MAINE STATE LEGISLATURE

Sustaining Maine's Forests:
Criteria, Goals, and Benchmarks for Sustainable Forest Management

Maine Council on Sustainable Forest Management

July 1996

Maine Council on Sustainable Forest Management
Department of Conservation
22 State House Station
Augusta, ME 04333-0022

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July 1, 1996

Governor Angus S. King, Jr.
1 State House Station
Augusta, ME 04333-0001

Dear Governor King:

We are pleased to present the recommendations of the Maine Council on Sustainable Forest Management regarding the *criteria*, *indicators* and *benchmarks* for sustainable forest management. This report fulfills two of the charges you gave us when you created the council in April 1995.

You asked us to define sustainable forest management and to develop the benchmarks of sustainability against which all forest landowners in the state can assess their forest management practices. We carried out these charges by: conducting independent research; sponsoring a panel to review our work; holding public discussions; and, seeking public input on all of our work. We appreciate your giving us the opportunity to work on issues of such importance to Maine's future.

This report contains 7 criteria with 29 benchmarks, the detail and specificity of which have not been seen in worldwide literature on sustainability. Maine leads the nation and the world on this topic. The Executive Summary is attached.

Our recommendations address the Principles of Sustainability developed by the Northern Forest Lands Council: *soil productivity*, *water quality*, *wetlands and riparian zones*, *maintaining harvest levels of quality wood*, *aesthetics*, *biodiversity*, and *recreation*. We also address an issue of prime importance to conserving the forest--*accountability and professionalism.* Healthy, biologically diverse forests are such a fundamental underpinning of the present and future economy that they require professional, ethical management from seedling to maturity and from the stump to the mill.

We do not consider the issue of sustainable forest management a closed book. Our work should be considered a work in progress.

Sustaining the forest is a complex task that involves many variables, including ecological processes, landowner objectives, and market forces. All must be considered in management and policy decisions. We hope that you will accept our recommendations as a package. To implement them piecemeal will not yield the same result and likely will not sustain the forest.

The council now moves ahead to tackle the next phase of your charge. We will endeavor to complete that work on time also. We thank you again for your confidence and hope that you will set policies that will sustain Maine's forests for us and for the many generations of Mainers that will follow us.

Sincerely,

Gary Cobb	Ronald Lovaglio	Robert Seymour
Harry Dwyer	Isabel McKay	Donald Tardie
Charles Gadzik	Janet McMahon	Peter Triandafillou
Malcolm Hunter		

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While we are pleased to share the credits for this report, we accept sole responsibility for any errors contain within.

Principal funding for this project was provided by the USDA Forest Service, State and Private Forestry through the Cooperative Forestry Assistance program.

"As Governor, I will work to enhance and protect the ability of Maine's working forest to continue to provide sustainable forest resources, healthy forest systems and socioeconomic benefits for the overall benefit of the people of Maine." --Governor Angus S. King, Jr.

Executive Summary

Overview

Governor Angus S. King, Jr. established the Maine Council on Sustainable Forest Management by Executive Order No. 11 FY 94/95 on April 25, 1995. He charged the council with four tasks:

- Define forest sustainability in practical terms feasible for implementation by all landowners;
- Recommend criteria and goals to ensure a sustainably managed forest;
- Recommend a methodology for the Department of Conservation to monitor forest landowners' progress toward achievement of forest sustainability goals; and,
- Review and assess Maine's forest practices rules and regulations for their adequacy in achieving sustainable forest management, and recommend changes where necessary.

In partial fulfillment of its mission, the council has developed a definition of sustainable forest management, and criteria, goals and benchmarks for sustainable forest management in Maine.

The Council's Mission

To develop practical, credible benchmarks of forest sustainability against which landowners can assess their forest management practices.

Vision

We believe that Maine's forests can and should be well tended and productive, yet still retain their essentially wild character. Our wise stewardship will ensure that Maine's forests will always support a healthy diversity of native plant and animal species as well as a broad distribution of mature trees. Strategically chosen areas of intensively managed forests and permanently protected ecological reserves will diversify the general landscape, which will be managed with care for multiple uses and values. Maine's forests will remain an important component of the state's economy. They will support a diversity of products and services that will help to support local communities. Forest owners will be free to manage their lands creatively according to sound silvicultural principles, balancing their own interests with the forest's many public values. In recognition of forest landowners' commitment to maintaining these public values, public policy will foster long-term investments in forest land ownership and management.

We envision forest landowners, state government, and other stakeholders working together, inspiring increasing public confidence that Maine's forests will truly sustain economic, recreational, ecological, and spiritual values for this and future generations. We will achieve our vision when Maine's citizens feel secure about the future of their forests.

Defining Sustainable Forest Management

"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."

Criterion 1: Soil Productivity

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

- Benchmark 1: Minimize soil movement and disruption caused by forest operations to optimize nutrient uptake by desired tree species.
- Benchmark 2: Maintain an appropriate organic layer in harvest areas to optimize nutrient cycling and soil structure.
- Benchmark 3: The MFS will work with appropriate agencies and stakeholders to:
  - { Develop a field handbook of regulations and voluntary BMPs for the protection of forest soils by June 1998;
  - { Disseminate the field handbook widely to landowners, loggers, and foresters; and,
  - { Develop and implement a reliable, simple, low-cost method for assessing compliance with soil protection BMPs.

  By 2007, the MFS should find significant annual increases in compliance with these revised BMPs.

Criterion 2: Water Quality, Wetlands and Riparian Zones

Goal: Conserve water quality and quantity and the functions and values of wetlands and riparian zones

- **Benchmark 1:** Establish and maintain windfirm stands with a continuous canopy closure of 65-70% next to all streams (both perennial and intermittent) mapped on USGS 7.5-minute quadrangles.
  - { For unmapped streams: By 1999, establish or strengthen existing protection standards statewide that minimize sedimentation and maintain shading.
  - { For mapped first and second order streams: Establish and maintain 65-70% canopy closure within 75 feet. No clearcutting within 250 feet.
  - { For third and higher order streams: Establish and maintain 65-70% canopy closure within 250 feet.

- **Benchmark 2:** By June 1999, evaluate the effectiveness of fixed and variable stream protection zones in protecting water quality of first and second order streams (mapped and unmapped) and make recommendations for a stricter standard if necessary.
- **Benchmark 3:** By June 1998, adopt uniform riparian zone timber harvesting standards for the state and establish an effective enforcement program. These statewide standards should be no less stringent than current DEP and LURC standards combined.
- **Benchmark 4:** By June 1998, develop watershed-level guidelines for moderating the effects on stream flow of timber harvesting. The guidelines will address harvesting of both upland and wetland forests.
- **Benchmark 5:** The MFS will:
  - Continue to work with appropriate agencies and stakeholders to refine existing water quality BMPs and to develop a field handbook of wetland BMPs by June 1997;
  - Disseminate the field handbook widely to landowners, loggers, and foresters; and
  - Develop and implement a reliable, simple, low-cost method for assessing compliance with water quality and wetland BMPs.

Criterion 3: Productive Capacity and Quality of the Timber Resource

Goal: Improve the productive capacity of the forest and the quality of the timber resource to sustain a stable or, if possible, increasing harvest of quality forest products and support a diversified forest products industry

- **Benchmark 1:** Total and species group harvest activity will not exceed sustainable levels for any rolling ten-year average. Sustainable harvest levels will be determined by computer modeling that incorporates growth, yield and management scenarios. Analyses will attempt to verify that current and planned harvest levels are consistent with projected future growth and yield.
- **Benchmark 2:** By 1998, the MFS should develop a process for assessing the impact of changes in public policy or land use patterns on the productivity of commercial forest lands. In addition, the MFS should review and assess the effectiveness of state laws in encouraging landowners to achieve the benchmarks, e.g., the Tree Growth Tax Law, Farm and Open Space Tax Law, and income and estate taxes.
- **Benchmark 3:** By 1997, all harvests of commercial forest products should be guided by silvicultural principles that ensure the long-term productivity of the forest.
- **Benchmark 4:** By 1998, Maine will implement a penalty mechanism that reduces the incentive for liquidation harvests.
- **Benchmark 5:** 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 1% per year until potential sustainable harvest levels are doubled from 1996 potential sustainable harvest levels.
- **Benchmark 6:** Landowners' use of professional forest management in harvesting decisions will increase to 100% by 2010.

Criterion 4: Aesthetic Impacts of Timber Harvesting

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

- **Benchmark 1:** By 2000, all forest landowners will demonstrate a good-faith effort to minimize the negative aesthetic impacts of forest management operations.
  - The Department of Conservation, in collaboration with interested stakeholders, should:
    1. Refine the voluntary aesthetics BMPs and produce a field handbook by June 1998;
    2. Disseminate the field handbook widely to landowners, loggers, and foresters; and,
    3. Develop and implement a reliable, simple, low-cost method for assessing the public's perception of the aesthetic impacts of timber harvesting by June 1998.
  - All harvest operations should incorporate voluntary BMPs for the protection of aesthetic values by the year 2000.

Criterion 5: Biological Diversity

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

- **Benchmark 1: Benchmark 1:** For landowners who own over 500 contiguous acres, mature, multi-story forests should eventually cover a significant portion of their ownership.[1] Because many of the issues associated with this criterion remain unresolved, the council recommends:
  - An analysis of the most recent USFS forest inventory data with respect to stand age, composition, and structure;
  - The formation of a technical advisory group;
  - The development of benchmark parameters for maintaining a diversity of forest maturity classes and structures appropriate to Maine conditions, including plantations; and,
  - The identification of implementation strategies while mitigating potential conflicts between these goals and those outlined in Criterion 3.

These tasks should take the council no longer than five months following the availability of USFS data.

[1] To attain the benchmarks related to ecosystem type and maturity class, landowners would use a management approach based on *landscape planning units* (LPUs). The benchmarks outlined in this section, or in the recommended follow-up process, would eventually be met on each LPU.

- **Benchmark 2:** By 1998, the state will strengthen existing programs that encourage private landowners to protect fragile or rare ecosystems and endangered species of animals and plants.
- **Benchmark 3:** By 1999, the state will establish a program to protect a representative array of all native ecosystem types. Protected areas will be well distributed across the state and will be located on public lands, existing private conservation lands, and, when representative examples cannot be found on these, on private lands, if possible. The council recommends that:
  - Reserve selection and design be driven by principles of conservation biology; and,
  - Private land dedication or acquisition occur on a willing landowner basis only.
- **Benchmark 4:** By 1998, forest operations will incorporate appropriate measures to maintain key habitat elements, especially those associated with later successional stages, following guidelines in "A forester's guide to managing wildlife habitat in Maine" or subsequent revisions. These guidelines should be used in conjunction with and not in conflict with Occupational Safety and Health Administration logging safety guidelines.
- **Benchmark 5:** Areas converted from natural forests to plantations should comprise no more than 15% of the state's land area, 20% of an ownership (or 200 acres, whichever is greater), or 25% of a LPU. These limits can be exceeded if additional plantations are mitigated by allocating a commensurate acreage to permanently unharvested areas or designated ecological reserves.
- **Benchmark 6:** By 1999, forest landowners and managers manage forests to minimize the need for insecticides and herbicides.

Criterion 6: Opportunities for Traditional Recreation

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

- **Benchmark 1:** By 1998, the Departments of Conservation and Inland Fisheries and Wildlife will conduct a thorough review of public recreation policies for consistency in encouraging continued public recreational access to forest lands while recognizing and protecting landowners' constitutional rights of private property ownership.
- **Benchmark 2:** By 1998, the Department of Inland Fisheries and Wildlife will increase participation in cooperative projects between forest landowners, public agencies and other interests to collaborate in the development of management policies that conserve the habitats of popular species.
- **Benchmark 3:** The natural resource agencies and interested stakeholders should continue to collaborate on such initiatives as the Governor's Council on Sportsman/ Landowner Relations. The natural resource agencies should also identify common themes and recommendations from the various recreation management initiatives undertaken over the last ten years, and implement those recommendations.
- **Benchmark 4:** The legislature should revise the Tree Growth Tax program to allow an additional reduction in land valuation or establish, or establish other incentives, for enrolled landowners who allow nonmotorized, public recreational access.

Criterion 7: Competence and Public Accountability of Forest Owners and Managers

Goals: To broaden the practice of sustainable forestry through education of all members of the forest products chain and to demand a certain level of competence and professional responsibility in all forest operations

- **Benchmark 1:** By 1998, the Department of Professional and Financial Regulation should place appropriate legal responsibility for complying with timber harvest and environmental regulations with those materially participating in timber harvesting operations by instituting and/or amending the licensing and continuing education requirements for such persons. Materially participating means those who are (1) engaged in the business of harvesting timber or other forest products for hire or profit; and/or (2) landowners who harvest more than 50 cords per year on their own land. Individual employees of contractors and employees of subcontractors should not be subject to licensing requirements.
- **Benchmark 2:** Increase the quality of all forest management operations beyond compliance with regulatory minimums by increasing participation of forest landowners and forest management personnel in certification programs. Financial incentives can assist in the achievement of this benchmark.
- **Benchmark 3:** Increase the use of professionally trained personnel in forest management operations. The MFS will initiate an outreach program so that by 2010, all landowners will have professional advice before they harvest timber.
- **Benchmark 4:** Increase knowledge, understanding and cooperation in solving statewide forest management concerns by:
  - Requiring the MFS to monitor and report annually to the Governor and Legislature on the status of Maine's forests and Maine's performance in complying with sustainable forest management criteria. This report could address the effectiveness of licensing and financial incentives in promoting certification of woods contractors and landowners; and,
  - Instituting forestry roundtable discussions among the many stakeholders to discuss forestry issues and to review data pertaining to forest management in the state on an ongoing basis.

Criterion / Year	Begin Action Now[1]	1997	1998	1999	2000	2007	2010
Criterion 1	B-1, B-2		B-3 (June)			B-3 impl.	
Criterion 2	B-1b, c	B-5 (June)	B-3 (June), B-4 (June)	B-1a, B-2 (June)			
Criterion 3	B-1, B-5	B-3	B-2, B-4				B-6
Criterion 4					B-1		
Criterion 5	B-1, B-5		B-2, B-4	B-3, B-6			
Criterion 6	B-3, B-4		B-1, B-2				
Criterion 7	B-2, B-4		B-1				B-3
Criterion / Year	Begin Action Now	1997	1998	1999	2000	2007	2010

[1] As noted in the body of the report, achievement of the benchmarks may take many years in some cases.

Overview

Introduction

Governor Angus S. King, Jr. established the Maine Council on Sustainable Forest Management (MCSFM) by Executive Order No. 11 FY 94/95 on April 25, 1995. He charged the council with four tasks:

- Define forest sustainability in practical terms, feasible for implementation by all landowners;
- Recommend *criteria*[2] and *goals* to ensure a sustainably managed forest;
- Recommend a methodology for the Department of Conservation (DOC) to *monitor* forest landowners' progress toward achievement of forest sustainability goals; and,
- Review and assess Maine's forest practices rules and regulations for their adequacy in achieving sustainable forest management, and recommend changes where necessary.

The council's mission

To develop practical, credible benchmarks of forest sustainability against which landowners can assess their forest management practices.

In partial fulfillment of its mission, the council has developed a definition of sustainable forest management, and criteria, goals, and *benchmarks* for sustainable forest management in Maine.

History

The MCSFM concept appeared in the final recommendations of the Northern Forest Lands Council (1994a), or NFLC; however, the council's roots can be traced to a number of legislative initiatives in Maine over the last several years. Those initiatives include the 1989 Forest Practices Act (12 MRSA 8867 *et seq*.); LD 1764, An Act to Preserve Productive Forests (116th Maine Legislature); and, LD 1347, An Act to Require a Silvicultural Basis for Harvesting that Produces Understocked Stands (117th Maine Legislature).

During its initial work phase, the NFLC did not address the issue of forest practices, considering it outside the scope of its mission. The public expressed strong concern, however, about forest practices during the NFLC's regular meetings and public listening sessions (NFLC, 1994a, 1994b). A broad spectrum of the public expressed serious concerns that current forest management practices and policies, including *clearcutting, liquidation harvesting, high-grading,* pesticide use, and increased mechanization, would not sustain the forest's many nontimber values, such as water quality, critical plant and wildlife habitat, soil productivity, and *traditional recreation*. The public's concerns about current forest management extended to the impacts on the long-term viability of forest-dependent human communities, employment opportunities, and the state's economy. Largely in response to these

[2] Key words defined in this report appear for the first time in italics. Some key words are defined in sidebars, but all are defined in Appendix 2.

concerns, the NFLC recommended in its final report that the states should assess whether current forest practices, programs, and regulations achieve the Principles of Sustainability (see Appendix 6) and, if found deficient, should implement actions to achieve these principles.

Maine people have also expressed their concerns through other avenues, as evidenced by the legislative initiatives mentioned above. The MCSFM represents the state's concerted effort to address people's concerns head-on and to deal with potential problems in a forthright manner.

A snapshot of the forest and the forest economy

- Maine has approximately 17 million acres of commercial forest land. This acreage has remained relatively constant since the first federal forest inventories in 1959. Forests cover 89% of the state's total land base. Ninety-six percent of this land is in private ownership, approximately 50% in large commercial ownerships of over 100 thousand acres. Maine leads the nation in all the preceding statistics (Birch, 1986 and 1996).
- Of these 17 million acres:
  - About 6 million acres are held by 109,000 small woodland owners in lots of 10 to 1,000 acres; and,
  - About 10.7 million acres are held by larger owners (including industrial and large, non-industrial holdings) in lots of 1,000 acres or more. Municipal, Native American and miscellaneous smaller holdings constitute the balance of ownerships.

New information about the forest forthcoming

The data from the fourth USFS forest assessment will be available for analysis by August, 1996. Historically, this data has been used principally to calibrate computer models assessing sustainable timber harvest levels. An opportunity now exists to use the new data to assess a broader range of forest parameters including:

- The characteristics of forest structure (e.g., tree height and the range of tree diameters);
- The amount of woody material on the ground; and,
- The variety of forest stand types.

The review of this data can help determine trends in Maine's forests and will assist in the development of reliable benchmarks for future comparison. Combined with the monitoring of conditions in ecological reserves, this analysis can provide the framework for assessing the long-term impacts of forest management activities on the overall health and condition of Maine's forests.

- About 570,000 acres are owned by the state's DOC (Bureau of Parks and Lands). Of these public holdings, about 350,000 acres can be relied upon to produce a regular flow of forest products.
- Maine's total timber harvest was about 6.1 million cords (equivalent measure) in 1994. Of this amount, 2.6 million cords (42%) were harvested for sawtimber, 2.9 million cords (48%) for pulp, and 0.6 million cords (10%) for *biomass* chips (DOC, MFS, 1995a).
- Maine exported 0.8 million cords of wood in 1994, or 13% of domestic harvest. Sawlogs constituted 82% of the export volume, while pulpwood constituted 15%. During the same period, Maine imported 1.2 million cords of wood, or 18% of all wood processed in Maine. Pulpwood constituted 62% of imports, while sawlogs constituted 33% (DOC, MFS, 1995a).
- In 1993, Maine's lumber, wood products, and paper industries produced goods and services valued at $4.7 billion (Maine Department of Labor, 1995a). In 1995, these

industries provided direct employment to 26,000 people (nearly 30% of all manufacturing employment) and accounted for 38% of Maine's manufacturing value added (Field, 1995; Maine Department of Labor, 1995b).

- After more than 250 years of timber harvesting, Maine's forests support a softwood lumber production level of approximately 70% of the peak year of 1909 (Maine Forest Products Council, 1995).

Despite Maine's leadership in the forest products sector, the public has expressed great concern about whether Maine's forests can continue to support the same level of harvest and manufacturing activity. These concerns are key reasons for the council's creation.

A note on economic and labor issues

At its meetings and in public comments, the council heard many people express concerns about economic and labor issues. Chief among these concerns were:

- Raw log exports, labor imports, workers compensation issues, mechanization of timber harvesting, and their impacts on logging employment;
- Regional shortages of timber harvesting work for loggers;
- Piecework pay rates and their impact on loggers' safety and incomes; and,
- The impact of current forest practices and corporate decisions on the stability of local, forest-dependent communities.

The council heard these--and many other--concerns loud and clear. It has discussed these issues at length but has come to the conclusion that they lie beyond the council's mission as given by the Governor, and outside the areas of expertise represented on the council.

In choosing not to deal with these issues at this time, the council does not dismiss them. They are serious issues that must be debated, and, where possible, resolved in the public policy arena. While current economic trends do not offer much solace to out-of-work loggers or declining rural communities, Maine's quality of life, the future of rural communities, and the future direction of Maine's economic policy hinge on the outcome of such a debate. This debate should bring to the table as wide a representation of affected stakeholders as possible. It should attempt, at a minimum, to establish a common understanding of the problems, challenges, and barriers to rural prosperity; and, beyond that, general agreement on the policy steps that need to take place.

A Vision for Maine's Forests

We believe that Maine's forests can and should be well tended and productive, yet still retain their essentially *wild* character. Our wise stewardship will ensure that Maine's forests will always support a healthy diversity of native plant and animal species as well as a broad distribution of *mature trees*. Strategically chosen areas of intensively managed forests and permanently protected e*cological reserves* will diversify the general landscape, which will be managed with care for multiple uses and values. Maine's forests will remain an important component of the state's economy. They will support a diversity of products and services that will help to support local communities. Forest owners will be free to manage their lands creatively according to sound *silvicultural* principles, balancing their own interests with the forest's many public values. In recognition of forest landowners' commitment to maintaining these public values, public policy will foster long-term investments in forest land ownership and management.

We envision forest landowners, state government, and other stakeholders working together, inspiring increasing public confidence that Maine's forests will truly sustain economic, recreational, ecological, and spiritual values for this and future generations. We will achieve our vision when Maine's citizens feel secure about the future of their forests.

Measuring achievement

Simply defining a vision and goals for sustainable forest management will not ensure their realization. Measurable benchmarks, accountability standards, and monitoring procedures must be established. With measurable benchmarks, we can determine where we are at a given time, whether we have achieved a given goal, and, if not, how far we have to go.

Some of the benchmarks currently lack good data or measures. In these cases, the council has recommended a process for establishing a baseline and beginning monitoring. In the case of the forest inventory, new data will be available shortly (by the end of 1996), and we can adjust benchmarks as necessary.

Setting priorities

The council recognized early on that it could not undertake a detailed analysis of each proposed benchmark. Both time and resource constraints forced the council to focus on its highest priority issues. Therefore, our work should be considered a work in progress, subject to change as new information becomes available.

Getting there

We believe that our vision, goals, and benchmarks are achievable, and that all forest landowners will play an important role in their realization. However, we will not achieve them quickly. Achieving many of these goals may take several generations (60-80 years at minimum). It will take time to restore important forest *ecosystem* structures, functions, and dynamics that may be less than ideal now.

Achieving these benchmarks across the Maine landscape will involve costs: to landowners, to loggers, to mills, and to consumers. There is no easy, free solution, but **doing**

nothing carries many costs as well. Voluntary compliance with Best Management Practices (BMPs) will take us a long way; nevertheless, the public demands and expects accountability, so some additional regulation may be necessary. Simply enforcing existing laws will help, but this has costs as well. Where costs fall disproportionately on a particular group, public policy should provide some incentive or reward for doing the right thing. Conversely, public policy should not subsidize activities that result in less-than-excellent forest management. No one *policy tool* will suffice--a carefully deliberated mix of tools is needed to move Maine toward its goal of a sustainably managed forest.

Forest management and stewardship is a long-term enterprise. Poor decisions made today (either in management or in policy) may not be remedied for many years. A windstorm, fire, or insect infestation can wipe out years of good management overnight. Although some of the benchmarks may seem prescriptive, most are intended to guide rather than regulate a particular management direction. Policy makers must allow forest landowners some flexibility to determine how best to achieve these goals and benchmarks.

Defining Sustainable Forest Management

The council defines sustainable forest management as follows:

"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 definition and the criteria, goals, and benchmarks that follow should not be considered in isolation. Each cannot stand without the others.

Criterion 1: Soil Productivity

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

Introduction

Maintaining soil productivity is key to sustaining forests. Healthy associations of soil flora and fauna and forest vegetation constitute an important pathway in forest nutrient cycles. Such associations thus maintain forest productivity. Timber harvesting can significantly affect soil properties, including nutrient cycles and structure, because it can remove significant quantities of biomass from a forest. Such biomass removal can also have impacts on other resources and values, such as water quality, vegetation dynamics, aquatic ecosystems, wildlife habitat, recreation, and aesthetics. Sustaining forests requires maintaining proper soil structure, texture, and organic matter, as well as adequate nutrient levels. Forest management practices that maintain soil nutrient cycles and structure generally protect other resource values as well.

Any activity that removes biomass from the forest alters the forest nutrient balance, either temporarily or indefinitely. Soil nutrient loss studies, particularly the Weymouth Point Study, demonstrate that *whole tree clearcutting* (WTC) removes approximately 90% of above-ground nitrogen, phosphorus, potassium, calcium, and magnesium. While this amounts to less than 5% of total nutrient reserves, it can significantly affect the amount of exchangeable nutrients available for plant uptake. Absent the return of some harvesting residues to a given site, exchangeable nutrients available for plant uptake suffice for less than one rotation on infertile sites. Leaving behind tops and limbs that would otherwise have been removed returned 33% to 61% of the nutrients to the site. Studies also found that WTC increased nutrient leaching from the soil for three years following harvest (Cooperative Forest Research Unit, 1994; Smith, 1984a, 1984b, 1984c).

No level of government currently regulates the amount of biomass removed during a timber harvest (e.g., whole tree harvesting versus bole removal only). Research literature suggests that the choice of harvesting method has significant implications for nutrient cycles; therefore, the council suggests a number of practices that loggers and land managers can incorporate into their operations as appropriate. Besides presenting an excellent discussion of the impacts of WTC, Pierce *et al. (1993*) suggest management guidelines that complement the council's suggestions.

Poor timing of harvests, inattention to soil conditions, poor choice of equipment, or improper training in equipment use can result in unacceptable soil disturbance. Soil disturbance associated with timber harvesting has two significant impacts on the future forest. First, sites with exposed mineral soils provide significantly less available nitrogen to plants than sites with organic surface horizons. Second, harvesting can stimulate the germination of undesirable species such as pin cherry and raspberry while injuring the shallow root systems of spruce and fir and create seedbeds for annual plants such as fireweed. This last series of impacts can result in a proliferation of competing vegetation, and the problem intensifies as site quality improves (McCormack, 1984); however, some scarification of the soil surface is necessary and desirable to promote germination of such important species as white pine and white birch.

Accelerated soil loss due to human action manifests itself in several ways, including gully formation, sedimentation of water bodies, and exposure of subsurface soil layers. Exposed mineral soil along downhill skid trails often erodes when sufficient runoff exists. Besides reducing site productivity, such trails must often be relocated during subsequent harvests, further impacting the site. A healthy debate exists in the scientific and forest management community as to whether soil compaction in northern climates is a relatively short-lived effect due to the loosening action of frost. Some believe that frost heaving resolves most or all soil compaction problems within a few years; others believe that soil compaction creates long-term problems, such as the creation of *erosion nets* on slopes, before frost heaving restores soil physical properties.

Public regulation has dealt with the more egregious situations, while voluntary BMPs have helped land managers improve their practices. Existing laws, such as the Natural Resources Protection Act and the Mandatory Shoreland Zoning Act, serve mostly to prevent sedimentation of the state's waters. They are effective in reducing soil erosion proximate to protected natural resources; however, they do not address the disruption of the organic layer that often occurs during timber harvesting.

Benchmarks

- **Benchmark 1:** Minimize soil movement and disruption caused by forest operations to optimize nutrient uptake by desired tree species.
- **Benchmark 2:** Maintain an appropriate organic layer in harvest areas to optimize nutrient cycling and soil structure.
- **Benchmark 3:** The MFS will work with appropriate agencies and stakeholders to:
  - Develop a field handbook of regulations and voluntary BMPs for the protection of forest soils by June 1998;
  - Disseminate the field handbook widely to landowners, loggers, and foresters; and,
  - Develop and implement a reliable, simple, low-cost method for assessing compliance with soil protection BMPs.

  By 2007, the MFS should find annually, significant increases in compliance with these soil protection BMPs.

Recommended Best Management Practices for the Protection of Forest Soils

- Protection of soil nutrient cycles
  - Do not use WTC on less fertile sites[3] or seepage slopes, which should not be clearcut at all; leave slash in the woods or return slash to the harvest area.
  - Regardless of harvest method, leave no slash at the landing. Distribute all slash as evenly on the site as the harvesting technology in use allows.
  - If whole tree clearcutting, use an alternate harvest method at the end of the next rotation.
  - Revegetate all regeneration harvests within one year of harvest, and regenerate all regeneration harvests with trees within five years of harvest.
- Protection of soil organic horizons
  - Conduct all forest activities at times of the year appropriate for the harvest site. Avoid wet weather logging, shifting operations to nonsusceptible areas when susceptible areas are wet.
  - Harvest high altitude areas only when the soil is frozen. Any disturbance of the soil organic mat can result in erosion of these very delicate soils whose high altitude ecosystems cannot quickly recover from disturbance.
  - Use harvest machinery with long booms or high flotation type tires.
  - Plan yarding patterns before harvest. Concentrate main logging traffic on a few, well-planned trails.
  - Vegetate or mulch compacted areas.
  - Use low pressure bearing equipment.

[3] Less fertile sites are classified as 4 or 5 in the Briggs (1994) site index guide.

Criterion 2: Water Quality, Wetlands and Riparian Zones

Goal: Conserve water quality and quantity and the functions and values of wetlands and riparian zones

Introduction

In forested landscapes, *conservation* of water quality and quantity requires carefully managed *riparian zones* and functioning *wetlands*. Intact riparian zones moderate soil and water temperatures and *stream* flow, filter sediments and contaminants from surface flow, and stabilize shorelines. In addition, the *litter* provided by riparian vegetation provides the main energy source for aquatic food webs in small to mid-sized streams (Brinson *et al.*, 1981; Moring *et al.*, 1985; US Army Corps of Engineers, 1991).

Stream channel: A channel between defined banks created by the action of surface water and characterized by the lack of terrestrial vegetation or by the presence of a bed, devoid of topsoil, containing waterborne deposits or exposed soil parent material or bedrock (Land Use Regulation Commission, Land Use Districts and Standards, Chapter 10, as revised August 15, 1991).

Wetlands occupy about 25% of the state's land area. More than half of this total consists of forested wetlands (Widoff, 1988). Wetlands are important to the conservation of water quality and quantity because they (1) regulate water flow by detaining storm flows for short periods, thus reducing flood peaks; (2) protect lake and stream shores by buffering the erosive action of waves and other storm effects; and, (3) improve water quality by retaining or transforming excess nutrients and by trapping sediments and heavy metals (Welsch *et al.*, 1995).

In addition to the importance of riparian zones for conservation of water quality and quantity, these areas provide breeding grounds, wintering areas, nesting sites, and other critical habitats for a variety of plant and animal species (Welsch *et al.*, 1995). Riparian zones have high numbers of species when compared to upland habitat types (Gregory *et al.*, 1991; Thomas, 1979). The habitat most heavily used by terrestrial wildlife is within 600 feet of streams and open water (Brinson *et al.*, 1981). Although intact riparian zones of 75 feet are often recommended for stream protection, wildlife biologists often recommend considerably wider zones to maintain wildlife habitat (Marston and Donovan, 1984; Moring *et al.*, 1985). Finally, riparian zones along streams, ponds, lakes, and wetlands are extremely popular recreational areas, particularly for traditional activities such as fishing, hunting, camping, hiking, bird watching, and canoeing.

Forest management in riparian zones has a greater influence on the ecological processes in small streams than in large streams. Small streams may be completely shaded by the forest canopy, receive most of their nutrients from leaf litter, and be strongly affected by soil disturbance on adjacent uplands (Burton and Likens, 1973). In addition, management of forested wetlands and land adjacent to headwater streams and ponds influences the water quality and stream flow of all downstream waters. In spite of their importance, small headwater streams receive the least protection under Maine laws, and are of lower priority in BMP guidelines (Lynch *et al.*, 1985; DOC, MFS, 1994, 1991). Paired *watershed* studies throughout the United States document the impacts of timber harvesting on stream flow, flow timing, and wetland hydrology (Bosch and Hewlett, 1982; Hornbeck *et al.*, 1993); however, neither Land Use Regulation Commission (LURC) nor Department of Environmental Protection

(DEP) timber harvesting standards for shoreland zones and existing BMPs address water quantity. They also do not apply to forested wetlands.

To protect streams from sedimentation and temperature changes that result from timber harvesting, the state should ensure that all streams are buffered by windfirm stands with a continuous canopy closure of 65-70%, and that minimum standards and enforcement are uniform from town to town. Also, the state should have the will and provide the staff to enforce these standards. These conclusions are based on the following concerns and observations.

- Maine's current timber harvesting standards do not afford sufficient protection to headwater streams (*first, second*, and many *third order* streams). LURC standards leave P-SL2 streams inadequately protected (e.g., there is no 40% removal in ten years rule and no clearcutting restriction), and even if a 75-foot strip of trees is left on each side of the stream, it is often too narrow to be windfirm in some *forest types* and on some soils). In addition, some uncertainty exists as to the effectiveness of this strip in preventing sediment from reaching streams, especially in hilly terrain (Forestry Issues Committee, 1984). Although DEP's standards are generally more stringent than LURC's with respect to second and third order streams, they offer no protection to first order streams (DEP's stream definition excludes first order streams).

- Minimum standards for organized and unorganized towns differ, as does the definition of a stream (see above comment and Figure 1). The same stream can be zoned differently depending on the jurisdiction through which it passes. From a public policy standpoint, this inconsistency creates confusion. A clear need exists for a single set of minimum, statewide standards for timber harvesting in riparian zones. These standards should incorporate the benchmarks that follow and should be no less stringent than current DEP and LURC standards combined.

- An assessment of BMP compliance on harvested sites in Maine (Briggs *et al.*, 1996) found that compliance with BMPs resulted in little or no delivery of sediment to surface waters. Conversely, the study indicated that noncompliance with individual BMPs resulted in a marked increase in sediment movement to surface water. Haul roads and skidder trails are the major sources of sediment entering streams that drain managed forest land. More than half of the haul road BMPs had relatively low compliance rates. Perhaps more significant were the results of a landowner questionnaire which suggested that knowledge of and familiarity with BMPs is low, particularly among small woodland owners.

- Many fisheries biologists consider headwater streams unprotected. Warmer than normal temperatures in headwater streams can be caused by an inadequate streamside buffer or overland runoff that flows over soils exposed by clearcuts or herbicide applications. Current standards do not regulate the distance of clearcuts (or their size) from LURC P-SL2 streams or DEP first order streams.

- The 40% removal in ten years rule was developed to maintain a filter strip and serve as a visual buffer rather than to ensure stream shading. Under this standard, a stream buffer that initially provided adequate stream shading could be reduced to inadequate levels over a very short time. With each successive harvest, the basal area and canopy can be further reduced, until the residual stand approaches the minimum standard for a clearcut. For

example, assuming an initial basal area of 100 ft^2/acre and a 10-year growth rate of 20%, the residual basal area could be reduced to 48 ft^2/acre after two harvests in 11 years.

- Streams draining less than 300 acres in the LURC jurisdiction receive less protection than larger streams. Because these streams can be difficult to identify, particularly in winter, they are exempted from some timber harvesting standards. From a practical standpoint, this exemption seems reasonable as long as a significant amount of sedimentation does not occur and shading is maintained. LURC requires that sedimentation not exceed 25 Jackson Turbidity Units, measured at the point where a stream drains one square mile, rather than at the harvest site. LURC staff consider this standard unenforceable, because the measurement cannot be done at or near the harvest site, making it difficult to determine fault. Enforcement staff also face difficulty in determining the source of sedimentation after the fact, particularly if the event is of short duration.

- No standards currently address changes in the timing and volume of stream flows that result from timber harvesting. Anecdotal information in Maine and paired watershed studies in other northeastern states clearly indicate that timber harvesting--especially clearcutting--influences the volume, duration, and timing of stream flow. Very few data exist regarding what role forested wetlands play in forest hydrology. The impacts on aquatic species of changing hydrology due to forest management are also poorly understood.

- Although LURC receives some assistance from MFS staff in compliance monitoring, it lacks the staff to enforce adequately current standards. Six LURC staff enforce LURC standards on 10.4 million acres (an average of 75 towns per person). Much of their time is devoted to development-related issues. Enforcement is also insufficient in many organized towns, where Code Enforcement Officers are responsible for enforcing timber harvesting standards. Code Enforcement Officers often work part-time, their focus is on development-related violations, and they may not have sufficient training or support to enforce timber harvesting standards. As a result, aggressiveness of enforcement varies considerably among organized towns. Finally, although the state's current enforcement system may provide an idea of compliance rates, it provides no indication whether the standards are effective (e.g., regulatory programs do not monitor water quality).

Benchmarks

- **Benchmark 1:** Establish and maintain windfirm stands with a continuous canopy closure of 65-70% next to all streams (both perennial and intermittent) mapped on US Geological Survey 7.5-minute quadrangles.[4]
  - For unmapped streams: By 1999, establish or strengthen protection standards statewide that minimize sedimentation and maintain shading.
  - For mapped first and second order streams: Establish and maintain 65-70% canopy closure within 75 feet. No clearcutting within 250 feet.
  - For third and higher order streams: Establish and maintain 65-70% canopy closure within 250 feet.
- **Benchmark 2:** By June 1999, evaluate the effectiveness of fixed and variable stream protection zones in protecting the water quality of first and second order streams (mapped and unmapped) and make recommendations for a stricter standard if necessary.
- **Benchmark 3:** By June 1998, adopt uniform riparian zone timber harvesting standards for the state and establish an effective enforcement program. These statewide standards should be no less stringent than current DEP and LURC standards combined.
- **Benchmark 4:** By June 1998, develop watershed-level guidelines for moderating the effects on stream flow of timber harvesting. The guidelines will address harvesting of both upland and wetland forests.
- **Benchmark 5:** The MFS will:
  - Continue to work with appropriate agencies and stakeholders to refine existing water quality BMPs and to develop a field handbook of wetland BMPs[5] by June 1997;
  - Disseminate the field handbook widely to landowners, loggers, and foresters; and,
  - Develop and implement a reliable, simple, low-cost method for assessing compliance with water quality and wetland BMPs.

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[4] While relying on US Geological Survey 7.5-minute quadrangles provides a common frame of refererence for all towns, ultimately similar timber harvesting standards should apply to all first order streams that have clearly identifiable channels, whether they are mapped or not.

[5] The 1995 USFS publication, "Forested wetlands: Functions, benefits and the use of Best Management Practices (Welsch *et al*., 1995)," provides a comprehensive list of BMPs that could serve as a starting point for discussion.

Figure 1. Comparison of DEP and LURC timber harvesting standards

Standards - LURC		Standards - DEP	
P-SL1 (major flowing waters): drain > 50 square miles; 250' zone.	**P-SL2 (minor flowing waters): drain < 50 square miles; 75' zone.**	**River: drains > 25 square miles; 250' zone.**	**Stream: drains < 25 square miles; 75' zone.**
40% rule. (10.17.5b(3))#	No 40% rule. Harvesting operations shall be conducted to maintain shading of the surface water. (No guidelines provided). (10.17.5h)	40% rule. (15.0.2a)	40% rule. (15.0.2a)
No clearcuts within 50' of stream; between 50-250' single opening maximum=14,000 square feet; 100' separation zone required for openings > 10,000'. (10.17.5b(2))		No clearcut openings within 75' of river*; between 75-250'; single opening maximum=10,000'; 100' separation zone required for openings > 5,000'. (15.0.2a)	No clearcut openings within 75'. (15.0.2a)
No slash within 50' of NHWM+; between 50-250' slash > 3" diameter must be less than 4' off ground. (10.17.5b(4))	No slash in stream channel. (10.17.5d)	No slash within 50' of NHWM+; between 50-250' slash must be < 4' off ground. (15.0.2c)	No slash within 50' of NHWM+ or greater than 4' off ground. (15.0.2c)
Unscarified filter strip; varies with slope; minimum width = 25'. (10.17.5c)	Unscarified filter strip; varies with slope; minimum width = 25'; 300 acre exemption.^ (10.17.5c)	Unscarified filter strip; varies with slope; minimum width = 75'. Standard is more stringent than LURC for all slopes. (15.0.2g)	Unscarified filter strip; varies with slope; minimum width = 75'. (15.0.2g)
No skid trails or roads in stream channel unless frozen; diversion standard exists. (10.17.5a)	No skid trails or roads in stream channel except when frozen; 300 acre exemption^: trail crossing standards less stringent than for P-SL1 streams. (10.17.5e)	No harvesting equipment in channel unless frozen and no ground disturbance results; diversion standard exists. (15.0.2d)	No harvesting equipment in channel unless frozen and no ground disturbance results; diversion standard exists. (15.0.2d)
Land management roads permitted.	Land management roads permitted.	No land management roads within 75' of river except for water crossings. (15.H.1)	No land management roads within 75' of stream except for water crossings. (15.H.1)

Numbers in parentheses correspond to standards of LURC Chapter 10.17 and 8/7/94 State of Maine Guidelines for Municipal Shoreland Zoning Ordinances.
+ NHWM=Normal High Water Mark
*DEP standards are more stringent than this for rivers flowing into great ponds.
^P-SL2 standards don't apply to streams draining 300 acres or less if stream sedimentation is less than 25 Jackson Turbidity units. The turbidity limit is measured at the 1 square mile drainage point, not at the site where the activity is taking place. This standard is considered unenforceable.
Some notes on scale: 1 square mile=640 acres; 25 square miles=16,000 acres; 50 square miles=32,000 acres; size of an average township = 23,040 acres.

Definitions - LURC	Definitions - DEP
Stream Channels: A channel between defined banks created by the action of surface water and characterized by the lack of terrestrial vegetation or by the presence of bedrock, devoid of topsoil, containing water borne deposits or exposed soil parent material or bedrock.	**Stream:** A free-flowing body of water from the outlet of a great pond or the point of confluence of two perennial streams as depicted by a solid blue line on the most recent edition of a USGS 7.5' series topographic map, or if not available a 15' series topographic map, to the point where the body of water becomes a river or flows to another water body or wetland within the shoreland area. *This definition does not include first order streams.*
P-SL1 Subdistrict: Areas within 250' of the normal high water mark of (a) tidal waters and (b) flowing waters downstream from the point where such waters drain 50 square miles or more. *P-SL1 streams are typically third, fourth or higher order streams.*	**River:** A free-flowing body of water including its associated wetlands from that point at which it provides drainage for a watershed of 25 square miles to its mouth.
P-SL2 Subdistrict: Areas within 75' of the normal high water mark of (a) stream channels upstream from the point where such channels drain 50 square miles, (b) coastal and inland wetlands zoned as P-WL and, (c) standing bodies of water < 10 acres in size, but excluding standing bodies of water which are < 3 acres in size and which are not fed or drained by a flowing water. *P-SL2 streams are typically first, second or third order streams.*	**Tributary Stream:** A channel between defined banks created by the action of surface water, whether intermittent or perennial and which is characterized by the lack of upland vegetation and by the presence of a bed devoid of topsoil containing water borne deposits on exposed soil; parent material or bedrock, and which flows to a waterbody or wetland as defined. This definition does not include the term "stream" as defined elsewhere in this ordinance and only applies to that portion of the tributary stream located within the shoreland zone of the receiving water.
	Shoreland Zone: The land located within 250' horizontal distance of the normal high water line of any great pond, river or salt water body; within 250' of the upland edge of a coastal or freshwater wetland; or within 75' of the normal high water line of a stream.

Criterion 3: Productive Capacity and Quality of the Timber Resource

Goal: Improve the productive capacity of the forest and the quality of the timber resource to sustain a stable or, if possible, increasing harvest of quality forest products and support a diversified forest products industry

Introduction

Sustaining the harvest and balancing age classes

The fundamental public policy question that the council must address is, "Can we sustain Maine's recent (1985-1995) harvest levels of 6.225 million cords?" The dominant factor influencing a continuous flow of wood products lies in the overall balance of age structure in Maine's forests. For timber production purposes, the ideal "balanced" age structure entails approximately equal representation of all age classes (usually 10-year groupings) across the landscape, up to the chosen rotation age (typically 60-80 years).

The actual structure of Maine's forests does not fit this ideal. Large scale influences, such as spruce budworm outbreaks that kill trees on thousands of acres and the reversion of abandoned farm land to forest, have shaped Maine's forests such that they now have a substantially unbalanced development class structure. Computer simulation models that "grow" and "harvest" the forests depend upon good information about stand structure. Modeling techniques for predicting overall from the forests require simplifying the complicated stand structures found in Maine's forests to fit generic structures such as those outlined in Criterion 5.

Computer simulation models which project tree growth, management actions, and harvest levels offer the best assessment of future harvest levels that Maine's forests can sustain. Continuous improvement of these models, matched with new data about forest conditions, will improve the quality of these analyses.

Total wood harvest is a function of forest land area, growth and mortality, management practices, and market demand for forest products. Overall market demand and manufacturing potential determine the annual harvest levels from Maine's forests. The benchmarks for this criterion address meeting present demand and accommodating potentially increasing demand, while striking a balance with the objectives of the other sustainable forest management criteria.

Current forest practices

No single issue has catalyzed public concern about Maine's forests more than clearcutting. Clearcutting that lacks a silvicultural basis is ecologically more disruptive, creates more profound aesthetic impacts[6], and often limits future options more so than less intensive harvest methods. Poorly conducted nonregeneration harvests however, can also have severe negative impacts on future forest productivity.

Clearcutting is both a logging practice and a silvicultural method. This has generated considerable confusion. Several logging practices that remove most or all of the overstory (e.g., shelterwood and seed tree harvests) are often mistaken for clearcuts, adding to the

[6] Any clearcut, whether silviculturally justified or not, will have short-term aesthetic impacts.

Benchmarks

w **Benchmark 1:** Total and species group (see sidebar) harvest activity will not exceed sustainable levels for any rolling ten-year average. Sustainable harvest levels will be determined by computer modeling that incorporates growth, yield and management scenarios. Analyses will attempt to verify that current and planned harvest levels are consistent with projected future growth and yield.

Species groups for statewide modeling of forest sustainability

w**Spruce:** white, black, and red

w**Balsam fir**

w**Hemlock**

w**White pine**

w**Cedar**

w**Other Softwoods:** red pine, tamarack, pitch pine, Jack pine

w**Northern Hardwoods:** sugar maple, red maple, yellow birch, beech, red oak, white oak, white ash, black ash

w**Intolerant Hardwoods:** white birch, gray birch, aspen

Analysis

{ The MFS will perform statewide analyses and subject them to peer review.

{ Analyses will project at least 40 years into the future.

{ The MFS will identify a means of collecting statewide data every 5 years to augment the USFS's decennial forest survey with a midcycle inventory.

{ If any species within a species group is identified to be of particular concern, it may be separated out for individual tracking and analysis.

{ The MFS will be responsible for modeling the impacts of regulations and public policies on biologically sustainable harvest levels.

{ Landowners holding more than 50,000 acres will be expected to conduct analyses of total and species group harvest on their individual holdings. These analyses would be part of any certification process. Landowners holding between 500 and 50,000 acres should ensure that their harvests do not exceed sustainable levels based on state or regional average growth rates; however, they will not be expected to perform modeling.

Clarifications

{ Achieving this benchmark will require considerable flexibility on the part of policy makers, as market and forest conditions (e.g., insect infestations, disease, weather damage) may require that harvest levels rise or fall relative to sustainable levels for short periods of time. In such cases, it may be appropriate to compare harvests against a rolling average longer than ten years.

{ The MFS should create an appropriate policy response to a rise in statewide harvest levels (in the aggregate or for an individual species) above sustainable levels.

- { Landowners who have substantially achieved this benchmark (or will in the near future) should not be subject to additional restrictions to offset the failure of others to achieve it.

w **Benchmark 2:** By 1998, the MFS should develop a process for assessing the impact of changes in public policy or land use patterns on the productivity of commercial forest lands. In addition, the MFS should review and assess the effectiveness of state laws in encouraging landowners to achieve the benchmarks, e.g., the Tree Growth Tax Law, Farm and Open Space Tax Law, and income and estate taxes.

w **Benchmark 3:** By 1997, all harvests of commercial forest products should be guided by silvicultural principles that ensure the long-term productivity of the forest.

Regeneration harvests

- { Harvest methods should promote future stand growth. Regeneration harvests should be used primarily on understocked stands, where the overstory is mature and impedes understory development. When prescribed, regeneration harvests should identify the stocking level that should be achieved within a specified time of overstory removal. The MFS should develop recommended species- and stand-specific stocking guides.

- { In general, regeneration harvests should maintain or improve preharvest stand composition, favoring high-value, long lived species that do not thrive when subject to frequent, major disturbances.

- { The use of clearcutting should be limited; it may be used when silviculturally justified and when alternative harvest methods will not produce a stand that fulfills sustainability objectives.

Nonregeneration harvests

- { Well-stocked stands should be treated with appropriate partial cutting practices that leave adequate residual stocking. Adequate stocking is considered to be between the B line and C line, as measured by stocking or other silviculturally based guidelines. Quality and species composition of the residual stand should equal or improve upon the preharvest condition.

- { Where necessary, stands should be marked by foresters with demonstrated silvicultural expertise. Diameter-limit cutting and other high-grading practices should be avoided.

General principles

- { Forest managers should apply harvest prescriptions on a stand-by-stand basis, paying careful attention to ecological boundaries and avoiding geometric harvest unit layouts.

- { On larger ownerships, treat stands at the right time. Harvest plans should be guided by long-term, strategic analysis of sustainable harvest levels (Criterion 3, Benchmark 1) and should meet landscape level ecological goals (Criterion 5, Benchmark 1).

policy aimed at reducing liquidation harvesting. Vermont first instituted a "land gains tax" in 1973 (32 VSA Chapter 236 *et seq.*). It could serve as model legislation for Maine. Other tax penalty mechanisms may work to reduce liquidation harvesting as well.

Intensive forest management

Harvest yields from individual sites in Maine's forests could improve substantially with wider application of intensive, *high-yield silvicultural* practices. Seymour (1992) found that yields from individual sites subjected to high-yield silvicultural practices range from 0.9 to 2.1 cords/acre/year. Such levels represent from 2.5 to 6 times the historic yields from Maine's forests.

The ability of forest landowners to establish plantations on fertile sites and to employ other yield-increasing practices on other appropriate sites is critical to maintaining or increasing current growth and harvest levels, and to offsetting any productivity losses that result from implementation of other sustainability benchmarks. High-yield silvicultural practices increase tree and stand value, improve average tree vigor and form, and reduce *cull*. The practices include:

- Partial harvesting to improve or maintain stands stocked with vigorous trees of good form;
- Underplanting and interplanting desirable species to increase the proportion of valuable species in existing stands;
- Use of even-aged management techniques to replace low-productivity stands with high-productivity stands;
- Use of specific silvicultural techniques on suitable sites to ensure regeneration of high-value species;
- Species control measures and precommercial thinning; and,
- Planting genetically improved trees with better growth.

Theoretically, the forest has the biological capability, and Maine's forest industry has the technological capacity, to increase fiber yields substantially. However, economic restraints and the growing public desire for

Herbicide and insecticide use in intensive forest management

Forest managers currently use herbicides to control competition between more valuable conifer species and less valuable hardwood and brush species and, to a far lesser extent, to prepare sites for planting. They also use insecticides to combat serious insect infestations. Currently used herbicides can help maintain soil and forest productivity, as they reduce the need to mechanically disturb sites to prepare seedbeds for natural regeneration or planting. Such mechanical disturbance can cause erosion and stimulate the sprouting of undesirable species.

Forest landowners currently apply herbicides to just over 50 thousand acres in Maine each year (Maine Department of Conservation, MFS, 1995a). This represents a slight decrease over the previous year, and a sharp decrease since 1989; however, herbicide applications have increased by about 50% since 1990-1992.

During the recent spruce budworm infestation (1970-1985), forest managers and the Department of Conservation conducted a massive spraying program to reduce mortality of mature balsam fir and spruce. The program began using Fenitrothion and Zectran, and evolved to using Bacillus thuringiensis, a "natural" insecticide. Carbaryl, however, was by far the most-used insecticide. Insecticides were applied to an average of 1.2 million acres annually. By reducing or delaying mortality, the program allowed forest landowners to salvage much timber from trees which would otherwise have died and rotted. While some level of tree mortality and rot is necessary to sustain forest nutrient cycles and provide habitat for a multitude of plants and animals, the anticipated level of mortality would have created a superabundance of dead, dying and rotting trees that would have been unacceptable from a societal perspective. The spraying may have had the unintended consequence of lengthening the "natural" mortality pattern, leading to some diversification of age classes in the stands regenerated following death or salvage.

The goal of high-yield silviculture is to maximize the fiber yield from a particular site in the shortest amount of time. To accomplish this goal, landowners must make investments that maximize the chance that a site will regenerate quickly to desirable species, minimize the effects of competing vegetation on those species, and maximize the growth potential of a site. Many, but not all, forest managers consider the judicious use of pesticides (particularly herbicides) essential to achieving the goal of high-yield silviculture.

forests managed with greater attention to nontimber needs will temper the theoretical yield increases.

Timber quality

Society and landowners reap substantial economic benefits from growing and harvesting high quality timber. Higher quality provides the potential for greater economic gains and increased marketing flexibility of forest products. As the real value of forest products increases, landowners have greater ability to achieve sustainability principles that may not have tangible economic value.

Consideration of what constitutes "value added" to timber depends on the landowner's situation. Owners integrated with a pulp and paper facility realize a substantial gain on the value of pulpwood entering the mill. This gain makes the difference in value between pulpwood and sawtimber much smaller than is apparent from stumpage prices. For landowners not integrated with a manufacturing facility, growing a high quality stand for multiple products allows them to capture as much value as possible at the stump. Loggers also benefit from the latter approach, as the spread between stumpage and mill-delivered prices is generally much greater for sawtimber and veneer wood.

Measures of value at both the species and product level vary over time. Many species unmarketable in the past now have value. Specifications for sawlogs have changed as well. This makes benchmarks associated with sawlogs or species problematic.

Incentives for improving forest practices

Few question the premise that forest practices statewide can be improved. The debate is over which policy tools should be used to achieve the improvement. Regulations (e.g., water quality standards) protect the public interest; however, some argue that regulations set the lowest common denominator. Others argue that the current regulatory framework does not protect the public interest. Both perspectives have merit. Landowner incentives, however, constitute an important tool in the policy mix. When properly implemented and monitored for effectiveness, incentives (particularly those of a financial nature) can stimulate forest landowners to practice excellent forest management. Conversely, financial disincentives can discourage unsustainable forest management practices. The council endorses use of the full range of policy tools to protect the public interest and encourage realization of the benchmarks.

Benchmarks

w **Benchmark 1:** Total and species group (see sidebar) harvest activity will not exceed sustainable levels for any rolling ten-year average. Sustainable harvest levels will be determined by computer modeling that incorporates growth, yield and management scenarios. Analyses will attempt to verify that current and planned harvest levels are consistent with projected future growth and yield.

Species groups for statewide modeling of forest sustainability

w**Spruce:** white, black, and red

w**Balsam fir**

w**Hemlock**

w**White pine**

w**Cedar**

w**Other Softwoods:** red pine, tamarack, pitch pine, Jack pine

w**Northern Hardwoods:** sugar maple, red maple, yellow birch, beech, red oak, white oak, white ash, black ash

w**Intolerant Hardwoods:** white birch, gray birch, aspen

Analysis

{ The MFS will perform statewide analyses and subject them to peer review.

{ Analyses will project at least 40 years into the future.

{ The MFS will identify a means of collecting statewide data every 5 years to augment the USFS's decennial forest survey with a midcycle inventory.

{ If any species within a species group is identified to be of particular concern, it may be separated out for individual tracking and analysis.

{ The MFS will be responsible for modeling the impacts of regulations and public policies on biologically sustainable harvest levels.

{ Landowners holding more than 50,000 acres will be expected to conduct analyses of total and species group harvest on their individual holdings. These analyses would be part of any certification process. Landowners holding between 500 and 50,000 acres should ensure that their harvests do not exceed sustainable levels based on state or regional average growth rates; however, they will not be expected to perform modeling.

Clarifications

{ Achieving this benchmark will require considerable flexibility on the part of policy makers, as market and forest conditions (e.g., insect infestations, disease, weather damage) may require that harvest levels rise or fall relative to sustainable levels for short periods of time. In such cases, it may be appropriate to compare harvests against a rolling average longer than ten years.

{ The MFS should create an appropriate policy response to a rise in statewide harvest levels (in the aggregate or for an individual species) above sustainable levels.

- { Landowners who have substantially achieved this benchmark (or will in the near future) should not be subject to additional restrictions to offset the failure of others to achieve it.

w **Benchmark 2:** By 1998, the MFS should develop a process for assessing the impact of changes in public policy or land use patterns on the productivity of commercial forest lands. In addition, the MFS should review and assess the effectiveness of state laws in encouraging landowners to achieve the benchmarks, e.g., the Tree Growth Tax Law, Farm and Open Space Tax Law, and income and estate taxes.

w **Benchmark 3:** By 1997, all harvests of commercial forest products should be guided by silvicultural principles that ensure the long-term productivity of the forest.

Regeneration harvests

- { Harvest methods should promote future stand growth. Regeneration harvests should be used primarily on understocked stands, where the overstory is mature and impedes understory development. When prescribed, regeneration harvests should identify the stocking level that should be achieved within a specified time of overstory removal. The MFS should develop recommended species- and stand-specific stocking guides.

- { In general, regeneration harvests should maintain or improve preharvest stand composition, favoring high-value, long lived species that do not thrive when subject to frequent, major disturbances.

- { The use of clearcutting should be limited; it may be used when silviculturally justified and when alternative harvest methods will not produce a stand that fulfills sustainability objectives.

Nonregeneration harvests

- { Well-stocked stands should be treated with appropriate partial cutting practices that leave adequate residual stocking. Adequate stocking is considered to be between the B line and C line, as measured by stocking or other silviculturally based guidelines. Quality and species composition of the residual stand should equal or improve upon the preharvest condition.

- { Where necessary, stands should be marked by foresters with demonstrated silvicultural expertise. Diameter-limit cutting and other high-grading practices should be avoided.

General principles

- { Forest managers should apply harvest prescriptions on a stand-by-stand basis, paying careful attention to ecological boundaries and avoiding geometric harvest unit layouts.

- { On larger ownerships, treat stands at the right time. Harvest plans should be guided by long-term, strategic analysis of sustainable harvest levels (Criterion 3, Benchmark 1) and should meet landscape level ecological goals (Criterion 5, Benchmark 1).

- { All harvests should incorporate provisions for wildlife habitat (Criterion 5, Benchmark 4).

- **Benchmark 4:** By 1998, Maine will implement a penalty mechanism that reduces the incentive for liquidation harvests.

- **Benchmark 5:** 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 should rates increase 1% per year until potential sustainable harvest levels are doubled from 1996 potential sustainable harvest levels.

- **Benchmark 6:** Landowners' use of professional forest management in harvesting decisions will increase to 100% by 2010.

Use of professional forester supervision on timber harvests[1]

Acreage class	1991 Acres	1991 Percent	1994 Acres	1994 Percent
1-1000	42,042	40%	57,775	44%
1001-5000	12,399	60%	21,356	74%
5001+	293,515	94%	329,268	96%
All acres	347,956	80%	408,399	81%

[1] Maine Department of Conservation, MFS, 1995a.

Criterion 4: Aesthetic Impacts of Timber Harvesting

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

Introduction

Forests cover 89% 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, sustaining the visual quality of Maine's forests is key to our quality of life.

People assess the health and integrity of the forest based on what they see. The citizens of Maine have often expressed their concerns over the condition of Maine's forests through this filter of aesthetics (Northern Forest Lands Council, 1994b). With so much of Maine's private forest land open to the public, forest management is highly visible to the recreating public. 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 have heightened the public's concerns about the management of Maine's forests.

Although scenic quality is highly subjective, most people agree that forest management can profoundly impact the forest aesthetic, up close and from a distance (Palmer *et al.*, 1995). While some management activities, such as pruning and early thinning, can have pleasant aesthetic impacts, most have an immediate negative impact that heals over time. Mitigating the negative short-term impacts of timber harvesting is an important step in communicating a strong stewardship ethic to the general public.

The council strongly encourages landowners to adopt as standard practice operational techniques that minimize the negative visual impacts of timber harvesting. The council recognizes that these should be applied with consideration of individual site conditions, but overall, forest landowners should consider the goal of minimizing negative visual impacts when making management decisions. The council proposes several voluntary BMPs to promote increased use of visual management techniques.

Implementing the BMPs associated with this criterion should lead to timber harvesting operations that minimize the most visually offensive aspects of logging and associated activities. These operations will avoid creating conditions that communicate wastefulness, sloppiness, and site destruction to the general public.

Some elements of the BMPs are beyond the control of small woodlot owners. Most recommended practices, however, have application to any forest operation.

Benchmarks

- **Benchmark 1:** By 2000, all forest landowners will demonstrate a good-faith effort to minimize the negative aesthetic impacts of forest management operations.
  - The Department of Conservation, in collaboration with interested stakeholders, should:
    1. Refine the voluntary aesthetics BMPs and produce a field handbook by June, 1998;
    2. Disseminate the field handbook widely to landowners, loggers, and foresters; and,
    3. Develop and implement a reliable, simple, low-cost method for assessing the public's perception of the aesthetic impacts of timber harvesting by June, 1998.
  - All harvest operations should incorporate voluntary BMPs for the protection of aesthetic values by the year 2000.

Recommended Best Management Practices for the Protection of Aesthetic Values

- Residue management (residues include tops, limbs, butt pieces, and cull trees.)
  - Use harvest technologies that keep harvest residues evenly distributed on the forest floor.
  - Minimize accumulations of tops, branches and cull logs at the roadside. Where harvesting leaves roadside residues, make efforts to return residues to the forest.
  - In harvested areas near roads and trails, process slash and residues so they lie close to the ground for quick decomposition, and to mitigate highly visible browning.
- Layout and presentation of harvest areas
  - Avoid long, straight edges for harvest boundaries that intersect with roads at right angles, or are visible from roads or water bodies.
  - Use more partial harvest treatments along roadsides and highly visible slopes. When harvesting to release established natural regeneration, ensure sufficient height development (3 feet) of the new stand before conducting a final release harvest.
  - Create or enhance scenic vistas through silviculture where the terrain allows.
  - Where full overstory removal occurs on visible slopes, integrate these harvests with a long-range plan that reduces straight edges and checkerboard effects and coordinates regeneration of harvested areas with harvest of new areas. Regenerate no more than 15% of a viewshed within a decade.
- Landing construction
  - Off-road landings can minimize conflicts between harvesting activity and public traffic. Such landings increase the amount of land removed from growing trees and should be used in balance with other techniques that increase the productivity of surrounding stands.

- { Minimize the size of landings. Avoid landings that create a continuous unvegetated zone along roadsides. Maintain landing depth at the minimum necessary to process wood. Minimize uncontrolled machine traffic behind landings.
- { Slope and grade landings to soften edges, remove excessive organic material, and eliminate standing water.
- { Revegetate landings with conservation mix, tree plantings, or other appropriate vegetation. In many instances, allowing natural vegetation to establish itself is the best strategy.
- { Remove trash and refuse from the site.

w Road construction

- { Keep new construction right-of-way widths to a minimum: the appropriate width will vary with site and soil conditions, but should not exceed 40-60 feet.
- { Without compromising safety, introduce turns that soften the impact of straight sights and edges and minimize the visual impacts of intersections with public roads.
- { Favor small bridges over large culverts for stream crossings.
- { Create scenic vistas through road siting in coordination with timber harvest layout.

Criterion 5: Biological Diversity

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

Introduction

Maintaining *healthy, well-distributed populations* of Maine's *existing, native flora and fauna* requires maintaining a *complete and balanced array* of different types of ecosystems to provide habitat for these species. Other benefits of maintaining an array of ecosystems include the production of timber, water, and diverse recreational opportunities, to name the most obvious three.

Ecosystems are defined as a group of plants and animals and the physical environment they inhabit; thus, they can exist at many spatial scales. A single fallen log constitutes an ecosystem; our entire planet is an ecosystem. The council defines ecosystems as synonymous with "natural communities" as defined by the DOC's Natural Areas Program (DOC, Maine Natural Areas Program (MNAP), 1991). This classification currently recognizes about 120 different ecosystem types, consisting of approximately: 25 types of forests, forested wetlands, and woodlands; 25 types of open uplands (mostly specialized kinds of shorelines, cliffs, and high-altitude areas); 30 types of nonforested wetlands; 12 types of lakes; 9 types of rivers; and 20 types of marine and estuarine systems. Most of these ecosystem types are tens or hundreds of acres in extent.

What does it mean to maintain a complete and balanced array of ecosystem types? Maintaining a *complete array* focuses attention on particularly rare or fragile types of ecosystems such as alpine areas and certain wetland types. Most of these fragile or rare ecosystems are not forest ecosystems, but they exist in landscapes dominated by forests. Thus forest management activities often affect them.

Maintaining a *balanced array* requires some decision about what constitutes a balance. Most people would agree that large scale conversion of Maine's forest ecosystems to suburban developments would unbalance the array. Some people would argue that large-scale conversion of northern hardwood forests to plantations of Japanese larch would also unbalance the array. The key issues here are "What is large scale?" and "How would conversion be distributed?" Converting 10,000 acres of natural forest to exotic plantations across the state might be acceptable, but converting millions of acres probably would not. Converting 10,000 acres within a single township might not be acceptable either.

Maintaining a balanced array of forest ecosystems also requires recognizing that forest ecosystems at different stages of maturity differ significantly from one another. In particular, they provide different types of habitat for plants and animals. Consequently, maintaining a balanced array of forest ecosystems requires maintaining a balanced array of successional stages. In managed forest landscapes, most stands are harvested before they reach ecological maturity. Thus, special attention is required if maintaining the structure and function of mature forests is an objective. Lorimer (1977) highlights the importance of this concept, indicating that before timber harvesting began in the 1600's, 84% of Maine's forests probably exceeded 75 years in age. We have significantly changed the availability of habitat for many vertebrates that use these older stands (DeGraaf *et al*., 1992) and probably a much larger number of

invertebrates, plants and other organisms. It is prudent to ensure that at least a portion of our forested landscape remain in these mature stages. Moreover, we should try to retain some of the habitat elements associated with these older stands (e.g., coarse woody debris and large trees) over a significant portion of the landscape. Many of these older stands were characterized by *multi-story* (two or more) forest canopies, which suggests that maintaining *structural diversity* could be very important as well.

Maintaining a portion of the forest landscape in a mature or multistory condition has proven to be one of the most complex issues that the council has faced. The council has deliberated extensively about how best to ensure that sufficient areas of Maine's forests remain in a mature, structurally diverse condition and has actively solicited public comment on this issue. Testimony and evidence provided by many large landowners suggest that mandating specific levels of mature forest and structural diversity, and limiting on areas under regeneration could reduce harvests and conflict with the goals and benchmarks of Criterion 3. Some of this conflict is based on the problem of moving from forest landscapes that may have relatively few mature or multistory stands now to landscapes that have these features. The council fully recognizes that fully achieving this objective will require many years, possibly a full rotation or longer. However, this is not the only issue. Analyzing the relationship between ecological diversity and timber supply is complex and requires up-to-date information on forest resources. The council lacked the time, the data, and the resources to address the issue adequately. Further, more up-to-date information on Maine's forest will not be available until late in 1996. Until this issue is analyzed in a publicly credible fashion, we will not reach consensus about where the right balance lies. Therefore, the council has outlined a process for addressing this issue after the forest inventory data has become available. In the interim, we offer some preliminary thoughts about (1) how to define maturity classes and stand structures (see definitions and figures 2 and 3 at the end of this section); and, (2) a point of departure (see sidebar beside Criterion 5, Benchmark 1).

Maintaining a diversity of forest stand structures in the working forest is not the only issue with respect to *biodiversity* in Maine's forests. Scientists have long argued that a balanced array of ecosystems should be set aside from use to serve as benchmarks for monitoring ecological change, and as a safeguard against the possibility that not all plants and animals can persist in ecosystems actively manipulated for human purposes. The council recognizes and generally supports the work of the Maine Forest Biodiversity Project on this issue.

Finally, although maintaining ecosystems as habitat is key to maintaining species, this step may not always suffice. For example, over-exploitation can eliminate a species even though its habitat remains intact. Also, in a few cases it may be necessary to restore degraded habitat, not simply maintain what exists.

Maine is not in a crisis with respect to biological diversity (Gawler *et al.*, 1996). Nevertheless, the state must grapple with some important issues. For example, we have little information about the status of the vast majority of species; many Maine species exist at the edge of their geographic range and may harbor important elements of genetic diversity; and old, relatively undisturbed examples of most forest and aquatic ecosystem types are very rare. Given these and other issues and the profound importance of maintaining biological diversity, it is prudent and wise to take the steps outlined below.

Benchmarks

- **Benchmark 1:** For landowners who own over 500 contiguous acres, mature, multi-story forests should eventually cover a significant portion of their ownership.[9] Because many of the issues associated with this criterion remain unresolved, the council recommends:
  - An analysis of the most recent USFS forest inventory data with respect to stand age, composition, and structure;
  - The formation of a technical advisory group;
  - The development of benchmark parameters for maintaining a diversity of forest maturity classes and structures appropriate to Maine conditions, including plantations; and,
  - The identification of implementation strategies while mitigating potential conflicts between these goals and those outlined in Criterion 3.

  These tasks should take the council no longer than five months following the availability of USFS data. In the sidebar above, the council proposes a point of departure for this work.[10]

Mature forests: A starting point

For landowners who own over 500 contiguous acres, *relatively mature forests* should eventually constitute at least 60% of the forests on the ownership and 40% of the forests within any LPU. *Mature forests* should eventually constitute at least 30% of the ownership and 20% of any LPU. Mature forests are a subset of relatively mature forests; therefore, the two recommendations above are not additive. To accomodate species with limited dispersal distances and slow recolonization rates, 50% of the mature forests should not shift across the landscape, but should remain in place for multiple rotations. Landowners should meet these goals to the extent feasible immediately, but complete attainment may take an entire rotation in some cases.

- **Benchmark 2:** By 1998, the state will strengthen existing programs that encourage private landowners to protect fragile or rare ecosystems and endangered species of animals and plants.
- **Benchmark 3:** By 1999, the state will establish a program to protect a representative array of all native ecosystem types. Protected areas will be well distributed across the state and will be located on public lands, existing private conservation lands, and, when representative examples cannot be found on these, on private lands, if possible. The council recommends that:
  - Reserve selection and design be driven by principles of conservation biology; and,
  - Private land dedication or acquisition occur on a willing landowner basis only.
- **Benchmark 4:** By 1998, forest operations will incorporate appropriate measures to maintain key habitat elements, especially those associated with later successional stages, following guidelines in "A forester's guide to managing wildlife habitat in Maine" (Elliott, 1988) or subsequent revisions.[11] These guidelines should be used in conjunction with and

[9] To attain the benchmarks related to ecosystem type and maturity class, landowners would use a management approach based on *landscape planning units* (LPUs). The benchmarks outlined in this section, or in the recommended follow-up process, would eventually be met on each LPU.

[10] See Figures 2 and 3 (pages 30-31) also. A special section on definitions of the terms used in this section and accompanying sidebar can be found on pages 32-33.

[11] The Biodiversity in the Working Forest subcommittee of the Maine Forest Biodiversity Project has taken

not in conflict with Occupational Safety and Health Administration logging safety guidelines.

- **Benchmark 5:** Areas converted from natural forests to plantations should comprise no more than 15% of the state's land area, 20% of an ownership (or 200 acres, whichever is greater), or 25% of a LPU. These limits can be exceeded if additional plantations are mitigated by allocating a commensurate acreage to permanently unharvested areas or designated ecological reserves.

- **Benchmark 6:** By 1999, forest landowners and managers should manage forests to minimize the need for insecticides and herbicides.

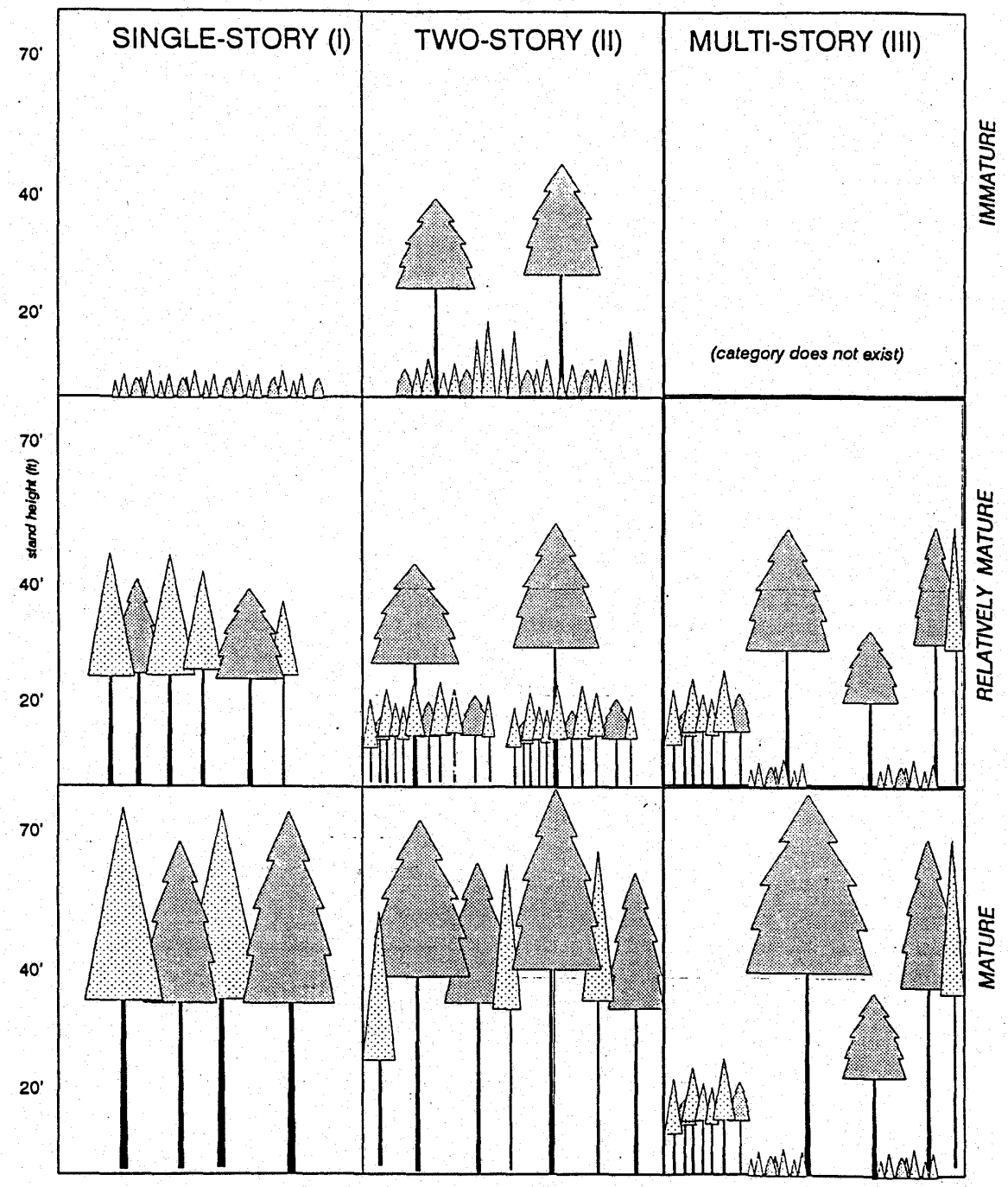
Plantation--single-story stands in which (1) ≥ 70% of the trees originate artificially by planting, and (2) the species planted does not occur naturally in Maine on the soil and/or site conditions where the plantation is established. Some examples include any monoculture of exotic species and black spruce or red pine plantations on upland hardwood sites. The following examples would not constitute plantations under this definition: stocking enhancement ("fill") plantings on sites with at least 40% stocking of natural regeneration; enrichment or restoration plantings designed to augment species composition; and, any reforestation of abandoned agricultural land.

initial steps to revise Elliott's work.

Figure 2. Conceptual diagram of forest maturity class distribution

Management regime/ Development stage	Period of establishment	Period of dynamic	Large-sized forest (~30%)
Multi-story stands	Thinnings & stand improvement	Selection harvests	Selection harvests Multi-story management ≥ 15%
Two-story stands	Thinnings & stand improvement	Commercial thinnings	Preparation harvests Harvest & release
Single-story stands	Thinnings & stand improvement	Commercial thinnings	Harvest & regeneration
Maturity class	Immature	Relatively mature	Mature
Structural development	Small size Canopy Establishment stage	closure Development of dominance	Large trees Very large trees
Approximate stand height by relative site quality			
High	20	45	70 >80
Medium	15	40	65 >70
Low	10	35	55

Figure 3. Graphical presentation of forest maturity class distribution



Suggested definitions of stand maturity classes

For the purpose of beginning the discussion regarding Benchmark 1 of Criterion 5, silvicultural systems are divided into three categories based on the prevailing post-harvest stand structure. The three categories are distinguished by the stocking (basal area) of trees over 40 feet tall at its minimum point over a typical rotation (60-100 years). For reference, these are assigned Roman numerals that correspond to the number of vertical strata maintained.

I. Single-story stands (synonyms: even-aged stands, single-cohort stands)--stands that have only one tree stratum. These stands result from natural, stand-replacing disturbances or clearcuts (as defined below) and are managed under even-aged silvicultural systems. Final harvest cuttings (silvicultural clearcuts, complete overstory removals) remove all or nearly all of the mature trees. Plantations are a subset of single-story stands. Numerical definition: stocking of trees > 40 feet tall less than R, as defined under two-story stands

II. Two-story stands (synonyms: two-age stands, two-cohort stands)--stands that have two vertically distinct tree strata, the taller of which consists of *reserve trees* left after an incomplete final harvest under any of the two-aged silvicultural systems. Either stratum may be dominant; where the younger stratum dominates, it is managed much the same as in an even-aged silvicultural system. As defined below, this category would also apply to some stands after shelterwood establishment cutting below the C line in which the older cohort is temporarily dominant prior to the removal cutting. Numerical definition: minimum stocking (at the final removal cutting) of trees > 40 feet tall less than the C line, but > R, where R = a minimum stocking of reserve trees and standing dead snags left for future growth or habitat enhancement. Let R = 10 (either 10 ft^2/acre of basal area in trees > 40 feet tall, or 10 trees over 10" *dbh*). Sound dead snags over 10" dbh may count for up to half of this total

III. Multi-story stands (synonyms: uneven-aged stands, multi-cohort stands, selection stands)--stands that have three or more tree strata or age classes. These would be managed with group or single-tree selection silviculture, dominated by shade-tolerant species, and remain in one place on the landscape for multiple rotations. These stands should be managed to provide some attributes of natural, late-successional forests such as coarse woody debris, large cavity trees, and dead snags. Numerical definition: minimum stocking $\geq$ C line (or equivalent crown closure), plus any reasonable structure that sustains the continued presence of at least one half of the stocking in trees meeting either of the requirements for mature stands

Other definitions

Relatively mature stands--

- Single-story stands--trees over 40 feet tall (or 40 years old) comprise $\geq$ C line stocking. For ease of application, corresponding levels of crown closure may be substituted if supported by forest inventory data

- Two-story stands: O + U $\geq$ 100, where O = basal area of reserve trees (over 40 feet tall), as a percentage of C line stocking; and U = percent stocking of *immature* trees over 20 feet tall (measured at a mil-acre or other appropriate scale). Any combination of the above would qualify

  Example 1: Improvement cutting in a northern hardwood stand that leaves 25 ft^2/acre of

high-quality sugar maple poles (average 6" dbh), while regenerating a new age class. Hardwood C line (at 6" dbh) = 40 ft^2/acre. Stand would qualify when residual poles grow back to the C line (at approximately 45 ft^2/acre or 8" dbh), or sooner if stocking of 20-foot trees made up the difference between poletimber stocking and the C line.

Example 2: Incomplete shelterwood removal cutting leaving 15 ft^2/acre of pine reserve trees (average dbh 10"), releasing well stocked understory of spruce and fir saplings 5 feet tall.

Softwood C line (at 10" dbh) = 105 ft^2/acre. After 15 years, released saplings reach 20 feet, and the 28 pine reserve trees grow to 25 ft^2/acre (12.8" dbh) which equals about 23% of the C line at this point. Stand would thus qualify if sapling stocking was 77% or greater

- Multi-story stands always satisfy this condition by definition

Mature stands--

- Single- and two-story stands--C line stocking (or equivalent crown closure), and either a height/age or dbh/stocking requirement:
  - Main canopy trees over 70 feet tall or 80 years old meet C line stocking level (long-rotation stands), or
  - $\geq$ 30 ft^2/acre of large trees (13"+ dbh for softwoods, except pine; 16"+ dbh for hardwoods and pine) of long-lived, shade-tolerant species
- Multi-story stands--C line stocking (crown closure) plus $\geq$ 30 ft^2/acre large trees (13"+ dbh for softwoods, except pine; 16"+ dbh for hardwoods and pine) of long-lived, shade-tolerant species

Landscape planning units (LPUs)--planning area of about 25,000 contiguous acres (or reasonable alternative proposed by the landowner) to which the sustainability criteria are applied

Reserve tree--trees over 40 feet tall that are retained after the final regeneration harvest of two-aged silvicultural systems for purposes other than regeneration

Complete clearcut--thorough removal of all overstory trees, regardless of their economic value; any harvest that creates an immature, single-story stand. This includes silvicultural clearcuts and complete overstory removal cuts

Understocked harvest (incomplete removal cut): any harvest that creates a type II stand (below C line, but not a clearcut). This would include any even-aged final regeneration harvest that leaves reserve trees that meet the requirement for type II stands.

Criterion 6: Opportunities for Traditional Recreation

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

Introduction

Maine's outdoor recreation values are deeply rooted in tradition. The vast, privately managed forest lands of Maine have been a renowned recreational resource since the era of the pioneer vacationers of the mid-1800's. The rich history and lure of the Maine woods enchant residents as well as visitors.

A majority of Maine residents enjoy activities related to fish and wildlife. These activities comprise an essential component of the state's recreation and tourism industry. Surveys show that people spend hundreds of millions of dollars annually on fish and wildlife related activities in Maine (Boyle *et al.*, 1988 and 1990; US Fish and Wildlife Service, 1989). Hunting and fishing traditionally have been the favorite activities; however, a wide array of nonconsumptive activities attract 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.

Through tradition and goodwill, Maine's private landowners largely have maintained a policy of free and open public *recreational access* to their lands for responsible recreation. 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 maintain an open recreational access policy. On smaller ownerships (generally in the southern part of the state) changing landowner attitudes 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.

A key principle inherent in the following discussion is that the state should continue to recognize and protect landowners' constitutional rights of private property ownership--including the right of exclusion--favoring incentives over punitive measures in its efforts to keep private forest land open for recreation use. The council also recognizes that many current and recent efforts address or have addressed one or more of these issues, and suggests that policy makers examine these efforts for common themes.

Inherent tensions exist between:

- Intensive forest management and traditional recreational uses of the Maine woods;
- Conversion of forest land to nonforest uses and the maintenance of traditional open access to the forest;
- Poor land management and the protection of fish and wildlife habitat; and,
- An increasing human population that demands 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 industrial forest land has increased, so has pressure on the owners of this land to provide more of what are generally accepted as public values, 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 Tree Growth Tax Law (36 MRSA §571 *et seq.*) exists to ensure that *ad valorem* property taxation does not create a financial disincentive for landowners to maintain their lands in forest management. Land enrolled in the program is valued at reduced rates that reflect the long-term nature of forest management investments. While protecting the recreational resource is a goal, participation in the program does not require an open recreational access policy. The program could be improved by offering added incentives to landowners who allow nonmotorized, public recreational access to their lands.[12]

The purpose of the Tree Growth Tax Law
"It is declared to be the public policy of this state that the public interest would be best served by encouraging forest landowners to retain and improve their holdings of forest lands upon the tax rolls of the state and to promote better forest management by appropriate tax measures in order to protect this unique economic and recreational resource." (36 MRSA §572)

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, some low-intensity recreationists may demand a different type of experience that sporting camps cannot provide. The marketplace currently does not accommodate this demand adequately. 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.

Maine people desire continuity in their traditional way of life. They seek to maintain a diverse landscape dominated by the undeveloped, natural environment, and to protect its scenic beauty, undeveloped character, and other special values. 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). The key public policy issue is one of resource allocation. Less intensive methods of forest management 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

[12] The Farm and Open Space Tax Law provides an additional 25% reduction in valuation of land enrolled in this program if public access is allowed to the enrolled property (36 MRSA §1106-A).

tradeoffs (economic, social, and environmental) associated with favoring one use over another? What are the impacts of increasing use on the quality of the experience?

Benchmarks

- **Benchmark 1:** By 1998, the Departments of Conservation and Inland Fisheries and Wildlife will conduct a thorough review of public recreation policies for consistency in encouraging continued public recreational access to forest lands while recognizing and protecting landowners' constitutional rights of private property ownership.
- **Benchmark 2:** By 1998, the Department of Inland Fisheries and Wildlife will increase participation in cooperative projects between forest landowners, public agencies and other interests to collaborate in the development of management policies that conserve the habitats of popular species.
- **Benchmark 3:** The natural resource agencies and interested stakeholders should continue to collaborate on such initiatives as the Governor's Council on Sportsman/ Landowner Relations. The natural resource agencies should also identify common themes and recommendations from the various recreation management initiatives undertaken over the last 10 years, and implement those recommendations.
- **Benchmark 4:** The legislature should revise the Tree Growth Tax program to allow an additional reduction in land valuation, or establish other incentives, for enrolled landowners who allow nonmotorized, public recreational access.[13]

[13] "Public access" as defined in the Farm and Open Space Law (36 MRSA §1106-A).

Criterion 7: Competence and Public Accountability of all Members of the Forest Products Chain

Goals: To broaden the practice of sustainable forestry through education of all members of the forest products chain and to demand a certain level of competence and professional responsibility in all forest operations

Introduction

The important contributions that forests make to Maine's economy and quality of life are well documented. The multiple and increasing demands upon the forest resource, coupled with the forest's complexity and the public's desire for well-managed forests, indicate the need for competent, professional management. Professional and ethical management must extend along the entire forest products chain, from the landowner to the forester to the logger and woods contractor to the purchaser of the final product. Maine's forests are too important to be managed any other way.[14]

Continuing education and public accountability are key elements of professional behavior. The council believes that all individuals who work in the forest should be licensed or certified, and that continuing licensure should be contingent upon a forest professional seeking continuing education opportunities and obeying all laws related to forest operations. Licenses should be available for an annual fee (suggested amount: $40). As the level of professionalism along the forest products chain increases, public support for forest management is likely to increase. If properly implemented, licensing requirements could create an economic benefit for Maine logging contractors by creating a financial disincentive for Canadian contractors to work in Maine. For example, licensees could be required either to maintain Maine workers compensation insurance or post a bond to operate in the state.

The council also believes that both forestry personnel and landowners should consider seeking certification through separate, voluntary certification programs. Examples include the Certified Logging Professional program for loggers and "Green Certification" for landowners. Certification would be conditioned upon independent evaluations of applied sustainable forest management practices and--for forest personnel--satisfaction of continuing education requirements.

The council recognizes that the steps outlined above will have costs to participants. In recognition of these costs, the council recommends that participants benefit from some form of incentive, whether it be financial incentives in terms of mill-delivered price, reduced workers' compensation premiums, or something else. To ensure wise use of the taxpayers' money, the council recommends that cost-sharing for various forest management activities be contingent on certification, either of the landowner, the contractor, or the managing forester.

Finally, many owners of smaller woodland parcels would benefit from professional advice prior to conducting a timber harvest. Many landowners have expressed the need for a place they can go to get unbiased forestry suggestions without feeling they are getting a sales

[14] Maine currently requires professional foresters to obtain licenses; however, many landowners do not engage a forester when seeking to market forest products from their land. Depending on the situation, harvest operations on lands under professional management may not be supervised by a forester.

pitch, either real or perceived. Having professional advice before a harvest can help the landowner avoid such common problems as timber trespass, timber theft, and improperly designed contracts.

Benchmarks

- **Benchmark 1:** By 1998, the Department of Professional and Financial Regulation should place appropriate legal responsibility for complying with timber harvest and environmental regulations with those *materially participating* in timber harvesting operations by instituting and/or amending the licensing and continuing education requirements for such persons. Materially participating means those who are (1) engaged in the business of harvesting timber or other forest products for hire or profit; and/or, (2) landowners who harvest more than 50 cords per year on their own land. Individual employees of contractors and employees of subcontractors should not be subject to licensing requirements.

- **Benchmark 2:** Increase the quality of all forest management operations beyond compliance with regulatory minimums by increasing participation of forest landowners and forest management personnel in certification programs. Financial incentives can assist in the achievement of this benchmark.

- **Benchmark 3:** Increase the use of professionally trained personnel in forest management operations. The MFS will initiate an outreach program so that by 2010, all landowners will have professional advice before they harvest timber.

- **Benchmark 4:** Increase knowledge, understanding and cooperation in solving statewide forest management concerns by:

  - Requiring the MFS to monitor and report annually to the Governor and Legislature on the status of Maine's forests and Maine's performance in complying with sustainable forest management criteria. This report could address the effectiveness of licensing and financial incentives in promoting certification of woods contractors and landowners and,

  - Instituting forestry roundtable discussions among the many stakeholders to discuss forestry issues and to review data pertaining to forest management in the state on an ongoing basis.

Appendix 1. Stocking Guides

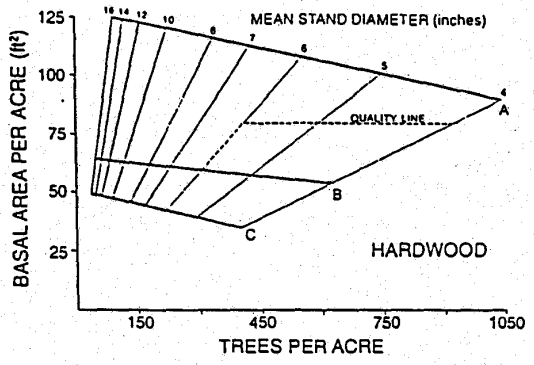


Figure 1.—Stocking chart for northern hardwoods is based on trees in the main crown canopy. The A line is average maximum stocking. The B line is recommended minimum stocking for adequate growth response per acre. The C line defines the minimum amount of acceptable growing stock for a manageable stand. The quality line defines the stocking measure in young stands for maintaining quality development.

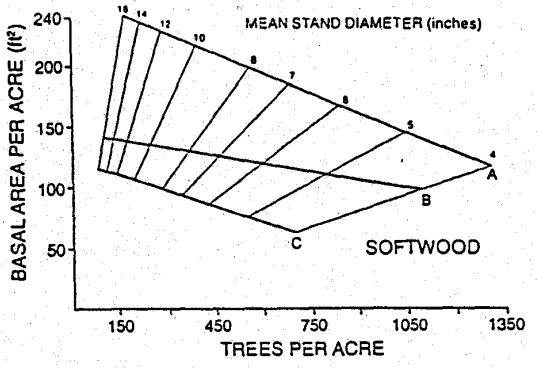


Figure 2.—Stocking chart for spruce—fir stands is based on trees in the main crown canopy. The A line is average maximum stocking. The B line is recommended minimum stocking for adequate growth response per acre. The C line defines the minimum amount of acceptable growing stock for a manageable stand.

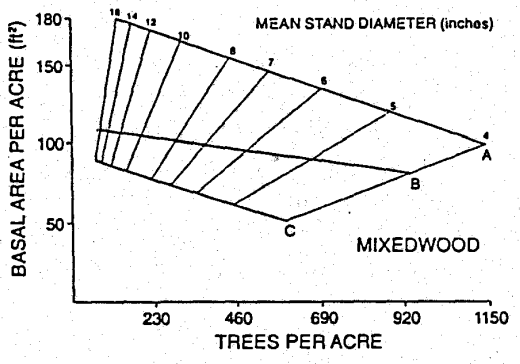


Figure 3.—Stocking chart for mixedwood stands is based on trees in the main crown canopy. The a line is average maximum stocking. The B line is recommended minimum stocking for adequate growth response per acre. The C line defines the minimum amount of acceptable growing stock for a manageable stand.

Source: Solomon, D. *et al.* 1995. FIBER 3.0: An ecological growth model for Northeastern forest types. USDA Forest Service, Northeastern Forest Experiment Station, General Technical Report NE-204. 24 pp.

Appendix 2. Working Definitions

Benchmark--intermediate objectives for attaining goals

Biodiversity--the variety and abundance of species, their genetic composition, and the communities, ecosystems, and landscapes in which they occur. It also refers to ecological structures, functions, and processes at all of these levels. Biological diversity occurs at spatial scales that range from local through regional to global (definition used by Maine Forest Biodiversity Project and Society of American Foresters)

Biomass--the total mass of all living matter in a given space. In the context of this report, the term refers to above-ground tree biomass only (trunk, branches, bark, leaves)

B line--recommended minimum stocking for adequate growth response per acre (Solomon, *et al.*, 1995)

Clearcut--

- **Silvicultural clearcut**--a method of regenerating an even-aged stand in which a new age class develops in a fully-exposed microclimate after removal, in a single cutting, of all trees in the previous stand. Regeneration is from natural seeding, direct seeding, planted seedlings, and/or advance reproduction. Cutting may be done in groups or patches (Group or Patch Clearcutting), or in strips (Strip Clearcutting). In the Clearcutting System, the management unit or stand in which regeneration, growth, and yield are regulated consists of the individual clearcut stand. When the primary source of regeneration is advance reproduction, the preferred term is overstory removal (Adams *et al.*, 1994)
- **Logging clearcut**--removal of most or all of the merchantable timber in a harvesting operation
  - **Commercial clearcut**--removal of only the more valuable trees, usually leaving small-diameter and poor quality stems
  - **Complete clearcut**--thorough removal of all overstory trees, regardless of their economic value; any harvest that creates an immature, single-story stand. This includes silvicultural clearcuts and complete overstory removal cuts
- **Statutory clearcut**--any timber harvesting on a forested site greater than 5 acres in size which over a 10 year period results in an average residual basal area of trees over 6 inches in diameter of less than 30 square feet per acre, unless one or both of the following conditions exist:

  A. If, after harvesting, the average residual basal area of trees over 1 inch in diameter measured at 4.5 feet above the ground is 30 square feet per acre or more, a clearcut does not occur until the average residual basal area of trees 6 inches or larger measured at 4.5 feet above the ground is less than 10 square feet per acre; or
  B. After harvesting, the site has a well-distributed stand of trees at least 5 feet in height, that meets the regeneration standards applicable under 12 MRSA, c. 805, §8869, subsec. 1. (MFS Rules Chapter 20, October, 1990)

C line--minimum amount of acceptable growing stock for a manageable stand (Solomon, *et al.*, 1995)

Conservation--the controlled use and systematic protection of natural resources

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

Cull tree--

- **Rotten**--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% of the cull volume in the tree is rotten
- **Rough**--(1) 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, (2) a live tree of noncommercial species

Diameter at breast height (dbh)--the diameter of a tree measured at 4-1/2 feet from the ground

Ecological reserve--a permanently protected area set aside from commodity extraction for the following purposes (1) to serve as benchmarks against which biological and environmental changes in both managed and unmanaged ecosystems could be measured, and (2) sites for scientific research, long-term environmental monitoring, and education

Ecosystem--an assemblage of interacting plants and animals and their common environment, recurring across the landscape

Erosion net--pattern of erosion on slopes resulting from the exposure of soils on poorly-designed downhill skid trails. Such nets promote faster drainage of rainwater and snowmelt, and can lead to the creation of gullies

Existing, native flora and fauna--species that currently exist in Maine (excludes extirpated species, such as woodland caribou), and that arrived in Maine without human intervention (excludes exotic species such as purple loosestrife, chestnut blight)

Forest type--a category of forest defined by its vegetation, particularly composition, and/or locality factors

Goal--the principal objective associated with a given criterion

Healthy populations--populations large enough to be viable (self-sustaining) but not so large that they have exceeded their habitats' carrying capacity

High-grading--forest management practices that remove the highest value trees from a forest stand, leaving behind the poorer specimens and often trees damaged by the harvesting operation. High-grading can often leave behind an aesthetically pleasing stand; however, the productivity and value of the residual stand are usually impaired for many decades

High-grading (MFS definition)--removing the biggest and best trees in a harvest without regard for the quality of the future stand. High-grading results in stands that are dominated by low quality trees, and is considered undesirable as it reduces the quality of products and future yield from the forest

High-yield silviculture--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)

Immature Stands--immature stands have well defined species composition; however, a majority of trees are unmerchantable for conventional products. They have developed beyond the stage for economical application of most early precommercial treatments. Forest stands in this development stage are most often treated in a wait and let grow fashion. These stands will provide medium-term wood supply needs, transitioning into the relatively mature stage over the next 10-30 years

Intensive recreational use--activity that focuses use on a relatively small area of land, such as a downhill ski area

Landscape planning units (LPUs)--a planning area of about 25,000 contiguous acres (or a reasonable alternative size proposed by the landowner) into which large properties are divided for the purposes of meeting certain criteria

Liquidation harvesting--the removal of all or most of the value in a forest stand, where such removal is intended to satisfy short-term economic objectives as opposed to long-term forest management objectives

Litter--fallen leaves, twigs and other organic matter

Materially participating--those who are (1) engaged in the business of harvesting timber or other forest products for hire or profit; and/or, (2) landowners who harvest more than 50 cords per year on their own land

Mature stands--

- **Single- and two-story stands--**C line stocking (or equivalent crown closure), plus either a height/age or dbh/stocking requirement:
  - Main canopy trees over 70 feet tall or 80 years old meet C line stocking level (long-rotation stands), or
  - $\geq$ 30 ft^2/acre of large trees (13"+ dbh for softwoods, except pine; 16"+ dbh for hardwoods and pine) of long-lived, shade-tolerant species
- **Multi-story stands**--C line stocking (crown closure) plus $\geq$ 30 ft^2/acre large trees (13"+ dbh for softwoods, except pine; 16"+ dbh for hardwoods and pine) of long-lived, shade-tolerant species

Monitoring--the periodic and systematic measurement and assessment of progress toward a benchmark

Multi-story stands (synonyms: uneven-aged stands; multi-cohort stands; selection stands)--stands that have three or more tree strata or age classes. These would be managed with group or single-tree selection silviculture, dominated by shade-tolerant species, and remain in one place on the landscape for multiple rotations. These stands should be managed to provide some attributes of natural, late-successional forests such as coarse woody debris, large cavity trees and dead snags. Numerical definition: minimum stocking $\geq$ C line (or equivalent crown closure), plus any reasonable structure that sustains the continued presence of at least one half of the stocking in trees meeting either of the requirements for mature stands

Plantation--single-story stands in which (1) $\geq$ 70% of the trees originate artificially by planting, and (2) the species planted does not occur naturally in Maine on the soil and/or site conditions where the plantation is established. Some examples include any monoculture of exotic species and black spruce or red pine plantations on upland hardwood sites. The following examples would not constitute plantations under this definition: stocking enhancement ("fill") plantings on sites with at least 40% stocking of natural regeneration; enrichment or restoration plantings designed to augment species composition; and, any reforestation of abandoned agricultural land

Policy tool--measure used to implement a policy, such as regulations, financial incentives, public-private partnerships, and other similar programs

Recreational access--land managed so as to provide free or low-cost opportunities for traditional recreational activities. Does not imply motorized or road access

Relatively mature stands--

- **Single-story stands**--Trees over 40 feet tall (or 40 years old) comprise $\geqq$ C line stocking. For ease of application, corresponding levels of crown closure may be substituted if supported by forest inventory data
- **Two-story stands**--O + U $\geqq$ 100 where O = basal area of reserve trees (over 40 feet tall), as a percentage of C line stocking; and U = percent stocking of *immature* trees over 20 feet tall (measured at a mil-acre or other appropriate scale). Any combination of the above would qualify
- **Multi-story stands**--always satisfy this condition by definition

Reserve tree--trees over 40 feet tall retained after the final regeneration harvest of two-aged silvicultural systems for purposes other than regeneration

Riparian zone--the band of forest that has significant influence on the stream ecosystem (Hunter, 1990). At a minimum, the boundaries of the riparian zone extend outward to the limits of flooding and upward into the canopy of streamside vegetation (Gregory *et al.*, 1991). Effective riparian zone width varies with stream size, flooding regime, slope of adjacent uplands, and forest type and condition. In addition, the width depends on the functions we want the riparian zone to perform (e.g., maintaining water quality in a stream flowing through a clearcut or providing habitat for songbirds)

Silviculture--the theory and practice of controlling forest establishment, composition, structure and growth. Silvicultural practice consists of various treatments that may be applied to forest stands to maintain and enhance their utility for any purpose

Single-story stands (synonyms: even-aged stands; single-cohort stands)--stands that have only one tree stratum. These stands result from natural stand-replacing disturbances or clearcuts (as defined below) and are managed under even-aged silvicultural systems. Final harvest cuttings (silvicultural clearcuts, complete overstory removals) remove all or nearly all the mature trees. Plantations are a subset of single-story stands. Numerical definition: stocking of trees > 40 feet tall less than R, as defined under two-story stands

Small ownership--forest ownership totaling less than 1,000 acres.

Stream channel--a channel between defined banks created by the action of surface water and characterized by the lack of terrestrial vegetation or by the presence of a bed, devoid of topsoil, containing waterborne deposits or exposed soil parent material or bedrock (Land Use Regulation Commission, Land Use Districts and Standards, Chapter 10, as revised August 15, 1991)

Stream order--

- **First order stream**--tributary streams (either perennial or intermittent) that have no branches. Any mapped stream segment shorter than 1,000 feet would not be used to determine higher stream orders
- **Second order stream**--the stream segment flowing downstream from the confluence of two first order streams
- **Third order stream**--the stream segment flowing downstream from the confluence of two second order streams

Structural diversity--the vertical stratification of vegetation layers in the forest ecosystem. A one-story stand has little structural diversity. Two-story and multi-story stands exhibit greater structural diversity

Sustainable forest management--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

Traditional recreation--those recreational uses of the forest that have characterized the region in the past and which continue to the present, including low-intensity, dispersed uses such as hiking, canoeing, primitive camping, bird watching and other wildlife observation, hunting, fishing, trapping, cross-country skiing, and snowshoeing, and limited, intensive recreational uses around core areas, such as sporting camps, pleasure boating, and developed camping

Two-story stands (synonyms: two-age stands; two-cohort stands)--stands that have two vertically distinct tree strata, the taller of which consists of reserve trees left after an incomplete final harvest under any of the two-aged silvicultural systems. Either stratum may be dominant; where the younger stratum dominates, it is managed much the same as in an even-aged silvicultural system. As defined below, this category would also apply to some stands after shelterwood establishment cutting below the C line in which the older cohort is temporarily dominant prior to the removal cutting.) Numerical definition: minimum stocking (at the final removal cutting) of trees > 40 feet tall less than the C line but > R, where R = a minimum stocking of reserve trees and standing dead snags left for future growth or habitat enhancement. Let R = 10 (either: 10 ft^2/acre of basal area in trees > 40 feet tall, or 10 trees over 10" *dbh*). Sound dead snags over 10" dbh may count for up to half of this total

Understocked harvest (incomplete removal cut)--any harvest that creates a two-story stand (below C line, but not a clearcut). This would include any even-aged final regeneration harvest that leaves reserve trees that meet the requirement for two-story stands

Watershed--the area contained within a drainage divide above a specified point on a stream

Well-distributed populations--populations of organisms widely-distributed across the state within their natural geographic range. This does not imply that a given species should occur in every potential habitat, only that a significant portion of potential habitat should be occupied. Furthermore, climate change will shift the natural range of a species over time, thus making this objective a moving target

Wetland--the definition most widely used by wetland scientists in the United States follows. Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered with shallow water. Wetlands must have one or more of the following three attributes (1) at least periodically, the land supports vegetation adapted for life in saturated soil conditions, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season (Cowardin *et al*., 1979). In Maine, wetlands include marshes, swamps, wet meadows, swales, bogs, and fens

Whole tree clearcutting--clearcutting in which the entire tree is removed from the forest, including branches and leaves, as opposed to the sawlog- and pulpwood-sized portions of the trunk

Wild (or wildness)--characteristic of unmanaged land, or land managed such that opportunities exist for remote recreation, solitude, and other quiet enjoyment of the natural landscape

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Appendix 5. List of Acronyms Used in this Report

BMP--Best Management Practices

dbh--diameter at breast height

DEP--Department of Environmental Protection

LD--Legislative Document

LPU--landscape planning unit

LURC--Land Use Regulation Commission

MCSFM--Maine Council on Sustainable Forest Management

MFS--Maine Forest Service

MNAP--Maine Natural Areas Program

MRSA--Maine Revised Statutes, Annotated

NFLC--Northern Forest Lands Council

USFS--USDA Forest Service

VSA--Vermont Statutes, Annotated

WTC--whole tree clearcutting

Appendix 6. Principles of Sustainability

The following are the Principles of Sustainability, as recommended by the Northern Forest Lands Council in its 1994 report, "Finding Common Ground: Conserving the Northern Forest."

- The maintenance of soil productivity
- The conservation of water quality, wetlands, and riparian zones
- The maintenance or creation of a healthy balance of forest age classes
- A continuous flow of timber, pulpwood, and other forest products
- The improvement of the overall quality of the timber resources as a foundation for more value-added opportunities
- The protection of scenic quality by limiting the adverse aesthetic impacts of forest harvesting, particularly in high elevation areas and vistas
- The conservation and enhancement of habitats that support a full range of native flora and fauna
- The protection of unique or fragile natural areas
- The continuation of opportunities for traditional recreation

Appendix 7. List of Council Members

- Ronald Lovaglio, Commissioner, Department of Conservation (Chair)
- Charles Gadzik, Director, Maine Forest Service (Vice-chair, ex-officio)
- Isabel McKay, Consulting Forester, Attorney, Newburgh (Secretary)
- Gary Cobb, Owner, Pierce Pond Camps, North New Portland
- Harry Dwyer, Principal, Ghost Dancer Forestry, Livermore Falls (November, 1995 - present)
- Malcolm Hunter, Libra Professor of Conservation Biology, University of Maine, Orono
- Janet McMahon, Conservation Planner, The Nature Conservancy, Brunswick
- Richard Schneider, General Manager, Comstock Woodlands Corp., Millinocket (July - August, 1995)
- Robert Seymour, Curtis Hutchins Professor of Forest Resources, University of Maine, Orono
- Peter Triandafillou, Chief Forester, James River Timber Corp., Old Town
- Donald Tardie, General Manager, Wood Products, Fraser Paper, Inc., Ashland

Staff:

- Donald Mansius, Chief Planner, Commissioner's Office
- Thomas Doak, Director, Forest Policy and Management, Maine Forest Service (July, 1995 - March, 1996)