forest land in Maine. Investments in timberland consist of three basic elements: bare land (including lands with high development potential), merchantable timber, and premerchantable trees. Overall investor returns depend on a number of factors, including performance on the value of each of these components over time, but also investor time horizons and the ability of the owner to break up the forest land into its individual components for resale as opportunities permit. The forest ownership shifts have generated public concerns about the future of large blocks of forest land in Maine (see text box on Plum Creek proposal), but these shifts have also created opportunities for unprecedented large-scale land conservation efforts (see next section, "Conserving Working Forest Lands").

Plum Creek's Comprehensive Resource Plan for Greenville and Rockwood Areas

In December 2004, Plum Creek Timber Company, Inc. announced that it is preparing a comprehensive Resource Plan for land the company owns in the Greenville and Rockwood areas. The plan area will cover approximately 40 percent of the company ownership in the state (currently 953,000 acres). Plum Creek filed an application for the plan with Maine's Land Use Regulation Commission in April, 2005.

Plum Creek's proposal lays out a 30-year plan for the Moosehead Lake region that designates specific areas for forest management, conservation, recreational and other non-residential development and residential lot development. The plan specifies the amount, type and location of development and conservation within the area. The proposal aims to protect and maintain the commercial forest land base; maintain and enhance the recreation and tourism economy; conserve and protect valued land and water resources; provide land for other economic enterprises; provide for residential recreational lot development on selected lakes, ponds and backland areas; and provide future predictability for the area.

The plan area covers approximately 426,000 acres in Somerset and Piscataquis Counties, encompassing a majority of the land area within 29 townships and plantations. The plan proposes 975 new residential lots, with up to 575 shorefront lots. The development will cover approximately 3,755 acres, to be phased in over a 10-15 year period. The plan will retain more than 95 percent of the land the company owns in the plan area as a working forest for long-term timber production and conservation; and provide public access over designated and planned trails in perpetuity.

The plan proposes the following non-residential development:
- A 3,000 acre area for a nature-based tourist facility in Lily Bay Township;
- A 500 acre area for a lodge facility on the southern peninsula of Brassua Lake;
- A 1,000 acre industrial site suitable for a large lumber mill or similar facility;
- Three commercial sites for campgrounds, storage facilities, and/or a small store (up to 600 acres in total); and,
- 80 acres within the proposed "no development/working forest area" for up to 4 new sporting camps and/or remote recreational cabin sites.

The plan proposes several mechanisms for conservation of resources within the plan area:
- Permanent 500-foot deep conservation easements will be placed on all of Plum Creek's shoreland ownership on 55 ponds, totaling 78.6 miles and 4,766 acres of shoreland.
- Permanent 500-foot deep conservation easements will be placed on 15 lakes and ponds on which development is proposed, totaling 101 miles and 6,124 acres of shoreland (including shorefront on the Moose River). From 58% to 80% of the shoreland of each water body will fall under permanent conservation.
- Permanent conservation easements will be placed on 71.3 miles of ITS snowmobile trail.

In earlier conservation transactions, Plum Creek sold 29 miles of shoreline around Moosehead Lake and 445 acres along the Kennebec River to the state.

Sources: (1) Plum Creek media release, 14 December 2004; http://phx.corporateir.net/phoenix.zhtml?c=68740&p=irolnewsArticle&ID=654717&highlight=moosehead. Last accessed 30 June 2005; (2) LURC website; www.maine.gov/doc/lurc/reference/resourceplans/moosehead.html. Last accessed 30 June 2005.

It is too soon to assess the net benefits to the state of these ownership changes. However, a number of key elements characterize many of the new ownerships:

- Long-term timber supply agreements with mills that formerly had an ownership connection to the land (e.g. mills in Hinckley, Rumford, and Jay, among others);
- General interest in maintaining certification of managed forest lands (e.g. land formerly owned by International Paper and Mead WestVaco);

- Willingness to negotiate very large scale conservation agreements, including the sale of both fee land and conservation easements (e.g. West Branch and Downeast Lakes);
- Aggressive harvesting to help recapture initial investment and concentrate growth on younger age classes;
- Sale of nonstrategic, outlying woodlots to other buyers;
- Marketing of so-called Highest and Best Use (HBU) lands (waterfront and land closer to population centers) for development; and,
- Termination of recreational camp leases in favor of outright sales of camp lots.

Investor-owners typically have short- to medium-term time horizons - 10 to 15 years, generally. However, some investor-owner lands purchased during the last decade were quickly resold and subjected to liquidation harvesting by subsequent buyers. The maintenance of traditional recreational access to these lands is not guaranteed except where conservation easements have been negotiated. The sale or lease of recreational use rights (including hunting and fishing access) is a very lucrative enterprise in much of the country, but is not common in Maine. But the overall future of these lands remains the overarching issue: will these remain as large contiguous tracts of undeveloped forest, and will these lands be actively managed as a source of timber over the long-term?

Table 4. Recent changes in ownership of Maine's forest land, parcels 10,000 acres or larger[18]

Grantor	Grantee	Acreage
Enron Corp.[19]	White Birch Paper Ltd.	61,689
SP Forests (International Paper)	Lakeville Shores	13,069
SP Forests	Lakeville Shores	24,327
Maine Timberlands	The Nature Conservancy	44,123
MeadWestVaco	Bayroot LLC	135,417
MeadWestVaco	Bayroot LLC	118,812
Merriweather LLC	State of Maine	133,716
MeadWestVaco	Bayroot LLC	63,773
Great Eastern Timber	Carrier Timberlands	49,469
SP Forests	Appalachian Mt Club	28,839
Aroostook Timberlands (Irving)	Gardner Land Co.	27,092
Aroostook Timberlands	Roxanne Quimby	24,083
MeadWestVaco	Bayroot LLC	22,880
MeadWestVaco	Bayroot LLC	13,626
Aroostook Timberlands	Lakeville Shores	11,555
Aroostook Timberlands	R A Crawford & Son	11,500
Aroostook Timberlands	Orion Timber LLC	234,000*
SP Forests	GMO Renewable Resources LLC	1,100,000*
Fraser	Heartland Forestland Fund V	238,000*
*Approximate acreage.		

[18] Required by 12 MRSA §8879. Data supplied by Maine Revenue Services for April 2002 - April 2004, augmented by anecdotal information believed reliable for certain large transactions occurring up to December 2004.

[19] Sale an outcome of Enron bankruptcy.

A footnote on tracking land sales

The information reported in this section does not tell the full story of land sales in the state. For example, anecdotal sources indicate that over 100,000 acres of forest land in parcels between 1,000 and 10,000 acres have changed hands over the last few years. Many of these parcels were split off from larger parcels acquired during larger scale transactions.

12 MRSA, §8879, sub-§1-A requires MFS to monitor changes in ownership of parcels of forest land 1,000 acres or larger and enrolled in the Tree Growth Tax program in the organized towns; however, towns are not required by law to report this information. 36 MRSA §581-E only requires towns to report the following on acreage enrolled in Tree Growth:

- Landowner names and addresses;
- Total acreage by forest type (hardwood, mixed wood, softwood); and,
- Year of acceptance into the program.

Further, MFS has no enforcement authority to compel towns to report this information. Therefore, MFS cannot report reliably on ownership changes for parcels less than 10,000 acres in size.

CONSERVING WORKING FOREST LANDS

"The value of the land consists entirely in its timber and generations to come will not furnish a demand for it for any other purpose."
- Report of the Land Agent to the Maine Legislature, 1848.

Maine has made great strides over the course of thirty years to conserve forest land. Over the past decade in particular, Maine has become a national leader in forest land conservation. But until recent times, the most notable feature of conservation land in Maine had been its relative scarcity.

Over the course of three hundred and fifty years of post-contact history, the territory that ultimately became the State of Maine was conveyed away wholesale, by grant, at auction, by private sale, and by lottery, as a means of raising public revenue. Large sales began following the Revolutionary War as a means for Massachusetts (then in possession of what is now Maine) to replenish its depleted treasury. By 1878, the task was complete, with virtually all of the public domain sold off. In that year, the Maine land agent reported to the Legislature "that all the public lands of the state [are] disposed of." Thereafter, only two small parcels of land - 1,053 acres in Sheridan (now Ashland) and 216 acres in New Sweden - remained in the public domain, apparently by omission or accident. Thus it happened that Maine ranks first in the nation in forest cover, but close to last in the nation in amount of publicly owned land.

As lands in the territory of Maine were sold off, Massachusetts reserved out of each township a small portion, typically 1,000 acres, commonly referred to as the "public lot" or the "ministerial and school lot." Maine continued this practice in its conveyances after it became a state. The public lots initially were reserved and held in trust for the support of schools and the ministry, and later solely for the support of schools. Upon incorporation, a town became the steward of the public lot within the municipality. The town commonly sold the lot. The state sold off substantially all of the timber and grass rights on the public lots in unorganized townships; many assumed that the sale of such rights was of infinite duration. The public reserved lots, like the rest of the state's public domain, all but disappeared into the fabric of surrounding private ownership.

A shift in attitude about the value of publicly-held land can be detected as early as 1913, when the Legislature reversed a policy of selling off state-owned islands. Early conservation efforts were largely privately-driven, such as the creation of Acadia National Park and Baxter State Park. In the early 1970's, as interest in conservation lands began to mount, the Attorney General's Office studied public lot ownership in Maine. The Schepps Report, issued in 1972, expressed the opinion that Maine's sale of timber and grass rights on the public reserved lots had expired with the harvest of the timber standing at the time of sale. Not surprisingly, this led to litigation. The Schepps argument prevailed in court, effectively reestablishing exclusive public domain over several hundred thousand acres of the public reserved lots in unorganized territories in forested Maine.

At about the same time, in 1973, the Legislature created the Bureau of Public Lands, charged with managing and consolidating public lands. The Legislature directed that the lands shall be managed for the general benefit of the people of the state under the principles of multiple use "to produce a sustained yield of products and services … to demonstrate exemplary management practices, including silvicultural, wildlife and recreation management practices, as a demonstration of state policies governing management of forested and related types of land (12 M.R.S.A. §1847)." The public reserved lots, newly repossessed by the state, came under the bureau's management, where they were traded and consolidated to form larger units of mostly forested public land ownership having high public values (such as scenic views and recreational opportunity), distributed throughout the state. By 1993, the bureau managed about 456,000 acres - a small public domain by comparison to most states, but representing a core of consolidated land units having high public values, and forming a foundation for further conservation efforts.

Since the 1970's, the pace and scale of forest conservation efforts in Maine have increased steadily. The backdrop for these efforts is the state's vast privately owned forestland, Maine's centuries-old tradition of public access to private lands for recreation, and the rapidly escalating turnover in land in the northern forest. Since 1998, more than 30% of Maine's total acreage has been bought and sold. Some of these forest land sales have resulted in fragmentation of habitat, timber liquidation, subdivision, and development. Sustained conservation efforts are directed towards ensuring some stability in this vital sector of Maine's natural resource-based economy, while ensuring public recreation access to an area justly renown for its outdoor recreation assets.

Land acquisition has not been the only means to conserve Maine's forests. A conservation tool having deep roots in Maine law is the Tree Growth Tax Law (TGTL). This program provides for tax assessment based upon the ability of the land to grow timber, rather than valuation for other potential uses, such as commercial or residential development. Landowners voluntarily enrolling in the program commit to manage enrolled land for long-term forestry-related uses, or suffer substantial withdrawal penalties. Lands enrolled in the TGTL program support Maine's forest economy, protect the environment, and enhance the quality of life in Maine communities. Over 11.5 million acres of forest land are enrolled in this program.

As Maine has moved forward with conservation efforts, some lands with very high public recreation values or special ecological or historical significance have been purchased in fee. But through extensive use of working forest conservation easements, conservation efforts in Maine have provided for continued private fee ownership while accomplishing conservation goals and protecting recreation opportunities. Typically, easements governing certain types of land use, such as development restrictions or requirements for sustainable timber production, are purchased from private landowners. The land remains in private hands, but the

easement ensures the continued availability of the land for sustainable forestry and recreation. Large-scale conservation easements covering hundred of thousands of acres of working forests in Maine have been secured in this manner.

Maine has benefited from private conservation efforts, including New England Forestry Foundation's work with the Pingree family to protect 762,000 forested acres in northern Maine, and The Nature Conservancy's purchase of 185,000 acres of International Paper Company land along the Upper St. John River. Forest land conservation efforts in Maine, however, characteristically involve extensive partnering with public and private entities, in cost sharing, coordination, and development. Key partners include the USDA Forest Service's Forest Legacy Program, the Land For Maine's Future Program, numerous private conservation organizations and land trusts, other public and private contributors, and of course, the landowner. Through such coordinated efforts, combined with the private efforts noted above, nearly two million acres have been protected in Maine. Most of this protection has been afforded through working forest conservation easements. Easement portions of major forest land conservation projects include the following: the West Branch Project (280,000 acres); Nicatous Lake (21,901 acres); Leavitt Plantation Forest (8,603 acres); Katahdin Forest Project (194,751 acres); Mt. Blue/Tumbledown (12,030 acres); Katahdin Ironworks (37,000 acres); and, the Downeast Lakes Partnership Project (312,000 acres), in addition to the two projects cited above.

Using the best available data, there are today about 3,400,000 acres of "conservation" land in Maine, including land covered by some sort of conservation easement. This accounts for about 15% of the state's area. About 3% of Maine is off-limits to timber harvesting. Much of this is in Baxter State Park, the adjacent Nature Conservancy Debsconeag Reserve, federal sanctuaries, federal and state parks, and state-owned public lands ecological reserves.

The accelerated pace of land sales in Maine over the past seven years- nearly 7 million acres have changed ownership – has created a special opportunity for land conservation. Changing ownership objectives portend changes in traditional management of forestland for timber production. Traditional Maine values associated with these lands, including the maintenance of wildlife habitat, recreational uses, and economic productivity of these lands, are at risk. Maine voters have repeatedly expressed strong interest in protecting public values associated with forestland. Through effective partnerships and the use of working forest conservation easements, Maine has used available conservation dollars in a remarkably efficient manner, and has been a national leader in forestland conservation. While much has been accomplished, the future likely holds even greater challenges for the state

LATE SUCCESSIONAL FORESTS

Although the protection of Maine's remnant late successional and old growth forests has received increased attention recently, the issue has been under consideration for many years (e.g., Maine Critical Areas Program, 1983; Pinette and Rowe, 1988; Gawler, *et al*, 1996; Elliott, ed., 1999). Although many issues require continued examination and discussion (particularly the solutions), concern is growing that with improved markets these remnants will soon drop out of the working forest matrix, and that existing ecological reserves and other "passively managed" forests will not suffice to ensure the continuity of such forests across the landscape.

One common misconception is that late successional forests are comprised uniformly of big, old trees. The Manomet Center for Conservation Sciences (Hagan and Whitman, 2003a) has identified for its purposes the key characteristics of late successional forests: "Late successional" forest implies a forest that is nearing one of potentially several old stages of forest condition after a relatively long period without major a stand-replacing disturbance (either by humans or natural causes). Late successional and old growth forests typically contain some - but far from all - trees between 100 and 200 years old or older; such forests contain small and young trees as well as large and old trees. Other indicators suggested by various researchers include multiple canopy layers; large diameter snags and down logs; a forest floor exhibiting pit-and-mound topography; abundance of lichens and fungi; thick, humus-rich soils; and, (in the case of old growth) little or no evidence of past timber harvest or agriculture (Yarrow, 2002).

McCarthy (1995) outlines some of the values of late successional and old growth forests. For example, the study of old growth forests has provided much of our knowledge about the structure, function, and natural disturbance regimes of forests, as they have largely remained free of human disturbance. Old growth forests serve as valuable benchmarks against which we can measure our performance on managed lands. Although there is some uncertainty, many believe that old growth forests function as reservoirs of biological diversity. Heritage values and ethical considerations can also form part of the value set.

Human activities since European settlement have been the dominant influence on the present composition of Maine's forests. Much of southern and central Maine was largely deforested and converted to cropland and pasture. Beginning in the mid-1800's, agricultural abandonment began, and the land reforested naturally (Foster, 2000). Maine is now one of the most heavily forested states in the nation. Notwithstanding the significant transformation of much of the state's landscape and a significant harvesting history, pockets of late successional forests and individual old trees within harvested stands have persisted to the present. These features persisted for a number of reasons, including lack of access, lack of markets, and landowner objectives. Manomet (Hagan and Whitman, 2004a) has identified some key issues regarding late successional forests:

- Late-successional forest remnants remain throughout Maine's working forest landscape, both in patches and individual trees scattered through stands; however, these remnants are disappearing for several reasons, including increased road access, improved timber markets, and more efficient silvicultural practices.
- Landowners have no economic incentive to maintain late successional forests or to grow large trees. Economic imperatives, changing technology, and good markets all are key drivers that act on landowners' decisions to harvest trees at smaller diameters and younger ages. In fact, many remaining late successional stands are prime candidates for harvest in the near future.
- Research in Maine is providing more evidence that some species, especially lichens and mosses, are linked to late successional forests. How much of this habitat is needed to perpetuate these species is unknown at this time.
- Scandinavian forests provide an object example of how broad scale intensive forest management has resulted in a substantial risk to biodiversity. Most of the species on the "Red List"[20] in Scandinavia are associated with late-successional forest.

Manomet has taken a leading role in developing both the science and possible solutions to the issue. Manomet has convened a working group to discuss the issue and has developed several informative documents that can help guide landowners, land managers, and policy makers as they grapple with this topic (see for example, Hagan and Whitman, 2003, 2004a, and 2004b).

Manomet has also developed rapid assessment indices for identifying and managing for late successional and old growth northern hardwood and spruce-fir forest stands (Hagan and Whitman, 2004b). These indices give an idea of the late successional and old growth values of any particular stand, based on the number of large diameter trees and the number of trees with particular lichen species present. These indices need to evolve and be developed for other forest types. For example, one metric in the indices is the number of trees with a DBH of 16 inches or larger. While appropriate for northern hardwood and spruce-fir types, the white pine type probably requires a significantly larger minimum DBH, as white pine can grow very rapidly on good sites. Further, according to the Maine Natural Areas Program (A. Cutko, 2005, personal communication), about 580,000 acres of forest land in Maine are passively managed (e.g., Acadia National Park). These lands will eventually meet most of the criteria for late successional and old growth forests; however, the trees may not meet Manomet's tree diameter or lichen criteria due to site constraints (e.g. extremely shallow or wet soils and high altitudes).

Notwithstanding a growing body of research and improved understanding of the functions and values of late successional and old growth forests, a number of key

[20] The Red List refers to a global or regional listing of species at high risk of extinction. The International Union for the Conservation of Nature maintains a global listing at www.iucn.org.

issues require development of a more common understanding, including, but not limited to:

- A better understanding of the types and extent of the remaining late successional and old growth forests in Maine;
- The range of patch sizes of such remnant forests as well as the minimum patch size necessary to ensure their continued viability;[21]
- Whether and how active forest management can perpetuate the functions and values of late successional forests (e.g., will lichens associated with late successional and old growth forests persist on isolated large trees?); and,
- Identification of plant and animal species that require the presence of late successional and old growth forests to complete part or all of their life cycles.

With the hope of avoiding crisis-driven decisions, MFS has encouraged the parties that care about and/or have a stake in this issue to enter into a dialogue and resolve the matter in a collaborative manner.

[21] For example, the Green Mountain National Forest (USDA Forest Service, 2005a) defines the lower limit of patch sizes at 5-10 acres. The White Mountain National Forest (USDA Forest Service, 2005b) sets a lower limit of 10 acres.

OUTCOME BASED FOREST POLICY[22]

The 120th Legislature endorsed the concept of outcome based forest policy as a tool for ensuring better results in Maine's forests (Public Law 2001, c. 339). The impetus for this legislation arose from MFS statements in the 2001 State of the Forest report about the limitations that a prescriptive regulatory framework impose on achieving desired conditions in Maine's forests (Maine Forest Service, 2001).

For example, while the Forest Practices Act has effectively ended the large, rolling clearcuts that generated much public concern and debate in the 1980's, the act and its implementing rules likely are the major driving factor behind the increase in partial harvesting. The volume harvested from Maine's forests has not changed significantly, just the extent and nature of harvests. Partial harvesting across such a broad expanse of the landscape (about 3% of Maine's forest land annually) may have impacts that we do not yet fully understand, but which could be long-lasting and difficult to correct. A simulation of the long-term landscape effects of the Forest Practices Act (Hagan and Boone, 1997) suggested that the rules in place at the time might be promoting fragmentation of habitat types and a loss of large blocks of interior forest. Further, the ability of residual stands to respond promptly and produce quality timber depends on what trees were left behind. Partial harvesting also influences what regenerates to fill the gaps created by harvesting; this influence may be positive or negative depending on the circumstances. While 1999 amendments to the rules created some flexibility in terms of arranging clearcuts on the landscape, the acreage partially harvested has not changed significantly.

Capone (2000) provides an excellent overview of outcome based forest policy. This article can be found at www.manomet.org/pdf/spring-2000.pdf.

The 2001 legislation directed MFS to pursue the creation of experimental areas where the principles of outcome based forest policy would be applied. The intent of this effort is to use a science-driven process to develop key criteria (e.g. soil productivity and water quality); and to allow cooperating landowners management flexibility provided they satisfy the established criteria. MFS remains enthusiastic about this concept, but recognizes the difficulties likely to arise in implementing it. In an attempt to develop a pilot project, MFS engaged in preliminary discussions with a large landowner on two occasions; however, those discussions ended both times with the sale of the land to another owner. Other large landowners contacted reported that they saw no benefit to participating. Other potential candidates have sold their land base. The turnover in large ownerships has complicated matters, as a key element of any successful outcome based forest management agreement is longevity and stability.

[22] Required by 12 MRSA §8879, sub-§1.

MFS plans to re-engage the forest landowner community shortly with an open letter asking for expressions of interest in pursuing this initiative. Even if MFS can engage a willing partner to meet the legislative direction, the process of developing a set of outcomes that advances both public and private interests likely will prove quite complex as it involves being clear about what society wants from the forest and how this meshes with private property rights.

LIQUIDATION HARVESTING

Liquidation harvesting is a business practice that involves three distinct actions: 1) the purchase of forested land; followed by 2) heavy harvesting of the land without regard for continuing forest management; followed by 3) the sale or attempted sale of the parcel, usually within five years of the original purchase. The short time elapsing between these actions is a primary distinguishing characteristic of liquidation harvesting.

Liquidation harvesting is a short-term, low risk, profit-driven real estate transaction that has the unfortunate consequence of reducing or degrading the flow of forest products and opportunities for future management of the forest land that is the foundation of many rural Maine communities. Liquidation harvesting commonly has negative effects on the future quantity and quality of available timber, forest regeneration, residual stand quality, wildlife habitat, soil productivity, water quality, and aesthetics. Liquidation harvesting fosters an economic climate around forest product pricing that places those who practice long-term forest management at a competitive disadvantage. Liquidation harvesting can result in the division of forest land into smaller parcels less likely to be actively managed for timber production.

Liquidation harvesting has occurred for some time in Maine. The practice has become institutionalized in financial circles, with established practitioners and clear pathways developed for financing and sales of land and harvested forest products.

Recent Progress

Progress on addressing the problem of liquidation harvesting has occurred on two fronts during the past two years:

1 - In 2002, the 120th Maine Legislature enacted Public Law Chapter 603, An Act to Address Liquidation Harvesting, directing MFS to continue gathering information on liquidation harvesting and report findings to the Legislature in its biennial State of the Forest Report. The legislation defined liquidation harvesting as:

> **"The purchase of timberland followed by a harvest that removes most or all commercial value in standing timber, without regard for long-term forest management principles, and the subsequent sale or attempted resale of the harvested land in 5 years."[23]**

[23] Public Law 2001, chapter 603, An Act to Address Liquidation Harvesting.

2 - In 2003 Governor Baldacci announced his Forest Stewardship Initiative, and the Maine Legislature passed it as Public Law 2003, chapter 422, An Act to Promote Stewardship of Forest Resources. The Governor's initiative included two key components relevant to liquidation harvesting. First, it directed the Department of Conservation to develop agency rules to "substantially eliminate liquidation harvesting." The rules require increased professional oversight of timber harvesting on forestland held for short terms and require that such harvests be conducted with attention to long-term forest management principles. Second, it directed the Department of Conservation to consult with stakeholders to identify additional solutions (complementary solutions) to the problem of liquidation harvesting, and report to the 122nd Legislature.

MFS assessments of liquidation harvesting

MFS has produced three estimates of the amount of land bought, cut, and sold within five years (Maine Forest Service, 1995, 1999, 2004a, and 2004b). Results indicate that liquidation harvesting took place on between 12,000 and 55,000 acres each year. MFS considers the 12,000 acre estimate low, as the entire 5-year time period had not yet expired when the sample was taken.

MFS's 2003 field study found that, in general, harvests occurring on lands purchased, harvested, and quickly resold exhibited practices that degraded the quality of residual stands. In general, the sites were heavily harvested; damage to the residual stands was prevalent. 82% of the acres had post-harvest stocking less than 40 square feet of basal area (barely above Forest Practices Act standards). While many of the parcels in the field study were heavily harvested, MFS staff found no violations of the Forest Practices Act.

Rule to Substantially Eliminate Liquidation Harvesting

In May 2004, Governor Baldacci signed Resolve 144, Resolve, Regarding Legislative Review of Chapter 23: Standards for Timber Harvesting to Substantially Eliminate Liquidation Harvesting, A Major Substantive Rule of the Department of Conservation. The rule to substantially eliminate liquidation harvesting is a highly targeted, carefully constructed approach to liquidation harvesting. The rule provides twelve exemptions that enable loggers, landowners, and forest products businesses who do not engage in liquidation harvesting to be exempt from the rule. These exemptions include:

1 - Lands owned before January 2, 2005 (the effective date of the Rule), or which are held for more than 5 years;

2 - Lands which are third party certified as sustainably managed;

3 - Harvests supervised by a certified resource manager;

4 - Harvests of less than 1,000 acres conducted by a Master Logger;

5 - Parcels owned by persons owning 100 acres or less of forest land statewide;

6 - Lands covered by permits for land conversion to other uses; and,

7 - Parcels containing 20 acres or less of forest land.

Several other minor exemptions also apply.

For those who buy, cut, and sell within a five year period and who do not qualify for an exemption, there are 3 major options designed to provide flexibility in harvesting operations. Those are:

1 - Without high-grading, limiting harvesting to 50% of the merchantable timber, as it existed when the parcel was bought; or

2 - A harvest plan signed by a licensed forester and consistent with silviculturally based standards; or

3 - Using a logger or forester who has successfully completing a training course accredited by the Maine Forest Service (for harvests up to 100 acres).

A hardship option and a variance provision provide additional flexibility for landowners and harvesters in unusual situations.

MFS also analyzed the potential economic impacts of the liquidation harvesting rule. From an overview perspective, MFS concluded that the overall net economic effect of the rule would be minimal. The rule would not significantly affect wood prices, because liquidation harvests are only a small portion of the harvests that occur in Maine annually. Net short term effects will be minimally adverse (some people and firms will be adversely affected while others are positively affected). Long term effects are expected to be beneficial as both timber supply and quality should improve on lands which would have been subject to liquidation harvesting. In the short term, specific individuals and firms that have practiced liquidation harvesting in the past may suffer reduced revenues as they adjust to the rule.

The liquidation harvesting rule took effect on 02 January 2005. MFS has developed an outreach and education program to those who may be affected by the rules, and is committed to enforcing the rule fairly and equitably, and to monitoring carefully the implementation of the rule to minimize unintended consequences.

Complementary Solutions

The Legislature recognized that liquidation harvesting is not a simple issue, and that no one action is likely to be effective in "substantially eliminating" the practice. The department convened a stakeholder group in August 2003 to assist MFS and DOC in developing additional solutions to address liquidation harvesting.

The stakeholder group operated under several key principles:

- There is no silver bullet.
- Multiple strategies are needed.
- Rules addressing liquidation harvesting are central.
- Both incentives and disincentives are needed.

- Unsustainable practices will persist if they remain profitable.

The Maine Forest Service delivered the final report and implementation plan to the Legislature in January 2004. The full report is available at www.state.me.us/doc/mfs/fpm/liq/mainpage.html.

The key recommendations from this report are:

Near term solutions

- Seek additional attention to mill procurement policies that encourage sustainable management and discourage liquidation harvesting, through private sector initiatives.
- Enact legislation to prevent subdivision of liquidated land. This was accomplished when the Governor signed Public Law 2003, chapter 622, An Act to Improve Subdivision Standards.

Longer term solutions

The department has received legislative authorization and support to conduct research on economic incentives to support long term forest management and sound silviculture. These incentives include:

- Repeal or reduction of capital gains taxes on the sale of timber on land held for a minimum period.[24]
- Reduction of capital gains and or property taxes for landowners enrolled in forest certification programs and/or committing to a higher level of forest management and/or providing public recreational access.
- Providing loan guarantees for sustainable forestry investments to increase access to capital for landowners committed to sustainable forest management to purchase forestland.
- Related concepts and mechanisms that could contribute to achieving the goal of supporting long term forest management and improved silviculture.

This research will be undertaken if MFS can secure funding.

[24] The Legislature acted on this recommendation in Spring 2005. Income taxes on the gains from the sale of timberland will be reduced incrementally for persons who hold timberland for at least 10 years and manage it sustainably, with a 100% reduction for timberland held at least 25 years. A companion bill that would have eliminated estate taxes on timberland failed to pass.

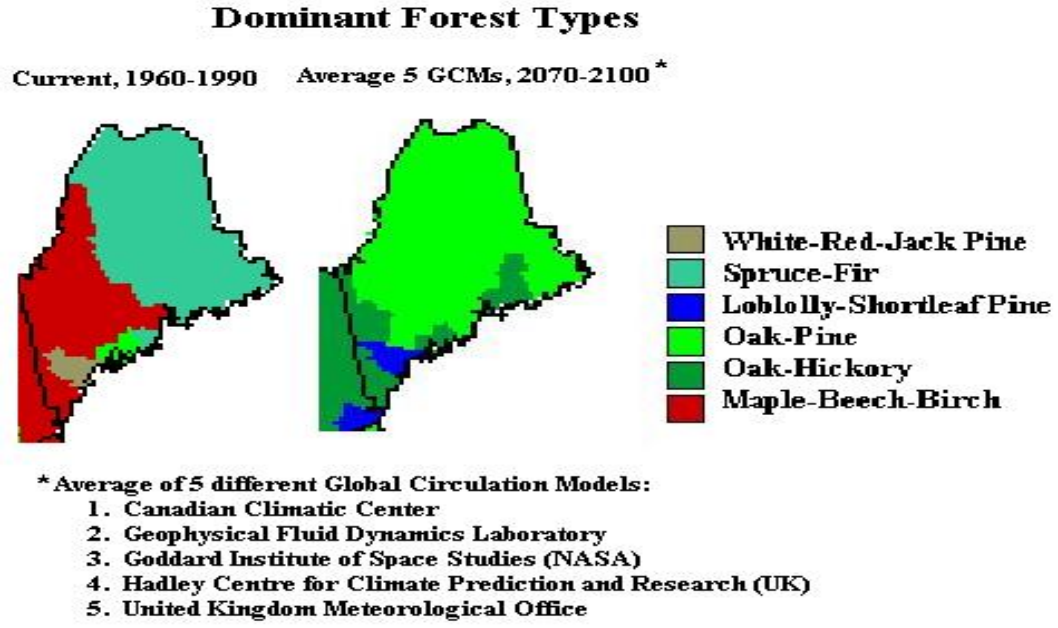
MAINE'S FORESTS AND CLIMATE CHANGE

Greenhouse gases are accumulating in Earth's atmosphere because of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. The National Research Council (2001) concludes that the changes observed over the last several decades are most likely due to human activities, but it could not rule out the possibility that some significant part of these changes are also a reflection of natural variability. Human-induced warming and associated sea level rises are expected to continue through the 21st century (National Research Council, 2001).

Long-term observations confirm that our climate is now changing at a rapid rate. Over the 20th century, the average annual US temperature has risen by almost 1 degree Fahrenheit, and precipitation has increased nationally by 5% to 10%, mostly due to increases in heavy downpours. The science available on this topic indicates that the warming in the 21st century will be significantly greater than in the 20th century. The rise in temperature could be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. Climate change modeling suggests the following effects on forests:

- Modest warming could result in increased carbon storage in most forest ecosystems in the US. Yet under some warmer modeling scenarios, forests (notably in the Southeast and Northwest) could experience drought-induced losses of carbon, possibly exacerbated by an increased fire disturbance.
- Likely changes in the species composition of the Northeast forests, including migration of sugar maple northward to Canada and replacement of Northeastern maple-beech-birch forests with oak-pine forests (Figure 31).

Figure 31. Projected forest type changes under climate change scenarios (Prasad, A. and L. Iverson, 1999-ongoing).



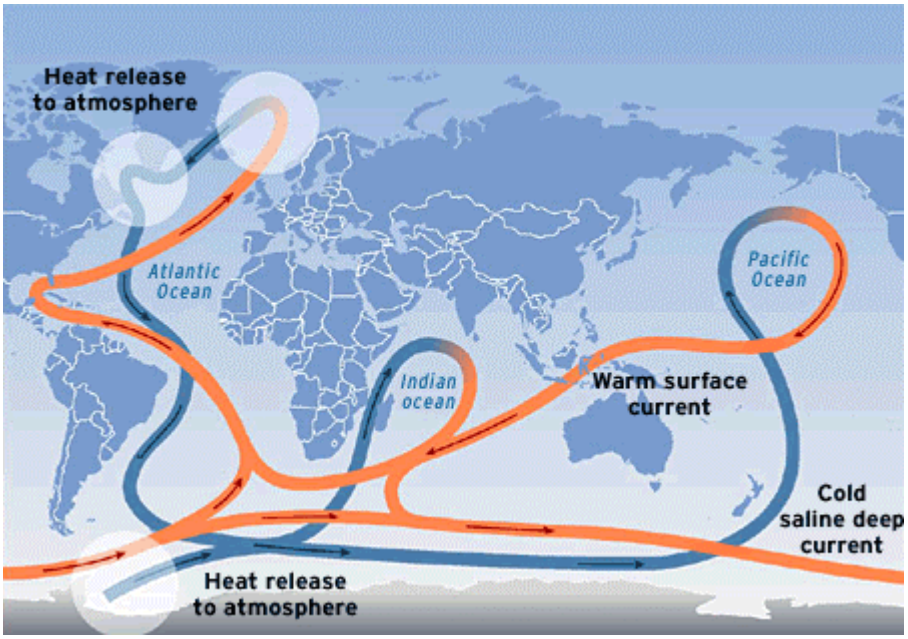
- Forest productivity may increase in the near term, particularly for hardwoods, due to synergistic fertilization effects between CO2 and nitrogen oxides. Ozone, however, can suppress these gains. To date, however, growth suppression due to ozone levels has not been documented as a problem in Maine. As nitrogen inputs increase, saturation may occur, with excess nitrates leaking from forest soils into watersheds. Nitrate leakage apparently can occur even without increased aerial inputs, particularly on low-fertility soils.
- Given the fact that middle and high latitude regions appear to be more sensitive to climate changes than other regions, significant impacts in these regions are likely to occur at lower levels of global warming.

Abrupt climate change scenarios

Some parties have begun to hypothesize abrupt climate change scenarios, based on historical, paleontological, and other evidence of such events in the past. While many in the general public and even in the policy community focus on the possible impacts of "global warming," the real issue is climate change, particularly of an abrupt nature.

One compelling scenario, documented in a report to the Pentagon, points to a possible global cooling. In this scenario, warming occurs for a period of time, causing increased melting of snow and ice at polar latitudes. As melting of the Greenland ice sheet in particular exceeds the annual snowfall, and there is increasing freshwater runoff from high latitude precipitation, the freshening of waters in the North Atlantic Ocean and the seas between Greenland and Europe increases. The lower densities of these freshened waters in turn pave the way for a sharp slowing or collapse of the thermohaline circulation system which drives the warm Gulf Stream current. Such a collapse would lead to cooler temperatures throughout much of the Northern Hemisphere - including Maine - and a dramatic drop in rainfall in many key agricultural and populated areas. Figure 32 depicts the flow of global ocean currents (Schwartz, P. and D. Randall, 2003. See also Gagosian, 2003, and National Research Council (U.S.). Committee on Abrupt Climate Change, 2002.).

Figure 32. Global ocean currents (Intergovernmental Panel on Climate Change)



Carbon sequestration opportunities

Forests play an interesting and important role in the earth's carbon cycle. On one hand, the loss of forests on a global scale to other uses (deforestation) is responsible for up to one-third of carbon emissions to the atmosphere, and ranks second only to the burning of fossil fuels as a source of CO_2 emissions. On the other hand, forests serve as a huge carbon sink: they capture CO_2 from the atmosphere through photosynthesis and store it as carbon in wood and other carbon-based compounds in soil, in understory plants, and in the litter on the forest floor.

Wood and paper products also play a role in mitigating CO_2 emissions by sequestering carbon. There are currently large stocks of carbon in forests, in wood and paper products in use, and in dumps and landfills. In 1990, 10.6% of the level of U.S. CO_2 emissions was harvested and removed from forests for products. If a substantial portion of this carbon could be prevented from returning to the atmosphere, it could be a notable contribution to mitigating carbon buildup in the atmosphere (Joyce and Birdsey, 2000).
Large amounts of additional carbon could be stored in U.S. forests, especially on nonindustrial private ownerships, but also in developed settings, through afforestation (the establishment of forests where the preceding land use was not forest), reforestation and practices to enhance the growth rate of trees in existing forests (Moulton, 2000). In addition to the benefits of carbon sequestration, such actions have the potential to maintain or enhance public trust resources and other public values of forests, such as biological diversity, soil integrity, and water quality.

The private, public, and nonprofit sectors have all undertaken a number of initiatives to promote afforestation, reforestation, and increased forest productivity

as a means of offsetting carbon dioxide emissions for a specific industry or firm (e.g., coal-fired power plants), or more generally. Many of these initiatives involve reforesting degraded lands.

Maine's forests conceivably could play a role in this emerging market activity, particularly if productivity-increasing actions become cost-competitive. The Chicago Climate Exchange currently reports trades at around $1.50 per ton of CO_2. The Climate Trust reports sales of carbon credits averaging around $1.72 per ton of CO_2. Australian markets currently hover around A$11.50 (US$8.84) per ton of CO_2. In Europe, compliance with the Kyoto Protocol has become a compliance issue for governments and businesses. Therefore, it is not surprising that carbon futures markets there - still highly speculative - currently operate between €15.75 (US$19.25) and €20.30 (US$24.80) per metric ton of CO_2. Any large scale actions in Maine would need to compete with projects of other types, e.g., building up carbon in agricultural soils and projects in other forest regions.

Additional Resources

Maine Department of Environmental Protection, 2004. A Climate Action Plan for Maine 2004. http://maineghg.raabassociates.org/

Maine Department of Environmental Protection website: www.maine.gov/dep/air/globalwarming/index.htm

Carbon Budget of United States Forests, USDA Forest Service Northern Global Change Research Program Research Projects: www.fs.fed.us/ne/global/research/carbon/forcarb.html

International Panel on Climate Change Special Report: Land Use, Land Change, and Forestry: Summary for Policy Makers: www.ipcc.ch/pub/srlulucf-e.pdf

National Assessment Synthesis Team, 2001. Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change, US Global Change Research Program. www.gcrio.org/NationalAssessment/index.htm

Pew Center for Global Climate Change: www.pewclimate.org

FOREST FIRE UPDATE AND A LOOK TO THE FUTURE

MFS's Forest Protection Division provides forest fire protection services for all of Maine's forest lands. By law, Rangers have final authority and responsibility for the control of forest fires statewide. MFS goals are to keep the number of forest fire starts to less than 1,000 and annual acreage loss to less than 3,500. A recent review of fire activity over the past five years indicates success at meeting these goals. The factors contributing to this success include:

Figure 33. Number of fires and acres burned in Maine, 1999-2003

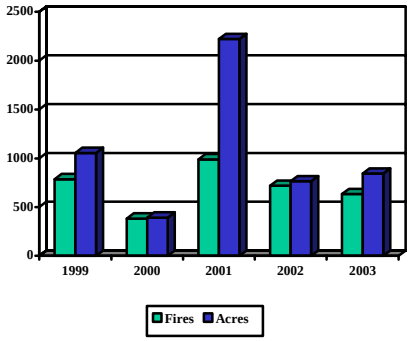
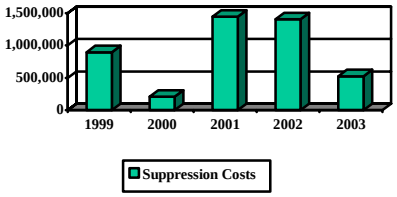


Figure 34. Fire suppression costs in Maine, 1999-2003.



- Quick and effective initial attack on all fires;
- Effective air detection and aerial suppression;
- Modern forest fire fighting equipment;
- Strong emphasis on fire prevention, including state control of statewide burning permits;
- Aggressive training and preparation;
- Improved access to remote areas of the state;
- Northeast Forest Fire Compact membership, providing resources during periods of high fire danger;
- Proactive public information campaigns;
- Fair and consistent law enforcement; and,
- Extensive automated weather stations providing accurate daily information used to assist in planning fire operations.

In 2001, Maine experienced a very active fire season. Although fire starts were held to a little less than 1,000, the fires that did occur were unusually destructive, and taxed the capabilities of the system to respond. During one particularly active period (38 lightning strikes in northern Maine), 2 fires in Maine were just monitored from the air for a week because the other fires posed a greater risk. One fire in Addison burned 500 acres and caused the loss of two structures, prompting MFS to develop a Wildland Urban Interface Committee. This committee was designed to assess the risk of wildfire to homes within and near forested areas, such as the one shown below. MFS has printed and distributed over 4,000 brochures and has developed public service announcements alerting homeowners to the potential threat of wildfire in interface areas and what they can do to limit their exposure to the threat of wildfires. MFS has partnered with the National Park Service to deliver software that can determine risk in Maine communities.

MFS faces two significant challenges to forest fire protection in the future: (1) minimizing fire suppression costs to remain within our budget; and (2) upgrading and diversifying the agency's aging fleet of UH-IH Huey helicopters.

Fire suppression costs have risen sharply over the past several years, primarily due to increases in hired equipment and fuel costs. MFS has increased its use of minimum impact suppression techniques (e.g., allowing low risk fires to burn) to help reduce these costs. For example, in 2002, MFS allowed a fire with limited risk to burn rather than take suppression action.

The Huey has been the state's aerial suppression workhorse since 1976. It is a proven design, capable of providing 100% of Maine's aerial suppression needs. The department has secured parts through the Federal Excess Personal Property (FEPP) system and through Army maintenance and procurement. Since 1989, the Army has begun phasing out the Huey helicopter in an effort to downsize and upgrade to a newer helicopter. All information indicates the Army will no longer operate the Huey after 2008. Without Army support, MFS will no longer have the ability to buy parts through the Army, and there will be no parts available through FEPP. Parts may be available on the commercial market but at a much higher price and with longer delivery periods. Without Army support, MFS will not be able to operate this aircraft affordably and reliably. MFS has developed a plan to identify and acquire aircraft to diversify and upgrade its fleet.

As fire danger fluctuates and as the state experiences periods of low fire occurrence and losses, public policy makers must remember that a strong, stable fire protection program – including a modern, diversified aerial fire attack fleet - is the best insurance against losses during periods of extreme fire weather.

AIR POLLUTION AND ATMOSPHERIC DEPOSITION IMPACTS ON MAINE'S FORESTS

The current debate regarding reauthorization of the federal Clean Air Act again raises the issue of the impact of airborne pollutants on Maine's forests. Ample evidence exists (US Environmental Protection Agency (USEPA) and National Atmospheric Deposition Program/National Trends Network (NADP/NTN)) that northern New England's airshed is not pristine. After accepting this rather noncontroversial point, the trends are less clear and depend on the pollutant of interest and the substrate sampled. Moreover, the impact of a particular pollutant is at least partially a function of the aspect of the ecosystem being assessed (e.g., the harmful effects of mercury on aquatic animal life are well documented, while significant impacts on forest trees are not, nor is the interaction between forest and aquatic ecosystems).

This section focuses on sulfur and nitrous oxides (SOX and NOX), ozone, and mercury. These pollutants are representative of the broader array, occur in Maine's forests, have been monitored across the region, and can negatively impact the flora and fauna of Maine's forested ecosystems.

The DEP web site (www.maine.gov/dep/index.shtml) provides a wealth of information for those wishing to delve deeper into the issues of pollution and pollution effects in Maine. The DEP has active and ongoing monitoring programs for air, land, and water quality.

Sulfur Dioxide (SOX) and Nitrous Oxides (NOX)

Deposition of sulfur dioxide and nitrous oxides lead to the formation of acids. With regard to SOX and NOX, the most recent USEPA reports indicate that air quality has improved regionally, with substantial reductions in sulfur emissions, particularly since 1995, and modest reductions in nitrogen emissions over the past 10 years. These results are mirrored in the NADP/NTN report, Air Quality Monitoring Considerations for the Northeast Temperate Network (National Park Service, 2002), which reports similar results from many individual monitoring sites in Maine.

Despite air quality improvements, USEPA water monitoring results indicate the continued presence of elevated levels of sulfur dioxide (SOX) and nitrous oxides (NOX) in New England's surface waters; no apparent change in the number of acidified waters; and, no improvement in acid neutralizing capacity in surface waters (Stoddard *et al*, 2003).

Numerous studies show that acid precipitation causes cation leaching and release of aluminum ions, particularly in the poorly buffered podzol soils of northern New England. While it has been clearly demonstrated that water acidification and increased levels of aluminum ions negatively impact organisms in aquatic ecosystems, such impacts are less easy to demonstrate in terrestrial settings. At some level, the loss of cations and release of aluminum must negatively impact soil fertility and reduce the supply of nutrients available for plant growth. But no good

evidence exists that demonstrates acid rain-induced loss of fertility has had widespread effects on overall forest growth rates in Maine or regionally. Nitrogen enrichment associated with acid rain and associated improved growth on nitrogen-poor forest soils may be masking any effects.

Despite the lack of generally occurring growth impacts, there are reports of impacts on forest trees on sensitive sites (e.g. sites with greater exposure, greater preexisting stress, and/or where acidic deposition exceeds the local site's buffering capacity). This is most prevalent in montane cloud and coastal fog zones where soils tend to be thin and trees are bathed in an acid cloud for extended periods. There are reports of foliar tissue injury associated with airborne SOX and NOX for trees in these cases. In these situations, the primary impact appears to be a weakening of trees' defenses against other biological and environmental stresses (e.g. winter drying in high elevation spruce). It is not clear that acid-induced leaf tissue injury has caused direct, long term damage and measurable loss of forest productivity.

The Conference of New England Governors and Eastern Canadian Premiers (NEGECP) has charged a scientific working group to conduct a regional assessment of site specific sensitivity of the regions' forests to current and projected nitrogen and sulfur deposition. Preliminary maps are already available for some neighboring jurisdictions. Maps for the entire region (including Maine) should be available by 2006.

Figure 35. Critical load of sulfur and nitrogen, Vermont and Newfoundland (NEGECP, 2003)

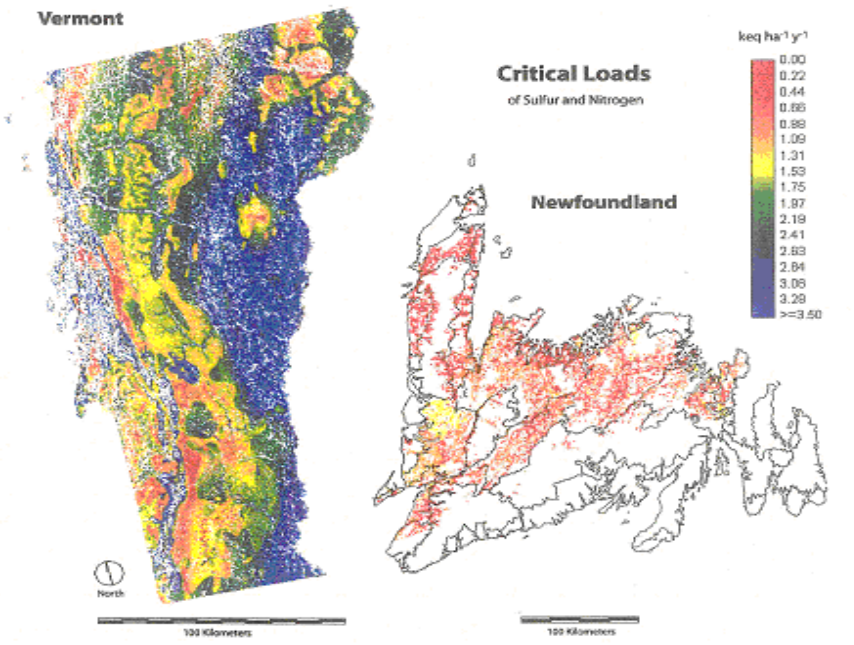


Figure 1. Critical load of sulfur + nitrogen deposition to upland forested areas of (a) Vermont and (b) Newfoundland. Sulfur + nitrogen atmospheric deposition rates higher than the critical load result in greater exports of nutrient cations (Ca^{2+}, Mg^{2+}, K^{+}) than inputs and eventual deterioration of soil fertility, forest health, and forest productivity. Critical loads are expressed in kilo-equivalents per hectare per year; nitrogen deposition includes both ammonium+nitrate forms.

Ozone

Nationally, ground-level ozone (GLO) is the most common air pollutant considered harmful to human health and the environment, accounting for more than 95% of the days where air quality standards are violated. GLO forms when sunlight bakes industrial smokestack gases and/or vehicle exhaust. Summer weather patterns with sunshine and hot, stagnant air combine, generate, and trap the gas at ground level.

For the past five years, results from air quality monitoring stations in Maine show that 88% of sampled days had "good" GLO levels, while only 2% of sampled days had "unhealthy" levels. A slight improvement trend has been noted; since 2002 there have been no reported exceedances of the EPA standard maximum allowable 0.08 ppm (8 hour average).

Nonetheless, there are clearly days during most summers when GLO levels in Maine are sufficiently high to be considered "unhealthy" for sensitive individuals. High GLO concentrations can harm plants, including trees. However, the weather conditions most likely to generate high GLO levels also tend to generate drought stress on plants, leading them to wilt and close their stoma. This largely protects sensitive leaf tissues from exposure.

Data collected by the National Forest Health Monitoring Program indicate that plant injury as monitored on sensitive species is so rare that the USDA Forest Service has stated, "The findings for Maine indicate that there is little or no risk of foliar injury due to [GLO] across the entire state (McWilliams *et al*, 2005)." A similar assessment can be inferred from ozone monitoring results from Acadia National Park. "Ozone injury surveys in the early 1990's in Acadia National Park did detect some injury, but the amount of injury per plant was slight, and it was on less than one percent of the plants examined in field surveys (National Park Service, *op. cit.*)." Such findings lead MFS to conclude that ground-level ozone has not been demonstrated to have a significant impact on Maine's forest ecosystems.

Mercury

Mercury is only one of the airborne heavy metal pollutants; however, it appears to be the most prevalent and of greatest concern in Maine. Although mercury occurs naturally in small amounts in Maine rocks and soils, most is deposited as airborne pollution from anthropogenic sources, with coal-fired power plants and commercial and industrial boilers being the largest sources. Although some airborne mercury is emitted from within the state, Maine-generated mercury emissions have dropped by more than 75% from their peak in 1991, with reductions by municipal waste incinerators leading the way. Similarly, implementation of the 1998 New England Governors and Eastern Canadian Premiers Mercury Action Plan has led to a drop in regional mercury emissions of more than 55 percent.

Sources of mercury within the region are only part of the story however; studies conducted in the 1980's showed that power plants located outside the region

contributed more to mercury deposition in the Northeast than plants within the region. There is little reason to suspect that this pattern has changed significantly.

Once in the air, mercury falls to the ground with rain and snow, contaminating soils and water bodies. Plants, including trees, can absorb both gaseous and soil mercury.

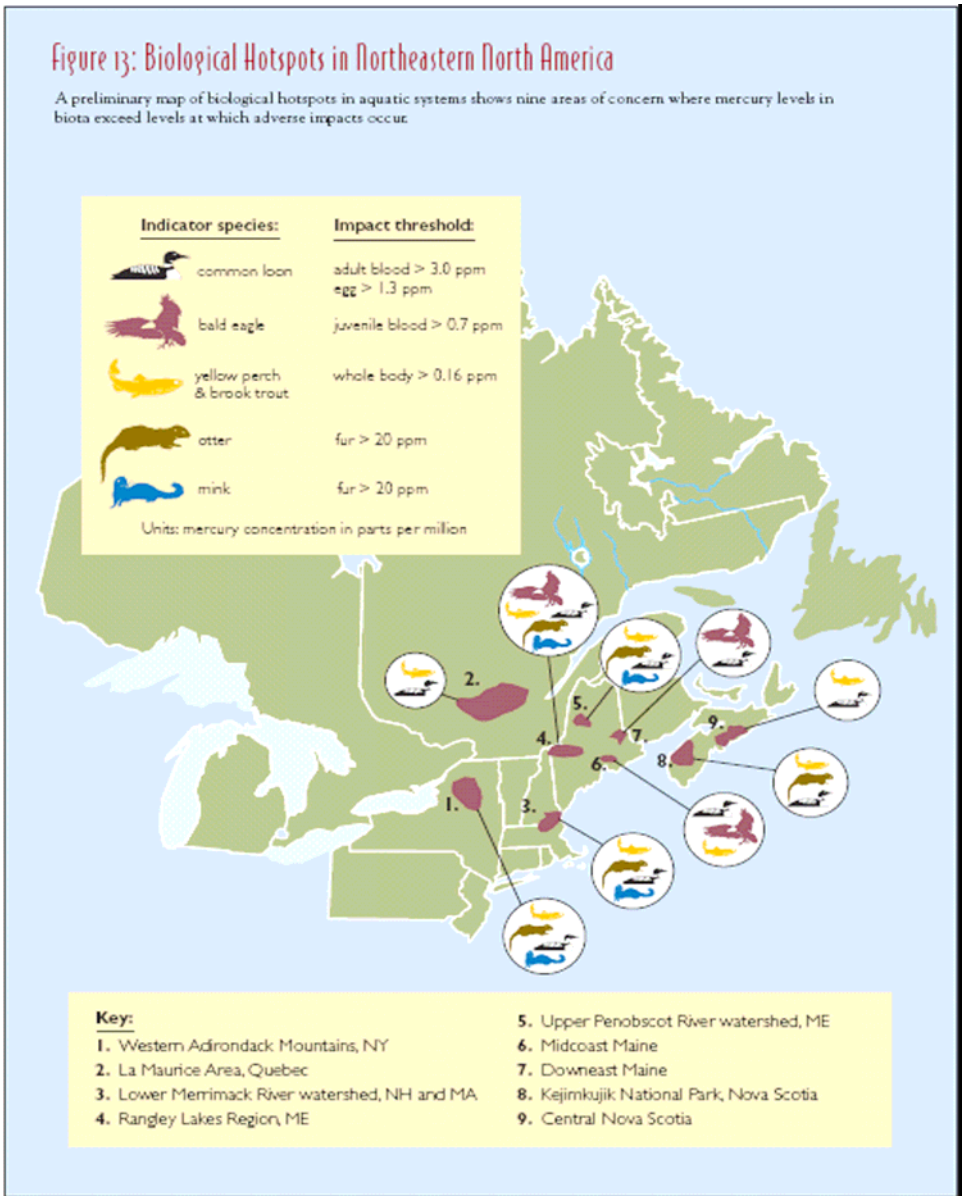
Some studies have demonstrated plant toxicity from elevated levels of mercury resulting in impaired photosynthesis reactions. Symptoms in these cases included severe stunting of seedlings and rootlets and leaf chlorosis and browning. However, there is no indication that plant toxicity is a problem to Maine's forest trees. A study by Frescholtz *et al* (2003) found that mercury in the atmosphere primarily influenced foliar uptake, while soil mercury tended to accumulate in plant root zones which seem to restrict translocation to other portions of the plants. This suggests that, for arboreal systems, mercury would tend to cycle out of trees during litter fall and accumulate in the soil. Unfortunately, it does not remain there entirely.

When mercury is deposited on the landscape, some of it falls directly into wetlands, streams and rivers, where it becomes available to the aquatic biota. In addition, a portion of the mercury that falls on the terrestrial portion of the landscape is either washed into aquatic ecosystems on soil particles or leaches through the soil into these systems. In these aquatic systems, bacteria can convert elemental mercury, which is not biologically active, into methylmercury, which is. Mercury in the form methylmercury is easily taken up by animals. It bioaccumulates and biomagnifies as it moves up the food chain. Mercury levels in Maine fish, loons, and eagles are among the highest documented in North America. Since 1994, the Maine Bureau of Health has had statewide advisories recommending that pregnant women, women of childbearing age, and young children limit their fish consumption. The advisories remain in effect today because mercury levels in fish have not decreased. Indeed, a recent USGS study (Chalmers, 2002) found the highest levels of mercury in any of the fish tissue sampled from the sample taken from the Kennebec River. The level of 2.71 μg/g exceeded the National Academy of Sciences guideline for the protection of fish-eating wildlife.

Evers (2005) summarizes the aquatic situation and identifies specific hotspots in the region. Four of these are in Maine (Figure 36). Beyond the aquatic settings, this report also documents buildup in insect-eating, montane songbirds.

Barring changes in federal regulation, there is no indication that mercury pollution from external sources will subside markedly in the near term. Even if it did, we would (and will) be dealing with mercury's impacts for the foreseeable future.

Figure 36. Biological hotspots in northeastern North America (Evers, 2005).



THE ICE STORM OF 1998 – A RETROSPECTIVE

In January 1998, a series of ice storms blanketed northern New England and New York with up to 3 inches of ice. Nearly 17 million acres of rural forests and urban trees across Maine, New Hampshire, Vermont, and New York were affected. Hardwood species suffered the most; trees bent and broke, and limbs shattered under the enormous weight. Estimates for natural resources losses exceeded $1 billion.

The ice storms damaged over 11 million acres in Maine. All 16 of the state's counties were declared disaster areas. The region's Congressional delegation responded in an effort to secure funds, and President Clinton signed a $48 million appropriation on 5 May, 1998 to help the 4 affected states' recovery efforts. Maine received $25 million of that appropriation, provided to the state through the regular Cooperative Forestry Assistance programs of the USDA Forest Service.

MFS used this funding to assist small woodland owners, towns, wood-using industries, and natural resource professionals in assessing and mitigating the damage to Maine's forests caused by the ice storms and to improve the state's ability to respond to future catastrophic disturbances.

Small woodland owners

Small woodland owners benefited from a number of programs delivered by the Forest Stewardship Program and related programs.

MFS sent information packages on ice storm recovery programs to 13,700 small woodland owners throughout the state, and initiated a media campaign to contact more landowners. MFS also set up a toll-free telephone number to encourage landowners and the public to call for information; more than 1,400 people called and received information packages.

In 2002, with the support of ice storm recovery funds, MFS launched the "Be Woods Wise" media campaign to encourage small woodland owners to make good decisions about their land. "Be Woods Wise" is designed to reach landowners who have never considered managing their land. It will carry on after the ice storm grants have expired and will become the flagship of Maine's Forest Stewardship Program.

Landowners obtained increased financial assistance from MFS for forest management planning. These plans included ice storm damage assessments and prescriptions for damage mitigation. More than 3,680 management plans covering 428,500 acres were written under this program, at a cost of $2.9 million. In

addition, landowners became eligible to receive cost-share assistance for implementing their plans' recommendations. Landowners implemented 1,800 practices, including clearing of roads and trails, reduction of fire hazards, removal of safety hazards, and installation of erosion control measures, at a total cost of $3.5 million.

MFS made high quality aerial photographs of the storm-damaged areas available to landowners at a very low cost through an agreement with the James W. Sewall Company of Old Town. These photographs are also available for viewing at all MFS District Forester and USDA Farm Service Agency offices.

Working with SWOAM, MFS helped fund a professional forester to assist SWOAM members in assessing and mitigating ice storm damage to their woodlots and to provide outreach and education to additional landowners. Matched by funds from SWOAM's membership, MFS funded this position over 3 years at a cost of $108,000.

The department's Maine Natural Areas Program received $50,000 to identify landowners in the ice storm footprint who may have rare plant populations or natural communities on their property. Over 4,000 landowners in 294 towns were identified. This information was made available at no charge to landowners and consulting foresters participating in the Forest Stewardship Program.

Towns

MFS's Community Forestry program assisted towns throughout the state in assessing and mitigating ice storm damage to street trees and town forests and planning proactive maintenance to help community forests withstand future severe weather events, hopefully lessening the need for financial assistance in the future. Eighty towns received financial assistance through the program, with a total outlay of $5.6 million. The Pine Tree State Arboretum received a grant to assist MFS in administration of the community forestry grants, including field inspections of all mitigation efforts.

Nineteen communities received grants as a part of the Oakhurst Tree ReLeaf, a MFS partnership with Oakhurst Dairy. Oakhurst dedicated $100,000 to fund a shade tree replanting program to replace trees destroyed by the ice storms, which MFS matched with an additional $300,000.

MFS also launched Project Canopy, an ongoing educational effort about the benefits of community forestry. Project Canopy, a cooperative effort between MFS and the Pine Tree State Arboretum, helps Maine communities develop long-term community forestry programs. The flexibility of Project Canopy enables the program to meet communities' needs, regardless of the level of their current community forestry program. This program has become the cornerstone of Maine's Community Forestry program.

Finally, MFS provided additional assistance to towns to address fire issues. Fifteen towns received a total of $350,000 to assess storm damage and address immediate clean-up needs. Subsequently, an additional 300 towns received a total of $2.7 million to upgrade fire fighting equipment, improve E911 response capabilities, and install dry hydrants to aid in fighting fires in rural areas.

Natural Resource Professionals

In partnership with the Pine Tree State Arboretum and the Maine Community Forestry Council, more than 100 licensed arborists and community foresters received training in ice storm damage assessment and remediation practices for towns, including hazard tree maintenance, community forest assessment, and grant management.

More than 300 consulting foresters received training in ice storm damage assessment and mitigation techniques, qualifying them to participate in delivering landowner cost-share assistance programs. Education continued through 2002 with annual training meetings and the publication of a quarterly newsletter for consulting foresters.

Loggers received training in safe operating techniques in ice damaged stands. Working through the Maine Forestry Instructors Association, 6 vocational schools received computer simulator systems to train Maine's future loggers in the safe operation of a variety of equipment. The CLP training program received grants of more than $400,000 to provide additional training to loggers on safe operation in ice-storm damaged stands. These grants provided training scholarships to 2,975 loggers, enabling them to obtain or retain their CLP certification. The Professional Logging Contractors of Maine received $200,000 to assist them in developing the Master Logger Certification Program.

Wood-Using Industries

MFS awarded a grant of $800,000 to the Maine Economic Development District Association to assist forest related businesses in ice storm recovery efforts. Some 38 companies enrolled in the program and received $777,500 in grants. Most of these companies used the assistance to help them cope with defective materials by increasing recovery efforts, changing manufacturing processes, or introduction of different products with accompanying marketing efforts.

Forest Health

MFS led the state's efforts to determine the initial impacts of the ice storms on Maine's forests and the evaluation of long-term trends in forest health in damaged stands. MFS developed a preliminary footprint of the storms through field reports, and then, using a comprehensive series of high quality aerial photography flights, fine-tuned the storm's impact. From information obtained from subsequent flights, MFS determined changes in forest health and predicted trends over the long run. MFS contracted with the James W. Sewall Company of Old Town to undertake the flights and photo interpretation at a cost of approximately $1 million. Following

preliminary interpretation of the aerial photographs, MFS staff ground truthed the preliminary data and incorporated their findings into the final footprint of the storms. MFS also collected information from other sources. Very few acres appear to have severe long term damage, but MFS is still finding evidence of long term damage and damage accrual. Some trees may show an increase in growth over the long term due to bigger crown mass resulting from sprouting. Many trees appear to have fully recovered, but we still do not know much about the long term effects of the storm damage on wood quality.

BENCHMARKING FOREST SUSTAINABILITY

Measuring forest sustainability has evolved significantly beyond a simple assessment of the balance between harvest and growth. Many comprehensive efforts to measure forest sustainability have been undertaken, at international, national, regional, and state levels. The use of criteria and indicators is widely recognized as a tool for improving our comprehensive understanding of the current situation in and possible futures for our forests.

The 118th Maine Legislature identified seven criteria of forest sustainability and directed the Maine Forest Service to develop standards (benchmarks) for each criterion by 2003 (Public Law 1997, chapter 720).

The seven criteria are, and the schedule for developing the standards was:

- Criterion 1: Soil productivity (2001)
- Criterion 2: Water quality, wetlands and riparian zones (1999)
- Criterion 3: Timber supply and quality (1999)
- Criterion 4: Aesthetic impacts of timber harvesting (2003)
- Criterion 5: Biological diversity (2002)
- Criterion 6: Public accountability of forest owners and managers (1999)
- Criterion 7: Traditional recreation (2003)

> "Taken together, criteria and indicators provide a mutual understanding and implicit definition of what is meant by sustainable forest management. They are tools for assessing trends in forest conditions, and they provide a framework for describing, monitoring and evaluating progress toward sustainability. It is important to note, however, that the criteria and indicators are not to be used as performance standards for certifying management or products at any level."[25]

The Maine Forest Service uses the following definition of sustainable forest management, developed by the Maine Council on Sustainable Forest Management (1996):

> **Sustainable forest management enhances and maintains the biological productivity and diversity of Maine's forests, thereby assuring economic and social opportunities for this and future generations. It takes place in a large ecological and social context and achieves a balance between landowners' objectives and society's needs.**

The criteria of sustainable forest management should reflect large scale public values - the big picture. Indicators are quantitative or qualitative variables than can be measured or described, and provide the means for measuring these forest

[25] Adapted from National Association of State Foresters Policy Statement: The Use of Criteria and Indicators in Sustainable Forest Management. www.stateforesters.org/positions/c&I.html

conditions and for identifying trends. Benchmarks are short term targets for each indicator.

The Legislature identified a process for development of the benchmarks, specifically:

- Identify individuals with scientific background and practical experience in each of the criteria areas and convene technical working groups;
- Assess current status and trends, and the desired objectives and actions to reach the objectives; and,
- Identify a range of alternative standards and recommend a set of standards based upon a comprehensive review of available information.

The Legislature also directed that MFS assess the economic impacts of implementing the standards and provide an opportunity for public comment on the recommended standards prior to final adoption.

With this report, MFS has now developed proposed goals, indicators, and benchmarks for all criteria. However, readers should consider the remainder of this report with the following caveats in mind:

- These proposed goals, indicators, and benchmarks should not be considered the final word on the subject. They represent the collected views of technical subject matter experts and MFS staff at the time when they were developed (some now date back several years). Further, of necessity, these were developed piecemeal; a more holistic view is now in order.
- The required public review has not taken place for most goals, indicators, and benchmarks. Further, the proposed goals, indicators, and benchmarks have not been finalized for public review. The goals, indicators, and benchmarks must be founded on a broader public discussion about the desired future conditions of Maine's forests, particularly in light of the fact that Maine's forests are 95% privately owned.
- The economic impacts of the proposed goals, indicators, and benchmarks have not been assessed. This likely will require the allocation of additional resources to MFS.
- Benchmarking is a continuous learning and improvement process. Based on additional scientific knowledge, experience developed over the last several years, the significant budget and staff reductions experienced by state agencies, and other factors, MFS plans to revisit the full suite of indicators over the next two years. Some indicators and benchmarks could be revised substantially and/or simplified, particularly those developed in the early years. Some indicators and benchmarks may be dropped; others may be proposed. The revised product likely will look very different.

Criterion 1: Soil Productivity (DRAFT)

Goal: Maintain proper soil structure, texture, organic matter, and adequate nutrient levels for forest growth.

Indicator 1.1: Harvested area with soil disturbance (removal of organic matter, exposure of mineral soil, soil erosion, compaction, destruction of soil horizons, or alteration of internal soil hydrology) that alters soil physical properties and degrades soil productivity.

Process Benchmark 1.1: MFS will use soils data from the Forest Health Monitoring plots (FIA/FHM) that are part of the annual forest inventory to develop base line information on soil properties on forested sites that have been harvested. These soil attributes are used to determine the extent or potential for soil erosion and soil compaction.

- % Cover of Bare Soil
- % Cover of Leaf & Branch Litter
- % Cover of Ground Vegetation (less than 6 ft. In height)
- Forest Floor Thickness: Forest floor consists of both Litter Layer (undecomposed leaves, twigs, and branches) and decomposed organic soil material.
- Soil Texture
- Slope Length
- Depth to Subsoil Restrictive Layer
- Evidence of Compaction
- % of area with Compaction
- Type of Compaction

Process Benchmark 1.1.a: Recognizing that the relatively small sample size from FIA/FHM soil subplots may not allow analysis at a finer scale than a statewide level, or that it may yield too few harvested plots for meaningful analysis, MFS and a technical working group will examine the base line data, and if necessary, recommend that MFS develop procedures to collect more data.

Assessment: The US Forest Service has developed an internet-based computer program, Disturbed Water Erosion Prediction Project (Disturbed WEPP), to predict runoff and sediment yield from young and old undisturbed forests, harvested forests, skid trails, prescribed and wild forest fires, and other conditions. Readers interested in a detailed description of the model and its application should refer to http://forest.moscowfsl.wsu.edu/fswepp/docs/distweppdoc.html.

The WEPP model is a physically-based soil erosion model that uses specific regional climate data, soil conditions, ground cover and canopy conditions, and topographic

conditions to predict the probabilities of annual runoff, erosion, and sediment load. MFS used 1999 and 2000 FHM soil data to run a preliminary WEPP analysis on harvested and undisturbed forest inventory plots (Timber harvest occurred on the harvested plots anywhere from the year of measurement up to six years prior to measurement.).

The results generally show minor differences in the probabilities of annual runoff, erosion, and sediment loads for harvested and undisturbed conditions. The differences begin to diminish as early as 5 years after harvest, as harvest sites quickly regenerate and accumulate crown cover. MFS will continue to aggregate and analyze soils data as it becomes available.

Indicator 1.2: Harvested area with significant change in soil chemistry that degrades soil productivity.

Process Benchmark 1.2: MFS will utilize data from FIA/FHM soil sampling and soil analysis, as it becomes available, to develop base line information on soil chemistry on forested sites that have been harvested. Soil analysis includes:

- Forest Floor samples: bulk density, water content, total carbon, total nitrogen
- Mineral soil samples: bulk density, water content, coarse fragment content (>2 mm), pH, total carbon, total nitrogen, exchangeable cations and sulfur, extractable phosphorus.

Assessment: Data for all of the above soil chemical properties are not yet available from the FIA/FHM sampling process.

Criterion 2: Water Quality, Wetlands, and Riparian Zones (DRAFT)

Goal: Maintain or, where necessary, restore the chemical, physical, and biological integrity of aquatic systems in forested areas.

Indicator 2.1: Percent of water bodies in forest areas (e.g. stream kilometer, lake hectares) in which the aquatic life is as naturally occurs.

Assessment: When MFS proposed this indicator in 1999, it recommended implementation of an in-stream water quality monitoring system to collect data on a range of parameters. While both state agencies and other researchers have undertaken some related work, it is not sufficiently comprehensive to address "forest areas." No additional funding has been allocated to establish such a system, and in the absence of such a system, no benchmarks have been developed for this indicator.

Indicator 2.2: Percent of harvested acres on which Best Management Practices for the protection of water quality are utilized effectively.

This indicator serves as a proxy for assessing water quality in forested ecosystems, based on the assumption that forest management operations effectively using Best Management Practices (BMP's), coupled with progressive management approaches, can minimize the negative effects of forest management on water quality.

Benchmark 2.2: The percentage of harvested acres on which Best Management Practices for the protection of water quality are utilized effectively will increase from 47 percent in 1995 to 75 percent by 2005.

Status and trends for this indicator: MFS implemented a statewide system to monitor the use and effectiveness of water quality BMP's on timber harvesting operations in March, 2001. Preliminary results were reported in the 2001 State of the Forest Report. Results subsequently reported in early 2002 slightly modified initial estimates (Maine Forest Service, 2002). A second report was in preparation as of late 2004.

- 2002 results indicated that water quality BMP's were used effectively on 63% of harvested sites where surface water was present. Though not directly comparable in methodology, this represented a substantial increase in BMP use since the Briggs report, the only prior quantifiable assessment of BMP use, which suggested an overall BMP use rate of 47%.
- Preliminary 2003 results indicate that:
    - 64% of sites used BMP's effectively, essentially no change from the 2002 result. The statistical significance of this increase has not been assessed.
    - 17% of harvested sites with surface water resulted in minor sedimentation of surface waters, in contrast to 27% of sites in the 2002 report.
    - Only 1% of sites with surface waters showed evidence of major soil movement and delivery to water bodies, in contrast to 8% of sites in the

2002 report. Again, the statistical significance of these results has not been assessed.

Overall, the most recent data suggest that while 64% of sites used BMP's effectively, over 80% of harvested sites with water bodies had no soil delivered to surface water bodies. If these apparent improvements represent trends, they suggest that the benchmark may be attained by 2005. At the same time, additional tools to enhance the validity of monitoring are under development regionally. Continued monitoring over the next several years will be necessary to establish that these positive developments are effective, consistent, and lasting.

Indicator 2.3: Percent of water bodies in forest areas (e.g. stream kilometers, lake hectares) with significant variation from the historic range of variability found in relatively undisturbed watersheds in pH, dissolved oxygen, levels of chemicals (electrical conductivity, sedimentation, nutrients or temperature change.

Assessment: When MFS proposed this indicator in 1999, it recommended implementation of an in-stream water quality monitoring system to collect data on a range of parameters. While some related work is ongoing, (e.g. case studies of water quality in headwater streams), no funding has been allocated to establish a statewide system. In the absence of such a system, no benchmarks have been developed.

Proxy Indicator 2.3.a: Number of stream miles affected by water quality law violations attributed to forest management operations.

Proxy Benchmark 2.3.a.1: The number of water quality law violations attributed to forest management operations will show a continuous decline, relative to enforcement effort, from the 1992-96 average of 50 per year[26].

Status and trends:
Enforcement actions related to timber harvesting are not segregated from other land uses, making direct assessment of this proxy indicator difficult. MFS Rangers conduct routine inspections of harvest operations addressing a wide range of issues in each inspection. Inspections for compliance with both DEP and LURC water quality regulations occur, and have increased significantly in frequency over the last 4 years. Inspections where water quality noncompliance is discovered typically are referred to the responsible agency (DEP or LURC). Although Table 2.3.a. shows that there continue to be well in excess of 50 harvests

Table 2.3.a. Forest Ranger Water Quality Inspections, 2000-2002

	Number of Inspections Not Approved	Total Inspections	Percentage Inspections Not Approved
2000	59	933	6.3%
2001	184	1794	10.3%
2002	204	2203	9.3%
2003	238	3523	6.8%
TOTALS	685	8453	8.1%

[26] Michael Mullen and William Galbraith, 1997, personal communications.

annually that are referred for additional investigation, there appears to be a downward trend of noncompliant sites based on the percentage of total harvests inspected. It is not known how many of these referrals result in enforcement action. These data do not include specific individual complaints of water quality violations related to timber harvesting. Including these data likely would increase the estimates of noncompliant sites.

Indicator 2.4: Percent of mapped, perennial first and larger order stream kilometers with acceptable levels of large woody material and snags within riparian zones.

This indicator is intended to provide a measure of the extent to which riparian zones are managed to account for essential stream functions and processes, including the provision of nutrients and substrate for in-stream biological activity, control and routing of water and sediment (hydrologic function), and habitat features. The importance of a supply of large woody material and snags to provide these functions is well established.

Process Benchmark 2.4.1: The Maine Forest Service and the technical advisory group charged with developing forest sustainability benchmarks for biological diversity should identify a range of acceptable levels of large woody material and snags that should be retained within riparian zones by 2002.

Process Benchmark 2.4.2: The Maine Forest Service should develop a methodology to measure this indicator using forest inventory data coupled with digital hydrological data by 2004.

Status and trends for this indicator: Information regarding biodiversity benchmarks is summarized elsewhere in this report (see Criterion 5, Biodiversity). This group developed 3 benchmarks relating to the indicator, "number and distribution of large diameter trees, snags, and down logs." The benchmarks address:

- Rough and rotten, large diameter trees;
- Large diameter dead trees and snags;
- Large diameter, down dead trees (large woody material).

For each category above, the biodiversity benchmarks establish a minimum of 4 stems per acre larger than 15 inches in DBH, at least one of which should be larger than 21 inches DBH.

An assessment of the benchmarks above, as established in the biodiversity benchmarks, is possible by limiting the analysis of forest inventory data to those plots where surface water is found on or near the plot (Table 2.4). These include all plots where at least one subplot in a cluster includes surface water of a size to be considered a separate land use, as well as all subplots where other surface water features were noted within the visual acre of the plot. This analysis provides a surrogate estimate of approximately 4.4 million acres (out of 17.2 million total acres) of Maine timberland that could be considered riparian forest. Recalculation of data for this riparian forest indicates that, as in all timberland, the benchmarks have not been achieved.

Table 2.4. Number of large diameter trees in Maine's riparian timberland (2004)[27]

	Millions of trees		Target trees/acre		Actual trees/acre	
DBH	≥ 15.0 in	≥ 21.0 in	≥ 15.0 in	≥ 21.0 in	≥ 15.0 in	≥ 21.0 in
All Live Trees	33.5	4.4	n.a.	n.a.	7.0	0.9
Rough/Rotten Live Trees	4.3	0.7	4.0	1.0	0.9	0.1
Dead Trees and Snags	5.2	0.8	4.0	1.0	1.1	0.2
Down dead Trees	n.a.	n.a.	4.0	1.0	n.a.	n.a.

The adequacy of the biodiversity benchmarks to serve as proxies in riparian zones for this water quality indicator has not been assessed. It seems a reasonable assumption that amounts of snags and large woody material in riparian areas should not be less than on the landscape as a whole. However, diameter thresholds, trees per acre, and the criteria that determine which plots are considered riparian could be modified to refine this assessment. For a relatively broad analysis, the forest inventory data supply the most comprehensive data set currently available. MFS anticipates continued discussion over the next year based on past and ongoing studies of forest structure and large woody material in riparian areas, as well as refined analysis of forest inventory data.

Indicator 2.5: Percent of stream kilometers in forested watersheds in which stream flow and timing has significantly deviated from the historic range of variability found in relatively undisturbed watersheds.

Process Benchmark 2.5.1: The agencies charged with developing a statewide water quality monitoring system should assemble existing data sets, identify the current conditions and trends in this indicator, and recommend interim/provisional benchmark(s) by 2003, and final benchmarks defining desired future conditions by 2005.

[27] Kenneth Laustsen, 2004, personal communication.

Proxy Indicator 2.5.a: Percent of stream-flow gauging stations in forested watershed in which a statistically determinable trend in stream flow and timing can be determined.

Status and trends for this indicator: In the absence of funding to establish an in-stream water quality monitoring system, no progress has been made on this indicator. Maine Geologic Survey (MGS) cooperates with the US Geologic Survey in a program that includes stream gauging, where stream and river flow records are collected monthly, and analyzed and published annually. At this time and for the foreseeable future, the number and location of gauge sites appear to be insufficient to assess broad trends in forested watersheds. Preliminary drainage basin analyses by MGS, stream assessment undertaken by a newly-formed multi-agency fluvial geomorphology working group, and individual case studies of stream flow in headwater streams will provide additional data for continued discussion.

Best Management Practices for Forestry: Protecting Maine's Water Quality

In Spring 2004, MFS introduced its new publication, "Best Management Practices for Forestry: Protecting Maine's Water Quality".[28] This publication, developed with the assistance of a multi-disciplinary team of natural resource professionals, significantly improves on the 1992 BMP manual, which was based upon a traditional prescriptive approach to BMP implementation. Emphasizing an outcome based approach to water quality BMP's allows greater flexibility for decision making by forest practitioners. Seven guiding principles (Fundamental BMPs) describe the decision making process of ***why and when*** to use water quality BMP practices. These fundamentals expand the traditional, prescriptive view of BMPs and emphasize to forest practitioners the importance of: defining landowner objectives; pre-harvest planning; anticipating site conditions; controlling water flow; minimizing and stabilizing exposed soil; protecting integrity of water bodies; and, handling hazardous material safely.

An outcome based approach is significantly different than prescriptive BMP implementation. Recognizing this, MFS responded by engaging in an extensive public outreach and educational campaign. By partnering with Maine's Sustainable Forestry Initiative and numerous Soil and Water Conservation Districts, 48 half day workshops during the initial 7 - month introduction were conducted. Over 700 foresters, loggers, landowners, and regulators attended these workshops. The new BMP manual has been well-received and has served as a model publication for other New England states.

Introducing the new BMP manual has complemented MFS's participation with USDA Forest Service and several northeast area states in a regional water quality BMP protocol assessment for forestry operations. This assessment - originally developed by MFS - has been adopted and modified by USDA Forest Service as "the tool" for assessing outcome based BMP implementation.

[28] This publication is available for download at: www.maine.gov/doc/mfs/pubs/bmp_manual.htm.

Criterion 3: Timber Supply and Quality (DRAFT)

Goal: To ensure that Maine's future timber supply is of sufficient quantity and quality to support a diverse and economically healthy forest manufacturing sector.

Indicator 3.1: Ratio of projected growth and harvest, as determined by modeling current management practices and trends in forest development

Benchmark 3.1.1: The ratio of projected growth and harvest for the statewide forest resource will show improvement from the ratio of 86 percent as identified in the 1998 Timber Supply Outlook by 2005.

Assessment: The latest findings in the report "Forests of Maine, 2003"[29] estimate that the current growth to harvest ratio for quality trees (growing stock) is 0.97:1.00; for all live trees the ratio improves to 1.06:1.00. Both estimates reflect substantial improvement from the inventory period prior to 1995.

Benchmark 3.1.2: The ratio of projected growth and harvest for major geographic and ownership divisions will show improvement from current projected levels by 2005.

Assessment: The most current estimates of growth to harvest ratios for major geographic areas are contained in the report "Forests of Maine, 2003." The growing stock version will be displayed to maintain correlation to 1995.

Table 3.1.2. Growth to harvest ratio based on growing stock trees, Maine, 2003

Region	1995 Softwood	2003 Softwood	1995 Hardwood	2003 Hardwood	1995 All Species	2003 All Species
Northern	0.17	0.85*	1.29	0.74**	0.42	0.80*
Eastern	1.10	1.02	1.99	0.85**	1.35	0.94**
Southern	1.15	1.36*	1.98	1.49	1.46	1.43
Western	0.64	0.87*	1.04	1.42*	0.98	1.11*
Statewide	0.51	0.96*	1.50	1.00**	0.81	0.97*

*Indicates improvement since 1995. ** Indicates area of concern.

Benchmark 3.1.3: The ratio of projected growth and harvest for distinct categories of tree species and quality will show improvement from current projected levels by 2005.

Assessment: The growth to harvest ratios for major species and for the quality categories of all live, growing stock and sawtimber are contained in the report "Forest of Maine, 2003" and are estimated as follows:

[29] This document is available for download at: www.maineforestservice.org/pubs.htm

Table 3.1.3. Growth to harvest ratio of selected major species by inventory year and by tree quality, Maine, 2003

Species	2003 All Live Trees	1995 Growing Stock	2003 Growing Stock	1995 Sawtimber	2003 Sawtimber
Balsam Fir	0.61	-0.07	0.53*	-0.06	0.38*
Red Spruce	0.96	0.34	0.64*	0.59	0.42**
White Pine	1.52	1.14	1.49*	1.14	1.40*
N. White-cedar	-0.03	1.42	0.65**	1.10	0.19*
Red Maple	1.23	1.93	1.09**	1.67	1.27
Sugar Maple	1.53	2.05	1.82	1.38	1.55*
Yellow Birch	1.25	1.41	1.31	0.99	1.23*
White Birch	0.79	0.91	0.69**	0.92	0.88**
Beech	-0.15	2.21	-0.46**	0.97	0.38**
Aspen	0.61	0.99	0.55**	1.58	0.18**
N. Red Oak	1.96	2.41	2.13	1.92	1.36

*Indicates improvement since 1995. ** Indicates area of concern.

Process Benchmark 3.1.1: MFS will simulate future forest development using computer modeling and report 50-year projections of growth to harvest ratios every five years. It will base simulations on the latest forest assessment data, harvest activity levels, and projected market demand.

Assessment: Progress on this benchmark can't be assessed until updated growth information becomes available from the annual forest inventory completion of the first cycle of measurements in 2003 and new growth and yield tables developed from the data. MFS has implemented a process to collect supplemental growth data. The approximately 500 plots in this separate study will provide an independent check of the growth estimate provided by FIA following the 2003 season.

Indicator 3.2: Acres by forest type and landowner category that are suitable and available for management and harvest

Benchmark 3.2.1: The number of forest acres available for management and harvest will support projected harvest and growth.

Process Benchmark 3.2.1: MFS will document the number of acres by forest type and landowner category where forest management or timber harvesting are limited by regulation, easement, or other restrictions.

Assessment: MFS does not have a reliable method to determine the number of forest acres where forest management or timber harvesting are limited by regulation, easement, or other restrictions.

A surrogate is provided in the report "Forests of Maine, 2003," where the major land use class of forested land with some sort of prohibition or limitation on timber harvesting totals 515 thousand acres. Of these acres, 280 thousand are classed as productive reserved (harvest prohibited); 33 thousand as unproductive reserved (timber growth limited and harvest prohibited); and 201 thousand as "other forest land (timber growth potential limited)."

Indicator 3.3: Amount of tree mortality occurring that could otherwise be used through the application of sound silvicultural forest practices

Benchmark 3.3.1: Forest landowners and managers will implement practices to reduce measurable tree mortality by 20 percent by 2009.

Assessment: The linkage of reduced mortality to specific landowner practices is difficult to assess with standardized FIA data and output. Landowner groups are coded to reflect the owner group at the time of plot remeasurement, which may or may not have been the same owner group at the previous measurement. To characterize that each owner group is directly responsible for any noted changes in mortality is potentially a flawed accounting. The correct analysis would be to examine just remeasured plots that remained within the same owner group. This would use a much smaller and more restricted set of plots, and the subsequent change in mortality analysis would be that much weaker. MFS will work to resolve this issue.

Table 3.3.1. Tree mortality volume by owner class, 1995 and 2003

Owner Group	1995 Mortality (cubic ft./acre)	2003 Mortality (cubic ft./acre)	1995 Mortality (board ft./acre)	2003 Mortality (board ft./acre)
National Forest	-25.1	***	-51	***
Other Federal		***		***
State/Local	-15.4	***	-26	***
Forest Industry	-16.4	***	-30	***
NIPF	-10.7	***	-18	***
Overall	-13.3	-14.3	-24	-25
***: Data not available.				

Benchmark 3.3.2: State policy will encourage landowners to implement yield-increasing practices that adhere to sustainability principles and are consistent with landowner objectives. As a result, growth rates should increase one percent per year until potential sustainable harvest levels increase by 25 percent from those documented in "Timber Supply Outlook for Maine: 1995-2045 (Gadzik *et al*, 1998)."

Assessment: The Timber Supply Outlook documented a base run average annual growth rate of 28.45 cubic ft./acre/year. Assuming that harvesting does not exceed growth rates over an appropriate period, a 25% increase would result in an average annual growth rate of 35.56 cubic ft./acre/year. This is roughly equivalent to the estimated net growth of 36.16 cubic ft./acre/year identified in the idealized forest

inventory level in Appendix E of the report. If growth rates improve by 1% per year, the benchmark could be attained by 2018 - 2020.

Maine's annualized inventory provides an intermediate assessment of progress gained to date. The most restrictive estimate of net growth for the period 1999 – 2003 considers just changes in growing stock volumes on timberland acres; that estimate is 29.90 cubic ft./acre/year. As a comparison, the most encompassing estimate of net growth for the period 1999 – 2003 would consider changes in all live volume across all forested acres. That estimate is 32.13 cubic ft./acre/year.

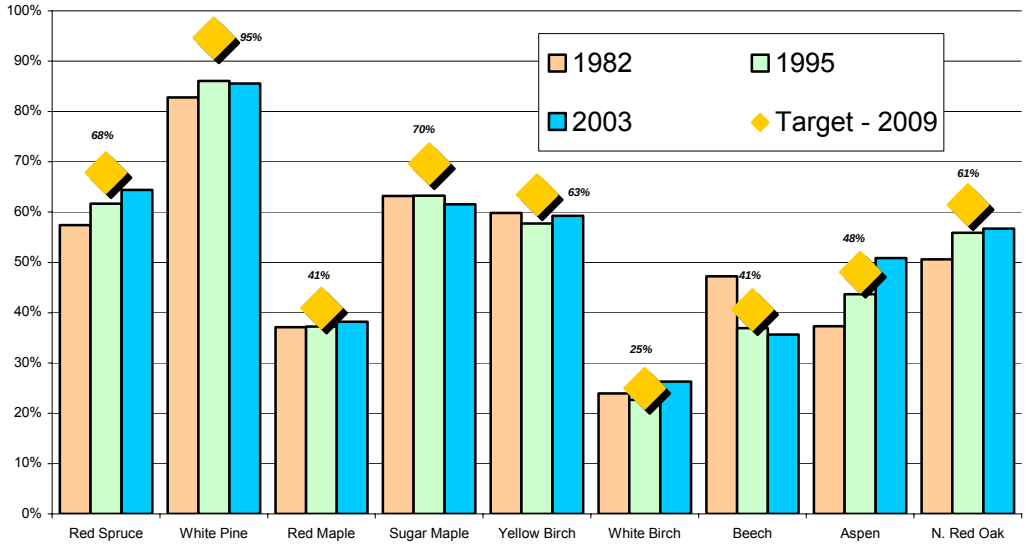
If the 1995 net growth estimate of 28.45 cubic ft./acre/year is projected forward at a 1% annual rate of increase for six years to 2001, matching the midpoint of the 1999 – 2003 period, the desired net growth would be an estimated 30.20 cubic ft./acre/year. This intermediate assessment of net growth - based on real data - is headed in the right direction, and is increasing at the prospective annual magnitude.

Some caveats apply to the assessment, however. For example, the improved yield run in the Timber Supply Outlook indicated a growth rate of 30.5 cubic ft./acre/year, or about a 7% improvement over the base run. Also, Maine's landownership patterns have changed significantly since the original development of the benchmark. The large industrial owners have largely divested their lands; the new investor-owners do not seem inclined to make investments in intensive silvicultural techniques such as planting, competition control, and precommercial thinning. The remaining industrial owners have filled the gap somewhat, but not completely. Finally, it remains to be seen whether state policy can or will "encourage landowners to implement yield-increasing practices that adhere to sustainability principles and are consistent with landowner objectives" on a scale sufficient to support achievement of the benchmark.

Indicator 3.4: The ratio of sawlog and veneer volume to total volume for red spruce, white pine, red maple, sugar maple, yellow birch, white birch, beech, aspen, and northern red oak

Benchmark 3.4.1: Increase the quality of trees growing in the Maine forest. All harvest of commercial forest products should be guided by silvicultural principles that promote long-term productivity of the forest, and high quality growth. As a result, the ratios of sawtimber volume to total volume for important species will increase 10 percent by 2009.

Figure 3.4.1. Ratio of sawtimber volume to total volume for important species, by inventory year, and desired 2009 target (10% improvement from 1995 estimate)



Assessment: Data from the "Forests of Maine, 2003" report is sufficient to assess the ratio of sawtimber volume to total volume for important species and also incorporates the restatement of the 1982 and 1995 inventory volumes. Of the nine species displayed, four species require further discussion with regard to achieving meeting the desired benchmark in 2009.

- White Pine: This mature - and maturing - resource base may be at an apex. Only 4% of the current acres are in the seedling/sapling stand size; therefore, the target may be difficult to achieve in the near future without specific, focused silvicultural practices.
- White Birch: This species has rebounded from a 1995 nadir. It currently just exceeds the desired target of 25% sawtimber volume. Maine's long history of fire suppression and continuing conifer release for high yield silviculture may preclude maintaining this level above the target into the near future.
- Beech: This species suffers from multiple problems, particularly the Beech Scale/Nectria complex and drought. Given the trends in sawtimber volume over the last 20 years, it is unlikely that beech quality will sufficiently rebound in the next 6 years to attain or exceed the desired target of 41%.
- Aspen: Is also a maturing resource that may not be able to maintain its current level above the desired target of 48%.

Criterion 4: Aesthetic impacts of timber harvesting[30] (NEW) (DRAFT)

Goal: Manage the visual impacts of timber harvesting to convey a strong stewardship ethic

Indicator 4.1: Number of forest landowners and the acreage managed by forest landowners certified as managed in compliance with the applicable objectives and criteria pertaining to aesthetics

Benchmark 4.1: The number of forest landowners and the acreage managed by forest landowners certified as managed in compliance with the applicable objectives and criteria pertaining to aesthetics will continue to increase (Benchmark 6.2.1).

Forests cover 90% of Maine's total land area. The visual amenities of this vast, forested landscape contribute to the state's character and identity. Whether in the wildness of the northern regions or the settled landscape of southern regions, the visual quality of Maine's forests is a key asset of our quality of life.

Commitments to aesthetic management differ widely among landowners, from the rigorous criteria applied by public land management agencies to less aggressive measures on private lands. This is due in large part to the different land management objectives of different landowners. Despite these differences, it is clear that people assess the forest's health and integrity based on what they see. This is particularly important where private lands are open to the public, and where forest management is highly visible. Maine people have often expressed their concerns over the condition of Maine's forests through this filter of aesthetics (Northern Forest Lands Council, 1994). With so much of Maine's private forest land open to the public, forest management is highly visible. Roadside accumulations of harvest residues, large numbers of bent or broken trees, excessive rutting of the ground, unnatural, geometric harvest edges, and other visual impacts of timber harvesting often heighten the public's concerns about the management of Maine's forests.

➔ A top-notch aesthetics reference ←
Jones, G. 1993. A Guide to Logging Aesthetics: Practical Tips for Loggers, Foresters, and Landowners. Northeast Regional Agricultural Engineering Service, Cooperative Extension: Ithaca, NY. 28 pp.

Most people agree that forest management can profoundly impact the forest aesthetic, up close and from a distance (Palmer *et al.*, 1995); the degree of impact varies with the individual. While some activities, such as pruning and early thinning, can have pleasant aesthetic impacts, many have an unavoidable, immediate negative impact that heals over time. Minimizing the negative, short-term impacts of timber harvesting is an important step in communicating a strong stewardship ethic to the public.

[30] Adapted from Maine Council on Sustainable Forest Management., 1996.

A number of the certification programs (notably SFI, FSC, and Master Logger) have criteria and objectives associated with aesthetics. Certified landowners and land managers, therefore, must generally address aesthetic issues in their harvest planning and implementation. SFI also has addressed the issue by developing a logging aesthetics training program. Over 100 loggers, landowners, and foresters received this training in 2002. MFS strongly encourages all forest landowners and land managers to adopt as standard practice operational techniques that address both foreground views and views of forest canopies to minimize the short term negative visual impacts of timber harvesting. MFS recognizes that these techniques should be applied with consideration of individual site conditions, but forest landowners should consider the goal of minimizing negative visual impacts when making management decisions.

Status and trend: The number of forested acres under some form of certification continues to climb. As certification programs evolve on a path of continuous improvement, the correlation of certified acres and management with consideration of aesthetic issues will continue to increase.

Rationale for this indicator: The aesthetics of forested settings are a matter of individual preference. The aesthetic impressions of a timber harvest can vary widely among people with different opinions about forest management. This indicator attempts to bridge that gap by focusing on the efforts of landowners to address aesthetic issues through their policies and performance.

Criterion 5: Biodiversity (NEW) (DRAFT)

Goal: Maintain healthy, well-distributed populations of native flora and fauna and a complete and balanced array of different types of ecosystems.

The term "biodiversity" refers to the variety of all forms of life – trees and other plants, invertebrate and vertebrate animals, and microorganisms – and includes the different levels on which life operates – from the level of genetic differences between individuals to the complex interactions within ecosystems (Gawler *et al*, 1996). Biodiversity sustains humanity. It helps provide the necessities of life: food, shelter, fiber, medicinal, recreational, cultural, spiritual, and aesthetic benefits, and ecosystem services such as air and water purification (Clarke and Downes, 1995). Conservation of biodiversity involves balancing human interactions with species and ecosystems to maximize present benefits while maintaining the potential to meet future generations' needs and aspirations. It is a foundation for sustainable forest management (Carey *et al*, 1999).

Many different factors can affect biodiversity at a number of levels, including human activities and natural processes. When conducted in accordance with generally accepted guidelines for biodiversity conservation, forest management activities can have relatively few impacts on biodiversity, particularly when compared with other human activities.

Maine's forests have undergone major changes in the nearly 400 years since the arrival of Europeans, including the removal and conversion of a significant portion of much of the forest for agriculture and industrial uses. Many wildlife species, including the wild turkey, whitetail deer, caribou, and timber wolf, were extirpated or driven to near extinction. American chestnut has nearly disappeared from the landscape, and American elm has been greatly reduced. Exotic species such as gypsy moth and white pine blister rust are well established.[31]

"Present information does not indicate a biodiversity crisis in Maine in terms of outright loss of species. But considering the number of rare species, the number of species for which we have no information, and the apparent insufficiency of unmanaged, representative ecosystems, neither does present information support complacency." (Gawler *et al*. 1996)

The forests and forest dynamics of today bear little resemblance to those of the pre-settlement forests in which native species evolved. Whereas much of the pre-settlement forest appears to have been composed of late successional stands containing a mosaic of small disturbance patches, today's forest landscape has largely lost its late successional component. Disturbance patterns in much of the presettlement forest seemed driven by small-scale, relatively frequent disturbances, such as tree-fall and small wind events, with disturbance affecting an average of approximately 1% of the forest each year (Seymour, R., A.

[31] Some of the material in this and following paragraphs adapted from US Department of the Interior, Biological Resources Discipline, 1999.

White, P. deMaynadier, 2002). Large-scale, catastrophic disturbances such as hurricanes and stand-replacing fires affected very large acreages, but on a return time measured in the hundreds or thousands of years. Today, fire prevention and suppression efforts have reduced the acreage affected by fire to a miniscule level. Between these two extremes, native insect outbreaks (e.g. spruce budworm) can severely affect their range of hosts over large acreages on periodic cycles as short as 30-50 years. Although this translates to average annual defoliation of 2-3% of Maine's total forest acreage, the actual events are episodic. Stand mortality and replacement are much less uniform than the figure indicates. This overall disturbance pattern allowed much of Maine's forests to develop into a multi-cohort, many-layered mosaic.[32]

Timber harvesting is now the dominant disturbance factor in Maine's forests, annually affecting over 500,000 acres, or about 3% of the forest land base. In contrasting today's managed forest with the unmanaged forests of the past, Maine's forests are now much simpler - both within stands and between stands - than they were in the past. For many reasons, Maine's current forests do not have the variety and distribution of structures (e.g. large cavity trees) or landscape patterns (e.g. large contiguous blocks of late successional habitat) that were more common before European settlement.

Change seems to be the only constant in life, and Maine's forests continue to change in the face of new and different pressures. Changes in the transportation of forest products have eliminated river drives, which in some ways improved the condition of our rivers and streams but have created a reliance on an extensive interior road network. Changes in timber harvesting and wood utilization technology make it possible to obtain more economic value from smaller trees than ever before. Exotic species continue to modify the composition and structure of Maine's forests. Chestnut blight has virtually eliminated the American chestnut from its native range, including Maine. American beech is losing ground to an exotic pest/pathogen complex. In southern Maine, the hemlock woolly adelgid threatens to invade from the south. Increasing abundance of some wildlife species, such as whitetail deer, could have marked influences on the future composition of Maine's forests (Abrams *et al*, 1999). Changing, inefficient patterns of human settlement are resulting in the loss of significant forest acreage to development in southern and central Maine, while this trend is nearly offset by farmland reverting to forestland in northern Maine[33] (Allen and Plantinga, 1999). In addition, land parcels are becoming smaller and ownership tenure is becoming shorter and industrial owners selling to private investors. Although the least understood, global climate change has the potential to change radically the composition and structure of Maine's forests (Hong *et al*, 2002).

[32] See Chokkalingam (1998), Lorimer (1977), and Seymour *et al* (2002) for more detailed discussions of the pre-settlement forest composition and dynamics.

[33] The minimum net change in aggregate forest acreage tends to mask the impacts on range-limited species of inefficient land use patterns in southern Maine.

Maine's forest ecosystems are remarkably resilient and have demonstrated a high capacity for recovery. Over the past half century, changes in the ways humans use and interact with the land have led to a sharp resurgence in the forest's extent as well as the recovery of many species that once hovered near extinction, such as the whitetail deer and the wild turkey. Nonetheless, the situation is not one that should lead to complacency. Biologists generally agree that habitat loss, degradation, fragmentation, and invasive species pose the greatest current threats to biodiversity (NatureServe, 2002; Noss *et al*, 1995; B. Vickery, 2002, personal communication). All of these factors are at work in Maine at a scale sufficient to warrant concern.

The proposed indicators and benchmarks attempt to monitor forest biodiversity at a coarse, statewide scale. The full range of information needed to fully assess the status and trends in biodiversity at all levels does not exist, and the high complexity of the information that does exist makes synthesis a difficult proposition. The primary scientific research necessary to set benchmarks precisely and with high confidence of appropriateness is still developing. Forests are extremely complex systems; therefore, it is unlikely that we will ever know the exact benchmark levels necessary to achieve any level of forest biodiversity. Setting high benchmarks may minimize the risk of losing forest biodiversity but may compromise society's ability to maintain other values demanded from forests. Somewhat lower benchmarks may not significantly compromise society's ability to retain forest biodiversity but may allow society to maintain other values associated with forests. Setting benchmarks very low may put forest biodiversity at great risk. The benchmarks presented here reflect the opinions of a diverse group of scientists with experience in managed and unmanaged forests in Maine and who understand the dynamics of landscapes with long forest management histories. The benchmarks were set with consideration of applying the precautionary principle toward conserving forest biodiversity. In addition, the information presented here should provide direction for biodiversity issues needing additional focus.

Indicator 5.1: Number and distribution of large diameter trees, snags, and down logs (≥ 15.0 in DBH)

Benchmark 5.1.1: The number of rough and rotten, large diameter trees in Maine's timberland should increase gradually over time to at least 68 million (4 stems per acre), well distributed on the landscape. At least 17 million of these trees (1 stem per acre) should be ≥ 21.0 in DBH.

Benchmark 5.1.2: The number of large diameter dead trees and snags in Maine's timberland should increase gradually over time to at least 68 million (4 stems per acre), well distributed on the landscape. At least 17 million of these trees (1 stem per acre) should be ≥ 21.0 in DBH.

Benchmark 5.1.3: The number of large diameter, down dead trees in Maine's timberland should increase gradually over time to at least 68 million (4 stems per acre), well distributed on the landscape. At least 17 million of these trees (1 stem per acre) should be ≥ 21.0 in DBH.

Table 5.1.1. Number of large diameter trees in Maine's timberland, 1959-2003 (millions of trees)						
		1959	1971	1982 (2003 Restated)	1995 (2003 Restated)	2003
Growing Stock	Mean	62.0	68.8	82.1	103.1	104.6
	Sig. Diff.			A	B	B
Rough & Rotten	Mean		33.0	24.7	18.9	14.7
	Sig. Diff.					
All Live	Mean		101.7	106.8	122.0	119.4
	Sig. Diff.			A	A	A
Dead & Snags	Mean				17.1	18.2
	Sig. Diff.				A	A
All Standing	Mean				139.1	137.6
	Sig. Diff.				A	A
Down & Dead	Mean				39.8	4.0
	Sig. Diff.					

Table 5.1.2. Distribution[34] of large diameter trees in Maine's timberland, 1995 and 2003			
Tree Class	1995	2003	% Change
Growing Stock Trees	43%	39%	-4%
Rough/Rotten Live Trees	15%	10%	-5%
Dead Trees and Snags	17%	11%	-6%
Down dead trees	n.a.	n.a.	n.a.

Status and trend for this indicator: The number of large diameter, rough and rotten live trees, dead trees, snags, and down dead trees does not attain the minimum levels recommended in "Biodiversity in the Forests of Maine: Guidelines for Land Management" (Elliott, ed., 1999). However, the potential exists to reverse this trend through active planning and management.

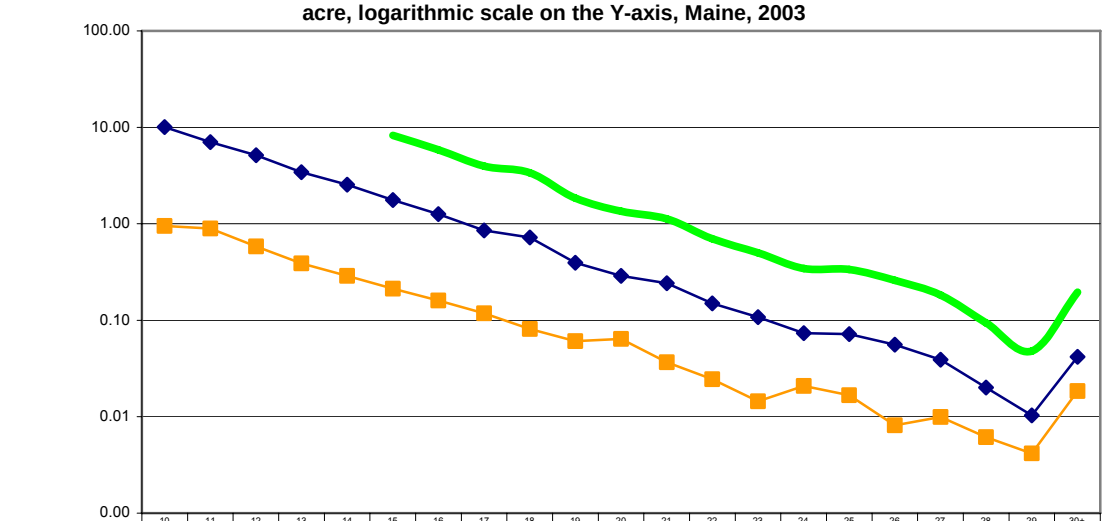
The number of large diameter live trees increased at a decreasing rate from 1971 to 1995 and has been stable since then. The number of large diameter, rough and rotten trees has decreased by 55% since the 1971 forest inventory; however, the statistical significance of this change is unknown. Trend data is unavailable for large diameter dead trees, snags, and down dead trees. In Table 5.1.2, the distribution of large diameter trees of various qualities decreased slightly between 1995 and 2003.

The decline in the number and distribution of rough and rotten live trees, dead trees, and snags poses dilemmas for policy makers. On one hand, the decline can be seen as a positive, because it indicates that landowners are removing the legacies of past high grading operations and focusing future growth on quality trees. Quality trees provide landowners with many more marketing options than

[34] Distribution expressed as a percentage of timberland inventory plots on which at least one large diameter tree (≥ 15.0 inches DBH) is recorded compared to all inventory plots.

rough and rotten trees, and increase the financial viability of forest management. Snags present real dangers to timber harvesters, particularly hand crews. About 16 percent of all logging fatalities in the U.S. result from falling limbs, logs, or snags (American Pulpwood Association, 1996). The US Occupational and Health Administration's regulations for managing snags may conflict with wildlife habitat management guidelines in some circumstances.

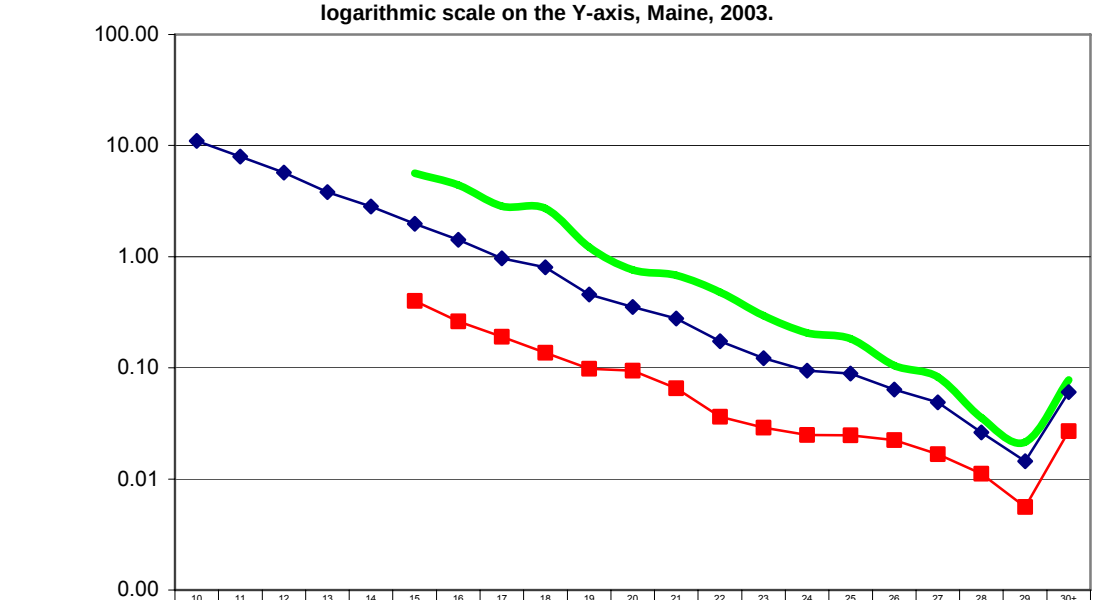
Figure 5.1.1. Current growing stock trees per acre by dbh class and the projected distribution needed to produce an average of 4 rough & rotten trees (15.0"+ dbh) per acre, logarithmic scale on the Y-axis, Maine, 2003



	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30+
Projected GS TPA						8.21	5.86	3.97	3.37	1.84	1.35	1.13	0.70	0.50	0.34	0.34	0.26	0.18	0.09	0.05	0.20
Actual GS	10.05	7.03	5.13	3.43	2.54	1.76	1.26	0.85	0.72	0.39	0.29	0.24	0.15	0.11	0.07	0.07	0.06	0.04	0.02	0.01	0.04
Actual R&R	0.95	0.89	0.58	0.39	0.29	0.21	0.16	0.12	0.08	0.06	0.06	0.04	0.02	0.01	0.02	0.02	0.01	0.01	0.01	0.00	0.02

On the other hand, the minor decline in large diameter, rough and rotten trees and dead trees and snags could be seen as a negative for those concerned about biodiversity. Rough and rotten live trees provide the future wildlife trees, snags, and downed logs that many species need for food and shelter. DeMaynadier (2002) indicates that the percentage of dead trees and snags greater than 10 cm (4 in) in relatively unmanaged stands in the Northeast ranges from 11-13% in hardwood stands to 16% in softwood stands, up to 30% in high elevation stands. Active management and planning, including careful harvest planning and supervision, will be needed to attain minimum acceptable levels of large diameter trees destined for wildlife habitat functions. Closer examination of forest inventory data (live tree distribution by DBH class, Tables 5.1.1 and 5.1.2) indicates that under even the most optimistic scenarios, achieving the benchmarks will be a very long-term process that spans several decades.

Table 5.1.2. Current all live trees per acre by dbh class and the projected distribution needed to produce an average of 4 dead & snag trees (15.0"+ dbh) per acre, logarithmic scale on the Y-axis, Maine, 2003.



	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30+
Projected ALL LIVE TPA						5.62	4.42	2.84	2.72	1.21	0.76	0.68	0.48	0.30	0.21	0.18	0.11	0.08	0.04	0.02	0.08
Actual ALL LIVE	11.00	7.93	5.72	3.82	2.82	1.97	1.42	0.97	0.80	0.46	0.35	0.28	0.17	0.12	0.09	0.09	0.06	0.05	0.03	0.01	0.06
Actual Dead & Snag						0.40	0.26	0.19	0.14	0.10	0.09	0.07	0.04	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.03

Rationale for this indicator: Large diameter trees provide important support functions for many species, particularly species that spend a large portion of their lives in older forests and/or require older forest structures at some point during their lives, such as some lichens and some ground beetles. A widespread decline in the density of large diameter trees might cause currently well-distributed species to become limited to ecological reserves. Large diameter live trees, particularly those with injuries and diseases that allow the creation of cavities, are highly preferred by a number of species. Every stand, even those managed as even-aged, should contain some large diameter, living and dead, standing and down trees to serve as a biological legacies and to provide some habitat continuity between harvests.

The density of large diameter, living, dead, standing, and down trees needed to support different biodiversity values is unknown. However, in forested landscapes with long histories of intensive silviculture, such as Scandinavia and the Pacific Northwest, policy makers and land managers are struggling to avoid extirpating forest species. In Sweden, one hundred years of increasingly intensive forestry has reduced the density of big trees and the volume of snags (Linder and Ostlund 1992). Many of Sweden's Red-Listed species (the equivalent of our threatened and endangered species) are associated with big trees, big snags, and logs. Reduction of these important components of forest structure through forest management may be extirpating many forest species from large areas of Sweden. Nearby Finland may lose up to 5% of its forest species (~1000 species) due to the loss of these features (Hanski 2001) that are commonly found in late-successional and old growth forests. Many of these are small, inconspicuous, and hard to identify

species such as insects, fungi, lichens, and mosses. Harvesting can affect poor dispersers at the stand level by temporarily changing structure and eliminating critical habitat features, and at the landscape level by creating large areas of unsuitable habitat for years or decades.

The following table illustrates the values of large diameter trees at all stages of growth and decomposition.

Table 5.1.3. Values and beneficiaries of large diameter trees[35]

Value	Beneficiaries	
Super canopy trees	Raptors, songbirds, lichens, bryophytes, fungi	Kuusinen, 1996; Newton *et al*, 2002
Cavity trees	Large bodied mammals, woodpeckers, bats, owls, bryophytes, secondary cavity nesting birds, invertebrates	Ranius, 2002; DeGraaf and Yamasaki, 2001
Large snags	Flying squirrels, bats, woodpeckers, lichens, invertebrates	Selva, 1994; DeGraaf and Yamasaki, 2001
Logs	Lichens, mosses, invertebrates, fungi, birds, mammals, amphibians	Ódor and Standovár, 2001; Sippola, 2001; Sverdrup-Thygeson, 2001; DeGraaf and Yamasaki, 2001; deMaynadier and Hunter, 1995

Indicator 5.2: Functional, connected riparian forests

Benchmark 5.2: No benchmark has been developed for this indicator at this time due to the lack of current, readily available, statewide data that measures the desired characteristics of riparian forests. Instead, the following recommendation is offered:

The Maine Forest Service should work with a technical working group to identify an appropriate, cost-effective indicator that permits a relatively robust assessment of the intactness, functionality, and connectedness of Maine's riparian forests. MFS should report its findings and benchmarks to the Legislature's Joint Standing Committee on Agriculture, Conservation and Forestry as part of the 2007 State of the Forest report. MFS should examine the reliability, availability, and cost effectiveness of sampling representative areas using the following tools:

- Satellite imagery: presence or absence of tree cover, forested buffer width, connectivity of riparian forests, gross height classes;
- Aerial photography: types of changes in cover, detection of structures and road crossings in the riparian area; and,

[35] Adapted from deMaynadier, 2002.

- Riparian forest management assessment: width and condition of riparian area, connectivity of riparian forests, gross height classes.

Rationale for this indicator: As the interface between terrestrial and aquatic ecosystems, riparian ecosystems are areas of great species richness. They constitute a dynamic and sensitive portion of the landscape. Riparian ecosystems serve numerous functions, including:

- buffering aquatic and wetland plants and animals from disturbance;
- preventing wetland and water quality degradation;
- providing important plant and animal habitat;
- exchanging energy between aquatic and terrestrial ecosystems; and,
- providing organic matter, nutrients, and structure to aquatic ecosystems.

> "Riparian zones are especially valuable wildlife habitat for many species such as mink, otter, beaver, and especially for cavity dwellers such as raccoons. Streams and rivers attract many kinds of wildlife; not only the water but also the ecotonal habitats usually associated with water courses provide habitats for species not usually associated with either the water or the adjacent forest or meadow. Forest management along water courses or shores probably has the potential to affect more wildlife species than anywhere else, because of the number of ecotonal microhabitats involved. Cavity trees along watercourses are preferentially used by many species – many large trees tend to occur in such habitats and those that lean are preferentially used by woodpeckers." (DeGraaf et al, 1992)

The scientific literature has a long record of documentation of the important contributions riparian forests make to aquatic food webs and the health of the overall aquatic ecosystem (see, for example, Verry *et al*, 2000). Now, an emerging body of scientific literature has begun to document the important contributions that healthy aquatic ecosystems make to terrestrial food webs and the health of surrounding riparian and terrestrial ecosystems, through the exchange of aquatic energy and nutrients (e.g. fish) transported and processed by terrestrial predators (see, for example, Power, 2001; Nakano and Murakami, 2002; Ben-David *et al*, 1998, and Bilby, 2000). Although the body of research for this topic is not well-established in the Northeast, it seems intuitive that retaining some level of healthy, functional riparian ecosystems contributes to the health of the aquatic ecosystem it surrounds, and vice versa.

Indicator 5.3: Forest stand structure

Benchmark 5.3.1: Maine's forests should be managed to attain over time a structural distribution that matches the following ideal (well distributed among forest types and across the state):

Table 5.3.1. Idealized structure[36]

Stand size class	Stand structure		
	Single storied	Two storied	Multi-storied and mosaic
High basal area in large sawtimber only[37]		at least 15%	
At least sawtimber[38]		at least 25%	
At least poletimber[39]	at least 50%		
Seedling/sapling/nonstocked[40]	no more than 30%		

Benchmark 5.3.2.1: The percentage of Forest Health Monitoring plots with old forest macrolichens present should not decrease below the current level of approximately 75%.

Benchmark 5.3.2.2: The percentage of Forest Health Monitoring plots with 3 or more old forest macrolichen species should not decrease below the current level of approximately 25%.

Status and trend for this indicator: Maine's forest appears to be fairly well distributed in terms of stand size. Using FIA protocols and algorithms, sawtimber stands represent 33% of the total acreage; poletimber stands 37%; and seedling/sapling 29%. However, the distribution of stand structural characteristics falls short of the ideal, particularly in high basal area sawtimber stands.

Table 5.3.2. 2003 Actual Stand Structure

Stand size class	Stand structure		
	Single-storied	Two-storied	Multi-storied & mosaic
High basal area in large sawtimber only	0.9%	0.8%	
At least sawtimber	11.3%	20.4%	
At least poletimber	70.6%		
Seedling/sapling/nonstocked	29.4%		

Most individual forest type groups do not attain this relatively even distribution. Some forest type groups are quite unbalanced. For example, the White/Red/Jack Pine group is deficient in the seedling/sapling classes. The Spruce/Fir group is skewed the opposite way, with an overrepresentation of 40% in the

[36] Adapted from DeGraaf, *et al* (1992), Maine Council on Sustainable Forest Management (1996) and technical working group discussions.
[37] Stands ≥ 100 ft^2 basal area in which trees ≥ 15.0 in DBH comprise at least 50% of the basal area. The idealized percentage is included in "at least sawtimber" category; it is not additive.
[38] Softwood stands 9.0+ in DBH; hardwood stands 11.0+ in, and the plurality of the crown cover is in trees of this size or larger.
[39] Softwood stands 5.0 in – 8.9 in DBH; hardwood stands 5.0 in – 10.9 in DBH, and the plurality of the crown cover is in trees of this size or larger.
[40] Stands 1.0 in – 4.9 in DBH, and plurality of the crown cover is in trees of this size.

seedling/sapling class. The other major type group, Maple/Beech/Birch, approaches the idealized structure, being just slightly deficient in the combined sawtimber size and two-story/multi-story and mosaic structural grouping.

Table 5.3.2a. Stand Structure, White/Red/Jack Pine Forest Type Group, 2003

Stand size class	Stand structure		
	Single-storied	Two-storied	Multi-storied & mosaic
High basal area in large sawtimber only	6.5%	2.9%	
At least sawtimber	27.5%	36.3%	
At least poletimber	95.6%		
Seedling/sapling/nonstocked	4.4%		

Table 5.3.2b. Stand Structure, Spruce/Fir Forest Type Group, 2003

Stand size class	Stand structure		
	Single-storied	Two-storied	Multi-storied & mosaic
High basal area in large sawtimber only	0.0%	0.5%	
At least sawtimber	11.2%	19.2%	
At least poletimber	60.3%		
Seedling/sapling/nonstocked	39.7%		

Table 5.3.2c. Stand Structure, Sugar Maple/Beech/Yellow Birch Forest Type Group, 2003

Stand size class	Stand structure		
	Single-storied	Two-storied	Multi-storied & mosaic
High basal area in large sawtimber only	0.6%	1.0%	
At least sawtimber	11.5%	23.5%	
At least poletimber	79.7%		
Seedling/sapling/nonstocked	20.3%		

Phase 3 plots monitor the lichen community in order to assess air pollution impacts and spatial and temporal trends in biodiversity. For the period 1999 - 2003, the sample of approximately 150 plots identified 42 lichen genera through specimen collection. Over 35 percent of the specimens collected are in genera that may represent late successional forests (A. Whitman, 2004, personal communication).

Rationale for this indicator: Sound management of the working forest matrix is essential to the conservation of Maine's forest biodiversity. While ecological reserves and other lands reserved from management can protect some elements of biodiversity, the reality is that reserves will never be large enough, connected enough, or located to protect all biodiversity (J. Franklin, 2002, personal communication).

For the purposes of this indicator, "large sawtimber" trees and stands are used as a proxy for late successional forests. Late successional forests provide a number of goods, services, and values to society, including large, often high-value sawtimber, watershed protection, recreation, spiritual renewal, and, in some cases, a reference point against which to measure the effects of more intensive forest management.

Late successional forests are not necessarily unmanaged. In fact, active management can accelerate the development of late successional functions and structures in forests.

However, late successional forests of all types are becoming less common in Maine. Older forests support some plant and animal habitat specialists, in part due to their heterogeneity and structural complexity, but also due to the relatively long time elapsed since a stand-replacing disturbance (Gawler, *et al*, 1996).

Lichens serve a number of functions in temperate forests, including nutrient cycling and as components of food webs. Epiphytic lichens are an important component of the biodiversity of many forest types. Late successional epiphytes can be dispersal limited and are often sensitive to the impacts of forest management activities. Other factors, including atmospheric deposition, also affect these organisms. The presence of adequate populations of late successional epiphytes provides evidence of the continuity of the functions and processes of late successional forests (Selva, 1994; McCune, 2000).

Indicator 5.4: Size, distribution, and representation of protected areas[41]

Benchmark 5.4.1: There should be at least two protected examples of each forest type within the state by 2013.

Benchmark 5.4.2: In each of seven geographic regions, the proportion of protected forest types should increase to at least half of the types that naturally occur in each region by 2013.

Benchmark 5.4.3: The total acreage of landowners who voluntarily protect special or unique habitats and who are certified as well managed should increase to at least 7.5 million acres by 2005.

Status and trend for this indicator: Within the last two years Maine's conservation lands have increased considerably, both in the form of conservation easements and conservation ownership. Key additions have included the Debsconeag Lakes region (The Nature Conservancy), Seboomook Lake area (Department of Conservation), and a corridor along the Machias River (Atlantic Salmon Commission). Currently nearly 3.2 million acres, or roughly 15 percent of the state, are in some broad form of land protection (Figure 5.4.1). Most of this acreage is managed forest, including state-owned public lands, state wildlife refuges, and working forest conservation easements. A much smaller subset, approximately 670,000 acres, or 3% of the state, is restricted from harvesting (Figure 5.4.2).

[41] A number of classification systems exist to define "protected areas," including the IUCN's six classes and Maine GAP's four classes. Each system segregates classes according to the level of land use restrictions (e.g. limited harvesting, recreational use). For the representational aspects of this criterion, "protected lands" refer to all lands on which harvesting is prohibited and include such lands as state Ecological Reserves, Nature Conservancy preserves, and State and National Parks.

Both types of land protection have increased substantially in the last decade. Since 1995 over 1,000,000 acres of private land have been placed under conservation easement, the state has purchased nearly 100,000 acres, and The Nature Conservancy has purchased over 225,000 acres. Moreover, in 2000, following a ten year effort, the state's Bureau of Parks and Lands designated nearly 70,000 acres of Ecological Reserves around high quality habitats.

Of the 23 forested natural community types in the state, at least one good example for each of 17 types is protected from timber harvesting, and at least two good examples o 14 types are prohibited from harvesting. Many of the six types without any protection are in southern Maine.

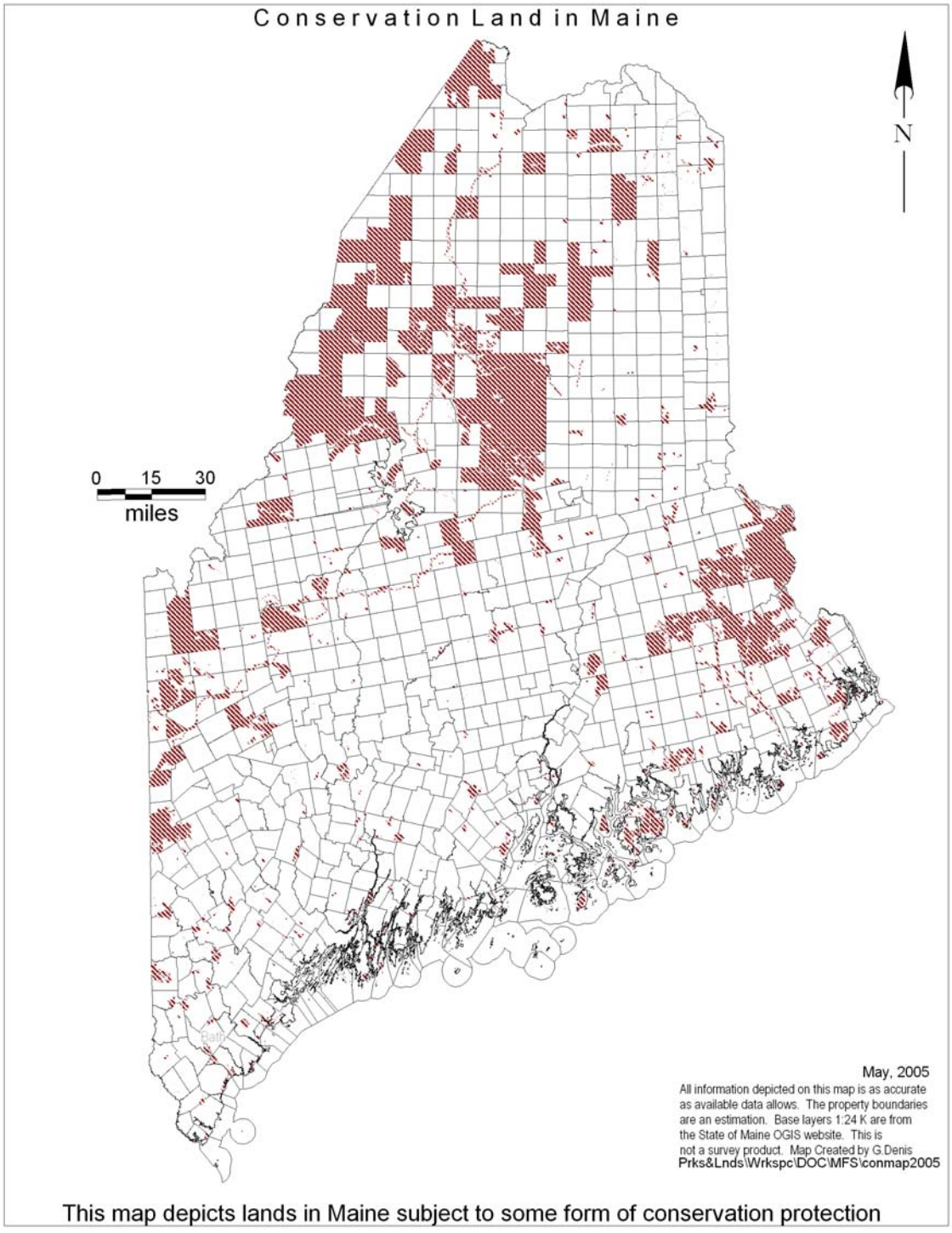
The representation of protected areas refers to the geographic distribution of protected forest types. The accompanying map (Figure 5.4.3) depicts this representation. For each of seven geographic regions, the number of protected forest types is divided by the number of forest types that occur in that region. The resulting fraction is the proportion of types protected in each region. For example, fifteen forested natural community types occur in the Boundary Plateau/St. John Uplands Section (northwestern Maine). Nine of those types have at least one protected example in the Section. For the entire state, Figure 5.4.3 indicates that 36 of 120, or 30%, of the forest types have at least one protected example in each region where they occur. For rare and uncommon forest types, 23 of 49, or 47%, have one at least one protected example

The maps indicate a pronounced geographic disparity. The overwhelming majority of protected acres and protected forest types are in northwestern and Downeast Maine, yet a disproportionate amount of Maine's rare species and species diversity lies in southern Maine. According to the criteria explained above, no forest types are sufficiently protected in Maine's southernmost region.

Replication of protected examples of forest communities is also lacking. Only 14 forest types have at least two examples protected in the state. The lack of protected forest types in southern and central Maine becomes more pronounced when replication is considered.

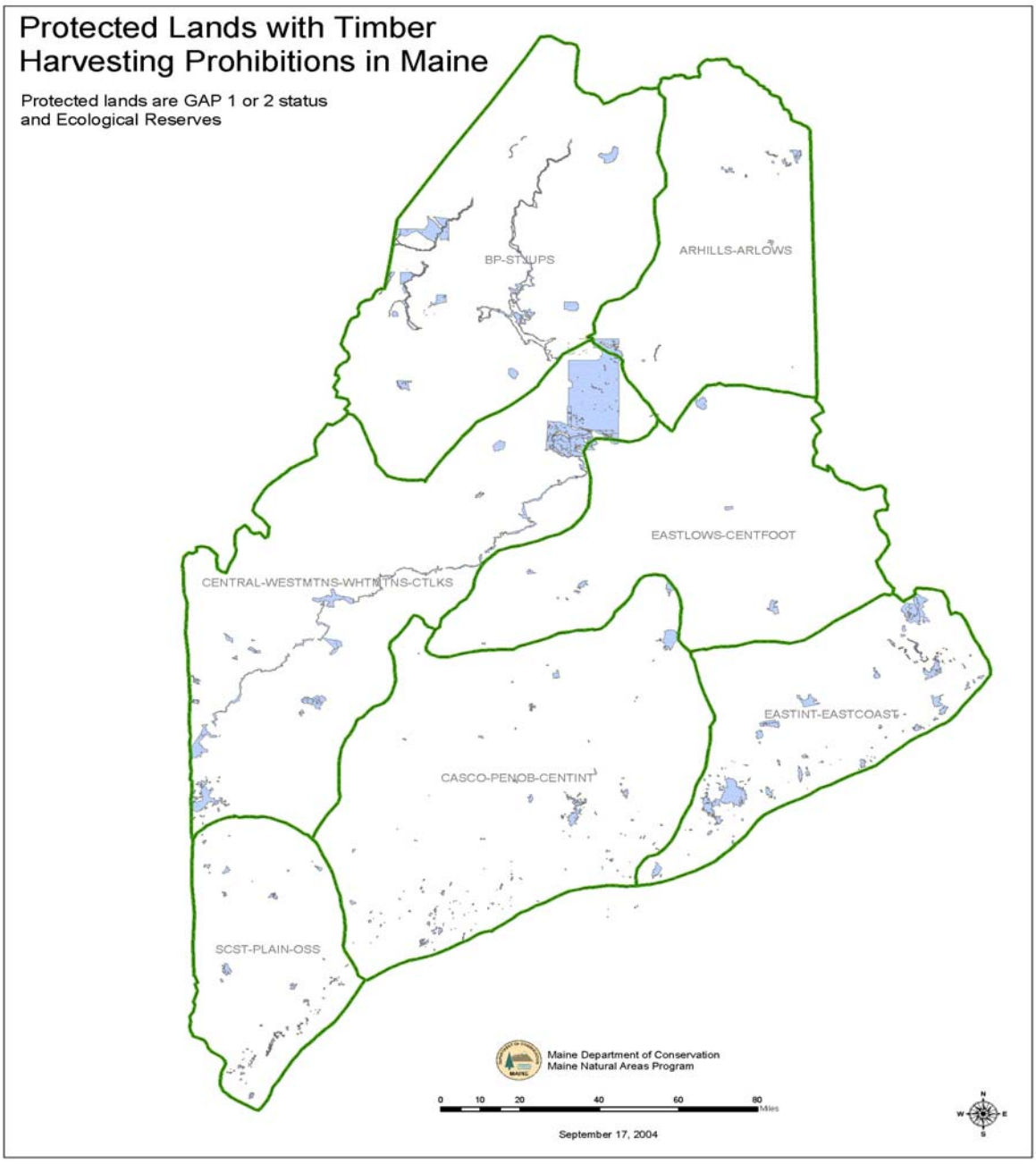
A number of private companies have internal policies regarding set-asides or special protection areas. Some of this information is public, but most is not. Nearly all companies with such policies have received third party certification. While statistics are not available for specific set-asides, the increase in third party certification suggests that the acreage of voluntary set-asides is increasing.

Figure 5.4.1. Conservation Lands in Maine[42]



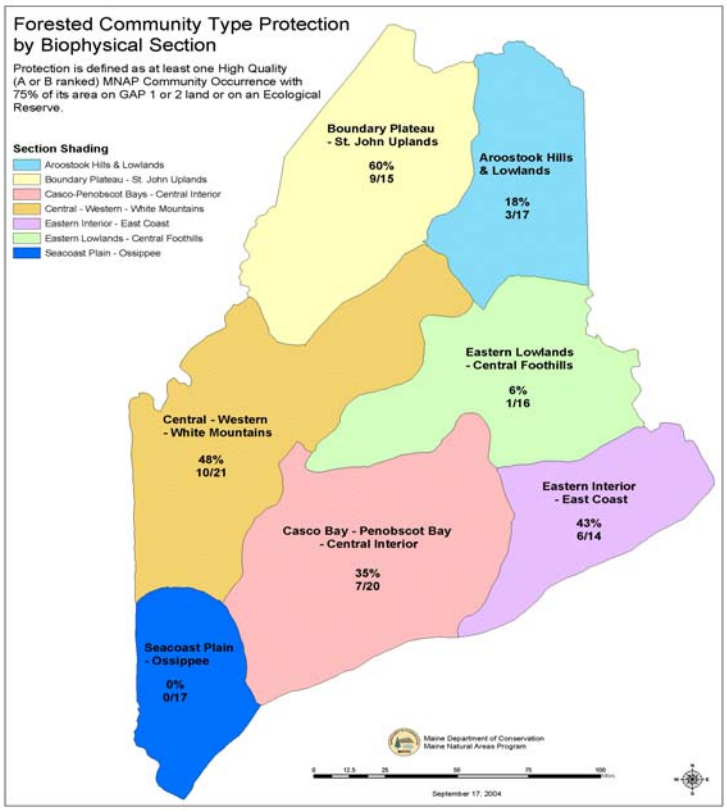
[42] Data source for this figure: Maine Bureau of Parks and Lands.

Figure 5.4.2. Protected Lands With Timber Harvesting Prohibitions.[43]



[43] Data source for this and following figures in this section: Maine Natural Areas Program. Note: This map overstates the acreage in this protection status. Only 46,000 acres of the St. John lands owned by the Nature Conservancy are in this status. This map also includes the Scientific Forest Management Area of Baxter State Park, which covers 29,600 acres.

Figure 5.4.3. Representation and Geographic Distribution of Protected Forest Types in Maine.



Rationale for this indicator: Despite recent research and management advancements, a great deal remains unknown about the biodiversity in Maine's forests, the habitat needs of its species, and the impacts of forest management. Numerous authors support the value of protected areas in conserving biological diversity (Norton, 1999, Terborgh and Soule, 1999). Protected areas serve as controls where human impacts are limited and many natural processes proceed unchecked. For example, studies in Baxter State Park conclusively demonstrated that spruce suffered less damage than fir from an uncontrolled budworm outbreak, and helped researchers understand which factors predispose a stand to budworm damage (McMahon, 1991). Consequently, protected areas may be compared to managed forests to improve our knowledge of how natural processes occur, and how forest management can react to or emulate such processes. Protected areas may also be designed to provide sufficient habitat for those species whose habitat needs are unlikely to be met for other purposes. The Maine legislature recognized the ecological importance of protected areas when it established Ecological Reserves (12 MRSA, Chapter 220, Section 1801).

Indicator 5.5: Conversion, parcelization, and roading of forest land

Benchmark 5.5.1: Maine's forest land area should remain relatively stable at or near 17 million acres.

Table 5.5.1. Acres of forest land, 1982–2003

Year	1982	1995	2003	% change 1982 – 2003	% change 1995 – 2003
Acres forest land (million acres)	17.7	17.7	17.7	+0.32%	+0.15%

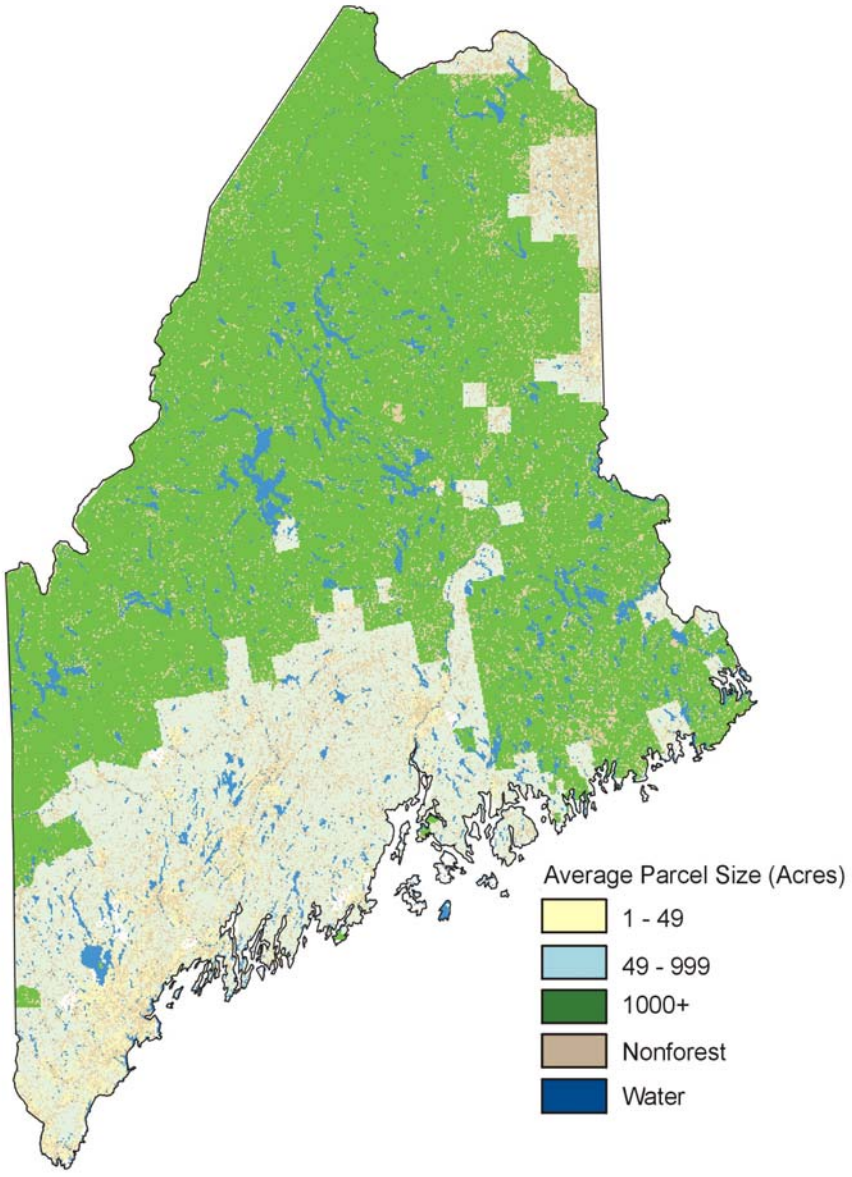
Benchmark 5.5.2: At least half of Maine's forest lands should remain in parcels of 5,000 acres or larger.

Table 5.5.2. Maine forest land ownership by parcel size (Birch, 1996)

Parcel size (acres)	Number of Owners	Total Acres (thousands)	Percent of Maine Forest Land
1-9	145,600	318	1.9
10-19	24,800	306	1.8
20-49	38,100	1,126	6.6
50-99	20,200	1,401	8.2
100-499	25,400	2,646	15.5
500-999	900	577	3.4
1,000 -4,999	400	680	4.0
5,000 +	200	10,006	58.6
Totals	255,600	17,060	100

The following presents current information in a pictorial format.

Figure 5.5.2. Distribution of land by parcel size, Maine, 2003



Benchmark 5.5.3: The percentage of Maine's forests that lie within 1,000 feet of a class 1, 2, or 3 road should stabilize at less than 35%.

Table 5.5.3. Percentage of forestland inventory conditions within specified distances of roads and trails, by road and trail class

Trail/ Road Class	0 - 300 ft	301– 1,000 ft	1,001 ft –1 mi	≥ 1 mi	Total[44]
0	0%	0%	0%	1%	1%
1	5%	6%	5%	0%	16%
2	8%	11%	11%	0%	29%
3	3%	5%	5%	0%	14%
4	1%	4%	15%	7%	27%
5	1%	3%	7%	3%	14%
Total	17%	28%	43%	11%	

Road Classification Descriptions

0 None within 1 mile
1 Paved road or highway
2 Improved gravel road (has gravel, ditching, and/or other improvements)
3 Improved dirt road (has ditching, culverts, signs, reflectors, or other improvements)
4 Unimproved dirt road/four-wheel drive road (has no signs of any improvements)
5 Human access trail- clearly noticeable and primarily for recreational use

Status and trend for this indicator:

Forest land: Small decreases in forest land acreage in most of southern Maine and Penobscot and Washington Counties are masked by equally small increases in Aroostook, Somerset, and Hancock Counties, among others. Nearly all of the changes appear not to be statistically significant. It is worth noting, however, the acreage of "urban forest land" increased from 39,000 in 1995 to 54,100 in 2003.

Parcelization: Although the National Woodland Owner Surveys conducted by the USDA Forest Service in 1982 (Birch, 1986), 1993 (Birch, 1996), and 2003 (B. Butler, 2004, personal communication) do not demonstrate statistically significant differences in a number of parameters regarding parcelization, the reported parameters indicate increasing parcelization. These parameters include average parcel size, median parcel size, and number of parcels between 10 and 100 acres. This is cause for concern, as smaller parcel size appears to correlate strongly with reduced landowner motivation to engage in active forest management.

[44] Row and column totals do not add to 100% due to rounding.

Roads: No trend information is available at this time, although it is clear that large landowners invested a great deal in their road networks following the end of the river drives. The figures clearly indicate though, how much the transportation system dominates the forest landscape. Over one-third of Maine's forest lies within 1,000 feet of a paved road or an improved gravel or dirt road. Only 12% of Maine's forest lies more than one mile from a paved road or improved gravel or dirt road.

Rationale for this indicator: The size, arrangement, and connectivity of forest blocks are critical to the conservation of Maine's forest biodiversity. "Biodiversity in the Forests of Maine" (Elliott, ed., 1999) provides an excellent treatment of this topic, and readers are directed there for more detail. The issue of fragmentation can be approached indirectly from the information above and from other sources, although it is difficult to develop a metric for it that is both understandable by lay people and relatively efficient to monitor. Large parcels, coupled with efforts such as independent third party certification and conservation easements, permit management for landscape level biodiversity values. Once large parcels are fragmented or divided into smaller parcels, society often loses the opportunity to apply the least expensive conservation strategies to a particular land base.

As with Indicator 5.1 (large trees), the issue of roads poses a dilemma for policy makers. On one hand, a widespread transportation network allows more efficient access by forest managers to make investments in forest productivity (e.g. site preparation, regeneration, and intermediate treatments, such as thinning). The transportation network also facilitates the movement of forest products to markets. Roads also reduce the skid road mileage and associated soil impacts. On the other hand, roads can significantly reduce movement of dispersal-limited species, such as salamanders (deMaynadier and Hunter, 2000). Roads also create hazards for wildlife capable of crossing them. The effects of roads on some elements of forest biodiversity can extend for hundreds of feet into the forest (Trombulak and Frissell, 2001). Maine is unique in having some of the least roaded areas in the eastern United States (Heilman *et al*, 2002).

The current status and trends in the sub-indicators outlined above should not result in a sense of complacency. It seems clear that the average forested parcel size is decreasing, probably to a greater extent in southern and central Maine, although the north is not immune from this trend.[45] The wide variation in landowner objectives can result in habitat fragmentation by itself. Other factors are also at work. It is not clear, and indeed unlikely, that future reversions of farmland to forestland will continue to offset losses to development. Although policy makers have grappled with this issue (e.g. the discussions on "Smart Growth") for several years, there is no information available that indicates a turnaround is in sight. Keeping the working forest matrix intact and in a state conducive to the conservation of biodiversity will pose a challenge to policy makers for some time to come.

[45] See the discussion of land use changes beginning on page 13 of this report.

Indicator 5.6: Degree to which forest management is consonant with natural forest dynamics

Forest ecosystems have evolved with natural disturbances, such as fire, windthrow, and pest epidemics. Forest ecosystems generally are considered resilient in the aftermath of such disturbances within the range of natural variation. Many scientists and forest managers have begun to embrace management strategies modeled on natural disturbance regimes (Crow and Perera, 2004). Maine's forests evolved within a pattern of "relatively frequent, partial disturbances that produced a finely patterned, diverse mosaic dominated by late-successional species and structures." Disturbances creating small canopy gaps were frequent. Large-scale, catastrophic (stand-replacing) disturbances were quite rare (Seymour *et al*, 2002).

Whereas Maine's natural forest dynamics tend to create a complex mosaic of species, types, and size classes across the landscape, timber harvesting - no matter how well planned and implemented - tends to simplify forest composition and structure (Crow and Perera, *op. cit.*). Most notable is the paucity of large trees, both living and dead, and other structural features that characterize unmanaged forests (McGee *et al*, 1998; Crow *et al*, 2002).

Notwithstanding the often significant differences between current forest management and natural forest dynamics, Foster (1997, 1998, 2000, and 2004) and Oliver and Larson (2004) remind us that while history can inform us about the conditions and disturbances that created today's conditions, we are now confronted with a suite of "novel environmental stresses [that] may surpass the ability of forests to control important ecosystem processes (Foster, 1997, *op. cit.*). Examples of such stressors include invasive and exotic species (e.g. hemlock woolly adelgid), air pollution, and abrupt climate change. These stresses are overlaid on past harvesting and land clearing patterns, and past disturbances to create a complex situation for which Foster (2000, *op. cit.*) suggests "there [is] no fixed 'original' landscape" against which to refer. Forest management can rarely - if ever - satisfy all interests and conserve all values; therefore, management involves tradeoffs among interests and values. The challenge to policy makers and land managers in the context of forest biodiversity is to design management strategies that involve the fewest tradeoffs (Oliver and Larson, *op. cit.*) and minimizing the risks of species loss.

No formal benchmarks are presented for this indicator. The indicator is presented to inform public discussion about the topic.

Status and trend: Total acreage harvested increased from 470,599 acres in 1995 to 511,070 acres in 2003. Clearcut acreage declined from 39,295 acres to 18,389 acres during the same period. Part of the increased total harvest acreage reported may be due to better reporting and compliance; however, the trend for total acres harvested is definitely upward (notwithstanding a decline from 2002 to 2003). Harvest levels remained remarkably stable during the period, indicating that landowners have increased non-clearcut harvesting to compensate for the reduction

in volume obtained by clearcutting. Total acres treated since the 1980's to improve future forest productivity (site preparation, planting, competition control, and spacing) are estimated at over 1.2 million. The total acres adjusted for treatment overlap are approximately 850,000.[46]

The current harvest footprint covers approximately 3% of the state's forestland area each year. Of the annual harvest footprint (2003 figures), approximately 51% of the acres are harvested by a partial harvest method (either individual trees or small groups of trees). The remainder is harvested using either the shelterwood (43%) or clearcut (5%) methods. About 5% of the state's land area currently is managed under intensive silvicultural regimes that approximate the effects of a major or catastrophic disturbance on forest succession (effectively reset to zero every 50-70 years). The "return time" and patch size of land managed under such regimes, however, does not match that of the natural forest (Seymour *et al*, 2002). The annual percentage increase in this acreage is small.

Rationale for this indicator: This indicator allows us to assess roughly the level of correlation between current forest management strategies and natural disturbance regimes.

Acknowledgments

The Maine Forest Service sincerely thanks the following individuals, who devoted many hours of their valuable time to help us develop the indicators and benchmarks for biodiversity as members of a technical work group:

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- Robert Bryan, Maine Audubon Society
- Malcolm Hunter, Jr., University of Maine, Department of Wildlife Ecology
- Kenneth Laustsen, Department of Conservation, Maine Forest Service

While every attempt was made to accommodate differing perspectives and to incorporate the many valuable suggestions provided by reviewers, this was not always possible. The Maine Forest Service takes full responsibility for the content.

[46] Lloyd Irland, 2000, personal communication, and Kenneth Laustsen, 2002, personal communication, adjusted to reflect new information.

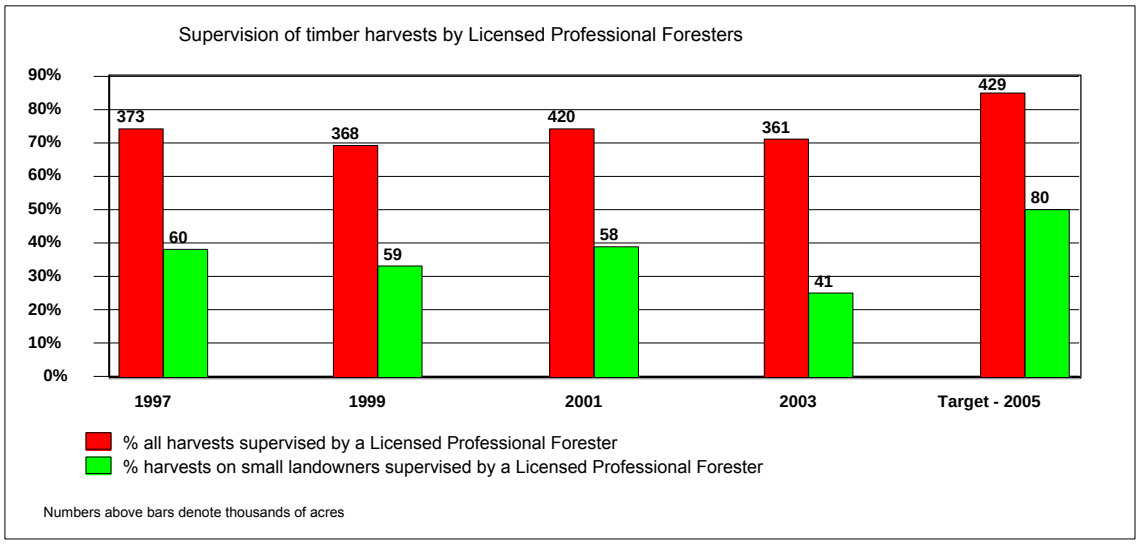
Criterion 6: Public Accountability of Forest Owners and Managers (DRAFT)

Goal: To broaden the practice of sustainable forestry and build public confidence by establishing and maintaining reasonable accountability measures

Indicator 6.1: Percentage and number of acres harvested where management planning, harvest layout, silvicultural prescription, and harvest operations are conducted under the direct supervision of a Licensed Forester (LF)

Benchmark 6.1.1: The percentage of acres harvested annually under the direct supervision of a Licensed Forester will increase from 74 percent (372,579 acres) in 1997 to 85 percent (estimated 429,000 acres) by 2005.

Benchmark 6.1.2: The percentage and number of acres harvested annually on small ownerships (under 1,000 acres) under the direct supervision of a Licensed Forester will increase from 38 percent (60,330 acres) in 1997 to 50 percent (estimated 80,000 acres) by 2005.



Assessment: There has been little progress on these benchmarks, and it now seems unlikely that they will be achieved. In 2003, 71% of all harvested acres were under the direct supervision of a Licensed Forester, essentially unchanged since 1997. On small ownerships, 34% of harvested acres were under the direct supervision of a Licensed Forester, a small but noticeable decrease from 1997.

Forester usage on large industrial ownerships has declined sharply, whereas it has remained well over 90% on investor ownerships. The Maine Forest Service will attempt to determine if the decline in forester usage on large industrial ownerships is real or due to reporting errors.

Encouraging more small woodland owners to involve a forester in planning and overseeing their harvests presents a significant challenge. The Maine Forest Service advocates for forester involvement in harvesting on smaller ownerships to achieve many positive outcomes for the landowner and the future forest. The diversity of landowners, landowner tenure and turnover, and other factors make this a multifaceted, seemingly intractable problem. Immediate revenue generation seems to drive many landowner decisions. Many seem unwilling to invest a portion of their harvest receipts in the services of a consulting forester. At the same time, many landowners make decisions with very little information. MFS strives constantly to raise awareness, help landowners identify sources of assistance, and perhaps most importantly, provide the landowner with key information at critical decision-making times.

MFS recommends that small landowners implement a controlled harvest by involving Licensed Foresters provide multiple services, including:

- Preparing a long-term forest management plan that describes forest conditions and outlines ways for the landowner to take appropriate actions to achieve his or her objectives over time;
- Preparing a timber harvest on behalf of the landowner to ensure that the landowners' management goals are addressed. The forester may:
  - Identify or develop appropriate access points and landings;
  - Designate or mark trees to be harvested to achieve silvicultural goals;
  - Mark harvest area boundaries;
  - Negotiate appropriate prices for harvested wood;
  - Assure that legal obligations are met and insurance to protect the landowner is in place;
  - Develop a written harvest contract that addresses these and other harvest provisions;
  - Identify and work with a skilled professional logger with appropriate equipment to conduct the harvest;
  - Market and administer payments for wood; and,
  - Supervise and administer the harvest on an ongoing basis to ensure it is completed to the landowner's satisfaction.

Maine Forest Service staff stress the many benefits to landowners of using consulting foresters during any contacts with landowners, as well as in publications, workshops, and other forms of outreach. MFS will work to identify more effective ways of communicating the benefits of consulting foresters to landowners. Some landowners have also expressed skepticism that consulting foresters will represent the landowner's best interests. Maine Forest Service also provides services to foresters with workshops and information to help ensure that landowners receive appropriate professional assistance.

Indicator 6.2: Number of acres (or number of landowners) under management certified by valid, independent, third party certifiers of sustainable forest management

Benchmark 6.2.1: The number of acres (or number of landowners) under management certified by valid, independent, third party certifiers of sustainable forest management will increase significantly from the current level.

Assessment: Progress toward this benchmark since 1997 has been remarkable. By December 2004, the management of nearly 6.9 million acres had received certification from one of the three major systems operating in Maine (Sustainable Forestry Initiative, Forest Stewardship Council, and American Tree Farm System). For a full discussion of issues related to this benchmark, see the Forest Certification section earlier in this report.

Indicator 6.3: Percent and number of timber harvesters who have received training and certification from the Certified Logging Professional Program (CLP) or an equivalent training system

Benchmark 6.3.1: The percentage of timber harvesters who received training and certification from the Certified Logging Professional Program or an equivalent training system will increase from an estimated 58 percent in 1997 to 90 percent by 2005.

Assessment: MFS considers this benchmark largely achieved, and a real success story in Maine's forest management history. Estimates of the number of loggers in Maine vary - a commonly accepted estimate is approximately 3,800 loggers in the state. In reporting progress on this benchmark, MFS uses number of CLP trained loggers, rather than percentage. Since its inception in 1991, over 4,800 loggers (including mechanical harvesters, supervisor/contractors, and conventional loggers) have completed the CLP program. 2,089 loggers maintained their certification in 2004.[47]

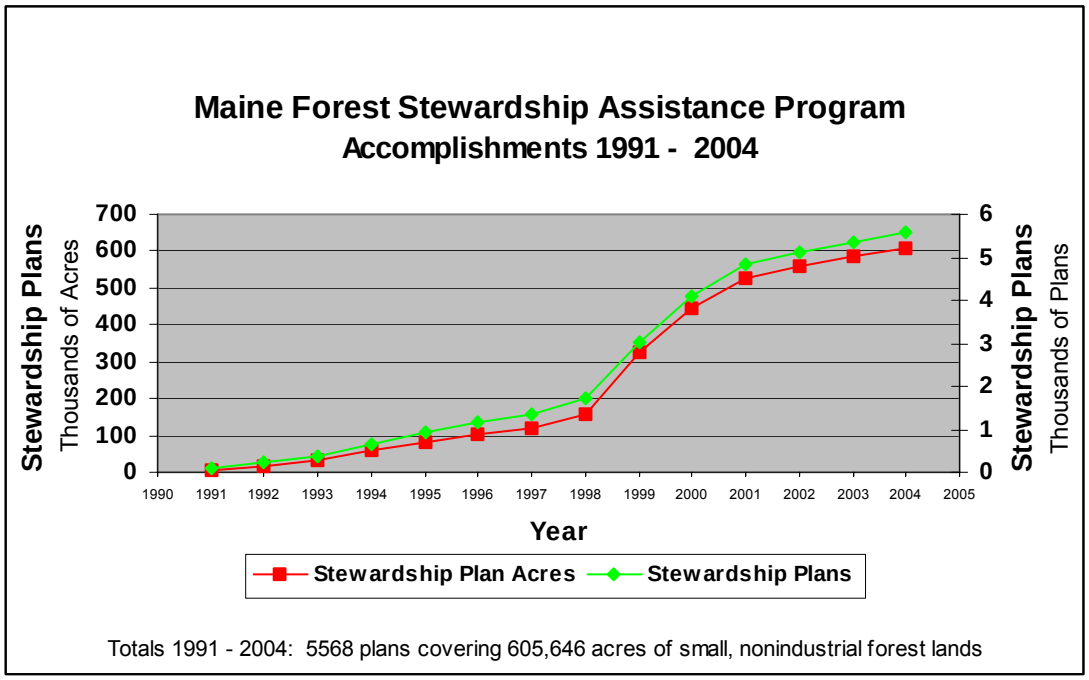
Indicator 6.4: Total acres of non industrial forest land with management plans meeting Maine Forest Stewardship Program guidelines

Benchmark 6.4.1: The number of acres of non industrial forest land with management plans meeting Forest Stewardship Program guidelines will increase from a cumulative total of 1,777 parcels and 162,664 acres in 1997 to 4,000 parcels and 400,000 acres by 2005.

Assessment: MFS considers this benchmark largely achieved, but it will continue to support efforts to increase these figures as much as possible. The Forest Stewardship Program has expanded to include 605,646 acres on over 5,568 individual parcels of nonindustrial forest land. It is worth noting that the majority of these plans were prepared in the aftermath of the 1998 ice storms, a time of

[47] See the ice storm retrospective section for more information about CLP and Master Logger Certification, and the certification section for additional information on Master Logger Certification.

heightened awareness and a substantial increase in federal funding for the program.



Totals 1991 - 2004: 5568 plans covering 605,646 acres of small, nonindustrial forest lands

Criterion 7: Traditional recreation[48] (NEW) (DRAFT)

Goal: Public policies that encourage private landowners to continue to provide traditional forest recreation opportunities

Indicator 7.1: Acreage of Maine forest land open to responsible public recreation

Benchmark 7.1.1: The number of acres open to responsible public recreation will not significantly decrease from the current level.

Benchmark 7.1.2: The amount of Maine conservation land intended for public use will increase from 1.06 million acres in 2000 to 1.28 million acres by 2005 (Adopted from Maine Economic Growth Council, Goals for Growth 2004).

Maine's outdoor recreation values are deeply rooted in tradition. Maine's vast, largely privately held forest lands have been a renowned recreational resource since the era of the pioneer vacationers of the mid-1800's. The quality of Maine's natural environment contributes to the quality of people's outdoor recreation experiences as well as to their quality of life (Commission on Maine's Future, 1989; Maine Audubon Society, 1996).

A majority of Maine residents enjoy some form of forest-based recreation, including fish- and wildlife-related activities, hiking, camping, and snowmobiling. These activities comprise an essential component of the state's recreation and tourism industry. Surveys show that people spend nearly $1 billion annually on forest-based recreation activities in Maine (Boyle *et al.*, 1988 and 1990; NEFA, 2001; US Department of the Interior, Fish and Wildlife Service and US Department of Commerce, US Census Bureau, 2002). Hunting and fishing traditionally have been the favorite activities; however, a wide array of nonconsumptive activities attracts increasing numbers of people to the Maine woods each year. Specialty guiding services for bird watching, hiking, and other activities have proliferated as the demand for such activities increases. Many of these recreational activities are big business and provide an opportunity for local economies to diversify.

Through tradition and goodwill, Maine's private landowners largely have maintained free and open public recreational access to their lands for responsible recreation. A consortia of large landowners (North Maine Woods, Inc.) charge day use and camping fees to access 3.7 million acres of forest land in the northwest part of the state, but the fees are used to cover the costs of managing the use and are not a profit center for the landowners. While some public access rights are prescribed in law (i.e., the Great Ponds Act), public recreational access to private lands is generally a privilege. In many states, forest landowners charge for or lease recreation rights. Yet, in spite of the pressures to generate additional revenue to cover the annual carrying costs of land, most large landowners in Maine continue to

[48] Adapted from Maine Council on Sustainable Forest Management. 1996. Sustaining Maine's Forests: Criteria, Goals, and Benchmarks for Sustainable Forest Management. Maine Department of Conservation, Augusta. 38 pp. + Appendices.

maintain an open recreational access policy. Changing landowner attitudes and land management goals, negative landowner experiences with poaching, trash dumping, unauthorized vehicle use, and other abuses have led to some recreational access restrictions; however, these privileges continue on most properties. In addition, the state has instituted programs to assist landowners with resolution of some of the problems that lead to recreational access restrictions, such as poaching, hunting without permission and littering.

Responsible, Ethical Recreation: The Key to Future Access

Maine has a unique history of public access to private land. Generations of Maine people have grown up enjoying relatively free and open access to private lands for recreation. According to the Department of Inland Fisheries and Wildlife, more than 10 million acres of working farms and forests are open to the public, thanks to the good will of private landowners from Kittery to Fort Kent.

However, access to private land is a privilege not a right, and the acts of a single irresponsible person can change a landowner's attitude toward public recreation overnight.

Responsible, ethical recreation is critical to ensuring that this long tradition continues. The state and private landowners have forged a number of alliances to address and manage recreational issues.

For more information about this important issue, visit the Department of Inland Fisheries and Wildlife Landowner Relations Program home page: www.state.me.us/ifw/aboutus/lorintro.htm.

Inherent tensions exist among a number of factors affecting forest based recreation, including:

- Intensive forest management and traditional recreational uses of the Maine woods;
- Conversion of forest land to nonforest uses, such as development, and the maintenance of traditional open access to the forest;
- Poor land management and the protection of fish and wildlife habitat; and,
- A society that makes increasing demands for a myriad of goods and services from the forest and the capacity of the forest to supply them.

Conflicts also arise between what are generally accepted as traditional recreational uses and newer, often more intensive recreational uses.

As recreational use of larger forest land ownerships and the public's expectations about recreation have increased, so have pressures on the owners of this land to provide more of what are generally accepted as public values – but not public trust rights, such as scenic views, a sense of wildness and remoteness, and a quality recreational experience. People also have deep concerns about the loss of access to forest land for traditional recreational uses, particularly in the southern part of the state.

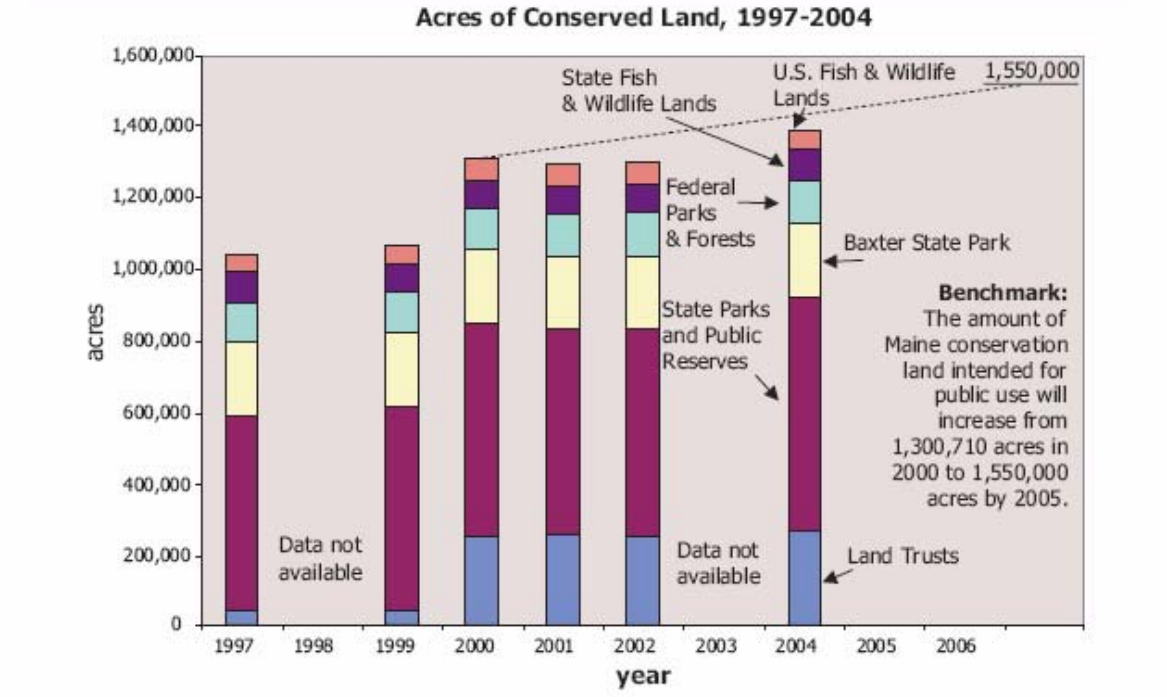
The Farm and Open Space Tax Law (36 MRSA §1101 *et seq*) provides options for landowners to receive a reduced valuation on their properties in return for maintaining or providing public values, such as scenic views, recreational access, and permanent conservation protections. Eligible landowners who allow reasonable public use may receive at least a 45% reduction in the assessed value of their property.

Sporting camps help manage some of the increasing demand for traditional recreation, particularly hunting and fishing, and can help accommodate certain compatible and appropriate newer uses. However, low-intensity recreationists (e.g. backpackers, canoeists, and cross-country skiers) may demand a different type of experience that sporting camps cannot provide. The marketplace currently does not accommodate this demand adequately, although some proposals are in the works. Finally, the sheer number of people seeking forest recreation opportunities increases the possibility of conflict between different uses, and diminishes the quality of the experience for many users.

In the last decade, the state and numerous land trusts have obtained conservation easements from the private owners of hundreds of thousands of acres of Maine land. These easements have been acquired through a variety of means, including direct purchase at fair market value or bargain prices, (e.g. the Forest Legacy and Land for Maine's Future Programs) or by donations from generous landowners. Many of these agreements permanently protect public recreational access.

17. Conservation Lands

Benchmark: The amount of Maine conservation land intended for public use will increase from 1,300,710 acres in 2000 to 1,550,000 acres by 2005.



Data Sources: Maine Coast Heritage Trust; Maine Department of Conservation, Bureau of Parks and Lands; Maine Department of Inland Fisheries and Wildlife; Baxter State Park Authority; Acadia National Park; White Mountain National Forest; Appalachian Trail Commission; US Fish and Wildlife Service; all 2004 data

Source: Maine Development Foundation, 2005.

Existing public lands face increasing demands and pressures similar to those faced by private landowners. State parks, public reserved lands, Baxter State Park, Acadia National Park, and the White Mountain National Forest all report difficulties in managing recreational use. Many of these entities have instituted, or are considering, measures to manage use, including new user fees, limits on the number of users, and vehicle restrictions. These pressures – and measures to address them - will only continue to grow.

The key public policy issue is one of resource allocation. Less intensive methods of forest management, including winter harvesting, are generally compatible with traditional recreational uses. More intensive silviculture is generally incompatible with these uses, at least in the short run (primarily during final removal and stand regeneration stages). Harvest planning that considers and protects important recreational resources (e.g., remote campsites, trails, and views from water bodies) can often mitigate the negative impacts of such operations. Such planning can include altering road alignments, leaving more of a forest canopy, or softening harvest unit edges. As our uses and perceptions of the forest evolve, society constantly needs to ask itself the following questions: What are the public's expectations of forest landowners regarding the provision of public values? What are forest landowners' responsibilities in this regard? What are the tradeoffs (economic, social, and environmental) associated with favoring one use over another? What is the importance of maintaining traditional uses versus accommodating newer uses? What are the impacts of increasing use on the quality of the experience?

Status and trend: Changing landowner attitudes and land management goals, incidents of abusive behavior by some recreationists, and increasing recreational pressures, led to a perceived increase in posting of private property in the 1980's and 1990's. Posting was most prevalent in southern Maine, which continues to experience high levels of development. Landowners, sportsmen, state agencies, and others undertook a number of initiatives to try to reduce this trend, and the issue appears to have leveled off. The huge increase in conservation lands over the last decade has been a major success story in Maine's conservation history. The acreage protected from development through public ownership or private conservation easements has skyrocketed. A number of initiatives in the works and continued interest of landowners and conservation partners indicate this upward trend will continue.

Rationale for this indicator: MFS has chosen to focus on the umbrella issues of access and conservation lands as benchmarks of sustaining traditional forest-based recreation. Without land to recreate on, or access to that land, there can be no debates about what kinds of uses can or should be accommodated. Although the status of neither indicator can be attributed completely to the support of forest-based recreation, it is fair to say that with 90% of the state's land area in forest, these indicators are likely to predict the status of forest-based recreation with a fairly high level of accuracy.

GLOSSARY

Accretion: Growth, usual basal area or volume increment, of existing merchantable trees over a given period; a component of stand growth.

As naturally occurs: Conditions with essentially the same physical, chemical and biological characteristics as found in situations with similar habitats free of measurable effects of human activity (38 MRSA § 466 subsec. 2).

Benchmark: Intermediate objectives for attaining goals.

Biodiversity (or biological diversity): The variety of all forms of life at various levels of organization, including individuals, populations, species, and ecosystems (Gawler *et al*, 1996).

Biodiversity conservation: The management of human interactions with genes, species, and ecosystems to provide the maximum benefit to the present generation while maintaining their potential to meet the needs and aspirations of future generations; encompasses elements of saving, studying, and using biodiversity (UNEP World Conservation Monitoring Centre, 2005).

BMP (Best Management Practices): Practices designed to be the most effective and practicable means to prevent or minimize environmental degradation, particularly nonpoint source water pollution.

Clearcut: A harvest in which all or almost all of the trees are removed in one cutting. Maine's Forest Practices Act rule defines a clearcut as "any timber harvesting on a forested site greater than 5 acres in size that results in a residual basal area of acceptable growing stock trees over 4.5 inches DBH of less than 30 square feet per acre unless the following condition exists: after harvesting, the site has a well-distributed stand of acceptable growing stock … of at least 3 feet in height for softwood trees and 5 feet in height for hardwood trees."

Commercial thinning: A silvicultural treatment that thins out an overstocked stand by removing trees large enough to be sold as commercial products. It is carried out to improve the health and growth rate of the remaining crop trees.

Criterion: A category of conditions or processes by which sustainable forest management may be assessed. A criterion is characterized by a set of related benchmarks which are monitored periodically to assess change.

DBH: The diameter of a tree measured at 4.5 feet above the ground. It is a standard forestry measure (USDA Forest Service, Forest Inventory and Analysis).

Dead trees: Trees that died between inventories (USDA Forest Service, Forest Inventory and Analysis).

Ecological reserve: An area that is not managed for timber or other commercial products and where natural processes take place with little or no human manipulation.

Forest management: Manipulation of the forest to achieve certain objectives, such as timber production, wildlife habitat enhancement, maintaining forest health, or conserving biodiversity.

Forest Practices Act: The Maine Forest Practices Act was adopted in 1989 to: 1) ensure adequate regeneration of commercial tree species within five years of completion of any timber harvest, 2) regulate the size and impact of clearcut timber harvesting. The law defines a clearcut, and authorizes the Department of Conservation to develop rules to establish performance standards for clearcuts.

Fragmentation: The subdivision of a forest (or other habitat) into isolated patches, accompanied by the loss of a certain portion of the original habitat to the cause of the fragmentation (e.g. roads and land clearing).[49] Fragmentation reduces the size and connectivity of stands that compose a forest or landscape and has two negative components for biota: loss of total habitat area, and smaller, more isolated remaining habitat patches.

High-grading: An exploitive logging practice that removes the best, most accessible, and commercially valuable trees in the stand, often resulting in a poor-quality residual stand.

High yield forest practices: The management of stands where spacing (stocking), density and species composition are controlled via significant investment in precommercial treatments such as planting or spacing, for the purpose of increasing timber yields to at least 0.8 cords/acre/year (mean annual increment).

Ingrowth: Volume (or basal area) of saplings reaching merchantable size over a given period; a component of stand growth.

Growth: A measure of the change in volume of a stand over time; generally, Gross Growth is a function of Accretion plus Ingrowth, while Net Growth equals Gross Growth minus Mortality.

Liquidation harvesting: The purchase of timberland followed by a harvest that removes most or all commercial value in standing timber, without regard for long-term forest management principles, and the subsequent sale or attempted resale of the harvested land in 5 years.[50]

Natural regeneration: The reestablishment of a plant or plant age class from natural seeding, sprouting, suckering, or layering.

Parcelization: The subdivision of larger land holdings into smaller ones.

Partial harvesting: A process whereby only part of a stand is removed during each harvest operation. Partial harvesting is not considered a regeneration method.

Planting: A technique for the artificial reestablishment of trees on a harvested or non-forested site.

Poletimber stands: Stands with a plurality of basal area in trees 5.0 – 9.9" DBH.

Precommercial thinning: A silvicultural treatment that involves removing some of the trees from a stand too small to be sold for timber, to reduce stocking in order to concentrate growth on the remaining trees.

Public trust resources: Natural resources that remain in the public domain, even though they may occur on privately-owned lands. Examples include air, water, fish, and wildlife.

[49] Gawler, S., J. Albright, P. Vickery, and F. Smith. 1996. op. cit.
[50] 12 MRSA §8868, sub-§6.

Quadratic mean diameter (QMD): A mathematical construct that describes the tree of average basal area, rather than the simple average of the diameter of a set of trees. The QMD is always larger than the average diameter because it gives more weight to larger diameter trees. In silviculture, use of the QMD keeps small trees from having too much weight in describing a stand (Bell, 1997). For example, if the average tree basal area is 0.55 square feet, the QMD is 10.0 inches DBH.

Regeneration: Seedlings or saplings existing in a stand; or the act of establishing young trees naturally or artificially. Renewal of a forest by either natural or artificial means.

Relatively undisturbed: Forested sites with intact soil duff layers that have not experienced harvesting for at least 20 years.

Riparian ecosystem: The area adjacent to water bodies and non-forested wetlands. They often include zones of gradual transition from water to upland ecosystems. A riparian forest is one type of riparian ecosystem (Elliott, C., ed., 1999).

Riparian zone: The land immediately adjacent to a perennial or intermittent body of water. Riparian zones can 1) store water and help reduce flooding; 2) stabilize stream banks and improve water quality by trapping sediment and nutrients; 3) shade streams and help maintain water temperature for fish habitats; 4) provide shelter and food for birds and other animals; 5) support productive forests which can be periodically harvested; and 6) can be used as recreational sites.

Rotten tree: A live tree of commercial species that does not contain at least one 12-foot sawlog or two noncontiguous sawlogs, each 8 feet or longer, now or prospectively, and does not meet regional specifications for freedom from defect primarily because of rot; that is, more than 50 percent of the cull volume in the tree is rotten (USDA Forest Service, Forest Inventory and Analysis).

Rough tree: The same as a rotten tree, except that a rough tree does not meet regional specifications for freedom from defect primarily because of roughness or poor form; also live trees of noncommercial species (USDA Forest Service, Forest Inventory and Analysis).

Sapling-size stands: Stands with a plurality of basal area in trees 1.0 – 4.9" DBH.

Sawtimber-size stands: Stands with a plurality of basal area in trees 10.0"+ DBH.

Shelterwood: A silvicultural system characterized the gradual removal of the residual stand in a series of harvests. The initial harvest removes most of the mature trees, leaving enough trees to serve as a seed source and to provide sufficient shade to produce a new crop.

Silviculture: The art and science of controlling the establishment, growth, composition, health, and quality of forests to meet the diverse needs and values of landowners an society on a sustainable basis.

Snags: Standing dead trees with most or all bark missing that are at least 5.0 inches DBH and at least 4.5 feet tall. Snags are trees that were recorded as dead in a previous inventory and are still standing during a subsequent remeasurement (USDA Forest Service, Forest Inventory and Analysis).

Spruce budworm: An insect larva that feeds on and in buds and young shoots of spruces and fir trees. An important forest defoliator that can cause extensive damage.

Stewardship: The administration of land and associated resources in a manner that enables their passing on to future generations in a healthy condition**.**

Sustainable forestry: Forest management that enhances and maintains the biological productivity and diversity of Maine's forests, thereby assuring economic and social opportunities for this and future generations. It takes place in a large ecological and social context and achieves a balance between landowners' objectives and society's needs.

Sustained yield: A regular and continuing supply of timber (or other desired goods or services) to the full capacity of the forest and without impairing the capability of the land.

Tree Growth Tax Law: Provides for the tax valuation of forest land on the basis of the land's productivity value, rather than on fair market value. The State tax assessor determines tree growth valuation for each forest type on a county basis. Municipalities apply their own tax rate to the tree growth valuation to determine taxes due on the land.

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ABOUT THE MAINE FOREST SERVICE

Established in 1891, the Maine Forest Service's mission is to protect and enhance our state's forest resources through forest fire prevention, technical assistance, education and outreach to a wide variety of audiences, and enforcement of the state's forest protection laws. Maine Forest Service offices are found throughout the state and provide Maine's citizens with a wide range of forest-related services.

For more information about the Maine Forest Service and its programs, visit our website at www.maineforestservice.org.

Back cover photo: National champion yellow birch, Deer Isle, photograph by Joe and Joe Bruno.

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