STATE OF MICHIGAN
DEPARTMENT OF NATURAL RESOURCES

Michigan State Forest Management Plan

Approved April 10, 2008

FOREST, MINERAL, AND FIRE MANAGEMENT
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Michigan State Forest Management Plan

David L. Price, Editor

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Table of Contents

List of Figures

List of Tables

List of Appendices

Preface and Acknowledgements

Achieving sustainability in the management of Michigan's natural resources has been a challenge for more than one-hundred years, preceding the establishment of the Michigan Department of Natural Resources (DNR) and the state forest system. Today, stewardship of the 3.9 million acre state forest system to accommodate the many ecological, economic, and social uses and values requires new approaches to managing this magnificent but also complex and interrelated natural resource. The compartmentalized management strategies of the past are giving way to more integrated and comprehensive strategies, as embodied by the DNR commitment to achieving sustainability of our natural resources using principles of ecosystem management. Sustainability assures the viability of biological communities and their economic vitality by protecting and maintaining the natural environment upon which the citizens and economy of Michigan depend. This new Michigan State Forest Management plan is a major step toward the management of the state forest system in a long-term, sustainable manner.

Providing valuable input into the planning project were the following DNR staff: Michael Bailey, Cara A. Boucher, Paul Curtis, Michael Donovan, Dr. Kerry Fitzpatrick, Kerry Gray, LT Creig Grey, Scott Heather, Dr. Robert Heyd, Donald Johnson, Dr. Tammy Newcomb, Dr. Lawrence Pedersen, Roger Mech, Ron Murray, David Neumann, Dennis Nezich, James Radabaugh, David Spalding, Joseph Taylor, and Thomas Wellman. Thanks also to Joshua Cohen and Phyllis Higman of the Michigan Natural Features Inventory who also provided input into the planning project.

Many thanks to the leadership of the entire DNR Statewide Council, divisional management teams, and all DNR ecoteam staff who also provided input into the plan and supported its completion.

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Executive Summary

A primary management objective for the landscape of northern Michigan during the 20th century was to restore the forest resource that was devastated from over-exploitation in the late 19th century. This restoration has laid the basis for a rich array of opportunities for our forests in the 21st century. Michigan's forests are healthy and still growing, with many options for future uses. There are multiple objectives for our forests, including continuing with use and restoration within a framework of long-term sustainability, while also enabling an expanding diversity of uses. This plan is intended to focus on future management and use of one large part of Michigan's forest resources: the 3.9 million acre state forest system administered by the Michigan Department of Natural Resources (DNR).

Part 525, Sustainable Forestry on State Forest Lands, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, requires the DNR to manage the state forest in a manner that is consistent with the principles of sustainable forestry, and to prepare and implement a management plan that states long-term management objectives and the means of achieving these objectives. Components of the management plan include:

1. Identification of the interests of local communities, outdoor recreation interests, the tourism industry, and the forest products industry, which are addressed in Section 3 of the plan.
2. Identification of the annual production capability of the state forest and management goals based on that level of productivity, which are addressed in Sections 3, 4 and 5 of the plan.
3. Methods to promote and encourage the use of the state forest for outdoor recreation, tourism, and the forest products industry, which are addressed in Sections 3, 4 and 5 of the plan.
4. A landscape management plan for the state forest incorporating biodiversity conservation goals, indicators, and measures, which are addressed in Sections 4 and 5 of the plan.
5. Standards for sustainable forestry consistent with section 52502 of Part 525, which are addressed in Sections 4 and 5 of the plan.
6. Identification of environmentally sensitive areas, which is addressed in Section 5 of the plan.
7. Identification of the need for forest treatments to maintain and sustain healthy, vigorous forest vegetation and quality habitat for wildlife and environmentally sensitive species, which are addressed in Sections 4 and 5 of the plan.

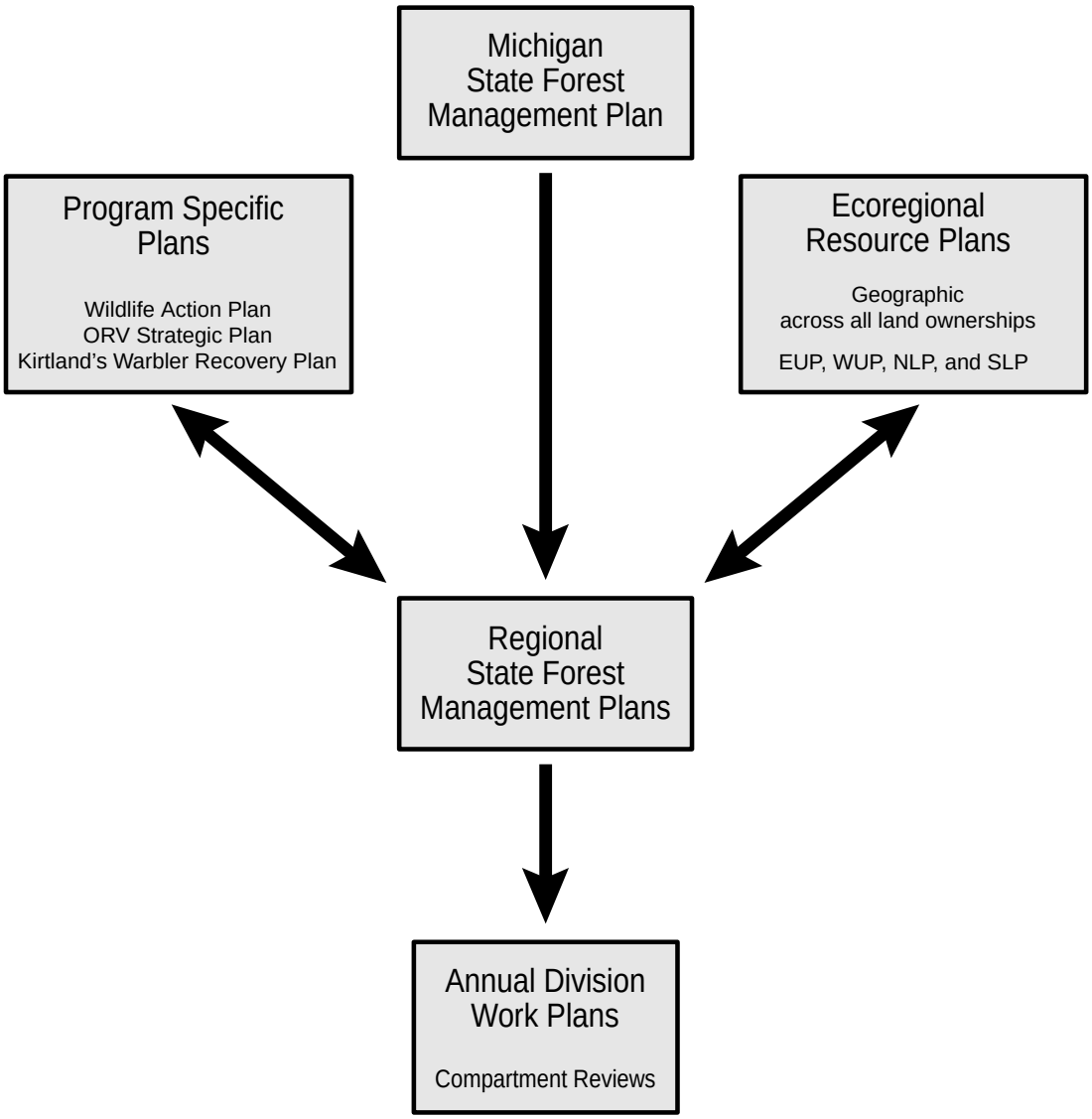
Part 525 also required the DNR to seek and maintain third party certification of the management of the state forest that satisfies sustainable forestry standards of at least one credible certification program. Subsequently, the DNR was certified under the standards of the Forest Stewardship Council (FSC) and the Sustainable Forestry Initiative (SFI). These standards also require the DNR to write, implement, and maintain forest management plans.

The DNR uses a 3-tiered planning structure for the management of Michigan's state forest resources: statewide, regional and forest management unit levels. The Michigan State Forest Management Plan and four Regional State Forest Management Plans (RSFMPs, expected by January 2009) provide landscape-level analyses and direction to enable tactical decisions for management of forest stands and compartments at the unit level. The aggregate of all forest prescriptions from compartment reviews are contained in the annual plan of work, which represents the tactical level of planning for state forest operations.

The DNR is also developing strategic plans that will address all ownerships in a region (including all DNR lands – forests, parks and wildlife areas, other public plans, and private lands), which will be

known as Ecoregional Resource Plans. Ecoregional Resource Plans will provide strategic goals and objectives that will also provide guidance for Regional State Forest Management Plans and other state planning efforts.

The relationship of the various types of DNR plans is shown in the diagram below. The Michigan SFMP and RSFMPs are companion documents that also provide direct linkage to other programmatic DNR plans, including Michigan's Wildlife Action Plan, the Michigan Off-Road Vehicle Plan, the Michigan State Comprehensive Outdoor Recreation Plan, and Natural River plans. The SFMP contains goals and objectives for all resource uses and values that apply to all state forestlands throughout the state. The RSFMPs are structured using a concept of distinct Management Areas (MAs) as a framework for describing the history, current conditions and trends, and specific management direction for vegetative management and other uses within the MA. Plan sections on special resource areas (Special Conservation Areas, High Conservation Value Areas, and Ecological Reference Areas) also address management direction for other uses and values (recreation, etc.) for more focused areas of the state forest management prescriptions that are contained in the annual plan of work are based upon the aforementioned plans.



This Michigan SFMP, in conjunction with the RSFMPs that are under development, is intended to achieve the planning requirements of Part 525 and forest certification standards. The drafting of these plans are joint efforts by the DNR Forest, Mineral and Fire Management, Wildlife, Fisheries, Law Enforcement, and Parks and Recreation divisions.

The Michigan SFMP plan contains six major sections. Three additional sections include appendices, a glossary, and citation of literature. Section 1 begins with a discussion of the purpose and use of the planning process. The plan outlines approaches for implementing landscape ecosystem management, with a deliberate, multi-level and integrated approach to planning, that provides strategic planning and direction at both statewide and ecoregional levels, and facilitates decentralized tactical planning at the forest management unit level. When used with other plans, inventories and projects, it will provide multi-dimensional biological and social-economic data to forest managers, which will help shape management options.

Section 1 also discusses the organization of the plan and its relationship to other DNR planning processes at the regional and unit levels, plan communication and implementation, and DNR Strategic goals. Section 1 concludes with a description of the state forestland management system, and a discussion of divisional management unit boundaries on a statewide basis.

Section 2 of the plan discusses the history of forests in Michigan and the genesis of the present state forest system. To provide the backdrop for present management, it is helpful to have an understanding of the composition, structure and natural ecological processes that were evident in the natural plant and animal communities that existed throughout the state prior to European settlement, and the condition of these communities following the subsequent period of large-scale extraction of the state's natural resources in the late 19th and early 20th centuries. The present landscape of the state is a legacy of this period of resource extraction and has direct bearing upon strategies employed in the present management of our natural plant and animal resources. These legacies include the recovery of the terrestrial landscape from deforestation, the recovery of aquatic systems from severe erosion and disruption of natural hydrological cycles, and continuing perturbations upon animal populations driven by recovery and change of habitat conditions. It is also important to understand the history of social and economic values that were, and continue, to be associated with the natural resources of the state. The extraction of natural resources in the form of timber and minerals was a dominant socio-economic system of northern Michigan in the late 19th and early 20th centuries. The collapse of the timber industry following the deforestation of the state (accompanied by a decline of mining industries) has now transitioned to a recovery of forest resources and more diversified and sustainable timber and recreation sectors. This recovery has occurred at different rates and degrees in different regions of the state.

An understanding of history sets the stage for Section 3 of the plan which describes the current forest conditions and trends from the perspective of the forest resource, forest health, wildlife habitat, water and fish habitat, and socioeconomic or human uses—including timber production, wildlife habitat, oil, gas and mineral production, recreation and tourism, and research and education.

Recent state forest average harvests have been close to 53,000 acres per year, with a 20-year average of about 700,000 cords per year. Timber harvest trends differ by species. The current conditions and trends for the state forest as a whole indicate that the annual production capacity for timber harvests will remain similar to what it has been or slightly increase. Harvests have predominantly occurred in five cover types: the aspen association, jack pine, the oak association, red pine, and northern hardwoods. Some significant trends can be noted since the mid-1990s for aspen, northern hardwoods, red pine, white pine and mixed swamp conifers. Due to intensive harvests in the late 1980s and early 1990s, the number of acres of aspen sold gradually decreased after 1997 and reached a low in 2003. Throughout this period, aspen volumes per acre remained steady at close to 20 cords per acre.

Volume of production from the northern hardwoods, red pine, and white pine cover types have increased since 1996. In contrast, production from mixed swamp conifers has dropped off sharply beginning in 2001, in part reflecting changes in cover type coding. Thus, the composition of timber sales has changed over the past decade, with the most significant change being more acres of selectively-harvested upland hardwoods sold as the number of clear-cut aspen acres declined. This tradeoff has resulted in less volume harvested per acre.

Major trends in forest health include increasing numbers of both native and nonnative insects and diseases, cervid herbivory affects on understory composition and regeneration, and the emerging environmental issue of global climate change. Some epidemic nonnative pathogens such as Dutch elm disease, the emerald ash borer and beech bark disease pose threats across the entire landscape of the state. Others are more localized in the range of their effect. The current management strategy is to contain and eradicate newly identified pathogens; however, some agents are now securely entrenched into ecosystems of the state. The effects of cervid herbivory (deer, moose, and elk) upon the composition and structure (particularly regeneration) of herbaceous and shrub strata of forest ecosystems are becoming an increasing concern. A DNR Cervid Herbivory Team is charged with developing methods and protocols for use in establishing thresholds for unacceptable levels of browse, developing monitoring processes and protocols for measuring the effect of cervid browsing on plant life, and determining where unacceptable levels of cervid browsing is occurring. Global climate change due to global warming has the potential to disrupt the natural composition, function, and health of native ecosystems. It could affect the range of native plant and animal species, and could potentially interact with other forest health threats by causing environmental stressors (such as the incidence and severity of drought) that can in turn trigger outbreaks of insect and disease infestations. All of these pose increasing threats to the health of the state's forest ecosystems, which may be expressed by potential major ecological changes in the composition of native forest communities and substantial economic effects.

Forest recreation is now trending toward year-round use, as the popularity increases for spring activities such as fishing for migratory steelhead, wild Turkey and mushroom hunting, and off-road vehicle (ORV) riding and for many winter sports such as snowmobiling, skiing, and ice fishing. This diversified activity provides year-round benefits to many local economies that were previously more seasonal in nature. General trends from various data sources indicate that hunting, fishing, and power boating recreation are relatively static or declining. Specifically, the trend of dispersed hunting recreation can be seen in the number of hunting license holders, which has been steadily decreasing over the past decade. Conversely, wildlife viewing, ORV, and snowmobile riding have grown in the past decade. The use of state forest campgrounds has been relatively stable over the past four years, with most use occurring in the Northern Lower Peninsula Ecoregion.

Unbalanced age-class distributions in early successional forest types are continuing relative "booms and busts" of wildlife populations that are dependent upon these habitats. This will continue for some time until the age class distributions are much more balanced.

Continued introductions of nonnative aquatic species have caused abrupt declines in economically important or rare species, massive changes in food webs, and considerable economic costs. The bioaccumulation of methyl-mercury and PCBs also continues to be a public health concern in the state.

Statewide management direction is provided in Sections 4 and 5 for a host of resource values and uses (such as recreation, vegetation, and watershed management) to facilitate achievement of long-term desired future conditions for the state forest, and to guide operational decisions regarding state forest management. These sections are intended to complement corresponding sections in the Regional State Forest Management Plans.

Section 4 builds upon the discussions in the previous sections on forest history and current conditions and trends and incorporates this information into specific statements of DFC for the many uses and values of the state forest. The DFC statements and their supporting goals and objectives provide a means through which the DNRs long-term management objectives can be achieved. Specific goals and objectives are intended to facilitate achievement of stated desired future conditions. Standards and guidelines are provided to facilitate the achievement of goals and objectives. Applicable criteria and indicators are also provided for use in monitoring the progress toward the achievement of goals and objectives and the achievement of sustainable, ecosystem-based management of DNR-managed forestlands. The stated desired future conditions, goals, and objectives are intended for reference by ecoregional planning teams in the development of regional forest management plans. The goals and objectives are not absolute, but are what the DNR envisions as desirable and necessary to achieve desired future conditions. Resource limitations and unanticipated future conditions may constrain their achievement.

Section 5 contains management direction, standards, and guidelines for resource areas that may have particular or special biological, ecological, social, or economic conservation objectives or values that need to be considered in management planning and activities. These areas are spatially explicit, and include Special Conservation Areas (SCAs–such as cold water streams and archaeological sites), High Conservation Value Areas (HCVAs–such as dedicated natural areas and critical dune areas), and Ecological Reference Areas (ERAs–high quality natural communities). Identified ERAs, HCVAs, and SCAs will be managed to conserve, protect and/or to enhance the defined conservation objective or value. The methods used will vary depending upon the objective and type of designation. Methods can include active management or access for multiple resource values that are compatible with the defined conservation objective or value. Regional forest management plans will include more detailed descriptions of such areas that are specific to each region as well as maps of many of their locations.

The plan concludes with Section 6, which describes the monitoring and management review processes that are required for assessing the effectiveness of management plans, and for incorporation of the results of monitoring into the revision of this plan and implementation of future management plans and procedures. The Statewide Council will conduct an annual management review based upon three components: the results of internal DNR audits of forest management units; annual Forest Certification Surveillance Audits; and results of an annual field management review. Operational components of statewide and regional management plans will be reviewed and revised as necessary, but at a minimum of every five years. Strategic components of statewide and regional management plans are to be reviewed and if necessary revised or updated at the completion of each 10-year compartment review cycle. If management review or monitoring results indicate the need for modification of the plan within a shorter time, the plan may be revised before the 5 and 10-year requirements.

Included in appendices is the text of Part 525, excerpts of the FSC and SFI standards, and a list of DNR Forest Certification Work Instructions. Also in the appendices are reference tables and graphs for section 3, detailed descriptions of divisional management units, and a list of Michigan's natural communities.

Approved:

Rebecca A. Humphries, Director

4/30/08
Date

Components of the State Forest Management Plan

1.1 Purpose and Use of the Plan

In 2004, the State Legislature enacted Part 525, Sustainable Forestry on State Forest Lands, of the Natural Resources and Environmental Protection Act (NREPA), 1994 PA 451, as amended (Appendix A). As defined by Part 525, sustainable forestry means forestry practices that are designed to meet present and future needs by employing a land stewardship ethic that integrates the reforestation, managing, growing, nurturing, and harvesting of trees for useful products with the conservation of soil, air and water quality, wildlife and fish habitat, and visual qualities. To foster sustainable forestry upon land managed by the Michigan Department of Natural Resources (DNR), Section 52503 of Part 525 requires the DNR to adopt a forestry development, conservation, and recreation management plan for state-owned lands. A primary purpose of this Michigan SFMP is to satisfy the planning requirements of Part 525 for the sustainable management of the state forest. There are other plans that address the planning requirements specified by Part 525 for the management of state parks and recreation areas and state game and wildlife areas.

Part 525 requires the DNR to manage the state forest in a manner that is consistent with the principles of sustainable forestry, and to prepare and implement a management plan that states long-term management objectives and the means of achieving these objectives. These concepts are not new to forest management they are however more prominently depicted in the SFMP than in previous plans and activities. Components of the SFMP include:

1. Identification of the interests of local communities, outdoor recreation interests, the tourism industry, and the forest products industry.
2. Identification of the annual production capability of the state forest and management goals based on that level of productivity.
3. Methods to promote and encourage the use of the state forest for outdoor recreation, tourism, and the forest products industry.
4. A landscape management plan for the state forest incorporating biodiversity conservation goals, indicators, and measures.
5. Standards for sustainable forestry.
6. Identification of environmentally sensitive areas.
7. Identification of the need for forest treatments to maintain and sustain healthy, vigorous forest vegetation and quality habitat for wildlife and environmentally sensitive species.

Standards for sustainable forestry that are addressed in the SFMP include:

1. Implementation of sustainable forestry by employing an array of economically, environmentally, and socially sound practices to conserve forests.
2. Promotion of the efficient use of forest resources.
3. Cooperation with forestland owners, wood producers, and consulting foresters to broaden the practice of sustainable forestry.
4. Planning and management of planted forest stands in a manner that complements the management of and promotes the restoration and conservation of natural forests.
5. Ensuring long-term productivity and conservation through reforestation, soil conservation, and afforestation.
6. Protection of water quality and streams, lakes and other water bodies consistent with DNR and Michigan Department of Environmental Quality (DEQ) best management practices.

7. Conservation of biological diversity by implementing stand and landscape level measures that promote the conservation of terrestrial and aquatic forest flora, fauna, and unique ecosystems.
8. Protection of forests from wildfire, pests, and diseases.
9. Management of areas of ecological, geological, cultural, or historic significance.
10. Maintenance and enhancement of high conservation value forests.
11. Communication to the public the DNRs progress in fulfilling its commitment to sustainable forestry and opportunities for persons to participate therein, through the preparation and implementation of management plans that clearly state long-term management objectives and the means of achieving those objectives.
12. Monitoring, measuring, and reporting of performance in achieving the commitment to sustainable forestry.
13. Requiring that forest management plans and operations comply with federal and state laws, and enhance the long-term social and economic well-being of forest workers and local communities.

Ecosystem management principles recognize that there are many criteria and indicators for identifying and assessing sustainability. These principles recognize and promote intergenerational sustainability, the dynamic character of ecosystems which include adaptation and evolution to changes in component flora and fauna, and the presence of multiple spatial and temporal scales. Forest capability and productivity in the context of sustainability includes a temporal aspect that must be considered and tracked.

The identification of the annual capability and productivity of the state forest is expressed by maintaining a baseline of current productivity, and subsequently monitoring and assessing changes that will inform adaptation of management goals as resources change over time. Forests are vibrant, growing, and changing estates with ever-changing biological, social, and economic capabilities. There is no single annual capability of the state forest. There are multiple capabilities to consider, such as timber and mineral production, recreational use and ecosystem services. Attempting to use numbers to presently describe all the capabilities of the entire state forest system would be misleading. Not only are there multiple combinations of capabilities and productive outputs (which may effect one another in negative or positive ways), but many elements have qualitative aspects that are not well expressed by numbers.

The intent of the SFMP is to describe and frame current management direction and to identify measurable goals that can be monitored and adjusted over time. Measurable goals may include numeric deliverables or outputs but also include qualitative and relational measures. Some elements of forest management are more readily quantified, and this is reflected in the SFMP by clear numeric objectives. This does not imply that those elements are more important, but it does mean that one aspect of those elements has been quantified. It also means that other elements which are currently not well documented need additional work.

Section 52505 of Part 525 also required the DNR to seek and maintain a third party certification of the management of the state forest that satisfies the sustainable forestry standards of at least one credible certification program. Certification was required by January 1, 2006. The DNR sought forest management certification under two standards:

1. The Regional Forest Stewardship Standard for the Lake States–Central Hardwoods Region (USA), as approved by the Forest Stewardship Council (FSC)–US Board on February 7, 2002, and accredited by FSC International on August 5, 2002. Initial FSC certification was granted to the DNR on December 31, 2005.

2. The Sustainable Forestry Initiative (SFI) 2005–2009 Standard as adopted by the Sustainable Forestry Board, Inc. on January 10, 2005. Initial SFI certification was granted to the DNR on December 14, 2005.

The DNR must be able to demonstrate that the management of the state forest is sustainable in order to maintain certification of forest operations. A measure of sustainability is compliance with the SFI and FSC certification standards, as assessed by annual third party audits.

Principle 7 of the FSC standard (Appendix B) and Objective 1 of the SFI standard (Appendix C) requires the development and maintenance of a forest management plan. The certification standards require strategic, long-term, landscape planning. Thus, another purpose of this SFMP is to satisfy these certification requirements.

The last statewide forest resources plan for the DNR was approved by the Natural Resources Commission on November 5, 1982 and is effectively known as the Statewide Forest Resources Plan of 1983. This document supersedes and replaces the 1983 plan.

1.2 Plan Organization and Relationship to other Plans

The base of the SFMP is essentially a compilation of current statutes, policy, strategies, other plans and science (social, economic and environment/natural resource), upon which further management direction for many uses and values is built. The SFMP provides a platform for viewing a broad spectrum of policies and management. It does not resolve conflicts or supersede direction based on statute, but it does make it easier to see conflicts between various resource objectives and to identify gaps in policy and management. These conflicts are commonly a consequence of disparate direction that should be addressed in the policy arena.

Neither the SFI nor FSC standard require a single management plan. Both standards recognize planning and plans at different scales and intensities and allow a degree of flexibility in meeting their certification requirements. The DNR has multiple planning processes and strategies concerning various resources at different scales and intensities. These processes, programs, and strategies address management of individual or multiple natural resource elements, flora, fauna, watersheds, and/or ecosystems. Department of Natural Resource land resources are organized into three categories, state forest, state parks and recreation areas, and state game and wildlife areas (state game areas, waterfowl production areas, etc.), which are managed or co-managed by four primary DNR divisions: Forest, Mineral and Fire Management, Parks and Recreation, Wildlife, and Fisheries divisions. The number of programs and the geographic scale of state-owned lands preclude the integration of all DNR plans for these resources into a single comprehensive plan. This SFMP specifically addresses the management of the state forest ownership, for a purpose that is similar to other plans which address the management of state parks and state game and wildlife areas.

The DNR uses a hierarchical geographic planning framework that coordinates many planning activities and guides operational decisions for management of the state forest (Figure 1.1). The framework consists of a suite of plans that includes a state level plan (the Michigan State Forest Management Plan), regional plans (Ecoregional Resource Plans and Regional State Forest Management Plans), and forest management unit level plans (the annual plan of work that is derived from the 10-year planning cycle for annual compartment reviews). The aggregate of all forest prescriptions from compartment reviews are contained in the annual plan of work, which represents the tactical level of planning for state forest operations.

The DNR is developing strategic plans that will address all ownerships in a region (including all DNR lands – forests, parks and wildlife areas, other public plans, and private lands), which will be known

as Ecoregional Resource Plans. Ecoregional Resource Plans will provide strategic goals and objectives that will provide guidance for Regional State Forest Management Plans and other state planning efforts.

Other programmatic planning efforts must be integrated to guide the management of the state forest, which include but are not limited to:

- Michigan's Wildlife Action Plan (Eagle et al. 2005)
- Conservation Area Management Guidelines
- River Assessment and River Management Plans
- Natural River Plans
- Master plans for wildlife areas located within the state forest
- Strategy for Kirtland's Warbler Habitat Management (Michigan Department of Natural Resources et al. 2001)
- (Draft) 2008–12 Michigan State Comprehensive Outdoor Recreation Plan
- Michigan Off-Road Vehicle (ORV) Plan 2005
- DNR Silvicultural Guidelines
- Annual Management Review

A summary of these and other planning processes, with links to the plans themselves is available upon the DNR forest planning website, and is titled "A comprehensive Summary of the Department of Natural Resources Planning Processes for Natural Resource Management in Michigan". Each of these planning components on the website incorporates specific division goals and objectives into an integrated management direction, and supports each other by providing more explicit planning direction and guidance for specific resource areas. When considered as a whole these form a compendium of planning initiatives that represent an over-arching management program for the state forest.

Although it is unrealistic to repeat the content of all plans in the SFMP, the SFMP can provide a framework for planning upon which further management direction can be based. The content of the SFMP is intended to complement the Regional State Forest Management Plans, which will be more detailed and prescriptive than the SFMP. The contents of Regional State Forest Management Plans are prescribed in DNR Forest Certification Work Instruction 1.3, Regional State Forest Management Plan Development. The primary purpose of regional plans is to provide landscape-level direction that informs tactical decision-making processes during compartment review at the forest management unit (FMU) level of operations.

Section 4 of the SFMP contains management direction for many uses and values of the state forest in the form of landscape-level desired future conditions (DFCs), statewide goals, objectives, standards, and guidelines for the sustainable management of the state forest system. These management directions are intended to be used for guiding the development of content in Regional State Forest Management Plans and for management decisions in the compartment review process. Section 4 of the Regional State Forest Management Plans is structured in a different manner from the SFMP and employs a concept of distinct Management Areas as a framework for providing quantitative direction for management on a regional-specific basis. This concept partitions the state forest into distinct areas with similar attributes, such as similar landforms or site potential, or concentrations of similar successional states or ownership. Specific management direction, standards, and guidelines will be provided for each Management Area. These plans will include summations of current and projected acreages for major cover types and Section 5 Special Resource Areas in each management area within the next 10-year compartment review cycle.

Section 5 of the SFMP outlines general management direction for Special Conservation Areas (SCA), High Conservation Value Areas (HCVA), and Ecological Reference Areas (ERA). Section 5 of the Regional State Forest Management Plans provide more detailed direction for these areas by providing spatially-explicit maps, specific management direction, standards and guidelines. Management direction for SCA, HCVA, or ERA areas will have a higher priority than direction given for the Management Area in which they are located.

The Regional State Forest Management Plans, in conjunction with other DNR plans and processes such as those listed above, will provide specific management direction that will inform the compartment review process. Annual compartment reviews by year of entry are conducted at the FMU level, and these reviews represent the tactical level of planning for forest operations. Compartment reviews are guided by operations inventory and compartment review procedures, as contained in Forest, Mineral, and Fire Management Division (FMFMD) Policy and Procedure 441, dated January 19, 2000. Proposed forest treatments that are considered during compartment review will be guided by the desired future conditions, goals and objectives contained in the SFMP and Regional State Forest Management Plans. Annual prescriptions for all year-of-entry compartments across all 15 FMUs are compiled into an annual plan of work, which in aggregate represents an annual operational plan for management of the state forest.

1.3 DNR State Forestland Management System

Traditional sustained yield management of forests became prominent in the United States in the late 19th century, and was generally adopted as management strategy by the present DNR in the early 20th century. There are a broad range of benefits and values that people desire from the state's natural resource base that are codified in plans, programs, and activities. Natural resources and human needs change over time – the challenge of natural resource management is to adapt and adjust plans and management activities to align with these changes while ensuring continued natural resource health into the future. The development and implementation of policies for sustainable use of natural resources is based on a number of overarching principles and approaches. These principles take a holistic view of resources, pursue multi-stakeholder engagement, plan for the long term, address local effects, and promote sustainable development and uses.

To meet these challenges, the DNR began a shift toward ecosystem management in the year 2000 for the planning and management of Michigan's natural resources. The concepts of ecosystem management are not new and have been accepted by many organizations including the Society of American Foresters (SAF 1993). The SAF holds that ecosystem management will maintain ecological and desired forest conditions, within which the sustained yield of products to meet human needs is achieved. The concept of ecosystem management is thus linked to the concept of sustainability, which is the hallmark of the two standards under which the DNR state forest is certified – the Sustainable Forestry Initiative and the Forest Stewardship Council.

Ecosystem management is a process that integrates biological, social, and economic factors into a comprehensive strategy aimed at protecting and enhancing the sustainability, diversity, and productivity of natural resources. This is in contrast to traditional sustained yield management, where the key objective is the production of forest products for human needs under the constraint of minimizing adverse environmental effects. Some of the other differences between traditional sustained-yield and ecosystem management strategies are outlined by the Society of American Foresters (Table 1.1).

At the stand and compartment level ecosystem management requires that FMU operations be integrally related to larger landscape and ecoregional considerations, whereby FMU operational decisions take into account landscape level concepts that are consistent with and support ecoregional

and statewide goals and objectives. FMUs are comprised of compartments, which are blocks of land that are 1,000–3,000 acres in size. An inventory process divides compartments into stands, generally ranging in size from 10–100 acres. Compartments are grouped by years-of-entry. Each year-of-entry contains approximately 10% of the compartments in a FMU. At the end of ten years, all of the compartments within an FMU will have been inventoried and reviewed.

The inventory and decision making process applied to compartments is governed by Forest Mineral and Fire Management Division Policy and Procedure No. 441, Operations Inventory and Compartment Review Procedures, dated January 19, 2000, which directs that inventory operations and associated compartment reviews be conducted using the "Operations Inventory Field Manual".

Operations inventory locates and identifies physical, biological, economic, and social information on each unit of land. It provides information for day-to-day operations relating to resource management issues such as timber, wildlife, forest recreation, water quality, reforestation, and land use. The Operations Inventory system requires information that describes the composition of the stand, site factors, and a management prescription that supports state and ecoregion goals and objectives for desired future conditions.

In this process of integrated planning, it is critical that statewide and landscape level ecosystem considerations are incorporated in the development of management unit goals and objectives upon which compartment and stand prescriptions are then based. This is the primary means by which ecosystem-based management is achieved. Following a public open house, stand prescriptions are finalized at a multi-disciplinary compartment review to ensure a public and DNR-wide understanding of compartment and management unit goals.

As of 2005, the DNR is in the process of converting from Operations Inventory to a new geographic information system-based inventory and decision making environment known as, "Integrated Forest Monitoring, Assessment, and Prescription" (IFMAP). IFMAPs design will facilitate multi-scaled, ecosystem-based decision making.

To facilitate the implementation of DNR management within the context of forest certification requirements, existing DNR policies and procedures for operational management have been supplemented by Forest Certification Work Instructions (Appendix D). These were written to allow the DNR to meet the requirements of sustainable forest management as defined in the SFI and FSC certification standards. A sub-set of these work instructions are required for use by field staff in the course of daily forest operations.

1.4 Mission, Vision, and Strategic Goals for the State Forest

1.4.1 Mission and Vision for the State Forest

In the context of public trust responsibilities that consider interests of all current and future citizens in the state's natural resources, the DNR has adopted the following mission statement:

The Department of Natural Resources is committed to the conservation, protection, management, use, and enjoyment of the state's natural resources for current and future generations.

The vision for the state forest is described in terms of its desired future condition, which is related to long-term management objectives. When these objectives are achieved the desired future condition of the state forest will:

1. Sustain fundamental ecological processes and functions that, in turn support representative, diverse, and productive biological assemblages.
2. Provide for a variety of ecosystem services that help sustain human civilization.
3. Provide for a variety of sustainable human values that are derived from ecosystems, including economic, recreational, and intrinsic values.
4. Provide for a variety of forest-based products.

These statements of desired future condition are not in any relative order of priority, since under the principles of ecosystem management (as previously discussed) the concepts of biological, social, and economic uses and values are balanced.

1.4.2 Strategic Goals

The DNR has established long-term strategic goals to guide our steps towards sustainable, ecosystem-based management of state forestlands. Under the concept of ecosystem management where ecological, social, and economic aspects have equal emphasis, there is no expressed relative value or priority assigned to these goals.

Ecological Goals

Goal 1. Practice sustainable, ecosystem-based management.–Resource planning and operations shall be conducted to maintain the long-term integrity, representation, diversity, and productivity of terrestrial and aquatic ecosystems; with recognition of valued human activities and uses derived from these systems. Fundamental processes, functions, and values of ecosystems shall be protected or rehabilitated. In doing so, the following set of objectives shall be followed:

Objective 1.1 Conserve Geophysical Processes. Emphasize conservation and rehabilitation of geo-physical processes such as soils formation, geomorphic sediment dynamics, carbon dynamics, hydrologic dynamics, and nutrient dynamics. Such processes are the foundation of the habitat conditions required to sustain desired biological assemblages.

Objective 1.2 Conserve Biodiversity. Encourage the management of intact, functional landscapes, ecosystems, and communities that will achieve the conservation of representative biological assemblages, including rare species; maintaining statewide biological diversity at ecosystem, species, and genetic levels.

Objective 1.3 Maintain Biotic Productivity. Manage lands in a manner to protect, maintain, and rehabilitate ecosystem processes and habitats to ensure sustainable production of desired forest, wildlife, and fishery resources.

Social-Economic Goals

Goal 2. Maintain essential ecosystem services. Resource planning and operations shall ensure the variety of ecosystem services (see glossary).

Goal 3. Sustain social-economic values. Resource planning and operations shall encourage the efficient and sustainable production of desired forest, mineral, wildlife, and fishery resources to provide a range of social and economic benefits.

Goal 4. Provide public access. Resource planning and operations shall protect and preserve the natural, historic, and cultural features of DNR-managed lands while providing appropriate public access to these resources. In doing so, the following set of objectives shall be followed:

Objective 4.1 Provide Recreational Opportunities. Provide for a variety of active and passive recreational opportunities, tailored to specific local ecological and social characteristics.

Objective 4.2 Provide Educational Opportunities. Provide public educational programs and opportunities that help build public understanding and appreciation for the important processes linking landscapes, ecosystems, habitats, and biological assemblages, and the human values and services derived from these natural systems.

Objective 4.3 Allow for Cultural Uses. Allow for cultural uses by indigenous peoples and others.

1.5 Statewide Ownerships and Management Unit Boundaries

Management of the natural resources of state public lands must be considered within the context of the land itself, the natural resource values that the lands provide, and the use of these natural resource values by people. Human or public interactions have a great affect upon the specific management purpose of DNR lands, whereby different areas of DNR land are managed for different natural resource values with different management purposes and objectives. Distinct management zones within the DNR ownership are state forestlands, state parks and recreation areas, and state game and wildlife areas, each with dedicated staff and resources necessary to accomplish their specific mission.

The DNR is the largest single land owner in the state, holding title to approximately 4.5 million surface acres of land and more than six million acres of subsurface mineral rights (Figure 1.2). A discussion of specific boundaries and administrative responsibilities for public and private land ownership and management are described in Appendix E.

1.6 Plan Implementation and Communications

The Michigan State Forest Management Plan will be considered to be implemented upon the effective date of signature the director of the Michigan Department of Natural Resources. This plan shall be communicated to all DNR staff, and made available to the public via the DNR internet web site or upon request.

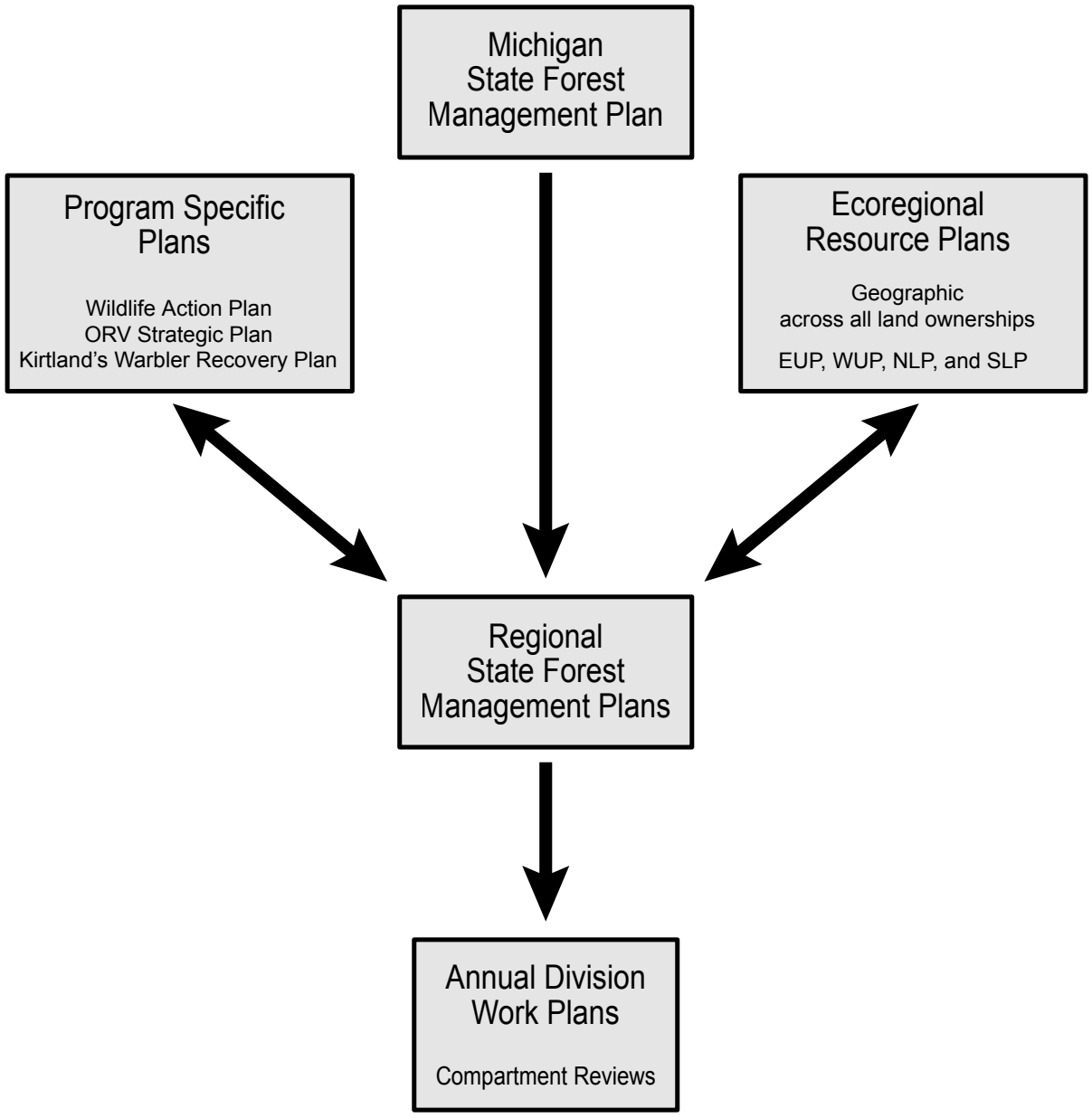


Figure 1.1.–The framework of DNR forest planning.

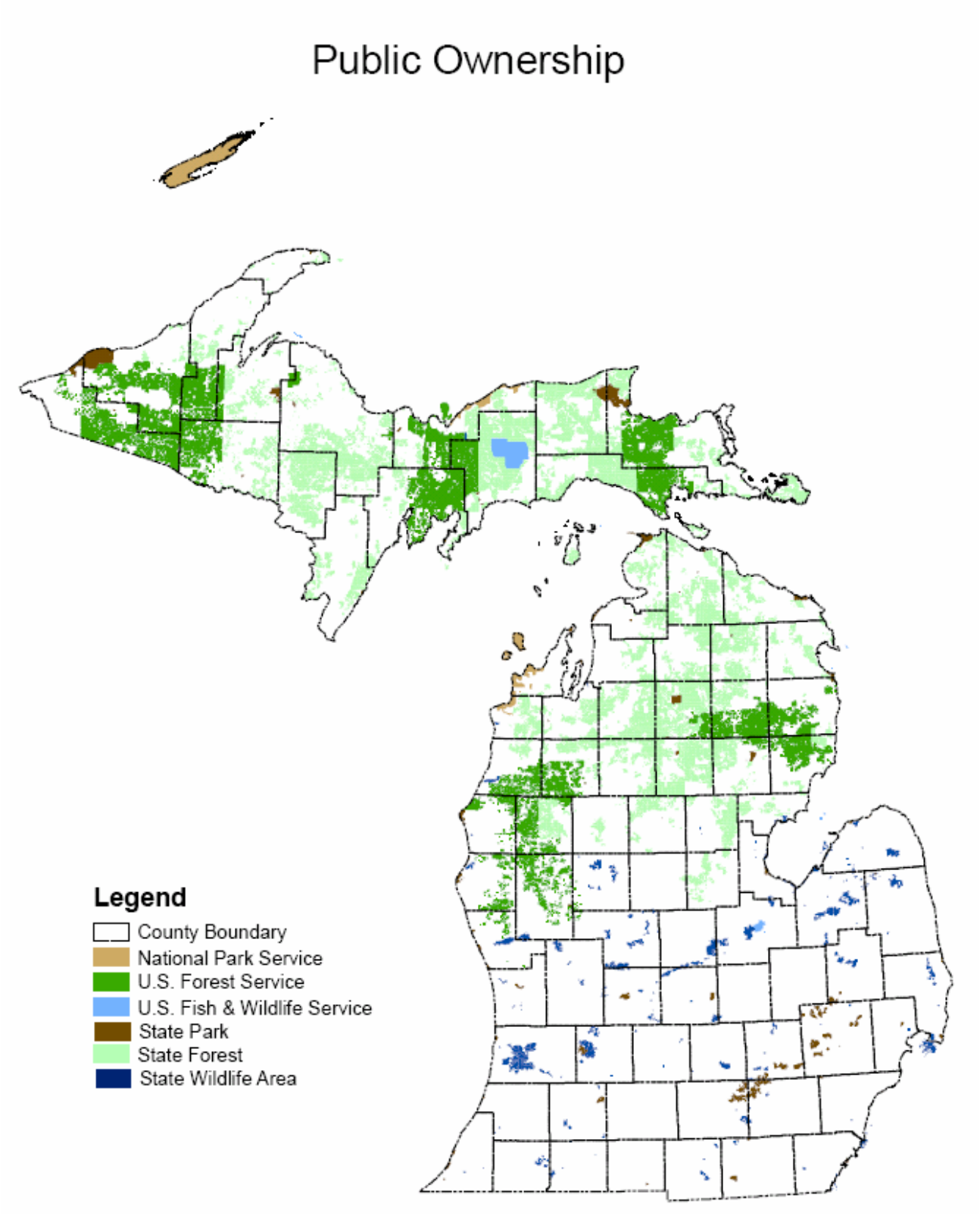


Figure 1.2.–Michigan's public lands (Michigan DNR 2004).

Table 1.1.–A comparison of management strategies (SAF 1993).

	Traditional sustained-yield management	Ecosystem management
objective processes	Sustained flow of specific products to meet human needs, constrained to minimize adverse effects.	Maintains ecological and desired forest condition within which the sustained-yield of products to meet human needs are achieved.
strategy for accomplishment	Resembles the agricultural model (plant, tend, harvest).	Reflects patterns of natural disturbance.
system character	Emphasizes production efficiency, but within environmental constraints.	Retains complexity and processes, provides framework for the whole system.
unit of management	Stands and aggregations of stands within an ownership.	Landscapes and aggregations of landscapes across ownerships.
time unit	Multi-rotations with rotation length determined by land-owner objectives.	Multi-rotations with length reflecting natural disturbance, although intensive management will cause some to be shorter.
current status	In transition, new knowledge is bringing in new values. Remains a valid strategy for portions of the landscape.	Evolving, accepted for management on national and state forestlands.

Forest History

2.1 Pre-European Settlement History (Glaciation to 1800s)

The present physical geography of the State of Michigan is a direct result of the Wisconsinan glaciation of the Pleistocene Epoch, when the state was totally covered by ice. As the present inter-glacial period began and the ice sheet gradually receded, southern Lower Michigan became mostly ice free approximately 13,000 years before present (B.P.). Upper Michigan became ice free approximately 10,000 B.P. The landform and soils of Michigan are the result of post-glacial lakes, rivers, erosion and soil development processes acting upon the glacial deposits, resulting in a diversity of terrain features including moraines, drumlins, eskers, kames, outwash plains and former lake beds that are interspersed with numerous lakes, streams and depressions, including four of the world's largest freshwater lakes.

It was upon this landscape of raw post-glacial parent material that life gradually returned. The primary succession of plant life was heavily influenced by the nature of the parent material, the climate (that was still very much influenced by the receding ice sheets) and the formation and disappearance of proglacial lakes. Theories of the succession of plant life from barren soil to tundra, and the migration of forest tree species and some animal species from their glacial refugia are fairly well established (Davis 1981; Pielou 1991). Post-glacial succession and development of forest and animal communities were first driven by a gradual warming of the climate, culminating in the hypsithermal of the current interglacial occurring approximately 7,000 B.P., and then by the subsequent and present cooling trend toward the next glaciation. The post-glacial landscape provided an abundance of habitat for a wide diversity of forest, savanna and aquatic plant and animal communities, which were distinctly influenced by Native American cultures that inhabited the two peninsulas, most notably through hunting and fishing activities and their interaction with the fire regimes of both savanna grasslands and pine lands. A comprehensive description of the complexity of the post-glacial climatic and anthropogenic interaction with plant and animal communities can be found in Pielou 1991.

The terrestrial landscape of Michigan is comprised of four distinct ecoregions (Figure 2.1): Southern Lower Michigan; Northern Lower Michigan; Eastern Upper Michigan; and Western Upper Michigan. Each ecoregion is distinct in its climate, physiography, soils, and vegetation. These distinctions are a result of the peninsular configuration of the state, which dramatically affects the climatic differences of both peninsulas. The distinctiveness of warm, vegetatively diverse Southern Lower Michigan and cold Upper Michigan is largely due to their latitudinal positions and the continental land masses on their southern borders. The four Great Lakes that surround the state also provide a significant influence upon the climate in portions of both peninsulas (Albert 1995).

The pre-European settlement (circa 1800) vegetative patterns for the state are based upon an interpretation of the federal government's General Land Office (GLO) surveys of 1816–56 (Figure 2.2), with surveys of the Lower Peninsula beginning in 1816 and surveys of the Upper Peninsula beginning in 1840. The interpretation of cover types on these maps is interpolated from section line and corner witness trees, similar landform, surface geology and soils data. Inclusions of dissimilar cover types that do not intersect a section line may not be reflected upon the maps. Despite these qualifications, the GLO survey maps provide a consistent landscape-level perspective of the circa 1800 cover types of the entire state. The maps are useful for assessing broad post-settlement trends for different cover types, the type and scale of pre-settlement disturbance regimes, and for identification of the locations of historic and presently rare natural communities.

The forest and other landscape communities that existed circa 1800 consisted of a mosaic of vegetative patterns ranging from anthropogenic-influenced savanna grasslands and southern hardwood forests in Southern Lower Michigan, to northern hardwood and pine forests in Northern Lower Michigan and all of Upper Michigan (Figure 2.3; Table 2.1). The pre-settlement landscape was dynamic and was comprised of a mosaic of community types in various stages of ecological succession, driven by long-term shifts in climatic conditions, and short-term natural and anthropogenic disturbance cycles. Four community types dominated the northern Lower and Upper peninsula landscapes at the time of the GLO surveys: the beech-sugar maple-hemlock northern hardwoods community; the beech-sugar maple southern hardwoods community; hemlock-dominated communities; and the mixed conifer swamp community. Eight other sub-dominant communities occurred on the landscape: mixed oak savanna; oak/pine barrens; beech-sugar maple northern hardwoods – absent the hemlock component; mixed oak/hickory forest; mixed hardwood swamps; red/white pine forests; white pine/mixed hardwoods; and cedar swamps. Lesser communities were spruce/fir/cedar forests, seral aspen/birch forests, and black ash swamps.

As an aggregate group, pine communities covered 4.1 million acres or 11.8% of the forested landscape. These included pure white pine forests, pure red pine forests, pure jack pine forests, mixed red/jack pine forests , mixed pine/oak forests, and the previously cited red/white pine forests and white pine/mixed hardwood forests. The pine forest communities were fire-driven ecosystems, dependent upon occasional catastrophic stand-replacing fires for regeneration, and frequent low-intensity fires that eliminated competition from non-fire adapted tree species and that in the case of red and white pine maintained a relatively open structure on the forest floor. Conservative estimates of recurrence intervals for fires in jack pine forests in northern Michigan ranged from 59 to 140 years. For red and white pine stands, estimates of recurrence intervals in northern Michigan ranged from 130–240 years (Whitney 1986; Price 1994; Cleland et al. 2004).

The natural disturbance regime that maintained white pine communities was characterized by a repeating, cyclical sequence of catastrophic fires, with light surface fires occurring at shorter intervals (Frelich 1992). White pine occurred most abundantly in areas where catastrophic fire intervals were about 150 to 300 years. More frequent fires, towards the 100–150 year interval, tended to favor red pine while intervals greater than 300 years tended to succeed to northern hardwoods. As a mid-successional species, white pine occurred most frequently with red pine (Table 2.1) and most often followed jack pine (Frelich 1992). Noncatastrophic surface fires occurred at intervals of 20–40 years (Frissel 1973 as cited in Frelich 1992) and tended to kill hardwoods invading the understory. Gaps created by winds and surface fires created multi-modal diameter distributions and formed increasingly multi-aged stands. White pine stands may have been maintained in the old-multi-aged stage for one to several centuries (Heinselman 1981), until the occurrence of another catastrophic disturbance.

A view of the complexity of the landscape and the composition and structure of circa 1800 forests can also be gained through analysis of GLO data for the frequency of association of several major tree species within upland glacial landforms in Northern Lower Michigan (Table 2.2). Strong associations are evident between beech, sugar maple, and hemlock on medium and coarse-textured end moraines and coarse-textured ground-moraine features. On fine-textured ground moraines and lacustrine deposits hemlock, white pine, and beech were dominant components of the forest community. Fine-textured end moraines were dominated by hemlock and red and white pine. Outwash plains were dominated by communities of jack, white and red pine. The species diversity and the complexity of the circa 1800 forest landscape are evident in by the variety of component species in each of the different landforms, which is a reflection of natural patterns of disturbance and species succession.

The diversity of circa 1800 forests is also reflected through analysis of a Northern Hardwoods Community in Chippewa County, Michigan (Table 2.3). Some elements of community structure are

apparent by the density of 141 trees per acre (with sugar maple, hemlock, yellow birch, and beech dominating in number) and the basal area of 154 square feet per acre (with hemlock, sugar maple, yellow birch, and white pine dominating the canopy of the forest).

The complex community composition in the circa 1800 northern hemlock-hardwood forest community was driven by a combination of long-term climatic-driven trends and the different adaptations to disturbance exhibited by different tree species. A contemporary study of the Sylvania Wilderness Area in Western Upper Peninsula is informative for gaining an understanding of the historical development of this forest community (Davis et al. 1994). The study included an analysis of a paleoecological record of pollen assemblages, which showed a dominance of a very fire prone red and jack pine community approximately 7,000 years B.P., correlating to the hypsithermal of the current interglacial. During the subsequent cooling trend a somewhat less fire-prone community of white pine, oak and red maple succeeded upon the site and dominated from 7,000 to 3,000 years B.P., with an average fire recurrence interval of 150–340 years (Frelich 1992).

Rapid increases in the abundance of hemlock and yellow birch became evident in the pollen record starting 3,200 years B.P. as the frequency of fires continued to decrease, with fire recurrence intervals extending to approximately 1,400–2,200 years (Whitney 1896; Price 1994). Sugar maple and basswood entered the forest soon after the invasion of hemlock and yellow birch, and windthrow gradually became the predominant form of disturbance, with recurrence intervals of approximately 1,200–2,200 years (Whitney 1986; Frelich and Lorimer 1991; Price 1994). Where the intervals between fires were long the white pine-oak-red maple forest was succeeded by hemlock and yellow birch at some locations and by sugar maple, yellow birch and basswood at other locations (dependent upon different edaphic site conditions), giving rise to the mosaic of hemlock, sugar maple, yellow birch and white pine northern hardwood forests that dominated the circa 1800 period.

Before settlement, grasslands such as wet meadows, oak and pine barrens, dry sand prairies, and tall grass prairies were scattered throughout Michigan, but the largest acreage was in the southern Lower Peninsula. At least 39 grassland areas were present, totaling approximately 2.3 million acres. Fire was an important element in the establishment and maintenance of these grasslands. Whether caused by lightning or set purposely by Native Americans, fire stimulated grass and wildflower growth, reduced competition, and discouraged the encroachment of shrubs and trees.

2.2 Post-European Settlement History (1600s to 1900)

European settlement of the state began soon after the expeditions of the Great Lakes region in the 1600s by the French explorers Etienne Brule and Robert René Cavelier de La Salle, beginning with the establishment of Jesuit missions at Sault Ste. Marie in 1668 and at St. Ignace in 1671. The fur trade drove the early development of the state. Ease of access for trading determined the location of other early French settlements in St. Joseph in 1679, present day Detroit in 1701 and at Fort Michilimackinac in 1715.

Michigan became established as a territory in 1805, and became the twenty-sixth state in the union in 1837. Following the GLO surveys in Southern Lower Michigan, land was cleared at a relatively slow, laborious pace for agriculture. However, it was the northern Michigan land surveys that led to the discovery of extensive pine forests and fueled the subsequent rush by timber speculators beginning in the 1850s.

Early (mid-1830s) government figures from the surveyor’s findings estimated the volume of standing pine timber in Michigan to be 150 billion board-feet (at 2 cords per 1,000 bd-ft this is equivalent to approximately 300 million cords). The lumber boom started in the 1850s in the Saginaw River watershed, and quickly spread westward and northward. By 1897 it was estimated that more that 160

billion board-feet of pine had been cut, with only about six billion board-feet of standing timber remaining, mostly in the Upper peninsula. In a mere 70 years most of the original pine and hardwood forests of Michigan were gone.

Following the logging of the forests, attempts were made to settle cut-over lands for farms. To prepare the land for agriculture vast amounts of residual slash had to be cleared from the landscape. The common practice to accomplish this was to burn it. This practice combined with the release of cinders from steam locomotives provided the sparks for a period of devastating wildfires, including the firestorm of October, 1871 which alone burned approximately 2.5 million acres. Fires occurred continuously over the following six decades, interspersed by additional large conflagrations in September of 1881 (over 1 million acres), October of 1908 (2.4 million acres), and in July of 1911 (156,480 acres). These fires consumed slash, homes, and lives and destroyed millions of trees with an estimated 73 billion board-feet of timber that had previously been spared from logging. It is estimated that for every two trees that were cut for lumber, one additional tree was destroyed – mostly due to the wildfires (Dickman and Leefers 2003).

European settlement brought major degradation to inland lakes and streams and Great Lakes water resources. Land clearing for agriculture, logging, and settlement altered local stream flow patterns and volumes, eliminated some waters, and introduced pollutants into others. Huge quantities of sediment from log drives and sawdust from sawmills were dumped into rivers. In one instance, the mouth of the Manistee River accumulated sawdust to the extent that it formed a delta of several square miles. At sawmill locations throughout the state, wherever sawdust was dispensed into the river, toxic and oxygen deprived conditions were created for fish. These detriments and the land clearing efforts that exacerbated soil erosion into rivers significantly reduced the quality of fish habitat in rivers and drowned river mouths. Drainage of wetlands and shallow water tables for agriculture did likewise. Dam and road construction caused extensive fragmentation of formerly interconnected waters and contributed to the elimination or reduction of many highly-migratory fish populations. Dam construction also caused severe water quality changes and eliminated rare high-gradient river sections. Overfishing of the most productive and larger water bodies eliminated or reduced fish populations.

Intensive commercial fisheries existed both in the Great Lakes and the large rivers tributary to the lakes and the numbers of commercial fishers increased through the mid 1800s (Garling et al. 1995). Interest in recreational fishing increased as people had more time to recreate and fishing equipment was developed. In 1859, 14 lower counties in Michigan prohibited fishing with nets (commercial fishing) in order to accommodate recreational fishing. By the late 1800s, recreational fishing was well established in inland waters, while commercial fishing still dominated in the Great Lakes. At the same time that habitat was compromised, enormous exploitation was also occurring.

The creation of the Michigan Fish Commission in 1873, the ancestor of the Department of Natural Resources—Fisheries Division, can be directly linked to the demand for more fish in Great Lakes waters and more “desirable food fish” in inland waters. To address this desire, Michigan implemented fish stocking as a management tool, and continues the practice today. From 1873 to 1897, the Michigan Fish Commission stocked millions of lake whitefish and lesser numbers of many other species into Great Lakes waters to address the rapid declines in commercially important fish. Many of these Great Lakes species and numerous nonnative fish species were also stocked in many inland waters. During this time, common carp *Carpio cyprinus* and other popular species such as brown trout *Salmo trutta* and rainbow trout *Oncorhynchus mykiss* and steelhead (the migratory form of rainbow trout) were introduced into inland waters.

Human activity during the post-European settlement period also had profound affects upon terrestrial wildlife populations of the state. Since wildlife are inextricably connected to the habitat that supports

them, large scale changes in vegetative cover such as timber harvest, fire, agricultural land conversion and subsequent reversions back to forest cover have been the nexus for many trends in wildlife populations. Some species benefited by these changes while others experienced declines. Examples of species that benefited from the change from the presettlement landscape to open plains and early successional aspen forests are white-tailed deer, Sharp-tailed Grouse *Tympanuchus phasianellus*, Ruffed Grouse *Bonasa umbellus*, and American Woodcock S*colopax minor*. The forested landscape of presettlement Michigan did not support large numbers of these species, but each experienced population booms in the early through mid-twentieth century due to the availability of additional habitat which was the result of the clear cutting of forests. White-tailed deer populations were greatly influenced by harvest pressures. By 1876, market hunters were killing 70,000 deer each year to supply the booming lumber camps, and shipped what they could not sell locally to big cities such as Chicago and Detroit. At about the same time fires burned over large areas of early successional habitat, causing a loss of forage. Together, these two factors then caused a rapid decline in deer numbers.

The decline of other species can also be directly attributed to over exploitation by hunting. As markets for wild meat developed, Michigan gained prominence as a source of wild meat for large eastern and mid-western markets. Market hunters removed large numbers of a wide variety of waterfowl, shorebirds, and small game for meat, while other birds were taken for their plumage for stuffing or to adorn hats. Market hunting of the Passenger Pigeon *Ectopistes migratorius* alone killed approximately 1.5 million birds near Petoskey in the summer of 1878. As the United States population grew, the demand for wildlife as a food source also increased. This demand led to the overexploitation of many Michigan species and resulted in severe population declines for some species and the extirpation of other species.

Wildlife species extirpated during and following this period include bison *Bison bison*, elk *Cervus elaphus*, woodland caribou *Rangifer tarandus*, cougar *Felis concolor cougar*, wild Turkey *Meleagris gallopavo*, Passenger Pigeons, Trumpeter Swan *Cygnus buccinator*, fisher *Martes pennanti*, and American marten *Martes americana*. Wildlife and invertebrate species nearly extirpated or greatly reduced in the state include beaver *Castor canadensis*, gray wolf *Canus lupus*, moose *Alces alces*, black bear *Ursa americanus*, resident Canada goose *Branta canadensis*, lake sturgeon *Acipenser fulvescens*, Piping Plover *Charadrius melodus*, Kirtland's Warbler *Dendroica kirtlandii*, Prairie Warbler *Dendroica discolor*, karner blue butterfly *Lycaeides melissa samuelis*, frosted elfin *Incisalia irus*, persius duskywing *Erynnis persius*, dusted skipper *Atrytonopsis hianna*, ottoe skipper *Hesperia ottoe*, Dukes' skipper *Euphyes dukesi*, and French Mitchell's satyr *Neonympha mitchellii mitchellii*.

With the industrial age and the rise of modern agricultural methods the reliance on wildlife as meat and revenue sources declined. In many cases the wildlife population declines were so severe that they could no longer support commercial activities. As populations of wildlife declined or disappeared in the state from overexploitation, public attitudes began to change, and recovery began by increasing enforcement of laws and regulations protecting wildlife. The state began enacting a series of laws protecting various species of wildlife. The first salaried game warden in the country was appointed in 1887 and Michigan's first deer hunting license was created in 1895. In 1897 a bill was introduced in the Michigan legislature in a futile attempt to establish a ten-year closed season on passenger pigeons. Toward the end of the nineteenth century the importance of wildlife as a commercial resource began to decline and the importance of wildlife as an economic commodity began to evolve. The value of an animal was no longer simply measured by the price it would attract in a market. The value became recreational, measured by the amount of money expended for licenses, equipment, and other amenities necessary for its pursuit. Sport hunting thus largely replaced commercial activity.

2.3 Contemporary History (1900 to the present)

Many settlers found that the climate and the sandy, burned over soils of Northern Michigan were often marginally productive for farming and many areas were simply abandoned. The State of Michigan thereby inherited a large portion of the cut-over pine lands of Northern Michigan due to the nonpayment of taxes during the early twentieth century. By 1907, almost half of homesteaded land had reverted to the state. Many of these lands tax reverted several times after being repeatedly sold by the state, and the question of what to do with these lands was a serious public policy issue.

One answer came through the rise of a new industry in northern Michigan in the early 1900s: that of recreation and tourism which provided a new use for the miles of Great Lakes shoreline, inland lakes and streams and other remaining natural resources. This trend was closely related to the growth of the automobile, the state highway system and a middle economic class in a large segment of the population, whose increasing wealth and free time resulted in greater demand for recreational opportunities. During this period it was recognized that regrowth of forests and the recovery of natural ecosystems was the foundation for the well being of the recreation and tourism industry.

A Forestry Commission was established by the Forest Commission Act of 1899, which also authorized the withdrawal of abandoned cut-over lands for forest reserves. The Forest Reserve Act of 1903 authorized the Forestry Commission to establish a state forest reserve on about 34,000 acres in western Crawford and Roscommon counties, which was the beginning of the present state forest system. The Forestry Commission was abolished in 1909 with the creation of the Public Domain Commission, which was charged with receiving tax-reverted lands and administration of the increasing public domain.

Concurrently, the Forest Reserve Act of 1891 gave the president the authority to establish national forests. The present Huron and Hiawatha Forests were subsequently established in 1909, the Ottawa National Forest in 1931 and the Manistee National Forest in 1938.

To stabilize the forest landscape, early managers recognized that protection from wildfire was required. The state legislature enacted the Forest Fire Act of 1903, which first authorized the designation of a Chief Fire Warden. The Chief Fire Warden was placed in general charge of a fire warden force that was in turn charged with preventing and controlling forest fires. Fire towers were constructed between 1912 and 1942 to provide a network for early detection of forest fires. When the State Department of Conservation (the precursor to the present Department of Natural Resources) was created in 1921, fire control was a primary responsibility upon the state forest reserves. The Forest Fire Law of 1923 authorized fire control outside of state lands.

Since 1935, the general stability in the area of forestland in Michigan can be attributed to forest fire control and activities dedicated to forest management, including forest regeneration. The Civilian Conservation Corps (CCC) was established in the early 1930s to help in this effort to revitalize tax-reverted, cut-over public lands. Between 1933 and the start of World War II the CCC fought forest fires and planted approximately 485 million trees in Michigan, including extensive pine restoration plantings on 134,000 acres (Dickman and Leefers 2003).

Concurrently with the efforts of the CCC, work continued for the restoration of game species. In 1937, Congress passed the Federal Aid in Wildlife Restoration Act (Pittman-Robertson) to support state efforts in wildlife restoration. This program along with state hunting and fishing license revenues continues to support wildlife restoration activities in Michigan. Natural biotic succession was also occurring. In the early 1900s, the regrowth of burned over lands and restrictions for hunting allowed white-tailed deer numbers to rebound to approximately 1.5 million by 1949. However, as the regenerating forests matured and openings closed in, there was a decline in forage and an associated decline in deer numbers starting in the 1950s. An increase in the timber market in the 1970s along

with a deer range improvement program reversed the downward trend and led to the highest deer numbers (approaching 2 million) in the history of Michigan in 1989. Disease concerns became a major issue with the discovery that bovine tuberculosis was endemic in the wild white-tailed deer population of northern Lower Michigan in 1994.

Other species of wildlife began returning to the state, either on their own or through dedicated restoration programs. Around 1907, moose migrated (probably over on winter ice from Ontario) to Isle Royale. In 1934–37, the (then) Michigan Department of Conservation undertook a project to reduce moose numbers on Isle Royale and replenish the mainland UP moose herd with animals from Isle Royale. Seventy-one moose were captured and relocated to mainland Michigan. The project was unsuccessful in establishing a mainland population, and in 1985 and 1987 an additional 59 additional moose were relocated from Ontario to Marquette and Baraga Counties. In 1918, seven elk were relocated from western states and released near Wolverine. The year 1918 also saw the enactment of the Migratory Bird Treaty Act, which stopped hunting of migratory bird species such as the Piping Plover. Wild Turkeys were reintroduced into Michigan beginning in the 1950s. Restoration of marten populations began around 1958, with the relocation of animals from Ontario into the Porcupine Mountains in the western Upper Peninsula. Additional releases were conducted in Upper Michigan in the 1970s and in northern Lower Michigan in 1985 to supplement existing populations. Fishers were first reintroduced in the 1960s on the Ottawa National Forest in western Upper Michigan. Resident Canada Geese were relocated from Minnesota in the 1960s and 1970s. During the 1980s, Michigan began a Trumpeter Swan reintroduction program as part of the North American Restoration Plan. Successes in the reintroduction of wildlife species was countered by the decline of other species due to less favorable habitat conditions, such as Common Loons *Gavia immer*, Kirtland's Warblers, Prairie Chickens *Tympanuchus cupido*, and Sharptail Grouse *Tympanuchus phasianellus*.

From 1897 through 1964, the Michigan Fish Commission (later called the Michigan Conservation Department) did not actively manage Great Lakes waters other than to regulate commercial harvest, though regulation was without a clear understanding of limits on fish productivity and the potential affects of over-harvest. Essentially, commercial harvest was allowed to continue unencumbered by the regulations in place.

Large changes in the fishery community for both the great lakes and inland waters were underway. Arctic grayling *Thymallus arcticus* were extinct by early the 1900s in spite of efforts to produce the species in hatcheries. Several other species were deemed extinct due, at least partially, to overexploitation: blue pike *Sander vitreus glaucus*, longjaw cisco *Coregonus alpenae*, blackfin cisco *Coregonus nigripinnis*, and deepwater cisco *Coregonus johannae* (Eagle et al. 2005). Sea lamprey *Petromyzon marinus* invaded the Great Lakes in the early 1900s through the Erie Canal, with a high abundance of reproducing populations by the mid-1900s. With both an inland and Great Lake component to their life cycle, this parasitic lamprey was particularly devastating to native lake trout populations. A sea lamprey control program was developed through the Great Lakes Fishery Commission in 1958 that continues today.

Another invasive species, alewife *Alosa pseudoharengus*, became prominent in the Great Lakes in the 1950s. At this time, lake trout numbers were very low as a result of commercial exploitation and sea lamprey parasitism. Without an effective predator such as lake trout, alewife numbers swelled and dieoff occurred in large magnitude along the shorelines of the lakes. At the same time, a growing interest in recreational fishing opportunities on the Great Lakes became apparent to fisheries managers. The Department of Conservation made a decision to introduce hatchery raised Pacific salmonids to control nuisance alewife populations and produce a sport fishery. A similar management philosophy led to stocking lake trout in Lake Superior to restore predator populations. The migratory salmonids have since adapted to reproduction in freshwater and use inland rivers to spawn and provide growing habitat for juveniles.

Environmental and fishery management practices since the mid 1900s assisted in rehabilitating many aquatic ecosystems. In particular, reforestation programs have stabilized forested landscapes, hydrologic and sediment processes, and waters therein. The federal Clean Water Act of 1972 removed the most serious water quality impairments and fishery management practices have rehabilitated many valued species of aquatic and terrestrial animal species. The ban of DDT and other similar persistent pesticides in the 1970s has contributed to a reduction in contaminant loading in fish and a significant rebound of some bird populations, such as Bald Eagles *Haliaeetus leucocephalus*, Osprey *Pandion haliaetus*, Peregrine Falcons *Falco peregrinus*, which were hard hit by the liberal use of pesticides shortly after World War II.

The importation of nonnative insects and disease has had a counterbalancing effect upon the regrowth of Michigan's forests, with exotics such as the chestnut blight, Dutch elm disease, gypsy moth in the 1900s and most recently the emerald ash borer causing declines in a number of native tree species.

By 1939, more than two million acres of land had entered the public domain, and by the early 1940s almost 5 million acres were under the management of the Department of Conservation. As of 2003, approximately 19.3 million acres of Michigan's total land area of 37,258,240 acres is again forestland (Figure 2.4). This represents 53% of the total land area, and an increase of 5.5% since 1980. This forestland is located predominately in the northern two thirds of the state. Michigan's 18.7 million acres of timberland is the fifth largest in the United States, exceeded only by the states of Georgia, Oregon, Alabama, and North Carolina. Timberland acreage has increased 7% since 1980 (U.S. Forest Service data).

Present vegetative communities and their dependent animal populations have been in an almost constant state of instability and adaptation over the past 20,000 years. This is due, in part, to a changing climate, fundamental changes in the configuration of the land and the composition of its surficial materials (Davis 1986), and the affect of more recent human activity. From the earliest period of European settlement and particularly in the 19th century, widespread extraction of the state's natural resources (including timber, minerals, fish, and game) occurred on a monumental scale. There are many legacies from this period, which include the deforestation, burning and reforestation of large portions of the state, the severe degradation and slow recovery of aquatic habitats from erosion and disruption of natural hydrologic cycles, the loss of many aquatic and terrestrial wildlife species due to loss of habitat and over exploitation, and rapid population growth of other wildlife species that were well adapted to the early successional communities present upon the landscape in the early to mid-20th century. Another legacy was the formulation of progressive policies and management to restore, enhance, and use natural resources in a sustainable fashion.

The past century's resource-based activity has led to several economic and social conditions, many of which carry through to the present day in the northern regions of the state. For example, a transition is occurring in many areas of the northern Lower Peninsula from a predominately timber-based economy to a more diversified timber, recreation, and agricultural-based socio-economic system. Changes have been more gradual in the Upper Peninsula, but a trend from a timber and mineral-based economy to a timber and recreation-based socio-economic system can be perceived.

The state will never again see vast forest acreages similar to those present in the circa 1800 period. Yet inventory data indicate that the forests of the state have been on a steady path towards recovery from the over exploitation and fire devastation that took place at the end of the 19th Century and the beginning of the 20th Century. This indicates that timber and other natural resource-based industries will remain significant, contributing segments of the social and economic fabric of the state for the foreseeable future.

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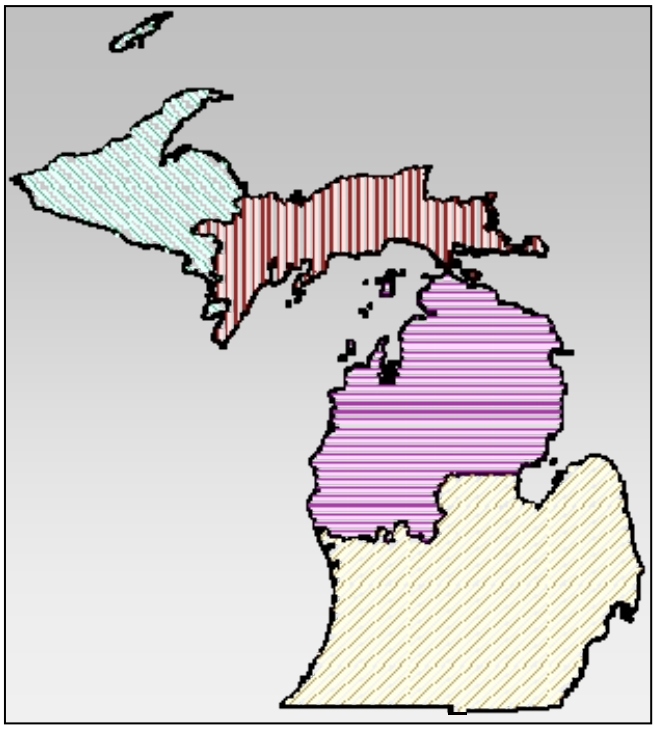

Figure 2.1.–Regional landscape ecosystems of Michigan (Adapted from Albert 1995).

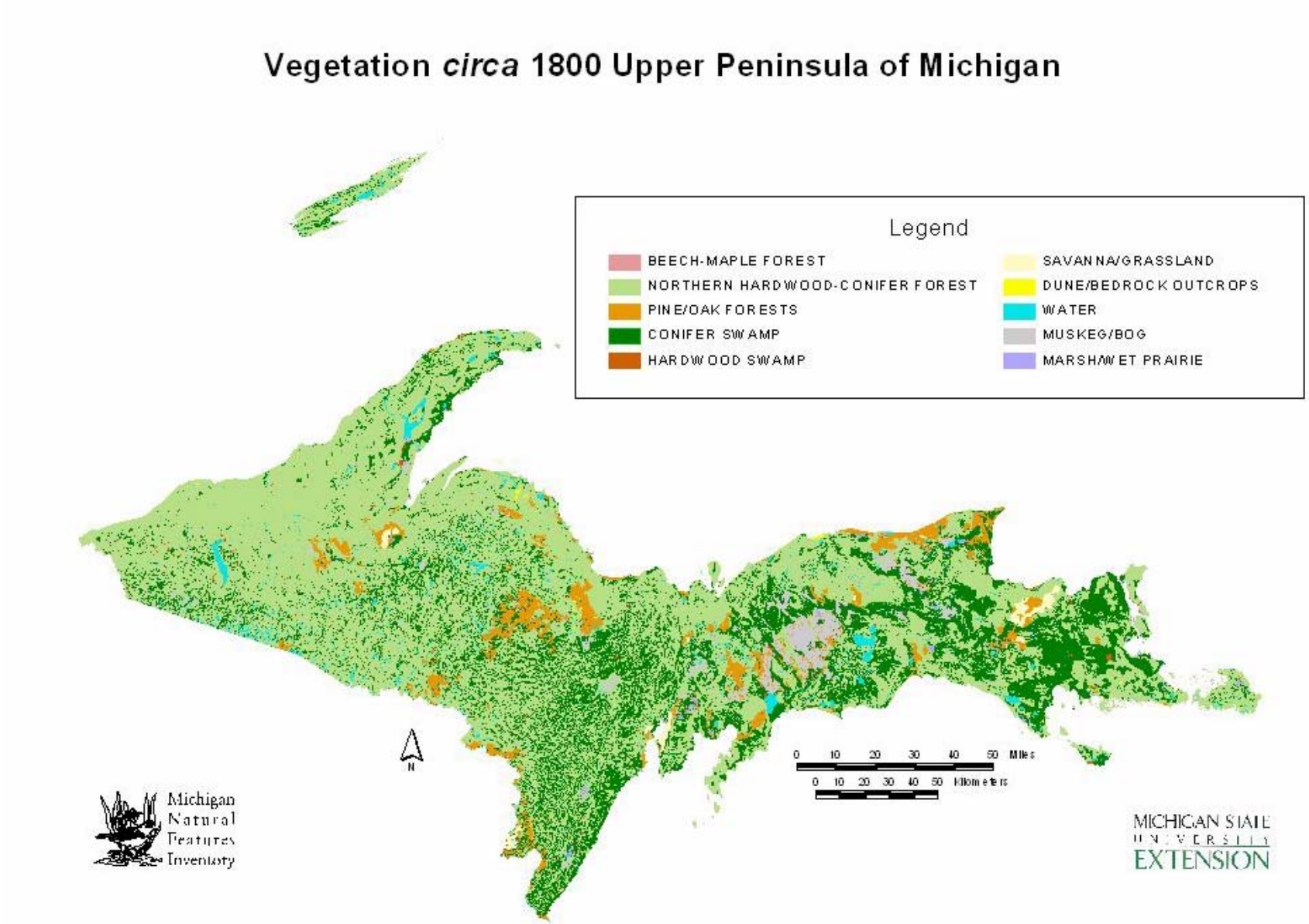

Figure 2.2.–Vegetation of Michigan circa 1800 (Michigan Natural Features Inventory 1998).

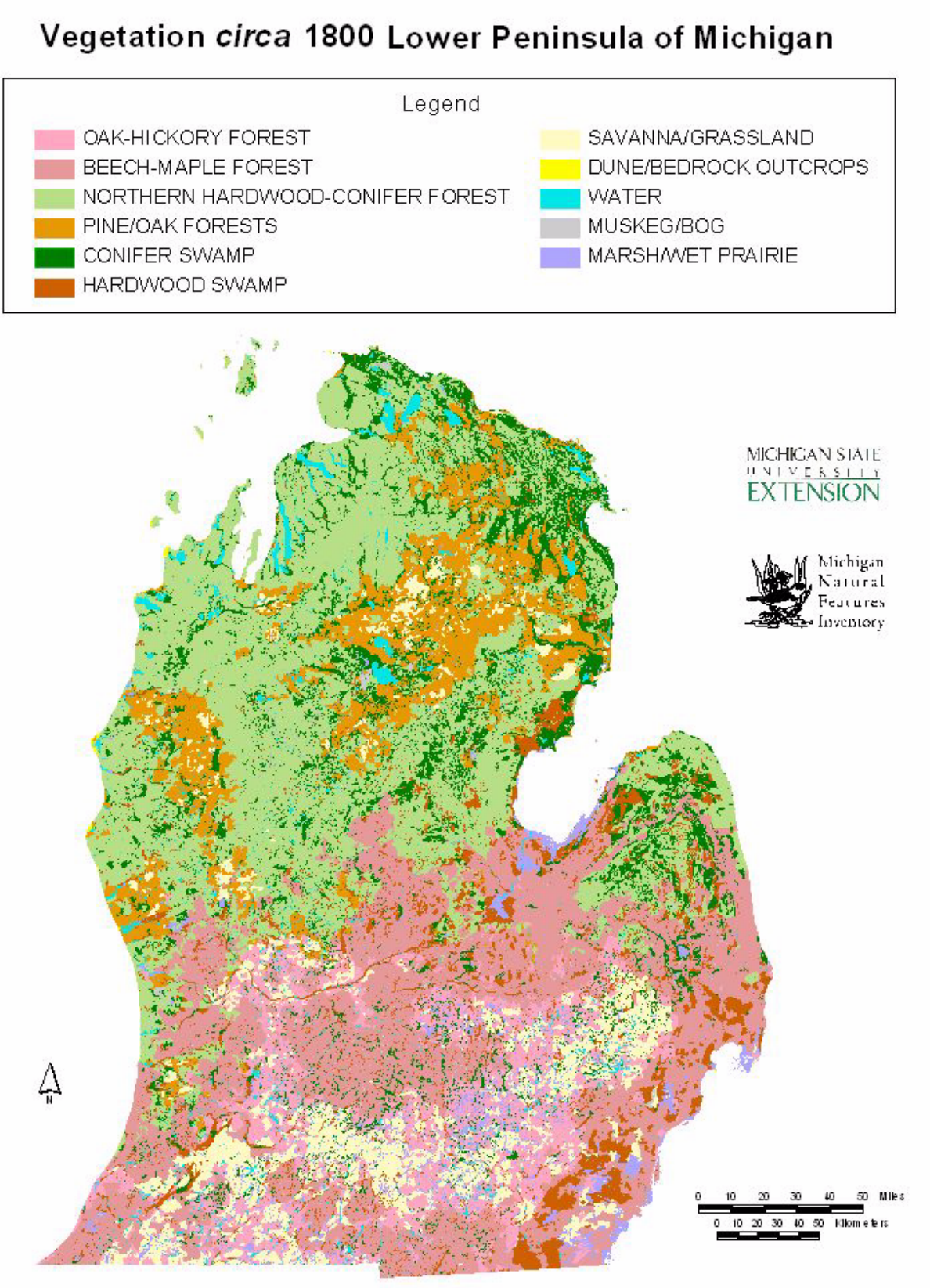

Figure 2.2.–Continued.

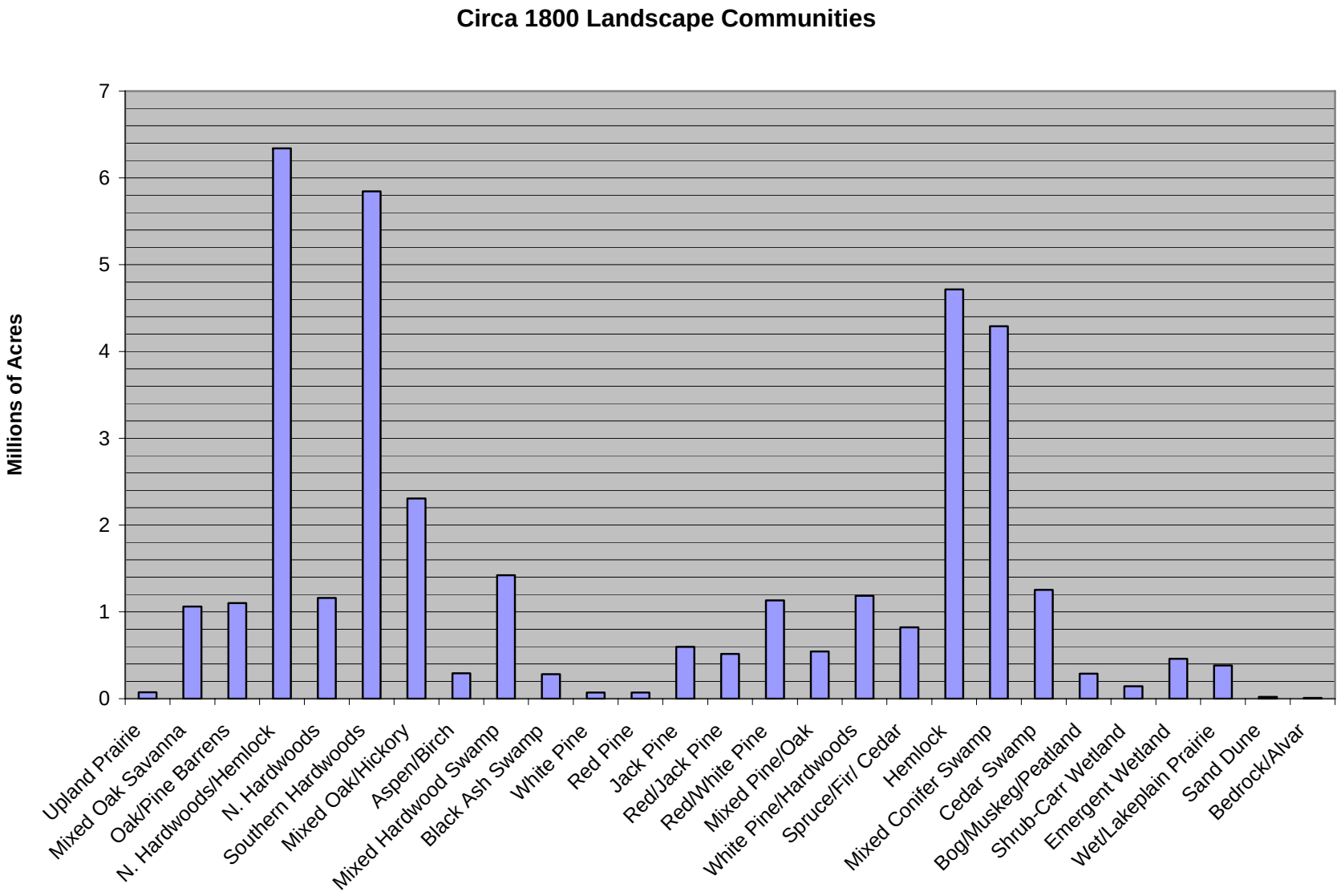

Figure 2.3.–Circa 1800 landscape cover types (Michigan Natural Features Inventory 1998).

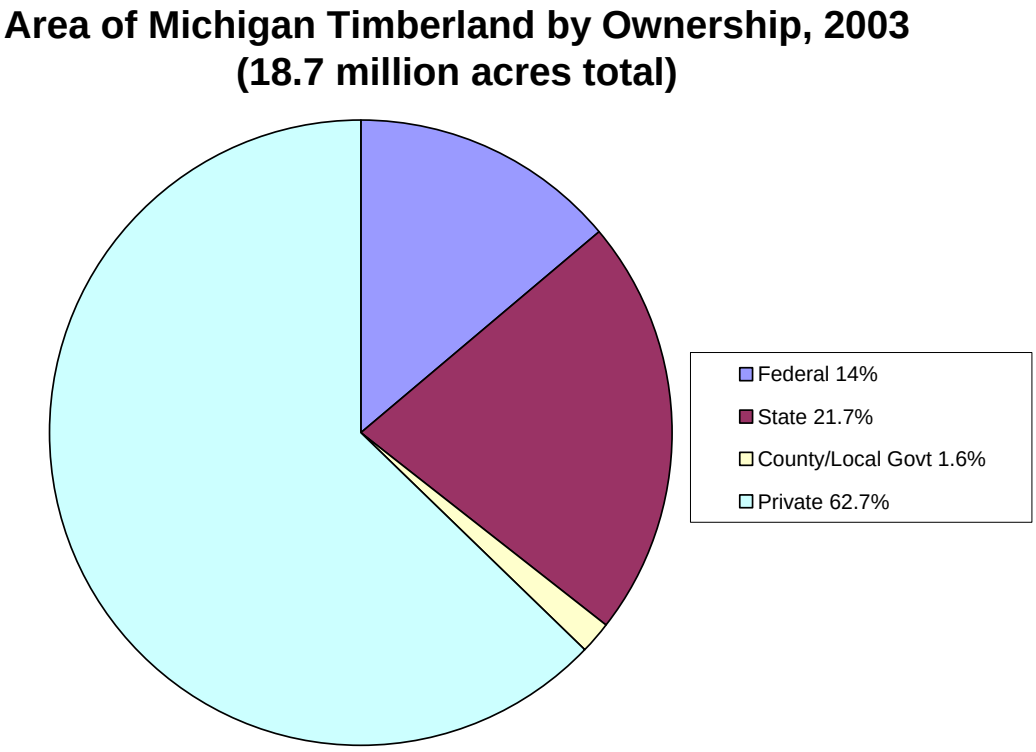

Figure 2.4.–Area of Michigan timberland by ownership (U.S. Forest Service, 2003).

Table 2.1.–Circa 1800 cover types by acreage and percent relative cover (Michigan Natural Features Inventory 1998).

Cover type	Acreage	Percent
n. hardwoods/hemlock	6,341,989	18.1
s. hardwoods	5,845,677	16.7
hemlock	4,714,602	13.5
mixed conifer swamp	4,290,553	12.3
mixed oak/hickory	2,306,373	6.6
mixed hardwood swamp	1,421,462	4.1
cedar swamp	1,254,055	3.6
white pine/hardwoods	1,185,681	3.4
n. hardwoods	1,161,644	3.3
red/white pine	1,132,097	3.2
oak/pine barrens	1,101,424	3.1
mixed oak savanna	1,061,564	3.0
spruce/fir/cedar	823,253	2.4
jack pine	596,836	1.7
mixed pine/oak	543,562	1.6
red/jack pine	515,819	1.5
aspen/birch	292,266	0.8
black ash swamp	280,705	0.8
red pine	70,889	0.2
white pine	69,141	0.2
Totals	35,009,591	100

Table 2.2.–Frequency of association of tree species with upland landforms in the northern Lower Peninsula prior to European settlement (Fisher 1994).

Species	Upland landform							
	Outwash plains	Ice contact features	End moraines			Ground moraines		Lacustrine sands and gravels
			fine-textured till	medium-textured till	coarse-textured fill	fine-textured till	coarse-textured till	
sugar maple	7.7	11.8	6.5	24.8	21.4	8.7	16.4	10.1
hemlock	6.9	11.7	20.8	17.7	17.1	27.1	17.9	23.4
beech	11.0	17.8	11.7	37.1	31.7	16.7	22.6	18.8
white pine	17.1	14.0	16.7	4.9	8.9	24.3	11.9	22.0
red maple	2.3	2.0	1.8	0.7	3.0	8.3	1.3	4.9
white oak	6.5	1.7	0.7	1.2	1.6	0.3	0.2	1.3
red oaks	1.9	2.4	2.3	0.5	1.3	0.4	1.7	0.1
red pine	15.5	20.5	21.4	5.2	5.3	3.7	14.9	5.5
jack pine	20.8	11.7	8.1	0.8	1.5	0.0	3.2	1.4
aspens	1.4	3.0	3.6	0.7	0.8	1.3	2.3	1.8
other hardwoods[a]	8.2	3.4	4.8	6.0	7.2	7.2	6.1	6.7
other conifers[b]	0.7	0.0	1.6	0.4	0.2	2.0	1.5	4.0

[a] Includes ash, elm, basswood, paper birch, yellow birch, and black cherry.
[b] Includes balsam fir and white cedar.

Table 2.3.–Species density and dominance in the circa 1800 northern hardwoods community of Chippewa County, Michigan (Price 1994).

Species	Number of trees	Relative density	Trees/ acre	Total basal area[a]	Relative dominance	BA[a]/ acre
aspen	6	0.7	1.0	2.0	0.2	0.3
beech	86	10.4	14.6	53.6	5.9	9.1
balsam fir	55	6.6	9.4	21.2	2.3	3.6
black/red oak	2	0.2	0.3	5.9	0.7	1.0
basswood	4	0.5	0.7	5.4	0.6	0.9
hemlock	170	20.5	29.0	252.3	27.8	42.9
ironwood	3	0.4	0.5	0.7	0.1	0.1
red maple	68	8.2	11.6	35.5	3.9	6.0
red pine	2	0.2	0.3	3.5	0.4	0.6
sugar maple	235	28.4	40.0	206.1	22.8	35.0
spruce	30	3.6	5.1	21.3	2.4	3.6
white birch	9	1.1	1.5	7.1	0.8	1.2
white pine	42	5.1	7.2	136.7	15.1	23.2
yellow birch	116	14.0	19.8	154.7	17.1	26.3
Totals	828	100	141	906	100	154

[a] basal area measured in square feet.

Current Forest Conditions, Uses, and Trends

The present forests of the state are a legacy of the natural vegetative succession pathways and post-settlement practices. The landscape is mostly composed of second growth forests that have been heavily influenced by a variety of human-induced disturbances. This started with harvesting of white and red pine and many other species, followed by large-scale catastrophic wildfires fueled by the resulting slash, and then moving to a period of near total exclusion of fire from the landscape. Few of these secondary forests possess the structural characteristics of the circa 1800 forests. With the exception of some rare community types, the state's present population levels, ownership patterns, and social and cultural values preclude the restoration of our remaining forests to circa 1800 conditions. Such restoration would necessitate dramatic changes in timber production, wildlife management and many forms of recreation.

The regrowth of the forest resource has presented us with more choices for management of these resources, including timber production, many forms of recreation, the provision of terrestrial and aquatic wildlife habitat, and the provision of other ecosystem services. However, this has also made management of these resources much more contentious, as different interests compete to use the state's forest resources for increasingly conflicting purposes. The capacity of forest resources to provide for these uses in a sustainable manner is finite. Since uses and nonuses are not perfectly compatible, the forest cannot provide maximum use for all demands. Provision of one use is often constrained by demands for other competing uses for the same resource, and the capacity of the forest base to provide for competing uses is infinite in its variability. Thus, the annual capacity of forest resources must be framed in terms of balancing competing uses. Emphasis should be on the means to enable uses to be compatible with other uses, with the recognition that at any one site one value or use may predominate over others.

In order to effectively formulate appropriate management strategies in this environment, it is helpful to have an understanding of the changes in forest composition and structure that has occurred over the past 150 years and the ecological consequences of those changes. According to Noss (1999), it is difficult to develop a strategy to manage forests in a sustainable manner without identifying the specific structural and functional changes that have led to current conditions. An understanding of how historical events have led to current forest conditions, coupled with an analysis of current inventory data and current uses of the forest resource base can provide the foundation for present strategies and future structural changes that will support sustainable forest management.

This section describes the current condition of DNR forest resources and the current capacity of its uses. It will also explore the ecological consequences of these uses in terms of changes in composition and structure. The analysis of forest resources in this statewide-scope forest management plan and in each of the regional forest management plans is based on an ecological classification system. Hierarchical systems use ecological factors for classifying land at varying geographical scales ranging from global to local land units (Table 3.1). The primary purpose for delineating ecological units is to identify land and water resources at different levels of resolution that have similar characteristics thereby implying similar management potential. Depending on scale, ecological units are designed to exhibit similar patterns in: (1) potential natural communities; (2) soils; (3) hydrologic function; (4) landform and topography; (5) lithology; (6) climate; and (7) natural processes such as nutrient cycling, productivity, succession, and natural disturbance regimes associated with flooding, wind, or fire (Cleland et al. 1997).

Michigan has four ecoregions that are widely recognized (Figure 2.1). The four ecoregions are geographically based systems for organizing information about ecosystems and ecosystem responses to management. Each ecoregion provides a theoretical basis for science-based planning and adaptive

management. The use of ecoregions often improves the accuracy of ecosystem models, projections of change, and predictions of desired future conditions. Ecological classifications in Michigan divide the state into progressively smaller ecological units and watersheds can be considered in this context. Within each ecoregion there are distinct identifiable subsections and watersheds that allow for a more strategic, multi-forest, multi-agency/ownership analysis and assessment of resources. Watershed analyses of the health of aquatic resources are parallel analyses that address aquatic community and habitat linkages across different terrestrial landscape attributes as well as provide the conduit and connection with the Great Lakes.

This state forest management plan provides an analysis of the forest resource base on statewide and ecoregional scales. The regional management plans provide an analysis of the forest resource on a subregional scales. The following sections begin an analysis of the condition of forest resources from both a state wide perspective and a more narrow focus upon DNR-owned forestland. It addresses the use of the resource base for timber production, discusses forest health conditions, and concludes with a discussion of wildlife, fisheries, and human uses of forest resources.

3.1 General Land Cover and Forest Resource Base

3.1.1 Statewide Forest Conditions and Trends

Five statewide forest inventories were conducted by the U.S. Forest Service during the last century, and data from the latest was available in 2005. These inventories indicate that forest acreage has remained relatively stable since the 1950s. The only exception was a slight decrease between 1966 and 1980, followed by an expansion between 1980 and 1993 (Figure 3.1). Losses or conversions out of forestland between 1980 and 1993 were compensated for by other lands being converted into forestland. The predominant land type converting into forestland was agricultural. In contrast to the stable forest acreage, total standing timber volumes have almost tripled since the middle of the last century, reflecting a maturing forest.

The expanding volume also indicates that more growth has been continuously added to the forest than what has been removed or died through natural causes as evidenced by annual growth that has steadily increased over the past 50 years (Figure 3.2). Michigan's surplus growing stock (annual net growth less harvests) is among the largest in the nation, with forests currently growing almost 3 times more wood than is being harvested each year, and this trend is expected to continue. The majority of annual net growth occurred in the hard and soft maple, white and red pine, and cottonwood and aspen forest types. However, this growth does not imply that the state is becoming increasingly covered by large contiguous tracts of forestland. Rather, as the landscape has been slowly restored and forests have matured, it has become increasingly fragmented by roads and other development. This has had negative affects upon interior forest wildlife species and conversely had a positive affect upon wildlife species adapted to open and edge habitats.

On an statewide basis, the largest circa 2000 forest type is northern hardwoods (5 million acres), followed by the aspen-birch association (3.2 million acres), mixed oak-hickory (2.6 million acres), aggregate pine communities (2.4 million acres), cedar and mixed conifer swamps (2.1 million acres), and southern (or central) hardwoods (1.5 million acres) (Figures 3.3 and 3.4).

With an understanding that classification systems tend to simplify forest types (which in reality are often quite heterogeneous in composition), several general trends are apparent when comparing the relative areas of the circa 1800 forests to the area of current forestland (Table 3.2). The aspen-birch association, black ash, red pine, jack pine, mixed oak-hickory and cedar forest types now cover a much larger proportion of the landscape than their circa 1800 extent. The aspen-birch association has increased in acreage by almost 1,000%, whereas the savanna and barrens communities, hemlock,

southern hardwoods, mixed conifer swamp, mixed white pine types, northern hardwoods and spruce-fir types now cover a smaller portion of the landscape than their historical extent. Savanna and barren communities, and hemlock types are now almost completely absent from the landscape.

The estimated extent of commercial timberland has changed significantly from 1935 through 2003 for forest type groups, and some qualitative (but not quantitative) trends can be determined (Figure 3.5). A detailed discussion of trends for different forest types follows.

The extent of the aspen-birch association has increased from less than 1 to over 16% of the forested landscape (Table 3.2). It is important to note that this comparison concerns larger, stand-level aspen communities. Aspen was historically a minor component of many circa 1800 forest communities and is likely under represented in the reconstructed maps of the pre-settlement landscape. Regardless, the large increase in acreage can be attributed to the extensive areas of the state that repeatedly burned and where secondary succession of these two seral species occurred in the late 19th and early 20th centuries. Net growth of aspen on a statewide basis is estimated to be one-third greater than that of removals (Table 3.3). However, it is significant that mortality of aspen exceeds that of removals by a ratio of 1.4:1, suggesting that a large volume of aspen is not being harvested and is likely senescent in mixed stands that are succeeding to other forest types. The net growth of birch is estimated to be over 1.5 times that of mortality and removals, and removals are almost twice that of mortality.

To a large degree, contemporary management practices have perpetuated the aspen community type. However, the aspen-birch association has been in decline since 1935 (although the decline became much less dramatic in the 1990s), again reflecting natural succession to more diverse late-successional community types (Figure 3.5).

This modern decline of seral aspen-birch association forests has major consequences for hunting interests that have become accustomed to high populations of game species that are adapted to and have thrived in this habitat, including Grouse, Woodcock, and white-tailed deer. If the proportion of aspen-birch association forest continues to decline, it is probable that populations of these game species will also decline. This also has significant ramifications for the timber industry which currently relies upon aspen as a major source of pulpwood.

The general ascending trend of the maple-beech-birch group and the decline in aspen-birch may possibly be attributed to its succession to shade tolerant northern hardwoods (Figure 3.5). When compared to the circa 1800 landscape, mesic northern hardwoods now cover 2.5 million fewer acres (a 34% decline), but they have increased from 21% to 26% of the relative forest cover in the landscape and continue to slowly reoccupy areas of their historic range (Table 3.2). Growth is almost twice that of natural mortality and removals, and removals well exceed mortality (Table 3.3).

A mere 0.4% of mesic northern hardwoods in Michigan remain in circa 1800 condition (with a highly diverse structure and species composition), with 59 documented occurrences. Of these, only 8 occurrences totaling about 56,000 acres are high quality representations of this cover type (Cohen 2000).

Since circa 1800, the acreage of mixed oak-hickory forests has increased by 300,000 acres (13%) and the relative area has doubled from 6.5% to 13.5% of the forested landscape (Table 3.2). This trend is also a legacy of turn of the century forest fires, to which the regeneration of oak is adapted. The ascending trend of the dry-mesic oak-hickory forest type may also be attributed to the general warming of the climate since the 1800s. Growth of oak is estimated to exceed that of mortality and removals by a ratio of 1.7:1, and removals well exceed natural mortality (Table 3.3).

Since circa 1800, mixed hardwood swamps have decreased by 586,000 acres (41%) to 835,000 acres in overall area, but this loss has been partially offset by an increase in black ash swamps which

increased by over 140% to 681,000 acres (Table 3.2). The acreage of lowland hardwoods has been on a general upward trend until the 1960s, with a slight decrease in acreage since that time, possibly attributed to increased pressure from development (Figure 3.4). Growth exceeds losses by mortality and removals by a ratio of 1.5:1. However, losses from mortality are over twice that of removals (Table 3.3). As discussed further in the section on forest health, disease and pests have affected the composition of lowland hardwood forests. American elm *Ulmus americana* was virtually eliminated by Dutch elm disease as a dominant overstory tree in many floodplain forests. The invasion of the emerald ash borer *Agrilus planipennis* threatens to further alter the species composition and structure of these forests.

The hemlock component has precipitously declined in many forests of the state. Hemlock formerly covered 13.5% of the landscape and now comprises less than 1% of forestland, declining by over 97% from an area of 4.7 million acres to little more than 100,000 acres (Table 3.2). Hemlock was a co-dominant species in 6.3 million acres (85%) of the circa 1800 northern hardwood forests, both in terms of density and dominance (Tables 2.1 through 2.3). In the circa 1800 landscape there were four primary hemlock associations: pure hemlock (902,000 acres), hemlock-white pine (1,060,000 acres), hemlock-sugar maple (2,326,000 acres), and hemlock-yellow birch (295,000 acres). The decline in hemlock can be attributed to several factors, including climate, disturbance, land-use history, and reproductive/life-history requirements of the species (Mladenoff and Sterns 1993). In the late 1800s, large areas of hemlock were harvested for the bark, which was used in tannin mills. The primary controlling factor governing rates of hemlock regeneration is likely the presence or absence of residual seed trees. Other factors are the shade-tolerant nature of hemlock, the historic occurrence of frequent destructive fires, the elimination of large-diameter woody debris nurse logs, and increased herbivore pressure, which have combined to inhibit the effective recruitment of hemlock throughout many portions of the landscape.

Since circa 1800, the mesic southern hardwoods community type has declined by 4.3 million acres (74%) from almost 17 to 8% of the forested landscape (Table 3.2). In large part this loss is due to conversion of this forest type to farmland and progressively to urban/open land, which when combined now occupy over 15 million acres of the landscape (Figure 3.4). There are currently 39 documented occurrences totaling 2,505 acres of the mesic southern hardwoods community in Michigan. Of these, only six occurrences totaling less than 100 acres are high quality representations of this cover type (Cohen 2004).

Mixed conifer swamps declined by almost 3.6 million acres (84%) since circa 1800, from over 12% to under 4% of the forest landscape (Table 3.2). This loss can be attributed to two primary factors: the historic clearing and draining of portions of this community type for agriculture, and the logging and conversion of the community to shrub-carr wetlands, which have increased in extent by almost three-quarter of a million acres. Conversely, the acreage of cedar swamps has increased by almost 8% since circa 1800, and has almost doubled its relative coverage of the landscape. The volume of cedar is increasing as growth is more than twice that of mortality and harvests combined. In turn, losses to mortality are more than twice that of timber harvest volume due to the relatively low use of cedar timber resources (Table 3.3). However, some growth is unused with losses of cedar through natural mortality being more than twice the volume that is removed by timber harvest. Of note, the trend of growth and mortality of black spruce is similar to that of cedar, with excessive losses also due to natural mortality.

There are three historic primary pine associations in Michigan: the mesic white-red pine forest, the dry northern forest dominated by jack and red pine, and the dry-mesic northern forest dominated by white pine and oak species. When considering the white pine communities (Table 3.2), the greatest changes are apparent in the various white pine communities, which have declined by over 80% (2.4 million acres in aggregate), from almost 7% to little more than 2% of the landscape. The mixed pine-

oak forest type (82% of which historically consisted of white pine and white oak) has declined by almost 200,000 acres (35%) since circa 1800. These declines may be attributed to the historic loss of white pine seed trees from the landscape and repeated wildfires during the post-logging era, which greatly inhibited the natural reproduction of this species. Conversely, relatively pure red pine forests have increased by almost 300,000 acres (51%), and relatively pure jack pine communities have increased by over 118,000 acres (20%). However, even with this increase the proportion of pine dominated forests in the overall landscape has decreased by over 1.7 million acres. Remnants of the dry northern and dry-mesic northern pine forests are among the rarest forest types in the Great Lakes region. Just over 0.2% of dry-mesic northern forest remains in presettlement condition in Michigan, with 34 documented occurrences. Of these, only 9 occurrences constituting just over 4,000 acres are of high quality (Cohen 2002a). There are 14 documented occurrences of the red pine variant of the dry northern forest in Michigan. Only 6 of these occurrences totaling over 600 acres are of high quality (with large boles and a more open, two-tiered canopy structure). The jack pine variant of the dry northern forest is more secure in Michigan, totaling over 333,000 acres (Cohen 2002b).

Intensive reforestation efforts in the early to mid 1900s have contributed to a doubling of the area of white, red and jack pine forests since 1935 (Figure 3.5) to around 2 million acres. Due to this effort, the restored pine forests are a resource that would have otherwise not existed in any significant volume. However, these efforts initiated the management of white, red and jack pine as monocultures, which have been perpetuated due to economic efficiency and demand. This requires less complicated silvicultural management techniques but also results in less landscape biodiversity. The complex composition and structure of circa 1800 dry northern, dry mesic, and pine and pine-oak barrens are barely represented in the current forest landscape. Furthermore, the modern exclusion of frequent and large scale fires from the forested landscape has greatly suppressed the natural regeneration of shade intolerant pine species. There is evidence that mid-shade tolerant white pine is regenerating in the understory of many current oak, red pine and aspen stands, portending a resurgence in the mixed pine-oak and mixed red-white pine forest types. This trend is discussed further in the next section.

The mixed oak savanna, oak-pine barrens and prairie communities were significant components of the circa 1800 landscape, occupying over 2.1 million acres in mostly the Southern Lower Peninsula (Table 3.2). Due to the suppression of wildfires and their ease of conversion to agricultural land, these communities have declined by over 99%, and are now only represented by small fragments that are scattered throughout the landscape. There have been major ecological consequences for plant and animal species that were adapted to savanna and prairie communities as they have also largely disappeared from the landscape and many remain imperiled as threatened and endangered species. In the Northern Lower Peninsula, circa 1800 pine barren communities covered almost 270,000 acres of the landscape. Today fewer than five high quality occurrences are known in Michigan, totaling only a few hundred acres.

3.1.2 DNR-Owned Forestland Conditions and Trends

The 3.9 million acres that are contained and managed by the DNR within the state forest system (Figure 1.3) are largely noncontiguous tracts of forest that are scattered throughout the landscapes of the northern Lower Peninsula of Michigan and all of Upper Peninsula of Michigan. Over half (51.6%) of DNR-owned forestland is located in the Northern Lower Peninsula Ecoregion. The Eastern Upper Peninsula and Western Upper Peninsula ecoregions contain 26.5% and 21.9% of forestland respectively (Appendix F). In contrast to the statewide landscape, the largest DNR community type is the aspen association at 885,000 acres (22%), followed by northern hardwoods at 508,000 acres (13%), jack pine at 367,000 acres (9%), red pine at 280,000 acres (7%), mixed swamp conifers at 261,000 acres (6%), the oak association at 244,000 acres (6%), and cedar swamp at 228,000 acres (6%) (Table 3.4). The current land base has changed significantly from circa 1800 conditions, where

two community types were then dominant: northern hardwoods (26%) and mixed conifer swamps (22%) (Table 3.5). Two other major community types of the circa 1800 period were mixed red and white pine forests and jack pine forests, where both represented around 10% of the area that is now the state forest. This section contains a more detailed discussion of the conditions and trends in the current cover types upon DNR-owned forestland.

Aspen Association

The aspen association consists of three primary species: trembling aspen *Populus tremuloides*, bigtooth aspen *Populus grandidentata* and paper birch *Betula papyrifera*. Consistent with statewide data, the acreage of aspen upon the state forest is many times its historical acreage (Table 3.5), as large proportions of the mesic and dry-mesic northern forest communities were converted to aspen after the logging era. There are more acres of aspen on the state forest than any other type, and the acreage of this cover type has been fairly constant (Table 3.4). Nearly 60% of aspen is located in the Northern Lower Peninsula Ecoregion (520,626 acres). Over a quarter (27.3%) of aspen (241,408 acres) is located in the Western Upper Peninsula Ecoregion. Aspen is a relatively small component (13.9%) of the Eastern Upper Peninsula Ecoregion with only 122,788 acres (Appendix F).

Multiple markets began developing for Michigan aspen in the 1960s, and aspen fiber is now in strong demand by the forest products industry. Aspen also provides good habitat for a number of wildlife species (such as deer, Grouse, and Woodcock). These species are adapted to and have been heavily favored by the preponderance of early successional forest types over the last century, and for which hunting groups and persons who simply enjoy viewing wildlife have an inherent interest in maintaining at high population levels. Due to these factors and to avoid the succession of the type, much of the commercially desirable acres of aspen were harvested by the mid-to late-1990s for the purpose of maintaining a large land base of aspen for the future. There are trade-offs associated with maintaining a high acreage of aspen into the future, where the benefits (including the continued provision of habitat for popular game species and a social and economic reliance on the industrial demand for aspen fiber) must be weighed against impacts of herbivory on forest regeneration.

The heavy rates of harvest over the past few decades have perpetuated an unbalanced age class distribution, with a large acreage of stands in the 10–30 year age classes (Appendix G). The largest change in size class has occurred in the medium to well-stocked pole timber class, which has declined by over 96,000 acres since 1988 (Table 3.6). There has been a corresponding change in well-stocked sapling stands, which have increased by over 91,000 acres during the same time. Over half (459,000 acres) of the current aspen land base is in the well-stocked sapling size class, again emphasizing the current skewed age class distribution of the aspen cover type.

Given the monotypic clonal life cycle of aspen, compositional and structural diversity is low in these stands. However, consistent with state wide trends some aspen acres are becoming more diverse as they succeed to other cover types (Table 3.7). Without alternative management to the contrary, it is apparent that a substantial acreage of aspen has the potential to succeed to a spruce/fir community or to northern hardwoods. Lesser amounts of acreage are succeeding to white pine, oak and lowland hardwoods. These areas total over 325,000 acres, and represent almost 37% of the current 885,000 acre land base of aspen. Estimated mortality of aspen exceeds removals by a ratio of 1.5:1 (Table 3.8). However, estimated growth of aspen still exceeds mortality and removals by a similar 1.4:1 ratio, and young aspen is present in the understory of almost 20,000 acres of existing oak stands and on over 18,000 acres of current red pine stands.

Northern Hardwoods

The northern hardwoods cover type is the second-largest acreage on state forestland at over 508,000 acres or 13% of the land base. Since most northern hardwood stands are being managed for an

uneven-aged structure (Appendix G) and the tree species that compose the type have varying growth characteristics, total basal area is a better measure for northern hardwood conditions and treatment decisions than is the age class distribution. In the past decade, timber harvests in northern hardwoods (mostly single tree selection) have surpassed aspen in accounting for the most annual harvest acres.

Northern hardwood acreage has not appreciably changed since 1988 (Table 3.4). The Northern Lower Peninsula Ecoregion has the largest (40.8%) acreage of northern hardwoods on state forestland at over 207,000 acres. The Western Upper Peninsula and the Eastern Upper Peninsula ecoregions have 171,749 (33.8%) and 129,254 (25.4%) acres of northern hardwoods forestland respectively (Appendix F).

Consistent with statewide trends since circa 1800, the acreage of northern hardwoods decreased by over a half-million acres (60%), with many of these acres having been converted to other cover types such as aspen, oak and red pine in the post-logging era (Table 3.5). Most northern hardwood acreage is in the well-stocked pole and saw size classes (Table 3.9). The largest changes in size class distribution occur with a 65,000 acres decline in pole timber and a 70,000 acre increase in saw timber classes, reflecting a continuing maturing of this cover type. The acres within each basal area class are relatively stable across the past three inventories (Table 3.10). Exceptions to this include the most recent inventory which has fewer acres in the two smallest basal area categories shown (<60 and 60 acres) and fewer acres in the 110 basal area class. However, there are more acres in the 70 and 80 basal area categories, in line with increased harvests of this type since the early 1990s.

Consistent with the life history characteristics of its component species, the estimated growth of northern hardwoods is over twice the volume of mortality and removals in the current acreage of the cover type (Table 3.8), and the understory type on 440,000 acres of northern hardwoods is predominately the same as the overstory species (Table 3.7). Other significant understory recruitment is by the shade tolerant conifers white spruce and balsam fir on 35,000 acres. Interestingly, northern hardwoods are predominant in the understory of 123,000 acres of existing aspen stands, over 67,000 acres of existing oak stands, and over 44,000 acres of current red pine stands, indicating potential succession to the northern hardwoods cover type on these sites.

The succession of some aspen, difficulties in regenerating oak, and the decreased use of chemical control methods on some red pine stands that are more ecologically suited for hardwoods portends a future state forest with a greater acreage of northern hardwoods.

Jack Pine

The acreage of jack pine in the state forest has been consistent since circa 1800, having only slightly decreased (Table 3.5). This is not surprising given large areas of xeric, outwash soil types within the state forest, to which the species is well adapted and competitive. Jack pine currently covers 367,000 acres of the state forest, with a slight decline of 35,000 acres (8.6%) since 1988 (Table 3.4). The greatest acreage (almost 234,000 acres or 63.7%) of jack pine upon state forestland is located in the Northern Lower Peninsula Ecoregion. The Eastern Upper Peninsula Ecoregion also contains a significant acreage (over 105,000 acres or 28.6% of the type) of jack pine. There is relatively little jack pine (28,000 acres or 7.7%) in the Western Upper Peninsula Ecoregion (Appendix F).

The Jack pine type is the only seral forest type that is somewhat balanced at approximately 40,000 acres per age class, although there is a moderate spike in the 0–20 year age classes (Appendix G). This reflects an emphasis upon salvage harvests of older age-classes of jack pine before they succumb to budworm infestations, and efforts to cut many older stands to preclude natural mortality. There remains significant acreage of jack pine exceeding sixty years of age for which mortality from budworm continues to be a concern. Over 80% of jack pine stands are managed in even-aged 60-year

rotations, although concerns over budworm and associated mortality are engendering considerations of a 50-year rotation.

Consistent with the ecology of jack pine and the habitat type upon which it occurs there is little natural succession occurring in the community. Other than jack pine itself, the most prevalent understory species is oak upon 43,000 acres (Table 3.11). Estimated growth of jack pine is slightly greater than losses through mortality and removals (Table 3.8). Since 1988 there has been a 96,000 acre decline in pole timber classes, and a corresponding 73,000 acre increase in the seedling class (Table 3.12). Overall there are a disproportionate number of acres in the well-stocked seedling and medium to well-stocked pole timber classes. To some degree, this is as a result of management of many jack pine stands for Kirtland's Warbler habitat, which is solely dependent upon young and dense (6–21 year old) jack pine stands for its survival.

Red Pine

In circa 1800, there were over 406,000 acres of red pine (predominantly mixed red and white pine associations) in the state forest, representing over 10% of the forested land base (Table 3.5). There are currently 80,000 acres of red pine in the state forest, mostly managed in monoculture planted stands (Table 3.4). The great majority (181,445 acres or 64.8%) of red pine state forestland is located in the Northern Lower Peninsula Ecoregion. The Eastern Upper Peninsula Ecoregion also contains a significant acreage of red pine with 77,776 acres, or 27.8% of all red pine acres. There are relatively few red pine acres (20,752 acres or 7.4%) in the Western Upper Peninsula Ecoregion (Appendix F). There has been a 45,000 acre (19%) statewide increase in red pine acres since 1988, although the acreage of seedling stands dropped by 58% (34,000 acres) over this same time period (Table 3.13).

Estimated growth in red pine is twice that of mortality and removals (Table 3.8). The age class distribution of red pine is heavily skewed to older aged stands (Appendix G).

There is a large acreage of stands in the 40–79 year age classes which correlates with intensive planting programs in the 1930s by the CCC and the state of Michigan in the 1950s. Accordingly, acreages of both well-stocked pole (up 38%) and well-stocked saw (up 95%) timber classes increased over 34,000 acres (Table 3.13). Very little red pine exists less than 40 years of age. Artificial regeneration by planting is required for reliable re-establishment of most stands due to unpredictable seed production and the species' shade-intolerant nature. From the 1970s to the present, regeneration has been fairly consistent at 10,000 acres per age class.

Due to fire suppression and competition on higher quality mesic (typically former northern hardwood) sites, many red pine stands in older age classes are succeeding to more shade tolerant species, as demonstrated by northern hardwoods predominating the understory on over 44,000 acres of red pine stands (Table 3.11). Interestingly, white pine and oak are dominant in the understory of 37,000 acres and 26,000 acres respectively, indicating some return of the mixed red-white pine and mixed pine/oak communities of the circa 1800 forest landscape. Aspen is in the understory of an additional 18,000 acres. All together these understory cover types represent a total of 125,000 acres or 45% of the current 280,000 acre red pine land base. Thus, a sizeable fraction of existing red pine stands has potential to succeed to mixed stands and other forest types in the future. Red pine is a fast growing species and higher values are received for logging in pure, uniformly-sized stands, but many of the conversions will likely be allowed to occur due to site suitability, wildlife, and biodiversity concerns.

With these successional trends in mind, the adoption of management prescriptions as described in Guidelines for Red Pine Management (Michigan Department of Natural Resources 2006) portend further diversification of red pine stands in the future. The genesis of these guidelines was to restore some balance to the age class structure and reduce the pressures for much higher treatments in two to

four decades by engaging in more harvests now. A major outgrowth of the project was to assess the suitability of sites where red pine is currently located and where it should be considered for regeneration based on habitat typing (Burger and Kotar 2003). This information is helpful in clarifying the basis for where red pine is a poor choice because of physical factors. Often where it is well suited, other forest species also are well suited and preferred over red pine for wildlife values. It is expected that further clarification of procedures for weighing timber and wildlife values at the stand, landscape, and state level will come in future years through established planning, public participation, and management review processes.

Mixed Swamp Conifers

The acreage of mixed swamp conifers has remained almost static since 1988, comprising over 261,000 acres of the state forest (Table 3.4), but the cover type has declined by almost 523,000 acres (60%) since circa 1800 (Table 3.5). The distribution of the cover type is fairly balanced across all ecoregions, with 94–98 thousand acres (36–37% of the type) located in the Northern Lower and Western Upper Peninsulas and over 69,000 acres (almost 27%) in the Eastern Upper Peninsula (Appendix F).

The age class distribution of mixed swamp conifers and black spruce are skewed to the older age classes (60 to 100+ years old) (Appendix G). There is relatively little active management of these community types, which has implications for increased forest health issues and natural mortality within the types. Most acreage of mixed swamp conifers is in the pole timber size class (Table 3.14), which increased by over 12,000 acres since 1988. Corresponding decreases were recorded in the acreage of the seedling-sapling size class. Other than in-kind recruitment, the only other association that is predominant in the understory is shade tolerant spruce/fir species on 42,000 acres (one-sixth) of the current acreage of the mixed swamp conifer cover type. An understory of mixed swamp conifers is present on over 67,000 acres of current cedar swamp cover type, reflecting a greater diversification of species within the cedar cover type (Table 3.11). For the black spruce component of this cover type, estimated growth is 5 times that of mortality and removals. However, natural mortality is estimated to be almost twice that of removals (Table 3.8).

Oak Association

Oak species were often a component of mixed pine-oak cover types in the pre-settlement landscape of upper Michigan, including dry northern forest, dry-mesic northern forest, mesic northern forest, oak-pine barrens, and jack pine barrens. However, it was only a relatively minor cover type (72,000 acres or 2%) of the circa 1800 state-forestland base (Table 3.5). The current oak association is common on moderate to low quality, sandy soil sites and is largely an anomaly resulting from the logging of the circa 1800 pine forest and the unnatural catastrophic fires that followed. It is primarily represented by four species: northern pin oak *Quercus ellipsoidalis*, black oak *Quercus velutina*, white oak *Quercus alba* and red oak *Quercus rubra*.

The acreage of oak has remained steady since 1988, covering 244,000 acres of the state forest (Table 3.4). The overwhelming predominance of oak acreage (229,682 acres or 94.3%) is located in the Northern Lower Peninsula Ecoregion. There are very few acres of oak (only 2–4%) in the Eastern and Western Upper Peninsula ecoregions (Appendix F).

The age class distribution of current oak forests is greatly unbalanced, with approximately 65% of oak stands between 70 and 100 years of age and with to 32% concentrated in the 80 to 90 year old age class (Appendix G). The 0–70 year age classes are more balanced, with a consistent recruitment of about 10,000 acres for each class. The DNR uses a silvicultural rotation age of eighty years, which means that for stands older than eighty years of age a limiting factor must be coded into the inventory database if it is not prescribed for treatment. In the case of oak, the persistence of this cohort is a

result of intentional retention of oak species for hard mast production. Most of the acreage of oak lies in the medium and well-stocked pole and saw timber size classes (Table 3.15). There are relatively fewer acres of oak in the sapling size class, reflecting problems in achieving adequate regeneration of oak. However, percentage increases in sapling acres show an improving trend in regeneration.

Of the major cover types on state forestland, oak is the only type in which estimated mortality and removals exceed growth (Table 3.8). This is mostly due to removals, which almost equal growth and which are more than twice that of estimated mortality. Oak-dominated stands common to moderate to low quality, sandy soil sites are anomalies which resulted from the removal of the pre-settlement pine forest and the unnatural catastrophic fires that followed. The 70–90 age cohort is a legacy of these large tracts of burnt over land, where in the early 1900s the regeneration of seral oak was favored over more shade tolerant species, and where historic seed sources of pine were then absent from the landscape. Maintenance of this cover type at its current level is not possible without replicating events of the past—which will certainly not occur.

Although some recruitment of oak is occurring in the understory of almost 76,000 acres of oak stands, the presence of other types in the understory indicates that much of the oak resource (124,000 acres, 51%, of the current 244,000 acre oak land base) has the potential to succeed to other forest cover types (Table 3.7), with white pine and red maple on moderate to low quality sites, and to sugar maple-beech types on higher quality sites. The continued existence of an oak component on higher quality northern hardwood sites will require silvicultural practices that benefit oak's mid-tolerant shade characteristics and that overcome its difficulty in out-competing more shade tolerant, northern hardwood species. The recruitment of white pine in the understory represents a return of the mixed pine-oak community, which was a significant community in the circa 1800 landscape. On a positive note, oak is present in the understory of 43,000 acres of existing jack pine stands, 26,000 acres of red pine stands, and over 25,000 acres of current aspen stands, representing a potential future oak component on these sites. Oak remains a valuable resource to maintain on the landscape, and on moderate and low-quality sites, silvicultural practices that encourage its establishment and recruitment as part of a mixed pine-oak cover type should be employed.

Cedar Swamp

Cedar swamps are present on 228,000 acres of state forestland, with over 41,000 (22%) more acreage in the 2006 inventory than the 1988 inventory (Table 3.4). The majority of state forest cedar acreage is in the Eastern Upper Peninsula, at 99,510 acres or 43.6% of the type. The remaining acreage is split between the Northern Lower and Western Upper Peninsula ecoregions, with 67,548 and 61,339 acres respectively (Appendix F).

The current acreage of cedar is consistent with the pre-settlement acreage of 219,000 acres (Table 3.5). Some of the recent increase may be the result of succession from shrub wetlands, but may also be a result of more accurate mapping of forest compartments. Most acreage lies in the well stock pole timber size class (Table 3.16), which has increased by 35% during this same time. Growth exceeds natural mortality by a ratio of 1.4:1 (Table 3.8). The age class distribution for cedar is skewed to older age classes (Appendix G), with the 100+ age class predominating. There is very little regeneration of cedar occurring, with declining acreages of sapling size classes. Regeneration problems in many areas are the result of severe browse damage caused by white-tailed deer populations, which prefer to use cedar swamps in the winter as both shelter and a food source. Cedar is predominant in the understory on 57,000 acres of cedar swamp (Table 3.11). However, this is exceeded by the mixed swamp conifer and spruce/fir forest types in the understory on 68,000 and 45,000 acres respectively, which portends future diversification of species upon almost half of the cedar swamp land base.

White Pine

White pine acreage increased by 38,000 acres (68%) between the 1988 and the 2006 inventory. The species presently covers an area of 94,000 acres of the state forest (Table 3.4). On a percentage basis, this is the greatest rate of increase for any species, and understory data indicates that this trend is continuing. Most acres of white pine are located in the Northern Lower (45,229 acres or 48.3%) and Eastern Upper (36,902 acres or 39.4%) Peninsula ecoregions. There are currently relatively few acres of white pine (11,437 acres or 12.2%) in the state forestland of the Western Upper Peninsula Ecoregion (Appendix F).

White pine was historically present not only in relatively pure stands (20,000 acres) but it was also a common species in several associations: the previously discussed mixed red-white pine type (386,000 acres); hemlock-white pine (314,000 acres); white pine-mixed hardwood forests (85,000 acres); and in white pine-white oak forests (3,100) acres (Table 3.5). By far, the mixed red-white pine, hemlock-white pine and white pine-mixed hardwood associations were the dominant pine communities in the circa 1800 landscape (Table 2.1, Table 3.2 and Table 3.5).

There is a large acreage of stands older than 40 years and in uneven age classes, indicating some natural recruitment of white pine around the turn of the 19th century (Appendix G). Where potential seed trees remain much natural regeneration of White pine is currently occurring in the understory of hardwood and mixed pine stands. In addition to regeneration in the understory of existing white pine stands, the species is also recruiting in the understory of aspen (27,000 acres), red pine (37,000 acres) and oak (37,000 acres) stands (Tables 3.7 and 3.11). This reflects the moderate shade tolerance of white pine, and indicates a gradual return of the white pine-mixed hardwood and the mixed red-white pine communities to the state forest landscape. Shade tolerant northern hardwoods and spruce/fir are also in the understory of about 11,000 and 21,000 respective acres of existing white pine stands (Table 3.11). These are not unexpected occurrences, since white pine was historically present as a co-dominant species in mesic northern hardwoods (Table 2.3), and white spruce and balsam fir are commonly present in remaining old growth stands of white pine.

Growth of white pine is twice that of removals (Table 3.8), and given the long-lived nature of the species it is not surprising that estimated mortality is low, with growth over 16 times that of mortality. There have been large increases in pole and saw size classes since 1988, but declining regeneration in the seedling size class (Table 3.17).

Hemlock

As in the statewide landscape, hemlock was historically present in 345,000 acres of the state forestland base in the form of hemlock-white pine and hemlock-yellow birch associations (Table 3.5). Hemlock was also a co-dominant component in the northern hardwoods cover type (Table 2.3 and Table 3.5). Today hemlock stands comprise just over 17,000 acres (0.4%) of the current state forestland base, and it is the least represented of any native tree species both in terms of absolute and percentage of acreage (Table 3.4). Most state forest hemlock acres are located in the Western and Eastern Upper Peninsula ecoregions, with 8,762 acres (50.1%) and 7,130 acres (40.8%) respectively. There is very little hemlock (1,587 acres or 9.1%) in the Northern Lower Peninsula Ecoregion (Appendix F).

There has been very little hemlock regeneration over the past century, with most remaining hemlock in the 100+ year and uneven aged classes (Appendix G). Although regeneration is limited, it is still occurring. The inventoried acreage of hemlock has increased by 39% since 1988, by a total of 4,900 acres (Table 3.4). The low acreage and regeneration can be attributed to several factors, including climate, disturbance, land-use history, and reproductive/life-history requirements of the species (Mladenoff and Sterns 1993). The primary controlling factor governing rates of hemlock regeneration

is likely the presence or absence of residual seed trees. Other factors are the shade-tolerant nature of hemlock, the historic occurrence of frequent destructive fires, the elimination of large-diameter woody debris nurse logs, and increased herbivore pressure, which have combined to inhibit the effective reproduction of hemlock throughout many portions of the landscape.

Most hemlock is located in the well stocked pole and saw timber size classes (Table 3.18). The vast majority of understory hemlock occurs in existing hemlock stands, with lesser amounts in northern hardwoods, mixed swamp conifers, lowland hardwood, and white pine stands (Table 3.11). Within existing hemlock stands the predominant understory vegetation is comprised of shade tolerant spruce/fir, northern hardwoods, hemlock, and mixed swamp conifers. Thus, where residual seed trees remain, is appears that hemlock is slowly returning to the forest landscape.

Lowland Hardwoods

Lowland hardwood cover types include balsam poplar swamp and lowland hardwoods. The inventoried acreage of balsam poplar swamp has increased by over 36% since 1988 and is approaching 72,000 acres (Table 3.4). The acreage of lowland hardwoods has increased by 26% since 1988 and now covers almost 136,000 acres. Most of the acreage of balsam poplar (41,289 acres or 57.6%) and lowland hardwoods (92,942 acres or 68.4%) is located in the Northern Lower Peninsula Ecoregion. Much lower acres of balsam poplar and lowland hardwoods are present in the Eastern Upper Peninsula Ecoregion, with 22,426 acres (31.3%) and 20,554 acres (15.1%) respectively. There are relatively fewer acres of balsam poplar and lowland hardwoods present in the Western Upper Peninsula Ecoregion, with 7,940 acres (11.1%) and 22,416 acres (16.5%) respectively (Appendix F).

Lowland hardwoods were historically a relatively minor component of the land base that now comprises the present state forest landscape (Table 3.5). The age class distribution for balsam poplar swamp is highly variable, with spikes in the 10–30 year and 60–90 year age classes (Appendix G). The age class distribution for lowland hardwoods is skewed to older age classes, with a large number of acres classified as uneven-aged.

Mortality of lowland hardwoods is a concern, with mortality slightly exceeding growth (Table 3.8). This mortality is due to a confluence of factors, such as forest pests, variations in ground and surface water levels, low commercial value that limits salvage cuts, accessibility concerns which limit active management, and regeneration concerns. The opposite is apparent for balsam poplar, where the growth to mortality ratio is by far the highest of any forest type.

Lowland hardwoods are regenerating well in the understory of present stands, with spruce-fir and mixed swamp conifers also becoming established on approximately 20% of the acreage (Table 3.7). Spruce-fir is the dominant component in the understory of balsam poplar stands, with balsam poplar naturally regenerating on less than 20% of the acreage.

Grasslands

Grasslands are typed as the dominant cover type on 125,000 acres (3.2%) of the state forest. This is a decline of 52,000 acres (29%) since 1988 (Table 3.4). Almost half (60,147 acres) of all state forest grasslands are located in the Northern Lower Peninsula Ecoregion. A significant acreage of grasslands is located in the Eastern Upper Peninsula Ecoregion, with almost 42,000 acres or 33.5% of the cover type. There is a much smaller acreage of grassland in the Western Upper Peninsula Ecoregion, with 23,146 acres or 18.5% (Appendix F).

Approximately 11,000 acres of grassland are co-located within the jack pine cover type. In the circa 1800 landscape of the Northern Lower Peninsula most grasslands were associated with pine and oak-pine barrens, which covered 88,000 and 13,000 acres respectively (Table 3.5). Aggregating barren

habitat with the circa 1800 acreage for grasslands yields a pre-European settlement total of 105,000 acres, which is only somewhat less than the current total of 125,000 acres upon state forestland. However, it is estimated that only approximately 1,460 acres of current DNR grassland lies within identified circa 1800 pine barren communities, so the vast majority of current grassland acres have shifted into other community types. Moreover, many additional acres of jack and red pine are currently located in areas of circa 1800 pine barren communities. There are presently less than 2,100 acres of identified pine barren remnants remaining in the state, and the community type is currently a rare occurrence upon the landscape.

3.1.3 Timber Harvest Trends

The Michigan DNR has 60 years of historical information on timber sales. The number of timber acres sold over this period (with some variability from year to year in the number of timber acres sold) has increased appreciably, with almost 10,000 more acres being added in each successive decade (Figure 3.6). Declines in harvest over the period were followed by substantial increases. This was true of a decline between 1984 and 1989 which was followed by increases throughout most of the 1990s. Since 1997, the level of sales has dipped slightly, fluctuating between 45,000 and 58,000 acres, with an average of approximately 53,000 acres.

Five cover types (aspen, jack pine, oak, red pine, and northern hardwoods) account for most (about 90%) of the timber sales from the state forest. Over the past 20 years the volume of timber sales has averaged around 700,000 cords per year (Figure 3.7). When considering volume of timber sold for the five major and the ten minor cover types since the mid-1990s, some significant trends can be noted for aspen, northern hardwoods, red pine, white pine and mixed swamp conifers (Tables 3.19 and 3.20). Reflecting the concerted effort prior to the mid-90s to maintain the acreage of the aspen cover type, the number of acres of aspen sold gradually decreased after 1997 and reached a low in 2003. Beginning in 2004, the acres of aspen sold have started to trend upward again. Throughout this period, aspen volumes per acre remained steady at close to 20 cords per acre. Volume of production from northern hardwoods, red pine, and white pine cover types have been increasing since 1996, reflecting the increasing maturation of these cover types. In contrast, production from mixed swamp conifers has dropped off sharply beginning in 2001, in part reflecting changes in coding.

DNR timber harvest trends differ by species. In the past decade, the acres of Michigan state forest timber sales have leveled off at an average of around 53,000 acres (Table 3.19), and the composition of these sales have changed. More acres of upland hardwood were sold as the number of aspen acres declined. This tradeoff resulted in the loss of some volume and increased labor requirements due to increased selective cutting (single-tree marking in the place of clearcut). Over the last decade, the DNR has planned an annual average of close to 60,000 acres for commercial timber sale through its inventory and treatment-decision process. This translates into an average of over 53,000 new timber sale acres sold each year. The reduction from what is planned for commercial treatment and what is sold is due to a variety of factors including markets, site conditions and weather, staffing and resources. The current annual capability of the state forest is predicated on economic, social and biological conditions. The following discussion of specific cover types focuses upon harvest level trends for different cover types over the coming decade.

Aspen

In a fifty-year rotation where acres were evenly distributed (what foresters refer to as having reached "regulation" or "area regulation"), 20% of the total acres would be in each ten-year age class. However, aspen harvests have fallen off so sharply in the past decade (due to heavy cutting in the prior decade) that the youngest (0–9) age class has slightly less than 10% of the total acres, and there is a very large difference between the number of acres in the 0–9 age class (86,986) and the 10–19

age class (195,327) (Appendix G). This is creating a "boom and bust" legacy problem for wildlife habitats and populations as well as for the wood products industry.

In comparison to the period of the 1960s to mid-1990s, there were less than half as many aspen acres that met commercial criteria for harvest in the past decade. During the next five to fifteen years a large number of aspen acres will reach commercially desirable ages. Balancing the age class distribution of the aspen cover type will continue to be a concern.

Given the number of acres in the older age (>80 years) classes, it is likely that acres of aspen will slightly decline. Assuming conversions drop the total acreage down towards 850,000 that would still leave 170,000 acres as the area regulation decade sum for five age classes or 17,000 acres annually. Annual aspen sales have averaged 9,177 acres since 1997, but they were generally falling over the period from 1997 to 2005 (Table 3.19). This should be reversed soon, with an emphasis on the balancing of age classes by increasing harvests in the 30–39 year age class, rather than waiting for the next cohort in the age class structure to reach commercial maturity over the next ten to twenty years. Over the next two to four decades, when the DNR has a large acreage of rotation-aged aspen, a closer examination at landscape, regional and statewide scales is warranted to determine the appropriateness of maintaining the aspen cover type upon landforms where it is not well suited.

Jack Pine

An accelerated rate of jack pine harvest has been necessary over the past two decades in order to avoid excessive mortality due to jack pine budworm infestations in over-mature stands, which were facing mortality and conversion to other forest types. The accelerated harvesting has resulted in a skewed age class distribution towards the 0–9 and 10–19 year age classes (Appendix G). This bias towards younger age classes is also accentuated in part by Kirtland's Warbler habitat work which requires shorter rotations. Between efforts to reduce acres in older-age classes and the continuing Kirtland's Warbler work, higher levels of harvests may be maintained for a few more years or even up to a decade. However, given the age structure of jack pine overall timber sale harvests are expected to decline by 25% to 50% from their recent sales average of 8,446 acres (Table 3.19) for a period starting in the coming decade and lasting for at least three decades. This is simply because the age classes approaching commercial readiness for the next three decades are less than 40,000 acres each, or less than half the average amount which has been harvested in recent years. Even the current 60–69 year age class has less than 40,000 acres.

Northern Hardwoods

Average northern hardwood sales for 1997 through 2005 have been relatively consistent at 15,085 acres (Table 3.19). Volume per acre has been increasing as stands have recovered and matured, and it is expected that volumes will continue to increase given current silvicultural practices. The current process focuses attention on a particular year-of-entry (approximately one-tenth of the state forest) rather than the entire forest. This tends to put upland hardwood stands on a twenty-year selection cut harvest schedule as the amount of growth in ten years is usually inadequate for a commercial sale. However, the additional basal area gained may be adequate at some time in the intervening years.

To potentially address this problem one possible trend in management would be for the DNR to operate outside of the 10-year compartment review cycle, and to optimally time harvests with variable growth rates by conducting inventory, preparing sales, and monitoring much of the forest on a continual basis, rather than on the current 10-year cycle. The DNR does not have the resources that would enable a shift to a continual management cycle in the near-term, nor would it be necessarily desirable to do so, but with the advent of new plans and software tools such a shift may be possible in the future.

Red Pine

To be balanced over the extent of its current acreage, the distribution of red pine should be at approximately 27,000 acres per age class. Between 1997 and 2005 an average of 8,039 acres of red pine were annually sold (Table 3.19). To date, most red pine harvests (approximately 80%) have entailed thinning stands rather than stand regeneration harvests. Thinning cuts tend to occur every 10–15 years, depending upon site quality and stand condition. Regeneration harvests generally occur between 60 and 90 years of age. Markets are currently best for utility pole-size stands, and the highest returns are on fourteen to sixteen inch trees. Bid values decline for larger size classes. Large acres of red pine are at or approaching the optimal 60–90-year age for regeneration harvest, and although the number of treated red pine acres may not increase during the next decade there should be a transition to more regeneration harvests. Thinning treatments will continue to outnumber regeneration harvests, but the ratio will fall from the current ratio of more than 8 to 1. Management guidelines for red pine have been in existence for several years, and increases in prescriptions for red pine regeneration harvests are beginning to occur. From an average of less than 700 acres for the previous decade regeneration harvests reached 1,552 acres in 2005 and were 1,136 acres in 2006. Regeneration harvests are expected to double during the next decade. Volume outputs will increase as regeneration cuts provide two to four times the volume of thinning cuts. Increased level of harvests should continue for several decades, until a more balanced age class distribution of red pine is achieved.

Oak

Sales of oak have averaged 6,651 acres from 1997 to 2005 (Table 3.19). Increased timber treatments within the oak cover type are likely, due to the concentration of acres in the 70–100 year range (Appendix G), and an increased understanding and acceptance of maintaining oak as a mixed pine-oak cover type. Most of these treatments will be with higher volume regeneration harvests. For the time being, however, the direction of oak harvests is not certain. Harvests are not likely to decline in the near-term. Over the long-term (three or more decades from now), oak harvests are likely to decline as the number of acres decline and the species is more integrated with other species. Future opportunities to increase acres of oak also exist, but both resource professionals and the public need to understand and accept the fact that it will mostly exist as part of a mixed pine-oak cover type.

Minor Cover Types

No minor forest cover type (Table 3.20) averages more than 2% of sales during the past decade and seldom does any other type reach 3% of the sales for any given year. There are many fewer acres of these forest types, and the average acres sold should be put within the context of current total state forest sales of around 50,000 acres per year. A brief discussion of these minor cover types follows.

Paper birch.–Annual sales of paper birch have remained low, averaging around 800 acres (Table 3.20). This is consistent with its overall decline in total acres for this type.

Hemlock.–Acres of hemlock sales have averaged around one-hundred acres per year (Table 3.20), with nearly all of the treatments being selection and shelterwood preparation cuts aimed at promoting regeneration of the species. These actions are consistent with a growing emphasis on restoring the mesic conifer component to many areas of the state forest. The sale of hemlock as a significant commercial species is not probable for the foreseeable future.

Lowland hardwoods and balsam poplar.–Lowland forest types have more factors that limit treatment on a greater number of acres than do upland types. These limiting factors range from access issues, best management practice concerns, and environmental issues, through wildlife concerns, markets, and regeneration issues. However, a need exists to adjust the harvest of balsam poplar stands with a goal of balancing the age class distribution of this cover type. A similar need exists to even out the

age class distribution of lowland hardwoods, as well as to address the issue of excessive mortality within this cover type. Over the past decade an average of 622 acres of lowland hardwoods and 727 acres of balsam poplar were harvested per year (Table 3.20). It is expected that these acreages may increase for each type over the next decade. An exception to this is harvests in riparian zones which will be limited due to beaver management efforts and for the maintenance of habitat connectivity.

Spruce-fir.–Sales of the spruce-fir cover type have averaged 720 acres per year as of 2005 (Table 3.20). Sales of this type are not anticipated to greatly increase due to a greater emphasis on increasing structural diversity of mesic conifers in community types such as northern hardwoods.

Cedar and tamarack.–Acres of cedar sales have declined to around 60 acres per year (Table 3.20) and will likely continue to do so, reflecting regeneration concerns for the species. Acres of tamarack sales have likewise been low at less than 200 acres per year. It is anticipated that sales of both cedar and tamarack will be statistically insignificant for the foreseeable future.

Mixed swamp conifers and black spruce.–Combined sales for mixed swamp conifers and black spruce have averaged close to 600 acres per year (Table 3.20), but have been trending slightly upward. A large increase in prescriptions within these lowland conifers is less likely than lowland hardwood cover types due to increased concern for the maintenance of wildlife habitat. Expansion of DNR activity in these types will receive extensive scrutiny by a wide array of interests and will need to be done in a very measured fashion. An aggressive effort will need to be made to develop criteria and standards to determine where and how it is viable to operate in these types.

White pine.–There is potential for increased sales of white pine over the next seven decades, as many planted stands approach a rotational age of 100 years. Over the past decade sales of white pine averaged 1,100 acres per year (Table 3.20). As it becomes an increasing component in mixed aspen, red pine and oak stands the potential production of white pine may become even greater in the future.

Increased prescriptions within these minor forest types are not likely to elevate them to the level of prominence accorded to the major timber types at any time in the immediate future. Only modest increases in harvests will likely be experienced with some of these types, most notably for lowland hardwoods, balsam poplar, mixed swamp conifers, and black spruce.

3.2 Forest Health Conditions and Trends

Michigan's forests are some of the most diverse in the United States. Statewide forest inventories identify over 75 different tree species with substantial mixtures of species within each of the major forest cover types. This diverse forest consists of a wide variety of plant species that provide habitat for wide variety of animal species and decreases susceptibility to broadscale disturbances by pests. Among the many stressors that can affect the diversity, productivity and vitality of Michigan’s forests are fragmentation, air pollution, native and nonnative insects and diseases, nonnative plant species, cervid herbivory effects on herbaceous vegetation and forest regeneration, and global climate changes which are manifested by changes in temperature and moisture gradients and in the frequency and severity of weather-related events. These threats are not mutually exclusive as there are complex interactions within and between both biotic and abiotic limiting factors. In this case, a limiting factor is defined as a biotic or abiotic causal agent (e.g., an insect, disease, or drought prone site) that has a negative influence on a tree’s ability to thrive.

Many limiting factors are native insects and diseases, which are a component of natural ecological processes that periodically kill weakened and senescent trees and make way for new and vigorous forests. They also help to maintain forest nutrient cycles by providing decomposing organic matter and nutrients necessary for forest growth. While outbreaks of some native insects and diseases

periodically cause unacceptable growth loss and tree mortality, they contribute to the process of forest regeneration, growth, and renewal that is essential to stable, healthy forest ecosystems. These natural factors exist at endemic levels within natural ecosystems and are only of major concern to forest health when stressors (e.g., periods of drought, or old age) predispose a host tree species to more severe outbreaks. Specific information on the biology, effects, and management strategies of limiting factors that influence Michigan's forest resources is available in the management guidelines used by the Forest, Mineral, and Fire Management Division.

Due to the expanding nature of the global economy, there is an ever present threat of the introduction of new nonnative invasive plants, insects, and diseases. Nonnative species have not evolved with and are not integral parts of our forest ecosystems. These organisms cause new and sometimes devastating effects that disrupt natural ecological functions and processes and have major ecological consequences on the composition and health of native forest communities. Recently introduced nonnative species include the emerald ash borer, beech bark disease and the hemlock woolly adelgid. The DNR works closely with the Michigan Department of Agriculture to monitor the movement of goods such as seedlings, nursery stock and forest products, and to establish quarantines to prevent the unintentional introduction of new nonnative species to Michigan's forests.

Climate change due to global warming also has the potential to disrupt the natural composition, function, and health of native ecosystems through changes in environmental factors such as the length of the growing season, and new temperature and precipitation patterns. This may have long-term effects on the range of native plant and animal species. Climate change has the potential to interact with other forest health threats by causing environmental stressors (such as the incidence and severity of drought) that can trigger outbreaks of insect and disease infestations. The DNR participated in a University of Michigan sponsored project to address global climate change, which has presented a strategy for potential adoption by the State of Michigan (Edison et al. 2007).

Michigan also participates in the national Forest Health Monitoring (FHM) program to evaluate the extent, severity, and causes of changes in forest health. The FHM program is designed to determine the status, changes, and trends in indicators of forest condition on an annual basis. It uses data from ground plots and surveys, aerial surveys, and other biotic and abiotic sources. FHM develops analytical approaches to better define forest health issues that affect the sustainability of forest ecosystems. Detection and evaluation components determine baseline or current conditions of forest ecosystems, and detect changes and trends over time. The need for more intensive evaluation monitoring projects arises when significant forest health changes or trends are detected.

More detailed discussions on selected forest health stressors are presented in the following sections.

3.2.1 Cervid Herbivory

With forest certification, there is a renewed focus on the effect of herbivory by cervids (e.g., deer, moose, and elk) upon ecosystem functions and attributes, such as the species and structural diversity of herbaceous and woody plants in forest ecosystems. The relationships between ungulates and forest regeneration are complex. Cervids are large mobile herbivores that will select habitat that provides their needs for food and cover. Cervid herbivory can effect forest regeneration and may be expressed in multiple ways:

1. Individual tree mortality, which in aggregate may affect the ability of a species to successfully regenerate (Webb 1957).
2. Altered (increased or decreased) plant growth rates (Webb et al. 1956; Harlow and Downing 1979)

3. Plant species composition (Graham 1954; Marquis 1974; Tilghman 1989).
4. Changes in plant form (Switzenberg et al. 1955), chemical composition, or nutritional quality (Campa 1989).
5. Wounds that may make plants more susceptible to disease and subsequent browsing (Bergstrom 1984).

Conversely, the manner in which forest vegetation is managed also has an effect on cervid population demographics (including density). Consequently, when high cervid populations cause regeneration failure, both forest management practices and cervid management goals must be considered to achieve a desired future condition. Given the complex interaction between cervids and forest regeneration, it is apparent that many variables other than cervids influence the species composition and success of forest regeneration. These variables operate at a variety of spatial and temporal scales, ranging from specific sites to landscape level interactions with habitats of different age, composition, and structure.

Results of investigations of the effects of cervid browsing have varied. Some of this variation may be due to differences in the silvicultural treatments studied (e.g., clearcut, shelterwood cut, selection cut, no silvicultural treatment), the length of the study, or the density of cervids in the study areas. To date, little attention has been given to evaluating cervid browsing at a particular site within the context of the surrounding landscape. Some evidence suggests that landscape level attributes may be important. For example, Campa (1989) found that level of deer and elk browsing on aspen was related, in part, to the distance of the site from winter thermal cover.

The effect of cervid browsing on regeneration is usually demonstrated using exclosures, which represent an extreme and unnatural scenario where no cervids are present. The results are often dramatic, with abundant regeneration inside the exclosure and little or stunted regeneration found in the control areas open to cervid browsing. The results from these demonstrations are difficult to translate into management recommendations. In many cases the exclosures are placed in areas where heavy browsing has been observed (Webb et al. 1956; Curtis and Rushmore 1958). This nonrandom placement of exclosures makes the extrapolation of results to other areas (where different site and landscape variables are present) tenuous at best.

Given the number of variables and possible interactions affecting forest regeneration, it is not surprising that the relationship between cervids and forest regeneration is complex and difficult to predict. In order to gain a better understanding of these relationships and to recognize the importance of addressing the problem, the DNR formed a Cervid Herbivory Team in 2006 that is charged with developing methods and protocols for monitoring and measuring the effect of browse on forest regeneration and herbaceous plants. In addition, the DNR continues to partner with a variety of university research projects on this issue.

3.2.2 Emerald Ash Borer

The emerald ash borer is a new, serious limiting factor for all *Fraxinus* species. A limiting factor being a biotic or abiotic causal agent (e.g., an insect, disease, or drought prone site) that has a negative influence on a trees (in this case an entire genera's) ability to thrive.

The emerald ash borer *Agrilus planipennis* (EAB) was discovered feeding on ash in Southeastern Michigan in 2002. This was the first detection of this exotic beetle in North America. The emerald ash borer is a native of China, Korea, Japan, and far eastern Russia. Ash trees *Fraxinus spp*. native to North America appear to have little to no immunity to EAB. Thus, as EAB spreads throughout

Michigan, it will significantly affect the vigor and survival of Michigan's 700 million white, green, and black ashes.

As of 2007, EAB has been found in adjacent areas of Canada, Ohio, Indiana, Illinois, Pennsylvania, West Virginia, and Maryland. EAB has not been detected in other areas of North America. EAB has killed millions of ash trees of all species and varieties. To date, this effect has primarily occurred in the 21 counties of Southeastern Michigan which has likely been infested since the early 1990s.

New remote EAB populations, called "outliers", are created mostly by the movement of infested firewood and have been detected throughout the entire Lower Peninsula and in parts of the eastern Upper Peninsula. As of October 2007, the EAB quarantine includes portions of Mackinac and Chippewa counties that contain outliers. It is probable that there are many other undetected outliers. Populations of EAB are spreading at a rate of about ½ mile per year (McCullough et al. 2004), and it is likely that outlier populations will eventually build and spread to all the ash resources in the Lower Peninsula. MDA continues to monitor and regulate the movement of all ash and wood products across the Mackinac Bridge.

There is much to learn about predicting EAB effects. A portion of EAB populations infesting healthy, vigorous ash appear to be pushed to a two year life cycle. Thus, we may be able to slow the spread and buildup of EAB populations by reducing ash basal area through the removal of declining and poor vigor ash. For a more detailed discussion of management options, see the FMFM Forest Management Guidelines: Ash Management/Emerald Ash Borer.

Quarantine Considerations

Lower Peninsula.–Efforts to eradicate EAB populations in Lower Michigan are no longer feasible. All counties in the Lower Penisula are quarantined. The quarantine restricts the movement of regulated articles. Regulated articles include ash nursery stock and green lumber; any other ash material including logs, stumps, roots, branches, as well as composted and uncomposted wood chips. All hardwood firewood is regulated.

There are two levels of quarantine in the Lower Peninsula in 2007: levels I & II. Movement of regulated articles is allowed within level I & II areas, from level II to level I counties, but not from Level I to level II counties without MDA approval. Visit the MDA website for specific quarantine language and updates at: http://www.michigan.gov/mda.

Upper Peninsula.–Eradication is the primary goal for EAB detected in the Upper Peninsula. The extent of the population, the number of trees and acres containing ash, site factors affecting treatment access (e.g., wetlands), and available funding will affect the decision to eradicate. Current eradication actions call for removing all ash within one-half mile of any infested trees.

3.2.3 Beech Bark Disease

Beech Bark Disease (BBD) continues to threaten Michigan's American beech resource. Beech is a component in 6.3 million acres of the maple-beech-birch forest type. This represents 138 million beech trees in all size classes. Of these, 15 million larger beech (greater than 9-inch diameter) are highly vulnerable to tree mortality. BBD is caused by the combination of an exotic scale insect *Cryptococcus fagisuga* and three species of the fungus genus *Nectria sp*. Tree decline, beech snap and mortality begin after *Nectria* fungi infect scale infested trees. "Beech snap" refers to the often observed breakage of the main stem of diseased trees with mostly healthy crowns. BBD is presently killing beech trees in areas infested with beech scale for 10 years or more. Many hundreds of acres of American beech are being harvested in the killing front areas of the eastern Upper Peninsula.

As of 2006, the scale infestation is currently concentrated in two primary epicenters, Luce County in the Upper Peninsula and Mason County in the Lower Peninsula (Figure 3.8). The University of Michigan continues to expand the Beech Bark Disease Monitoring & Impact Analysis System (BBDMIAS) plot network. Data collected for the BBDMIAS and field observations continue to annually reveal new beech scale infestations. Using data from the BBDMIAS, an effort was begun in 2004 to calculate the current and projected spread of beech bark disease in Michigan. The goal is to develop a model based on empirical data to predict how rapidly beech scale and beech bark disease will spread through Michigan and to determine if spread rates in Michigan are consistent with estimates from other regions of North America. Spread rates will vary from stand to stand since the beech resource in the Lower Peninsula is much more fragmented than that in the Upper Peninsula.

The most dramatic increase in beech mortality in 2006 was reported at Tahquamenon Falls State Park on the Chippewa/Luce County border, where over 90% of the beech overstory is either dead or severely declining.

The USDA Forest Service Research Facility in Delaware, Ohio continues to collect scions from resistant beech in Michigan to study BBD resistance. Scions from resistant American beech are collected in December or January and sent to the research facility. When seed is available, Michigan has agreed to host 1 or 2 seed orchards for propagating resistant beech.

3.2.4 Eastern Larch Beetle and Larch Caseborer

Eastern larch beetle *Dendroctonus simplex* populations cause periodic mortality in eastern and the south-central Upper Peninsula. The last known bark beetle epidemic was in 2002 on tamarack *Larix laricina* stressed from the drought of 2000–01 and repeated defoliation by the larch casebearer *Coleophora laricella*.

The casebearer is an exotic needle-mining insect that was introduced to the lake states in the early 1900s. Populations are usually brought under control within 2 years by two introduced parasitoids. Repeated heavy defoliation concurrent with drought can cause branch dieback or tree mortality.

3.2.5 Gypsy Moth

Gypsy moth *Lymantria dispar* continues to defoliate oak forests statewide. Other forest types (most notably aspen) are also affected, but populations build and remain higher on oaks. The large scale acres of defoliation (peak of 750,000 acres) of the 1980s and early 1990s have not been repeated. This is likely due to the widely introduced fungal pathogen, *Entomophoga maimaiga.* Cool wet springs favor infection and spread of this pathogen within even low level gypsy moth populations. However, given a series of warm dry springs, populations can build as happened in 2006. Gypsy moth defoliation stresses trees, but only contributes to tree decline and mortality when combined with other factors such as drought, poor sites and over-maturity.

3.2.6 Oak Wilt

Oak wilt C*eratocystis fagacearum* continues to spread naturally and artificially through much of the Lower Peninsula and in the south central Upper Peninsula. Movement of oak wilt on firewood and spring and early summer tree pruning/ bark injuries plague efforts to slow the spread of this fatal oak disease. To slow the overland spread of oak wilt, harvesting restrictions are observed on state land. Harvesting of forests where red oak trees remain after harvest is not allowed between April 15 and July 15. Sap-feeding beetles responsible for spreading oak wilt are most active during this time. These

small (1/4-inch long) beetles can pick up spores from diseased trees and transmit them to oak trees that have been damaged during logging operations.

U.S. Forest Service oak wilt suppression funds for detecting and treating oak wilt epicenters in Michigan's Upper Peninsula have helped efforts to detect and treat oak wilt and to rid the Upper Peninsula of this threat to its oak resources.

3.2.7 Red-Headed Pine Sawfly

The red-headed pine sawfly *Neodiprion lecontei* periodically defoliates young red and jack pine. Sawfly populations have been active in the eastern Upper Peninsula and the northern Lower Peninsula beginning in 2002. Heaviest infestations are in pines growing under stress, particularly those at the edges of hardwood forests, on poor soils, and where there is heavy competitive vegetation. In general, it infests and damages trees less than 15 feet tall. Moderate to heavy defoliation stunts height growth of infested trees and forking may result from top kill. Complete defoliation usually kills the tree. If necessary for stand growth and survival, damaging populations are evaluated and managed using registered pesticides.

3.2.8 Jack Pine Budworm

The jack pine budworm *Choristoneura pinus pinus* is considered the most significant pest of jack pine. Stands older than 50 years are vulnerable to damage. Jack pine over 50 years old that has suffered 2 or more defoliations during the past 3 years is at highest risk of top kill or mortality. Tree mortality and top kill resulting from budworm defoliation creates fuel for intense wildfires. Harvesting stands when they reach maturity can minimize budworm-caused tree mortality and reduce the threat of damaging wildfires.

3.2.9 Spruce Budworm

The spruce budworm *Choristoneura fumiferana* is one of the most destructive native insects in the northern spruce and fir forests of the Eastern United States and Canada. Periodic outbreaks of the spruce budworm are a part of the natural cycle of events associated with the maturing of balsam fir. Outbreaks have resulted in the loss of millions of cords of spruce and fir.

Balsam fir is the species most severely damaged by the budworm. White and black spruces are suitable host trees and some feeding may occur on tamarack, pine, and hemlock. Spruce mixed with balsam fir is more likely to suffer budworm damage than spruce in pure stands.

The spruce budworm has lightly to moderately defoliated a few thousands acres in several counties in Michigan's Upper Peninsula for the last decade. Occasional heavier defoliation has result in some top kill and tree mortality. Large scale epidemics occur on a 30 to 50 year cycle, with the last epidemic lasting for 10 years and ending around 1982. As our balsam fir resource matures, it is expected that another large-scale epidemic will occur.

3.2.10 Dutch Elm Disease

Dutch elm disease *Ophiostoma ulmi* continues to cause extensive mortality of American elm *Ulmus americana*. Newly infected large trees may survive and show progressively more symptoms for one or more years. Trees infected through root grafts wilt and die rapidly. Dutch elm disease continues to

cause extensive mortality of American elm within both upland and lowland hardwood communities. It is expected that stocks of American elm will continue to decline throughout the forest landscape.

Although there are resistant American elms available for planting, caution should be used as this resistance has not been widely tested over a long period, and a new damaging bark beetle, the Banded Elm Bark Beetle *Scolytus schevyrewi*, is killing elms in the western United States and has now been found in southern Michigan.

3.2.11 Forest Tent Caterpillar

The forest tent caterpillar *Malacosoma disstria* (FTC) is found throughout the United States and Canada wherever hardwoods grow. It is a native insect that has attracted attention since colonial times. The forest tent caterpillar often defoliates extensive areas every 6 to 16 years. Outbreaks typically last for 3 years in any given area, and then subside. Diameter growth may be reduced as much as 90% during an outbreak. Such defoliation kills few trees except for those that are suppressed. Only a few small scattered pockets of aspen and oak defoliation remain as evidence of the large scale FTC epidemic which began in 2000 and spread throughout many areas of the state.

FTC favored hosts are broadleaved trees. In Michigan's Lower Peninsula, oaks, sugar maple, and quaking aspen are favored. In the Upper Peninsula, oaks and aspen are favored and sugar maple is only lightly defoliated. Other tree species fed upon include birch, cherry, basswood, and ash. Species not fed upon are red maple, sycamore, and most conifers.

3.2.12 Oak Decline

Periodic occurrences of decline and death of oaks *Quercus spp.* over widespread areas have been recorded since 1900. These outbreaks, variously named oak decline, oak dieback, or oak mortality, are caused by a complex interaction of environmental stresses and pests and have been given the name oak decline.

The disease has occurred throughout the range of oak in both forest and urban settings. It is not limited to any one species or species group. Outbreaks have been most frequent and severe among red *Quercus rubra*, scarlet *Q. coccinea*, pin *Q. palustris*, and black oak *Q. velutina* in the red oak group and among white *Q. alba* and chestnut oak *Q. prinus* in the white oak group.

Trees are weakened by environmental stresses (such as drought, saturated soils, or frost) or by pests (such as defoliating or sucking insects). These stress factors often weaken trees so much that they succumb, sometimes suddenly, to the root killing and girdling actions of insects and diseases. The two major pests associated with oak decline are *Armillaria mellea*, a root disease commonly called Armillaria root rot, and *Agrilus bilineatus*, the twolined chestnut borer (TLCB). Usually the progression of decline is slow, occurring over several years. However, the combined actions of TLCB in the stem and root disease can bring about rapid decline and death.

Other important tree genera that have suffered serious declines include ash *Fraxinus spp.*, birch *Betula spp.*, beech *Fagus spp.*, and maple *Acer spp*.

3.2.13 Sudden Oak Death

Sudden oak death, now known as Ramorum blight *Phytophthora ramorum*, has not been detected in Michigan's nurseries, urban forests, or forestlands.

3.2.14 Twolined Chestnut Borer

The twolined chestnut borer *Agrilus bilineatus* attacks white oak *Quercus alba*, scarlet oak *Q. coccinea*, northern pin oak *Q. ellipsoidalis*, bur oak *Q. macrocarpa*, chestnut oak *Q. prinus*, northern red oak *Q. rubra*; post oak, *Q. stellata*, and black oak, *Q. velutina*.

TLCB primarily attacks oaks that are drought stressed, over-mature, suppressed, or otherwise declining. Urban oaks that suffer stress from trunk and root injury, soil compaction, and changes in soil depth are equally vulnerable to attack by this pest. Oaks that have been defoliated by insects such as gypsy moth *Lymantria dispar* and forest tent caterpillar *Malacosoma disstria* may also be attacked by TLCB.

3.2.15 Black Ash Decline and Mortality

Black ash decline and mortality continues to be common in many parts of the state. This is related to past drought conditions. Trees like black ash, which grow in wet soils, often suffer during droughts. Wetland trees tend to develop shallow root systems that cannot cope with a prolonged drop in soil moisture. Rising water tables after a prolonged drought may also drown deeper roots developed as the tree sought moisture during the drought years. Black ash decline is being reported throughout the Midwestern states.

3.2.16 White Ash Root Rot

A white ash root rot is causing extensive wind throw of mature ash in high quality northern hardwood stands in Northern Lower Michigan. Stresses from overstocking are likely involved. University and USDA Forest Service forest pathologists and entomologists visited ash decline areas in Northern Lower Michigan. Ash yellows was diagnosed as one of the causal agents of decline. Armillaria and other root pathogens are also involved. Further study based on these findings is in progress. Understanding ash health is paramount in assessing the susceptibility of ash resources to the emerald ash borer.

3.2.17 Hemlock Woolly Adelgid

In August of 2006, hemlock woolly adelgid was found in landscape hemlock in the Northern Lower Peninsula's Emmet County. The infestations were traced by the Michigan Department of Agriculture and found to have originated from nursery stock imported from West Virginia in 2003.

Native to Asia, the hemlock woolly adelgid *Adelges tsugae* (HWA) is a small, aphid-like insect that is threatening the health and sustainability of eastern hemlock *Tsuga canadensis* in the Eastern United States. HWA was first reported in Virginia in 1951. By 2005, it was established in portions of 16 states from Maine to Georgia, where infestations covered about half of the range of hemlock. Areas of extensive tree mortality and decline are found throughout the infested region.

Hemlock decline and mortality typically occur within 4 to 10 years of infestation in the insect's northern range, but can occur in as little as 3 to 6 years in its southern range. Other hemlock stressors, including drought, poor site conditions, and insect and disease pests such as elongate hemlock scale *Fiorinia externa*, hemlock looper *Lambdina fiscellaria fiscellar*ia, spruce spider mite *Oligonychus ununguis*, hemlock borer *Melanophila fulvogutta*, root rot disease Armillaria mellea, and needlerust *Melampsora parlowi*i, accelerate the rate and extent of hemlock mortality.

The MDAs HWA quarantine restricts movement of eastern hemlock into Michigan from infested counties of other states. All eastern hemlock shipments require a phytosanitary certificate. Infested trees eventually die. Hemlock stands and areas adjacent to nurseries and high use recreation areas are surveyed annually as part of a Forest Health Monitoring Evaluation project. These rapid early detection surveys began in 2003.

3.2.18 Hemlock Looper

The hemlock looper *Lambdina fiscellaria* is a native defoliating insect. It causes periodic defoliation of hemlock. The larvae can be extremely destructive to hemlock, balsam fir, and white spruce. During an outbreak it will also feed on many other species growing in association with hemlock including larch, cedar, paper and yellow birch, basswood, and maple. Hemlocks may die after one year of severe defoliation and fir in one or two years. Populations build rapidly and are difficult to detect, making management of looper epidemics nearly impossible. An exception is in concentrated recreation areas where damage is detected early, allowing time for foliage protection measures.

3.2.19 White Pine Weevil

The white pine weevil *Pissodes strobe* is a destructive insect of eastern white pine, jack pine, and Norway spruce. The weevil breeds in and destroys the terminal leader, causing forking and crooking of the tree. In general, it prefers open-grown trees. The weevil feeds on the previous year's terminal in the spring and on laterals in the summer and fall. Stem deformities may result in wood defects such as compression wood and bark-encased knots that reduce the value of sawn lumber. This reduction in wood quality is considered the major effect of the white pine weevil. Detrimental effects from the weevil can be avoided though recruitment of white pine through the understory of existing forest stands, and by planting higher densities of jack pine such that surviving shoots are trained upward.

3.2.20 White Pine Blister Rust

White pine blister rust *Cronartium* ribicola is the only stem rust of white pines in North America. An apparent native of Asia, blister rust was introduced to eastern North America on eastern white pine *Pinus strobus* seedlings from nurseries in Germany in about 1898. Currants and gooseberries in the genus *Ribes* serve as an alternate host for the rust fungus that causes white pine blister rust. Blister rust and the white pine weevil have given eastern white pine a reputation as a difficult species to culture in forest stands. However, there is evidence of increasing natural recruitment of white pine, which provides a convincing counter argument to the validity of this concern.

3.2.21 Diplodia Shoot Blight

Diplodia shoot blight *Diplodia sapinea (also known as* Sphaeropsis shoot blight) infects many pine species. This disease causes severe damage only to trees that are predisposed by unfavorable environmental conditions. Predisposing environmental factors include poor sites, drought, hail or snow damage, compacted soils, excessive shading, insect activity or other mechanical wounding. The most common hosts are Austrian, Scot's, red, and jack pines. In trees that are relatively free from stress, this disease kills only current-season buds and shoots, and 2nd-year cones. Older twigs and branches are damaged only if they are mechanically wounded or the tree's natural defenses are impaired by environmental stresses. Diplodia effects are primarily manifested by growth loss and top kill. However, small seedlings and saplings in natural regeneration systems or adjacent to overstory pines can experience extensive mortality during droughts.

3.2.22 Nonnative Invasive Plant Species

Numerous nonnative invasive plant species are known in Michigan that can have significant adverse effects to native ecosystems. The Michigan Invasive Plant Council website: http://forestry.msu.edu/mipc provides a formal list of invasive plants in Michigan, a full description of the listing process, and other invasive plant information and links.

Sixteen plant species are currently regulated under Part 413, Transgenic and Nonnative Organisms, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (Table 3.21). The DNR administers the law, with consultation with the departments of Environmental Quality and Agriculture. Under this legislation, eleven aquatic plant species are classified as prohibited and five are restricted for lawful possession or introduction, except under permit for purposes specified in the Act. Additions to or deletions from the statutory list are to be submitted to the legislature.

Forty-one additional nonnative plant species are regulated under Michigan Department of Agriculture Regulation Number 715 as noxious weeds (http://www.michigan.gov/mda/0,1607,7-125-1569_16993-11250--,00.html). Nineteen prohibited species cannot be sold or grown in the state, while 22 restricted species are generally considered as nuisances or economically detrimental. These species are generally considered problematic for agricultural purposes. However, five of the prohibited species are included on the list of invasive species with potential to affect native ecosystems.

Several invasive plant species are currently considered to be of greatest concern in the Great Lakes region. These include autumn olive *Elaeagnus umbellata*, black locust *Robinia pseudoacacia*, black swallow-wort *Vincetoxicum nigrum*, cluster head pink *Dianthus carthusianorum*, common buckthorn *Rhamnus cathartica*, Eurasian watermilfoil, garlic mustard *Alliaria petiolata*, giant hogweed, glossy buckthorn *Rhamnus frangula*, Japanese barberry *Berberis thunbergii*, Japanese knotweed, nonnative honeysuckles (e.g., *Lonicera tatarica*), leafy spurge *Euphorbia esula*, multiflora rose *Rosa multiflora*, Oriental bittersweet *Celastrus orbiculata*, pale swallow-wort *Vincetoxicum rossicum*, phragmites, purple loosestrife *Lythrum salicaria*, spotted knapweed *Centaurea maculosa*, Scots' pine *Pinus sylvestris*, and tree-of-heaven *Ailanthus altissima*.

Roads and concentrated recreation areas (such as trails, parks, and campgrounds) continue to provide vectors for the spread and establishment of many invasive species. Several of these invasive nonnative plant species are now well established in southern Michigan and are beginning to be more frequently detected in the northern Lower Peninsula and the Upper Peninsula. Garlic mustard has been found in the vicinity of Marquette, the Cut River Bridge, and Manistee. Significant infestations of glossy buckthorn have been detected at Seney Wildlife Refuge, and near Escanaba and Crystal Falls. Common buckthorn has been detected in the Crystal Falls Management Unit and at Bewabic and Straights state parks. Phragmites, purple loosestrife, and reed canary grass have spread well into the northern Lower Peninsula and scattered infestations have been documented in the Upper Peninsula. Autumn olive, the nonnative honeysuckles, multiflora rose, Japanese barberry, and Japanese knotweed occur throughout the northern Lower Peninsula and the Upper Peninsula and are problematic in some areas. Many additional invasive species are known in northern Michigan that to date have lesser known effects to forests. Many of these establish well in disturbed areas and can be of concern if they are present near areas undergoing forest prescriptions.

It is critical to employ means of early detection while infestations of invasive plant species are relatively small. However, no comprehensive, systematic survey has been conducted to document their distribution on state lands. Preliminary county distribution maps have been developed by Michigan Natural Features Inventory (MNFI) based upon University of Michigan herbarium records. These distribution maps provide a coarse-scale assessment of species distribution in Michigan.

However, they are limited in several ways: 1) known occurrences are mapped at the scale of a county, thus over-representing species distribution, and 2) many known occurrences of invasive species in Michigan are not documented by herbarium records, thus rendering the distribution maps incomplete. Several detailed mapping efforts have been contracted to document the distribution of invasive plant species on state lands, including in Grand Mere, Warren Dunes and Warren Woods state parks, state campgrounds in the EUP, and the Shiawassee State Game Area.

The DNR is working with MNFI to develop and implement a mapping strategy to acquire better species distribution information. Several GPS-linked mapping tools are under consideration, including: 1) the Weed Information Management System program developed by the Nature Conservancy, 2) the National Institute of Invasive Species Science Global Organism Detection and Monitoring System, 3) an unnamed mapping protocol developed by MNFI in 2005, and 4) the USFS/DNR Moving Map Display System. GPS mapping on state lands is expected to be a continual effort. The integration of data from multiple mapping tools and at multiple scales will be considered during the development of the DNR strategy, in order to integrate information from other entities (such as the U.S. Forest Service and MSU) that have developed other mapping strategies.

In order to determine which species warrant active control efforts a risk assessment tool must be employed to systematically determine the risks posed by individual species. The Michigan Plant Invasiveness Assessment System (http://forestry.msu.edu/mipc/tool.htm) was designed by the Michigan Invasive Plant Council to identify relevant biological, ecological, management, and economic information needed to evaluate the effect any given plant upon Michigan ecosystems, and provide the foundation for a recommended plan of action. The assessment uses the following factors to determine the overall effect of a plant species: biological character, affect, distribution, control methods, control effort, and value. As of September 2000, about a dozen plants have been partially run through the assessment tool, but no plant assessments have been completed to date. The integration of invasive species risk assessment information in FMFM FMU compartment reviews is now being implemented.

Most active control of invasive plant species is occurring at state game areas, state parks, and state recreation areas, or on private lands through the Landowner Incentive Program (LIP). These efforts have been directed primarily towards control of black locust, Austrian pine, Scot's pine, autumn olive, nonnative honeysuckles, glossy and common buckthorn, Japanese barberry, multiflora rose, narrow-leaved cat-tail, reed grass (phragmites), purple loosestrife, reed canary grass, garlic mustard, wild parsnip, sweet clover, and spotted knapweed. Control mechanisms have included combinations of manual and mechanical cutting and/or removal, herbicide application, prescribed fire, and seeding with native vegetation. Control efforts have been carried out by various combinations of DNR Forest, Mineral, and Fire Management; Parks and Recreation; and Wildlife division staff, independent contractors, Michigan Civilian Conservation Corp, AmeriCorps groups, and volunteers.

In northern Lower Michigan control efforts have been conducted at Hoffmaster and Wilderness state parks, the Houghton Lake State Forest Campground, and on private lands through the LIP program, targeting species that include lyme grass, baby's-breath, spotted knapweed, phragmites, purple loosestrife, and multiflora rose.

In the Upper Peninsula, control efforts have targeted spotted knapweed and garlic mustard at Porcupine Mountains Wilderness State Park, glossy buckthorn at the Seney National Wildlife Refuge and in the Crystal Falls FMU, cluster head pink in the Marquette area, and garlic mustard near the Cut River Bridge and several state forest campgrounds. Scots' pine is being systematically removed from all state forestland, and experimental prescribed burns are scheduled to reduce spotted knapweed in Shakey Lakes Natural Area in Menominee County.

Garlic mustard monitoring, management, and eradication projects are gaining particular momentum throughout Michigan. Public and private organizations are working through Cooperative Weed Management Areas in an effort to remove garlic mustard and keep it from establishing in new areas of the Upper Peninsula and the northwest Lower Peninsula. Herbicide treatments have been conducted at several state campgrounds and a seventy-acre northern hardwoods site in the eastern Upper Peninsula has a seven-year prescribed burn plan which includes follow-up use of glyphosate herbicide treatments on persisting plants. Treatments are designed to contain the spread of the plant and eventually eliminate garlic mustard. Additional monitoring of the plant community response to burning and herbicide treatments is planned.

The establishment of biological control organisms is also one area of interest. Recent successes with the release of two small leaf-feeding beetles on purple loosestrife have reinforced the positive benefits that a successful and carefully implemented biological control program can have. Purple loosestrife populations have declined in many areas where infestations are large enough to support the release of Galareucella beetles.

The DNR is working with MNFI to compile data on all control and restoration efforts on state lands and to train staff on early detection and rapid response techniques. Finding a long-term management solution for invasive plant species may be difficult, as the only recourse for control in many instances is labor intensive removal or herbicide treatment.

3.3 Wildlife Habitat Conditions and Trends

Strategies on the conservation of wildlife species continued to evolve in step with the understanding of the tremendous affect that human development has had and continues to have upon the landscape of the state. It is known that the survival of wildlife species is inextricably linked to the habitat that supports them and that the degradation or loss of habitat is often the primary threat to species viability. Based upon this premise the State of Michigan developed a Wildlife Action Plan (Eagle et al. 2005) with the goal of providing a common strategic framework that will enable Michigan's conservation partners to jointly implement a long-term holistic approach for the conservation of wildlife species. The plan primarily uses a statewide coarse-filter approach based on wildlife habitat needs to conserve rare, declining, and common species, and also provides a fine-filter approach to address species that may not satisfactorily respond to habitat or ecosystem-based conservation approaches. Using both approaches will provide a more-balanced strategy for the conservation of wildlife diversity.

There are currently 947 known vertebrate and invertebrate wildlife species in Michigan. It is estimated that there are an additional 15 to 20 thousand insect species in the state. Rather than discuss individual wildlife species in depth, this section of the plan discusses trends for the major types of vegetative communities that support wildlife on state forestland and the characteristics of those communities that are important to maintain habitats for diverse and sustainable wildlife populations.

The present natural communities of northern Michigan are very different from the pre-European settlement forest. Michigan was historically occupied by species that were adapted to the compositional and structural conditions of the native vegetative communities throughout the landscape. Various anthropogenic and natural disturbance regimes produced the communities that were present during the circa 1800 period of Michigan's history, with anthropogenic effects (especially fire) recently being hypothesized as significant contributors to many community conditions immediately prior to European contact (Mann 2006). Natural disturbance regimes included fire, windthrow, drought, flood events, beaver impoundment, disease and insect infestation. Many of these ecological processes have been altered or severely restricted by present management.

The primary disturbance factors affecting Michigan's state forest are now commercial timber harvesting, exotic and native forest pests and diseases, recreational activities, road building, and hydrocarbon development. During the last 150 years Michigan's native communities and associated wildlife populations have undergone dramatic change as vast areas were cleared, burned over, and reforested. Compared to pre-European settlement forests, today's forests are relatively young and still in the process of recovering from the lumbering era of the late 1800s. Even so, present forest communities are now older and have greater diversity and structure than forests of just 50 years ago, and the wildlife populations that occupy these communities are becoming more reflective of the maturing forest. Evaluating the condition and trends of the major forested and nonforested habitat types in the state forest system helps to frame some of the major wildlife issues on these lands.

3.3.1 Upland Deciduous Forest Habitats

The major upland deciduous forest cover types on the state forest are the aspen association, northern hardwoods and the oak association.

Aspen Association

As previously discussed, the intensive land clearing and logging of the late 1800s and early 1900s, followed by extensive burning and reforestation through natural seeding and regrowth from rootstocks, has resulted in a large expansion of aspen-dominated forest compared to pre-European settlement conditions (Table 3.2). Statewide aspen-birch acreage subsequently declined by 2 million acres as second growth forests matured over the period of 1935 to 2003, but the rate of decline has slowed over the last decade (Figure 3.5). The aspen association now occupies approximately 885,000 acres or approximately 22.5% of the state forest (Table 3.4) and is relatively stable (Table 3.4). Aspen will continue to be a major forest type in Michigan for the immediate future, meeting demands both for wood fiber and wildlife habitat.

However, the structure of the state forest aspen resource is changing as a consequence of past heavy harvests 1 to 3 decades ago that were conducted for maintaining the large land base of aspen. The current age-class distribution of aspen is now very uneven (Appendix G), and this will lead to a declining trend in the 10- and 20-year age classes, with a projected decline of almost one-quarter of 2006 levels in the decade beginning in 2016 and an even more pronounced 50% decline for 10–30 year old habitat beginning in 2026 (Table 3.22). This unbalanced age-class distribution is perpetuating relative "booms and busts" of wildlife populations that are dependent upon the various stages of aspen development. This will continue for at least one more 50 to 60-year rotation until the age class distribution of aspen is more balanced.

Approximately 70 species of vertebrates use aspen-dominated forest as habitat in northern Michigan (Doepker et al. 2001), including the important game species, Ruffed Grouse, white-tailed deer, snowshoe hare, and American Woodcock, which have been decreasing nationally for the past 20 years. The value of aspen as wildlife habitat is also dependent on the productivity of the site. Productive sites that produce dense, young aspen stands with a variety of fruiting shrubs in the understory of saw-timber sized stands provide habitat for the greatest variety of wildlife species. Nutrient poor, dry sites produce less dense and diverse aspen associations, and trees on these sites often lack vigor and may be more susceptible to disease and pest infestation. Such locations tend not to provide habitat conditions that are most beneficial to aspen-dependent wildlife species, and may be more valuable if allowed to follow natural successional pathways for conversion to white and red pine cover types. This will result in less acreage of aspen, but will have less effect on aspen-dependent wildlife populations than the greater potential trend for conversion of more productive sites from aspen to the northern hardwoods cover type (Table 3.7).

Northern Hardwoods

The northern hardwoods community (mesic northern forest) is currently the second largest forest type in the state forest, occupying over 508,000 acres or about 13% of the land base, and it is increasing in acreage (Table 3.4). Northern hardwoods provide habitat for approximately 115 wildlife species (Doepker et al. 2001) and large contiguous blocks of northern hardwood forest provide important habitat for "forest interior" wildlife species.

The value of northern hardwoods to wildlife is largely dependent upon structural and compositional diversity within the community. The lumbering era and some present management practices have reduced the species diversity of northern hardwood stands, particularly affecting the conifer component. Currently single tree selection is the method of timber harvest that is most frequently employed in northern hardwoods. This harvest method increases structural diversity by perpetuating seedling, sapling, pole and sawlog-size classes within a stand, but it sometimes results in reduced tree species diversity because lower value species are not selected for retention during timber sale preparation.

Nonnative pathogens have also affected the composition of the northern hardwoods community. Dutch elm disease has removed nearly all elm trees from this forest type, and further compositional changes are likely if the current emerald ash borer infestation removes ash from the landscape and beech bark disease significantly changes the age-class distribution of American beech by eliminating the largest, oldest and most productive beech trees from northern hardwood stands.

The Mesic Conifer Initiative in the Western Upper Peninsula Ecoregion is expected to partially restore the conifer component to the northern hardwood forests of this region by increasing the amount of hemlock, white pine, and white spruce in such stands. Restoration of the conifer component will improve habitat conditions for wildlife in these forests. The structure of northern hardwood communities can also be enhanced for wildlife through implementation of DNR Within-Stand Retention Guidelines (Michigan Department of Natural Resources 2006b) to retain some trees in older age classes and allow them to become decadent as den trees, snags, and coarse woody debris.

Oak Association

Oak association forest covers 244,000 acres (6.2%) of the state forest (Table 3.4). Oak species were a component of naturally mixed pine-oak communities in the circa 1800 landscape of upper Michigan, but was only a relatively minor cover type (72,000 acres or 2%) of what is now the state forestland base (Table 3.5). The current acreage of oak is a relic of the circa 1800 logging of pine forests and the unnatural catastrophic fires that followed.

The number of oak acres is declining in the state forest, and based upon understory types approximately half of the oak cover type in the state forest is gradually succeeding to other types (Table 3.7). Current sapling and pole-sized age classes of oak are only around 10,000 acres (Appendix G), and maintenance of this cover type at its current level is not possible without replicating the events of the past, or developing silvicultural techniques that can more reliably regenerate oak. Land managers are currently faced with a dilemma: whether it is better to continue to retain mature oak in the 70–100 year age class for its mast producing capability today, knowing that it will eventually die and succeed to other types; or if it is more prudent to cut mature oak and aggressively experiment with different methods to regenerate oak.

Oak forests provide habitat for approximately 95 vertebrate wildlife species in northern Michigan including the eastern hognose snake, white-tailed deer, and wild Turkey (Doepker et al. 2001). Oak acorns, along with beechnuts, are the primary sources of hard mast for wildlife in the northern forest. Developing the capability to successfully regenerate oak in the northern forests of Michigan is

important to maintaining healthy populations of some of these most popular game species on state forestlands.

3.3.2 Upland Coniferous Forest Habitats

Jack pine and red pine are currently the predominant upland coniferous forest cover types on the state forest. This is in contrast to the dominance of mesic conifers such as white pine, red pine, and hemlock in circa 1800 mixed conifer forests, which now occupy a relatively small proportion of the state forest system. The mesic conifer initiative in the Western Upper Peninsula Ecoregion was developed to increase both the mesic conifer component in deciduous forest types and the amount of mixed conifer upland forest. As reflected in understory data (Tables 3.7 and 3.11) natural regeneration of white pine is increasing in many forest types, particularly in the oak, aspen and red pine communities. Populations of wildlife species that use mesic conifer communities can be expected to increase as the future acreage of mesic conifers increases.

Jack Pine

Jack pine is a dominant or associate tree species in several natural communities including interdunal wetland, poor conifer swamp, boreal forest, dry northern forest, oak-pine barrens, pine barrens, and Great Lakes barrens. The acreage of jack pine in the state forest is similar in magnitude to circa 1800 (Table 3.5). This is not surprising given the large areas of xeric, outwash soil types within the state forest, to which the species is well adapted and competitive. Jack pine currently covers 367,000 acres (9.3%) of the state forest, but has declined by 35,000 acres (8.6%) since 1988 (Table 3.4). Jack pine provides habitat for approximately 65 species of vertebrates (Doepker et al. 2001) including the federally-endangered Kirtland's Warbler and the state endangered Prairie Warbler.

Jack pine is the dominant and best represented tree on the driest and least fertile soils in northern Michigan. On glacial outwash plains in the northern Lower Peninsula 142,644 acres of the state forest are managed within dedicated Kirtland's Warbler management areas. The management of stands using an opposing wave pattern has contributed to a significant increase in the Kirtland's Warbler population over the last 20 years.

In the absence of stand-replacing fire, even-aged management through clearcutting and replanting is the most important means of regenerating desired wildlife habitat in the jack pine community.

Red Pine

Red pine is a dominant or associate tree species in several natural communities including boreal forests, dry-mesic northern forests, dry northern forests, oak barrens, oak-pine barrens, pine barrens, Great Lakes barrens, and bedrock glades. Today, these red pine dominated natural communities are some of the rarest natural communities in the state. Circa 1800, there were over 406,000 acres of red pine (predominantly mixed red and white pine associations) in the area of the present state forest, representing over 10% of the forested land base (Table 3.5). There are currently 280,000 acres of red pine in the state forest (Table 3.4).

Much of the red pine in the state forest system originated through planting during the Civilian Conservation Corps era approximately 70 years ago and state planting program in the 1950s, with a relatively small proportion of it occurring in natural communities. The age class distribution of red pine is thus heavily skewed to older aged stands (Appendix G). The DNR guidelines for red pine management help to identify the best sites on which to restore natural red pine communities and at the same time correct the heavily skewed age-class distribution in existing planted stands.

Wildlife species adapted to using red pine to fulfill important life requisites are adapted to the structural characteristics of red pine forest in natural communities. Red pine trees can function as nesting cover for numerous bird species including Pine Sisken, Yellow-rumped Warbler, and Pine Warbler. Natural red pine communities also provide habitat for approximately 55 vertebrate species (Doepker et al. 2001). Wildlife habitat values associated with red pine will be enhanced by management activities that restore the composition and structure of red pine dominated natural communities.

White Pine

White pine-dominated forests cover approximately 94,000 acres of state forest and are increasing in acreage. There has been a 68% increase in white-pine community acreage since 1988 (Table 3.4). Given the prevalence of white pine in the understory of many stands (Tables 3.7 and 3.11) this increasing trend is expected to continue. White pine is a dominant or associate tree species in several natural communities including boreal forests, dry-mesic northern forests, dry northern forests, mesic northern forests, oak-pine barrens, pine barrens, Great Lakes barrens, and bedrock glades. White pine provides habitat for approximately 55 species of wildlife (Doepker et al. 2001), including the Bald Eagle (state threatened), and the Merlin (state threatened).

White pines are often wind-firm and individuals can be left as legacy trees. Super canopy trees are often used by raptors as perches and preferred by nesting Bald Eagles and Osprey when they are located near bodies of water. Large mature trees with broken tops provide valuable habitat for cavity nesting wildlife. Fallen tops provide coarse-woody debris that is used by several species. White pines also have sturdy, creviced bark that black bear cubs can easily climb to escape danger and because of this are considered the preferred escape tree.

Hemlock

Hemlock was historically present on 345,000 acres of the state forestland base, mostly in mixed stands of hemlock-white pine and hemlock-yellow birch associations (Table 3.5). Hemlock was also a co-dominant species in the mesic northern forest community, and was a component of dry-mesic northern forests and hardwood-conifer swamps. Hemlock-dominated stands are presently rare, comprising just over 17,000 acres of the state forest.

Hemlock provides habitat for 69 species of wildlife (Doepker et al. 2001) including the Red-shouldered Hawk and the Northern Goshawk. Hemlock serves as an important source of thermal cover for white-tailed deer and moose. The historical value of hemlock as stands, groups of trees, and individual trees is well documented in this regard. It provides cover for porcupines, fisher, and marten, as well as nesting cavities for Woodpeckers, Flickers, and red squirrels. Hemlock is a long-lived species (mean longevity is about 400 years), and individual trees that become decadent provide perches and cavities for wildlife. Large over-mature trees eventually blow down, providing coarse woody debris on the forest floor which has value for foraging predators, amphibians, and forest regeneration as nurse logs.

Unlike white pine, the conditions required to successfully regenerate hemlock are not occurring naturally. There has been very little hemlock regeneration over the past century, with most remaining hemlock in the 100+ year and uneven aged classes (Appendix G). Successful regeneration of hemlock requires multiple favorable conditions, adding to the imperative of retaining seed trees. Under planting of hemlock is often required to return hemlock as a component of the landscape. The mesic conifer initiative is a useful tool to help expand the hemlock component within other forest types across the entire state forest system.

3.3.3 Forested and Nonforested Wetlands

Wetlands on the state forest system fall into two major cover types, forested wetlands and nonforested wetlands. Forested types include cedar swamps and lowland hardwoods, but also include tamarack swamps and treed bogs. Nonforested types include bogs, fens, emergent marshes, and scrub-carr wetlands. The nonforested wetlands are some of the least managed vegetation types on state forestland except where they were created by the damming of streams and are managed as wildlife floodings.

Wetlands are some of the most productive environments for a wide variety of fish and wildlife species. Ephemeral wetlands such as vernal ponds within upland forest are critical breeding habitat for amphibians and provide some of the earliest green vegetation in the spring for black bears and other wildlife species. Early spring flooding of wetlands also provides significant spawning habitat for fish species such as northern pike. The amount of wetlands on state forestlands has remained the same between 1988 and 2006 (Table 3.4).

Wildlife habitat values associated with wetlands are generally best preserved or enhanced by maintaining or restoring natural hydrological regimes in the wetland, and maintaining or enhancing structural characteristics by leaving adequate snags and downed woody debris when managing forested wetland cover types.

Mixed Swamp Conifers

Mixed swamp conifers comprise over 261,000 acres of the state forest (6.6%), but the cover type has declined by almost 523,000 acres (60%) since circa 1800 (Table 3.5). Mixed swamp conifer species (black spruce, cedar, tamarack, balsam fir) are most often associated with the poor conifer swamp natural community. Mixed swamp conifers provide habitat for approximately 70 vertebrate wildlife species (Doepker et al. 2001) and are particularly important as winter areas for deer in some locales.

Most acreage is in the pole timber size class, which increased by over 12,000 acres since 1988 (Table 3.14) while the type acreage as a whole remained virtually unchanged. Corresponding decreases were recorded in the acreage of the seedling-sapling size class. The vast majority of this cover type on state forestland is older than 70 years. The wildlife values associated with the younger age classes are rapidly disappearing, largely due to lack of harvest prescriptions and a concerted effort to reduce the scale and intensity of fire disturbance in the landscape. Lack of confidence in the ability to regenerate this cover type contributes to managerial reluctance to prescribe treatments in this type. While the wildlife values associated with the older age classes are secure, more research into silvicultural techniques to regenerate this community needs to occur.

Cedar Swamp

Cedar swamps are present on 228,000 acres (5.8%) of state forest (Table 3.4). This acreage is consistent with the circa 1800 acreage of 219,000 acres (Table 3.5). Cedar swamps are most often associated with the rich conifer swamp natural community. Cedar swamps provide habitat for a variety of wildlife species including snowshoe hare, bobcat, elk, and deer. Cedar swamps are critical winter habitat for deer in the Upper Peninsula, providing both thermal cover and food. Cedar swamps also provide habitat for approximately 50 vertebrate wildlife species (Doepker et al. 2001).

Most of the acreage of cedar swamp lies in the well-stocked pole timber size class with an age class distribution that is highly skewed (Table 3.16 and Appendix G). More than 80% of cedar swamps are over 80 years old with the 100+ age class predominating. Cedar swamps over 80 years old were able to regenerate during a period of relatively low deer populations immediately following the peak of the lumbering era and the subsequent landscape level fires that followed (Pregitzer 1990). With a

relatively young forest as compared to circa 1800 forest, the present summer range supports higher populations of deer. These deer are concentrated into a limited acreage of winter cover, severely restricting the ability to currently regenerate cedar swamps.

The inability to successfully regenerate cedar, combined with the preponderance of other conifers and lowland hardwoods in the understory of the cedar type will likely gradually lead to a state forest with less cedar in the landscape and lower populations of those wildlife species dependant upon cedar swamps.

3.3.4 Grasslands

Grasslands are present upon 125,000 acres of the current state forest, but have declined by 52,000 acres from the acreage in the 1988 inventory (Table 3.4). This is still many times the historic acreage of less than 4,000 acres (Table 3.5). Almost half (60,147 acres) of all state forest grasslands are located in the Northern Lower Peninsula Ecoregion (Appendix F).

A significant acreage of grasslands is located in the Eastern Upper Peninsula Ecoregion, with almost 42,000 acres or 33.5% of the cover type. There is a much smaller acreage of grassland in the Western Upper Peninsula Ecoregion, with 23,146 acres (18.5%). Wildlife species associated with grasslands have experienced some of the greatest declines in population levels since the mid 1960s (Herkert 1995).

Grasslands on the state forest system fall into three broad categories. These categories are: maintained wildlife openings; natural grasslands that are part of barren or savanna communities; and old field grasslands. Maintained wildlife openings are actively managed openings within the forested landscape designed to enhance habitat components for wildlife. Most of these openings were created to provide herbaceous forage for deer and elk.

Native northern grasslands include pine barrens, oak-pine barrens, great lakes barrens and dry sand prairie, and were historically maintained by fire disturbance. The suppression of fire in these landscapes has allowed trees to encroach on these grasslands. Restoration of these native grassland systems using prescribed fire is a key method of improving grassland wildlife habitat on state forestlands.

3.4 Water and Fisheries Conditions and Trends

Michigan is responsible for stewardship of 43% of the Laurentian Great Lakes, which hold over 20% of the world's fresh water. The Great Lakes have extensive, diverse, and productive coastal wetland complexes along shorelines and at river mouths. These wetlands serve as spawning and nursery grounds for many Great Lakes fishes, mussels, amphibians, and reptiles, and as feeding grounds for these organisms as well as water birds and mammals.

Extensive wetland ecosystems are supported inland by the humid and cool climate combined with widely distributed porous soils. Diverse hydrologic and geomorphic landscape settings provide an array of wetland types, supporting diverse and productive biological assemblages. Wetlands in northern Michigan are typified by strong groundwater sources and northern vegetative and animal species. Many wetlands are found at the interface of lakes, rivers and streams, and provide important ecological services to those systems as sources of high quality water and aquatic wildlife habitat.

Michigan contains over 10,000 lakes and 36,000 miles of rivers and streams that support a diversity of aquatic communities and fisheries typical of the range commonly found across northern North

America. The forested landscapes of northern Michigan contain approximately half of these lakes, including a number of very large, often deep lakes (54 lakes greater than 1000 acres and up to 290 ft in depth). Due to colder climates, substantial groundwater inflows, drainage of unproductive soils, and often significant depths, many of these northern lakes are classified as oligotrophic (clear, cool, or cold waters, relatively low levels of nutrients and plenty of oxygen for fish in the deeper waters), or mesotrophic (cool waters with moderate nutrients). These lakes support assemblages of aquatic plants and animals common to cold or cool waters in northern North America.

Northern Michigan is home to 49% of the state's stream mileage. About 39% of northern streams and rivers drain hilly and porous landscapes, receive abundant groundwater inflows, and thus are typically cold or cool during summer. These streams support coldwater communities that include naturally-reproducing and stocked trout species. The remaining streams and rivers are warmer and support diverse aquatic communities, populated by a variety of minnow (Cyprinid), sucker (Catostomid), perch (Percid), and sunfish (Centrarchid) species. Streams that connect to the Great Lakes also provide seasonal spawning and rearing habitats for a variety of abundant, migratory Great Lakes fishes; these are typically fishes that prefer cold- or cool-water temperatures.

Fisheries habitats are categorized according to their unique features and roles that they play in the life cycle of fishes. Several categories of aquatic habitats have been identified in Eagle et al. 2005 and include: shoreline, nearshore, and offshore areas, ponds, lakes (small, medium, and large), headwaters and small tributaries (cold and cool), medium rivers (cold and cool), large rivers (cold and cool), very large rivers, bogs, fens, wetlands (ephemeral and emergent), swamps, and floodplains. Unique attributes can also be associated with each of the major habitat types such as nutrient status and dominant substrate. Each of these features and their status has been categorized by Great Lakes basin as part of Michigan's Wildlife Action Plan (Eagle et al. 2005).

Conservation needs related to aquatic habitat include addressing issues of invasive species and fragmentation of habitats. Displacement of native species populations by invasive species results in altered food webs, changes in nutrient dynamics, disruption of natural processes, and alterations in life cycles of the native species (Eagle et al. 1995). Habitat fragmentation is caused by changes in land use or by barriers to fish passage. Land use changes that affect stream temperatures can act as thermal barriers during critical summer months and prevent fish from reaching upstream cooler habitats. Physical barriers include dams and culverts. Undersized or perched culverts at road crossings or other locations can be year-round or temporary barriers at critical times when fish need to seek either upstream or downstream habitat that is more suitable. This can be disruptive to both migratory species such as salmon and walleye as well as nonmigratory species such as brook trout or smallmouth bass as fish are known to use multiple types of habitats and areas throughout their life cycles. Other habitat issues related to aquatic resources include the conversion of wetlands to other types of land use, dredging of near-shore areas, channelization, alterations to riparian zones, dams, erosion and altered sediment loads in streams, altered hydrologic regimes, and disease (Eagle et al. 2005).

As mentioned in the previous section, the Great Lakes waterways experienced an extremely high rate of invasive species introduction and establishment after the St. Lawrence seaway and Welland Canal were opened. Invasive species came both directly into the Great Lakes as well as from the ballast water and hulls of ocean-going ships. In addition to alewife and sea lamprey, several other ecologically disruptive introduced species include round goby *Neogobius melanostomus*, the zebra mussel *Dreissena polymorpha*, quagga mussel *Dreissena bugensis*, and spiny water flea *Bythotrephes cederstroemi*, and the fishhook water flea *Cercopagis pengoi* have caused abrupt declines in economically important or rare species, massive changes in food webs, and considerable economic costs. Although PCB levels appear to be dropping in fish found in the Great Lakes, the bio–accumulation of methyl-mercury and PCBs continues to be of concern in the state in regard to fish

consumption by humans. The Michigan Department of Community Health has issued a special advisory for all inland lakes in Michigan due to mercury levels in predatory fishes such as pike and smallmouth bass.

3.5 Socioeconomic Context – Human Uses and Trends

Michigan's forests are a significant component of the social, economic and environmental well-being of its citizens. The economic contribution of these forests include employment opportunities, wealth creation and the production of commodity and noncommodity products and values for the benefit of both the rural and urban population of the state. Wood products and forest-based recreation and tourism are two primary elements of the overall forest-based economy, and both elements are beneficial for the development and maintenance of strong rural economies. During 2005, these two combined sectors are estimated to provide 150,000 jobs and contribute over $10 billion to the state economy.

The economies of many northern Michigan counties are particularly dependent on earnings from wildland-based industries, including timber, mining, recreation and wildlife (Table 3.23), especially in the Upper Peninsula where there is a rich history of such industries that have been interwoven with the social fabric of the region. Ontonagon, Keweenaw, Delta and Gogebic counties in the in the Western Upper Peninsula Ecoregion approach or exceed one-quarter of total earnings from these industries. In the Eastern Upper Peninsula Ecoregion, Alger, Schoolcraft and Mackinac counties approach or exceed one-quarter of total earnings. In aggregate, the Northern Lower Peninsula is not as dependent upon wildland-based industries, but on an individual county basis, earnings from these industries in Montmorency, Presque Isle, Kalkaska and Crawford Counties exceed one-quarter of total earnings. Earnings are but one measure of the values associated with our wildlands. Our forests also generate a wide array of amenity values for people who live in or visit the northern portion of the state.

State forestlands provide for a wide variety of human uses, including production of timber and fiber for the forest products industry, oil, gas and mineral production, hunting and fishing opportunities, recreation and tourism, and public education and research. Sustainable forest management is greatly influenced by the demands of each of these uses. However, the ability of the DNR to manage the state forest and provide for these and other uses is highly dependent upon revenue generated through timber sales as there is very little general fund support of these programs and others such as inventory, and wildfire and forest health protection.

3.5.1 Timber Production

Michigan has a relatively diverse timber products economy. This provides a strong economic foundation for the state as well as the means for managing a diverse forest. Three primary industrial categories of timber products are often identified: lumber and wood products, wood furniture and fixtures, and pulp and paper products. All three are well represented within the state.

In recent decades, these sectors have experienced substantial changes in their markets similar to those affecting agriculture and manufacturing. Such changes have included pressures for greater efficiencies in costs of production, new technologies and their accompanying costs, globalization effects, and organizational restructuring. Despite the changes, the timber products industry remains vital to the economic well-being of Michigan communities and will continue to be so for decades to come.

Besides the jobs they directly create, they are also responsible for many jobs and income in trade and transportation sectors, as well as additional indirect jobs from their economic activity. In total, Michigan's timber products industry and related service and support sectors are estimated to sustain over 100,000 jobs and provide close to $8 billion of value added to the statewide economy. The lumber and wood products category includes sawmills, manufactured product mills (oriented strand board, etc.), millwork, and wood containers (pallets, etc.). Including logging, this category has close to 2000 businesses employing close to 15,000 people. Annual salaries exceed $400 million, and the value added to the state economy that is directly attributable to this category approaches $1 billion.

Michigan's office furniture industry is prominent on a global scale, employing more than 30,000 people with a payroll in excess of $1 billion. This industry's roots can be traced back to an earlier logging era. Today, there remain close to 10,000 people engaged in wood furniture and fixtures manufacturing.

Michigan has close to 200 pulp and paper establishments, producing a wide variety of products ranging from printing and writing paper, envelopes, paperboard containers and an assortment of other products. These companies employ over 16,000 people, with a payroll in excess of $700 million, and contributed over $2 billion (value added) to the state economy.

Cellulosic biomass production of ethanol is an emerging concept that has the potential to provide a significant market for pulpwood in the future.

Michigan's timber industry is inextricably linked to both domestic and global markets, which have tremendous implications for the well-being of this sector of the state economy, and for the strength of many rural economies throughout the northern regions of the state. Although the state has a diverse timber products economy, it is a net importer of wood-based products, ranging from lumber, composite panel products, and veneer, through household and business furnishings, and paper products The annual demand for wood-based products is roughly equivalent to annual tree growth in all of the state's forests. As of 2004, however, statewide annual growth exceeded annual harvest and losses from mortality by a ratio of 1.8 to 1 (Table 3.3). Excess demand is thereby being met by imports from other domestic, and increasingly global, markets.

World-wide demand for wood products has continued to rise in recent years. Internationally, much attention has been paid to new large wood product demands coming from China, but there are also increased demands from other countries such as India. Domestically, the housing industry has been a primary driver of demands for wood materials which are used in new home construction. As of late 2007 and early 2008, the housing market is in a notable slump, to the point of affecting the stock market and overall national economy. It may be some years before the housing market recovers; however, in the interim, foreign markets and other domestic markets for wood products—including new demands for biomass products like cellulosic ethanol—are expected to offset the lower housing-related wood product demands.

Several factors have a complex but direct bearing upon demand in both domestic and international markets. These are an increasing demand for wood products that are internationally certified for production in a sustainable manner; greater efficiency and scale of timber and fiber production (including climatic factors and land and labor costs), federal tax policies; international trade agreements; and increasingly higher transportation costs. These factors have affects upon the operation and profitability of both primary and secondary producers of forest products in Michigan and the Great Lakes region, which are reflected in recent shifts in corporate ownership, land ownership patterns and employment. Local or niche markets, which in large part are driven by transportation costs, may play an increasing role in the profitability of both primary and secondary

producers of timber product in the state. Moreover, the state's large positive growth balance in timber relative to other states may lead to additional expansion of its timber products economy.

3.5.2 Oil, Gas, and Mineral Production

The state owns mineral rights, including oil and gas, on almost 7 million acres of land (Table 3.24), roughly one-fifth of the total land area of the state. Since 1976, annual revenues from the development of state-owned mineral resources, largely oil and gas, continue to provide revenue to the Michigan Natural Resources Trust Fund, which provides financial assistance to local governments and the DNR for the purchase of lands for outdoor recreation and/or the protection of natural resources and open space. The Trust Fund also assists in the appropriate development of land for public outdoor recreation. However by law, no more than 25% of the Trust Fund revenues available for appropriation each year can be used for development, therefore the majority of funding is allocated for acquisition projects.

Oil and gas production is a significant land use throughout the Lower Peninsula, with most wells being located in major sedimentary rock formations in the Northern Lower Peninsula (Figure 3.9). There is no oil or gas production in the Upper Peninsula. Red locations on the map indicate new wells drilled in 2000 to 2005 mostly in a band stretching roughly from Manistee to Alpena counties. Black indicates older wells, some of which are no longer in production. About 25% of the 13,722 oil and gas wells in the state are located on state-owned land in the Lower Peninsula. About 31% of the oil and gas wells in the Northern Lower Peninsula are on state-owned lands.

Part 5, Section 502, of NREPA,1994 PA 451, as amended, authorizes the DNR to enter into contracts for the Metallic and Nonmetallic Mineral, Oil and Gas and Underground Gas Storage Leasing Programs.

There were 785,114 acres under 7374 state oil and gas leases at the end of FY 2005 resulting in total revenue of $73,182,040, of which $62,220,262 was related to royalty. The December 2004 Oil and Gas Auction resulted in 96,764 acres being leased and the June 2005 Auction resulted in 70,845 acres being leased, for combined total revenues of over $10 million.

There were 31,412 acres under 78 state underground gas storage leases at the end of FY 2005, which resulted in $73,468 in revenue. Sixteen leases totaling 18,446 acres do not have an annual rental, as all monies were paid in advance for the longer-term leases. Several Northern Niagaran Reef Trend oil and gas fields have been converted to underground gas storage fields. These fields, with the recycling of natural gas, produce additional liquid hydrocarbons, that otherwise would not be recovered.

Mining is a very important land use in Michigan with mineral occurrences located throughout the state (Figure 3.10). There are 850 producing mineral occurrences in the state with more than 80% of these being sand and gravel operations. Mining operations for metallic ores, such as iron, copper, and other metals are concentrated in the Western UP with numerous undeveloped mineral occurrences. There is current interest in expanding mining for metallic minerals in the Western Upper Peninsula.

Many nonmetallic operations, especially sand and gravel, are located in the Lower Peninsula.

There were 48,647 acres under 203 state metallic minerals leases at the end of FY 2005 resulting in revenue totaling $168,668, which was related to bonus and rentals. Mining for metals in Michigan in FY 2005 resulted in the production of iron ore along with a very small amount of copper and silver, all on private lands. Today, exploration efforts continue on the state-owned lands under lease, while applications for new leases are being received on a regular basis.

There were 3,226 acres under 38 state nonmetallic minerals leases at the end of FY 2005, which resulted in $334,733 total revenue all from royalty payments. Special leases were developed for construction sand, gravel, cobbles, boulders, and clay as well as one for limestone or dolomite. The production of nonmetallic minerals from state-owned land continues to be an important source of locally used materials for road and other construction purposes.

Significant opportunities exist for further mineral development on state-owned lands, but there are potential conflicts with other land uses. Revenue received in FY 2005 for all four programs was the second highest in the DNRs mineral leasing history, which dates back to 1927. Given the recent escalation of energy prices on world markets, it is reasonable to expect that future mineral activity and the related revenues will remain high, and that there will be greater pressure for increased production from state-owned lands in the future.

3.5.3 Forest Recreation and Tourism

The DNR is mandated by Part 831, State Forest Recreation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, to develop, operate, maintain, and promote an integrated recreation system that provides opportunities for hunting, fishing, camping, hiking, snowmobiling, off-road vehicle trail riding, boating, trail related activities, and other forms of recreation within the state forest. To fulfill this mandate, the DNR developed a 2008–12 Michigan State Comprehensive Outdoor Recreation Plan (Michigan Department of Natural Resources 2007) that identifies key outdoor recreation issues and goals to meet the needs of public demand for outdoor recreation. This plan provides a focus for the state forest to renovate and construct the appropriate low maintenance intensity rustic recreation facilities (state forest campgrounds, water access sites, and trails) to support dispersed natural resource-based outdoor recreation, while also protecting the environment.

Michigan has the largest public land base for dispersed recreation east of the Mississippi River. Direct and secondary benefits from tourism and recreation in the state are estimated to have contributed around $16 billion to the state economy in the year 2000. Of this total, $3 billion was spent on outdoor recreation which supported approximately 50,000 jobs throughout the state. Spending on overnight trips of greater than 60 miles from home for outdoor recreation generates $1.7 billion in spending, accounting for about 20% of all tourist spending on trips (excluding airfare) (Stynes 2002). These figures exclude spending on recreation activities within 60 miles of home and do not include the substantial purchase of equipment and other durable goods associated with outdoor recreation.

The state forest contributes greatly to overall state recreation and tourism opportunities. In 2000 there were 10.4 million visits to developed state forest recreation and trail facilities, totaling 49.8 million annual hours of recreation. There were an additional 8 million visits for dispersed recreation upon the state forest totaling 23.5 million annual hours (Michigan Department of Natural Resources 2000a). Recreation and trail programs in the Forest, Mineral and Fire Management Division have significant economic effects for Michigan’s local communities.

In the past, traditional recreation and tourism activities such as camping, hunting, fishing, hiking and biking were focused primarily during the summer and fall months. Forest recreation is now trending toward year-round use, as the popularity increases for spring activities such as fishing for migratory steelhead, wild Turkey and mushroom hunting, and ORV riding and for many winter sports such as snowmobiling, skiing and ice fishing. This diversified activity provides year-round benefits to many local economies that were previously more seasonal in nature. General trends from various data sources indicate that hunting, fishing, and power boating recreation are relatively static or declining, but wildlife viewing, ORV, and snowmobile riding have grown in the past decade.

The dispersed recreation opportunities provided by the state forest are exceptional, providing extensive areas for hunting, fishing, mushroom, and berry picking, nature observation, hiking and dispersed camping. These uses totaled 8 million visits with 23.5 million hours of recreation in 2000. The largest proportion of dispersed use is for hunting, followed by fishing, nature observation and hiking (Michigan Department of Natural Resources 2000a). The state forests are a key reason why Michigan ranks nationally at or near the top, in hunting participation each year. The state forest comprises 47% of Michigan's public land base. This large public hunting ground contributes significantly to the annual 8.9 million hunter days, enjoyed by 705,000 residents and 49,000 nonresident hunters. In 2001, the overall value of hunting to Michigan's economy was estimated at 1.3 billion dollars, including: 670 million in retail sales, 326 million in wages and salaries, 103 million in tax revenues, and 12,144 jobs (IAFWA 2002). White-tailed deer hunting is the most popular game species hunted in Michigan and accounted for 506 million of the 1.3 billion dollars of economic activity associated with hunting in Michigan in 2001 (USDI and USDC 2001). Wildlife viewing involves an additional 2.8 million people, with annual trip expenditures of $267 million and another $934 million spent on equipment (USDI and USDC 1998). A measure of the general trend of dispersed hunting recreation can be seen in the number of hunting license holders, which has been steadily decreasing over the past decade (Figure 3.11).

The state forest recreation program consists of an integrated system that includes developed facilities for camping, pathways for multipurpose nonmotorized (hiking, skiing, biking, and equestrian) recreation, distinct trails for motorized (snowmobile and ORV) recreation, and developed water access sites for boating and fishing, as well as undeveloped and dispersed recreational opportunities such as hunting, food gathering, and wildlife viewing. In developing, operating, maintaining, and promoting this recreation system, the DNR focuses on balancing the effects these uses have upon the integrity of the whole forest system.

The state forest campground program was started in 1926 in response to increased unregulated camping in state forests. This use was jeopardizing the continued health and well being of the forest by increasing the risk of forest fires and causing user generated soil erosion problems. From its inception, state forest campgrounds focused on providing rustic camping opportunities with limited amenities, no programming, small campgrounds, and large waterside sites. The forest is the main attraction of a state forest campground. In 2000, there were 149 campgrounds with 3,383 sites. All 149 are located on a lake or stream. Ninety have developed water access sites to facilitate boating and all 149 offer on-site fishing opportunities. Eleven are horse trail camps, attached to the Michigan Shore-to-Shore Riding Hiking Trail. Sixty-one provide direct access to state forest pathways (nonmotorized state forest trails) and seven have direct access to the ORV trail/route system. Use of state forest campgrounds has been relatively stable over the past four years (Figure 3.12), with most use occurring in the Northern Lower Peninsula Ecoregion.

Developed water access sites to facilitate boating and fishing are maintained at 116 locations, 90 of which adjoin campgrounds. These sites include parking and a ramp to launch boats, and can include toilets. These primarily provide access for fishing and small water craft. Additional access is provided via forest road endings or crossings on the 7,500 miles of rivers and streams in the state forest system. These include much of the blue ribbon trout fishing opportunity in Michigan on streams such as the Au Sable, Manistee, Jordan, Pine, Pere Marquette, Sturgeon, Maple, Thunder Bay and Escanaba rivers. There were an estimated 652,000 active registered boats in 1998, with 13.5 million boating days on inland waters. Registered boaters spent an estimated $365 million on boating trips in 1998 (Lee 1999).

Extensive aquatic resources throughout the forests provide tremendous recreational opportunities to the large human population of Michigan and nearby states and provinces. Recreational and commercial fishing are known to be extremely valuable: approximately 1.4 million Michigan

residents and 352,000 nonresidents angled in Michigan in 2001. They fished over 19.3 million angler days, worth a conservative direct economic net value of $839 million. In 2001, the overall value of sport fishing to Michigan's economy was estimated at $2.1 billion (including $1.1 billion in retail sales, $553 million in wages and salaries, and $178 million in tax revenues), and providing 21,301 jobs. Michigan ranked seventh nationally with respect to the economic benefits of sport fishing following Florida, California, Texas, Minnesota, North Carolina, and Wisconsin (USFWS 2001). About 2/3 of Michigan's recreational angling occurs on inland waters. Walleye are sought by many anglers and occur in many of the northern lakes larger than 300 acres. There are good fisheries for lake trout and rainbow trout in several of the large, deep, oligotrophic lakes. Other game fish targeted by lake anglers include smallmouth bass, largemouth bass, northern pike, muskellunge, and panfish. Trout angling is avidly pursued on northern streams, with angling for walleye, northern pike, and smallmouth bass in the larger, cooler rivers. Major fisheries for Great Lakes fishes occur where rivers connect to the big lakes. Species targeted on northern rivers include Chinook and coho salmon, steelhead (rainbow trout), walleye, smallmouth bass, white and longnose sucker, and northern pike.

Nonmotorized pathway/trails (multi-purpose recreational) provide an opportunity for hiking, bicycling, equestrian use, cross-country skiing and nature observation. They range in length from less than one quarter of a mile hikes, to scenic overlooks, to pathways hundreds of miles long. There are 66 state forest pathways stretching a total of 880 miles. More than one-quarter (242) of pathway miles are groomed to support cross-country skiing, receiving extensive use by local residents and tourists. Over a third of the miles are in the Michigan Shore-to-Shore Riding Hiking trail, which stretches from Oscoda to Empire and involves the cooperation of the Michigan Department of Natural Resources, the US Forest Service, the Michigan Trail Riders Association, equestrian associations, utilities, private land owners and local units of government. Another notable trail program is the 145 certified miles of the National Park Service North Country Scenic Trail, portions of which are located on Michigan state forests.

The Trailways Program capitalizes on the infrastructure of inactive railroad rights-of-way which often provides a statewide connection from town to town, using the rail bed and existing bridge structures for the trail. As active rail lines become inactive, these corridors present a one-time, limited window of opportunity to link communities, resources, culture and people. Much of the direction of the program is outlined in the 1993 Michigan Statewide Trails Initiative. Rail-Trail mileage in Michigan has grown from the first miles acquired in 1970 in the Upper Peninsula to a system approaching 1,200 miles. In 2006, there are 1,145 miles of Rail-Trails in Michigan, with 814 miles (71%) managed by Forest, Mineral, and Fire Management, 198 miles by Parks and Recreation Bureau and 163 miles by local units of government. For the period of 2000 to 2005 there have been 300,000 annual visits to these trails.

The ORV Trail program provides four types of trail riding opportunities; motorcycle trails, all-terrain vehicle (ATV) trails, ORV routes and scramble areas. There are 5 scramble areas, 2 of which are in state forests, St. Helen's Motorsport and Black Lake Scramble areas. The ORV trail/route system currently covers 3,193 miles with 73% located in state forests. 40% of the system is dedicated to cycle trails, 43% to ATV trails and 17% to ORV routes. In the Lower Peninsula, the system is the only legal place to ride non-Secretary of state-licensed ORVs on public lands other than frozen waters. In the Upper Peninsula, it is legal for ORVs to operate on state forest roads as well as the designated trail system, unless a specific state forest road is posted closed to ORV use. There were 4.2 million annual use days in the period of 1998–1999. Annual trip expenditures for recreation on public land exceed $40 million, with an additional $134 million spent on ORV equipment (Nelson et al. 2000). The number of ORV licenses has increased by 77% since 1998 to a 2005 total of almost 186,000 (Table 3.25).

There were 6,216 miles of designated and groomed snowmobile trails in 2005, with approximately 25% of the designated trails on state forestlands. Both snowmobile and ORV trail systems rely upon the cooperative working relationship of the DNR with 65 nonprofit groups and local units of government to perform trail maintenance and grooming activities, which are supported by user fees. 78% of all snowmobile use is on the designated trail system, of which 82% is by state residents and 18% is by out-of-state visitors. Snowmobile trail permits peaked in 2001 at almost 270,000 permits, and have declined slightly with a 2002–2005 average of less than 245,000 permits per year due to lower seasonal snowfall (Table 3.25). On trips greater than 100 miles from home or with an overnight stay, there are annual expenditures of $110 million with an additional $235 million on snowmobile equipment (Stynes et. al 1998).

3.5.4 Public Research and Education

The Michigan Department of Natural Resources budgeted approximately $6.6 million in FY 2006 to support a wide variety of ongoing forestry, wildlife and fisheries monitoring, assessment, and research projects that are designed to increase knowledge and to improve methods of sustainable management of Michigan's public lands. Many of these research projects are accomplished in cooperation with state Universities through formal agreements and on an as needed call for proposals for subjects of interest. The DNR produces an annual report to document the commitment to sustainable forestry research and to inform discussion on research needs and collaboration opportunities among the DNR divisions.

Products of research projects often include educational materials that serve to convey research findings to the public. Since almost 63% of timberland in the state is in private ownership (Figure 2.4), public education programs are a critical part of encouraging sustainable natural resource management throughout the state.

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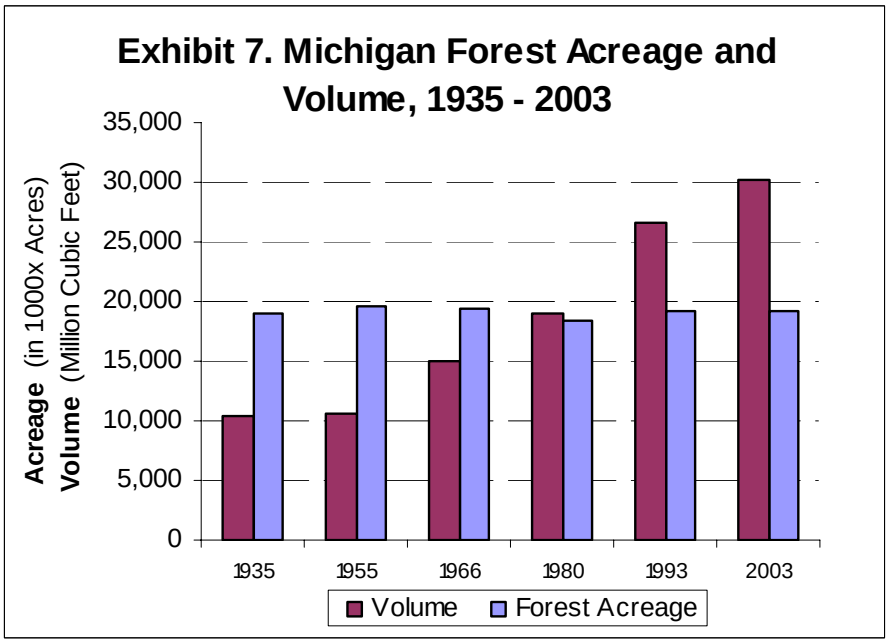

Figure 3.1.–Acreage and volume of Michigan forest from 1935–2003 (U.S. Forest Service 2003).

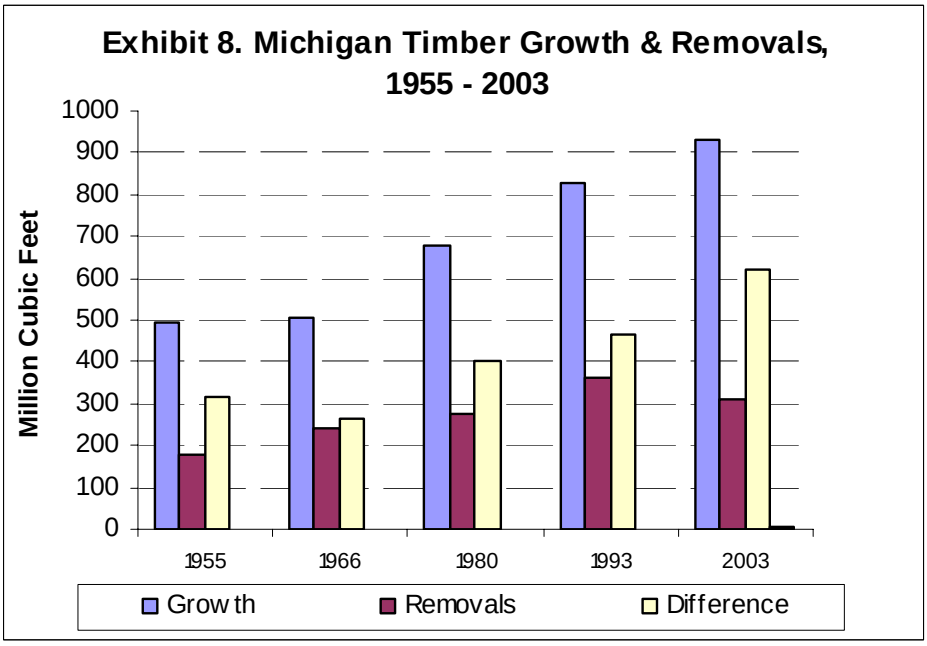

Figure 3.2.–Volume of Michigan timber growth and removals for 1955–2003 (U.S. Forest Service 2003).

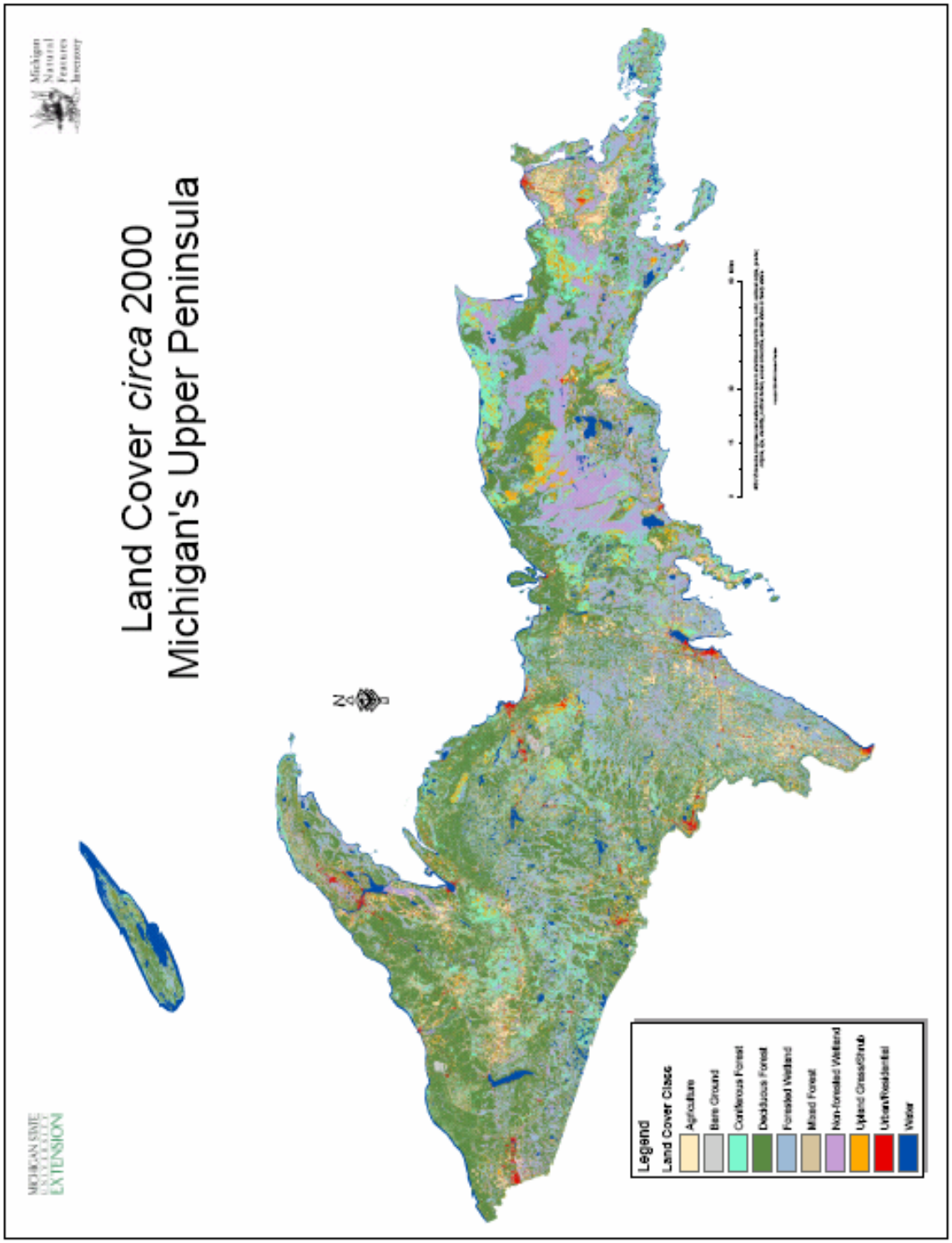

Figure 3.3.–Land cover of Michigan circa 2000 (Michigan DNR 2001).

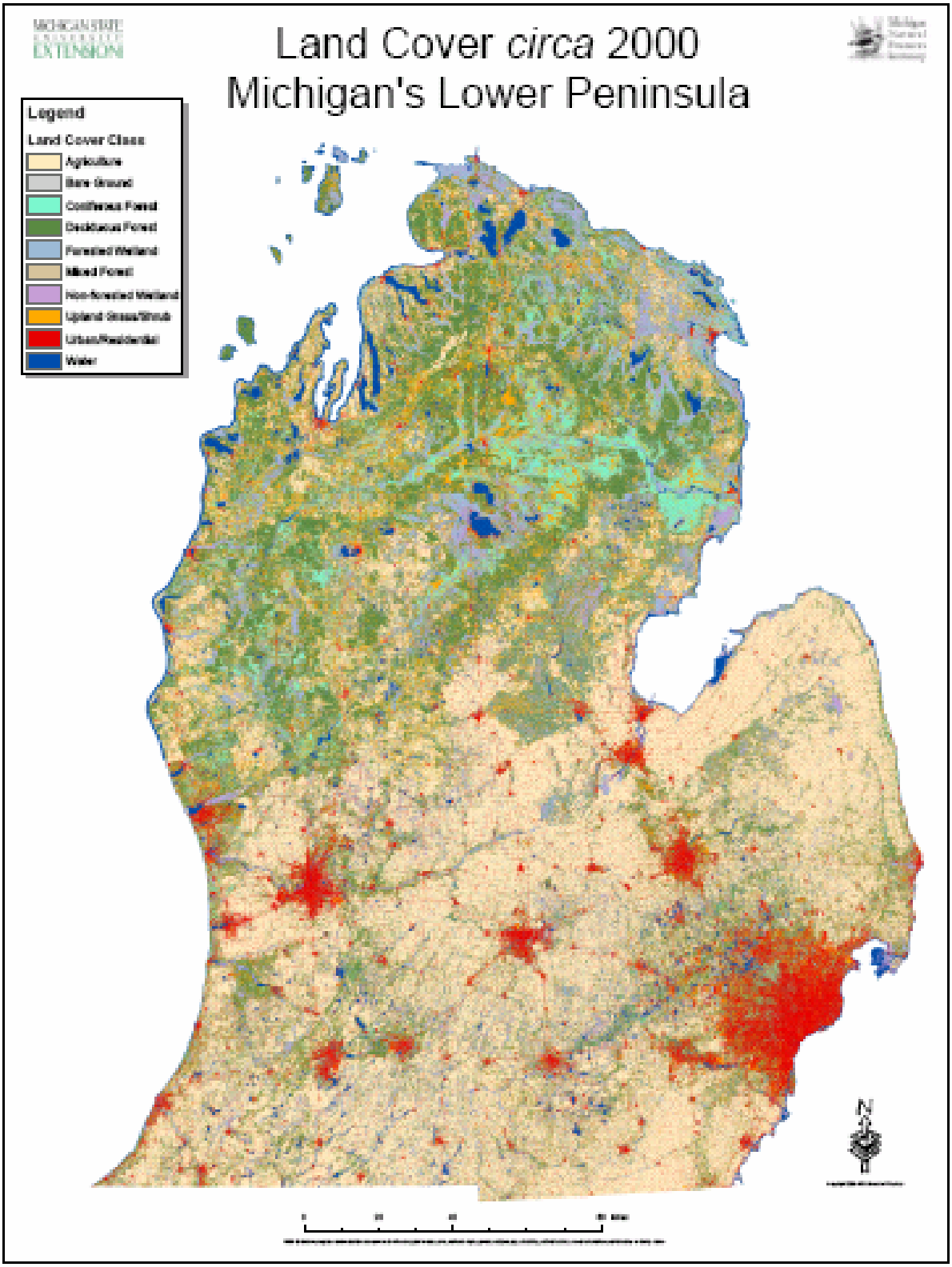

Figure 3.3.–Continued.

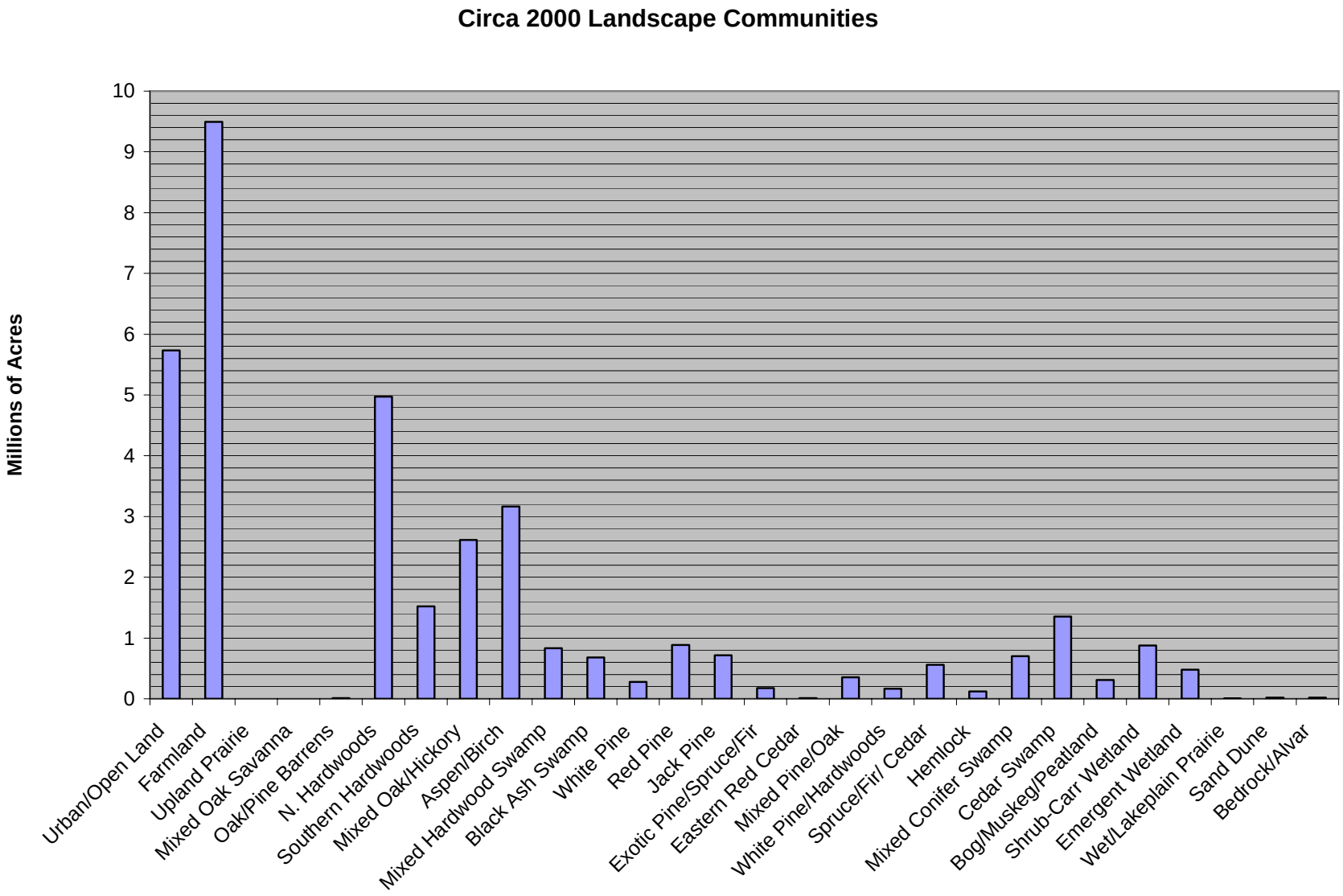

Figure 3.4.–Acreage of circa 2000 landscape communities (U.S. Forest Service 2003; MDNR 2001).

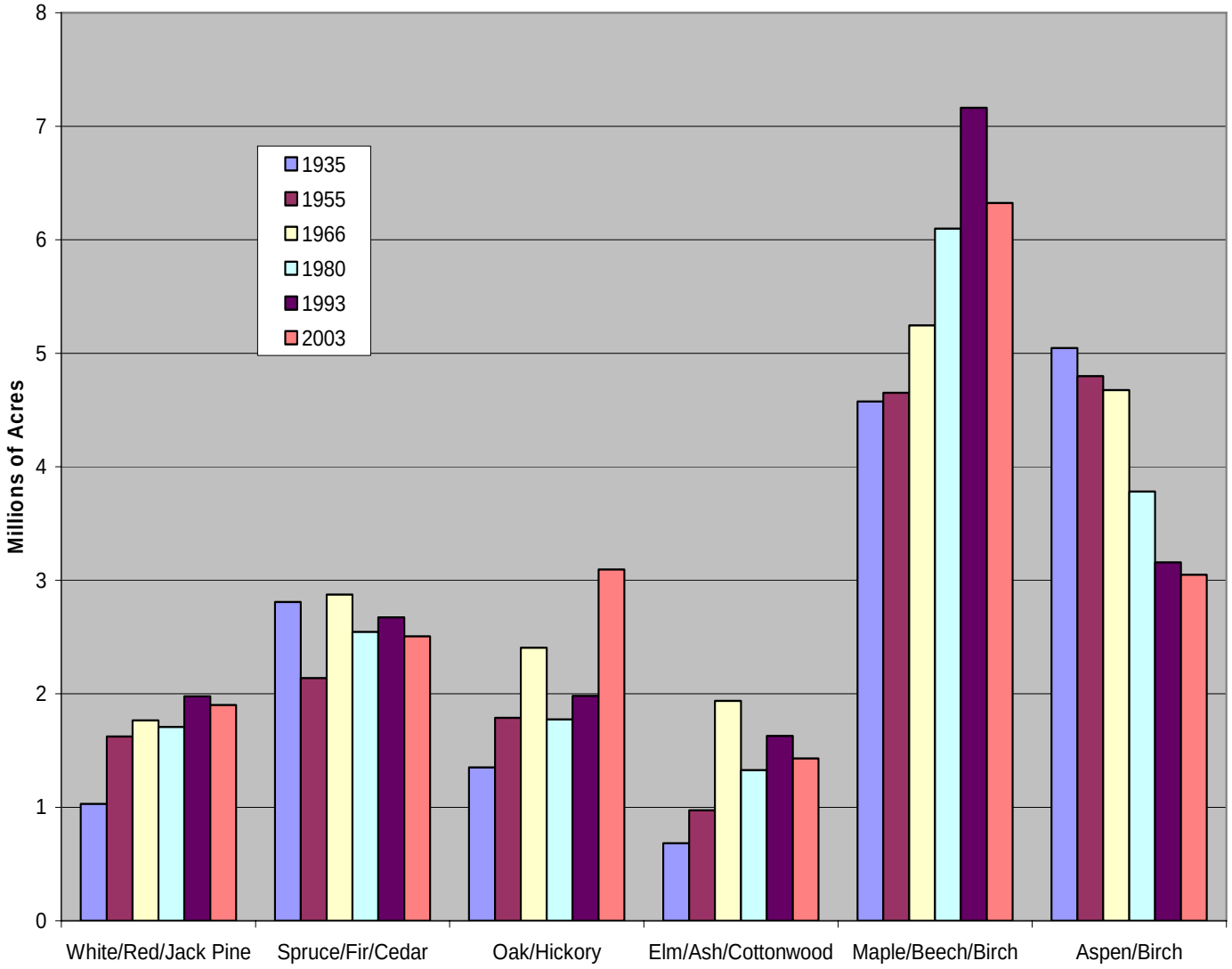

Figure 3.5.–Area of commercial timberland by forest type group for 1935–2003 (U.S. Forest Service 2003).

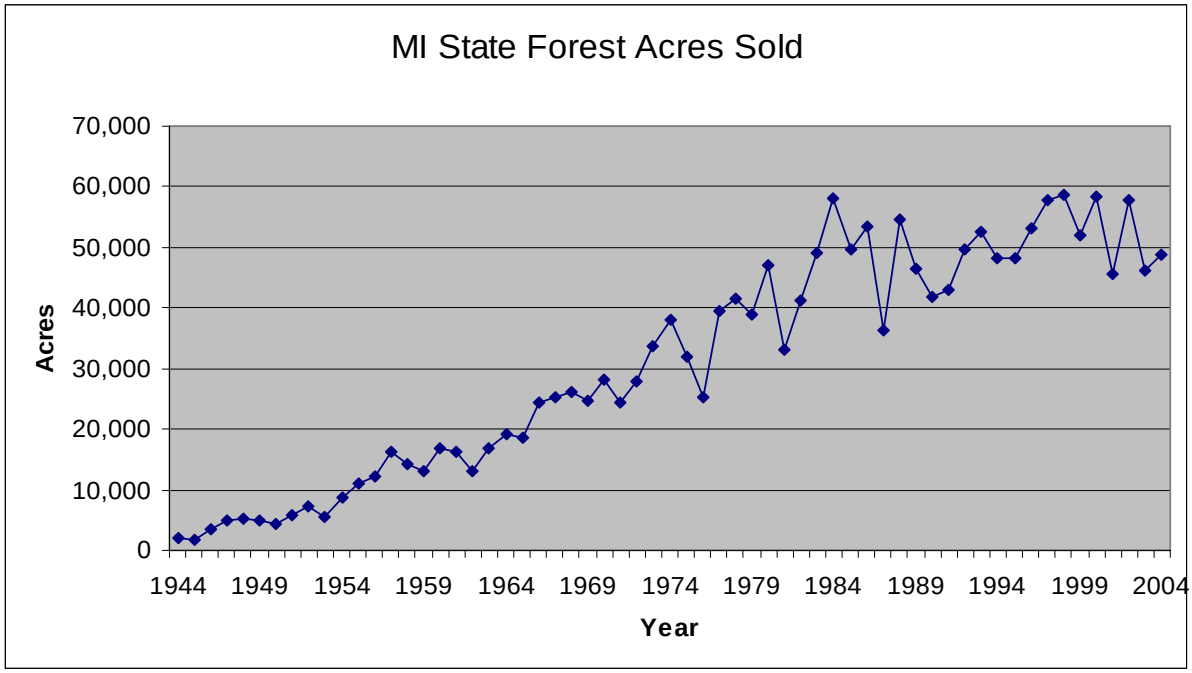

Figure 3.6.–Acreage of state forest timber sold from 1944 to 2004 (Unpublished DNR timber sale data).

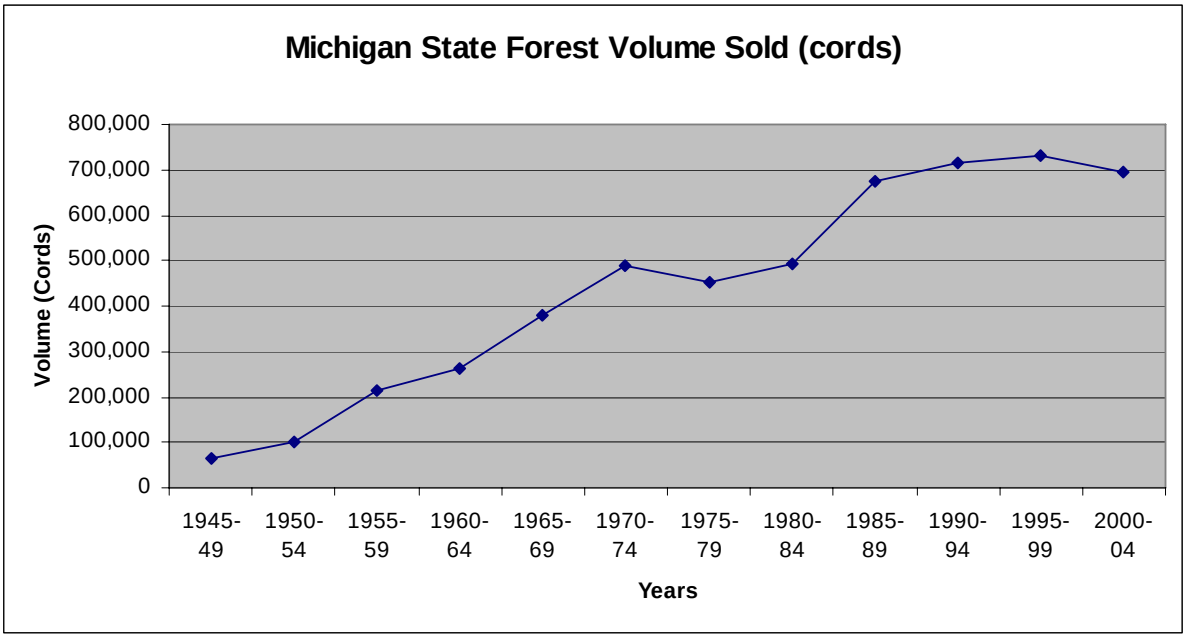

Figure 3.7.–Volume of state forest timber sold (cords) from 1945 to 2004 (Unpublished DNR timber sale data)

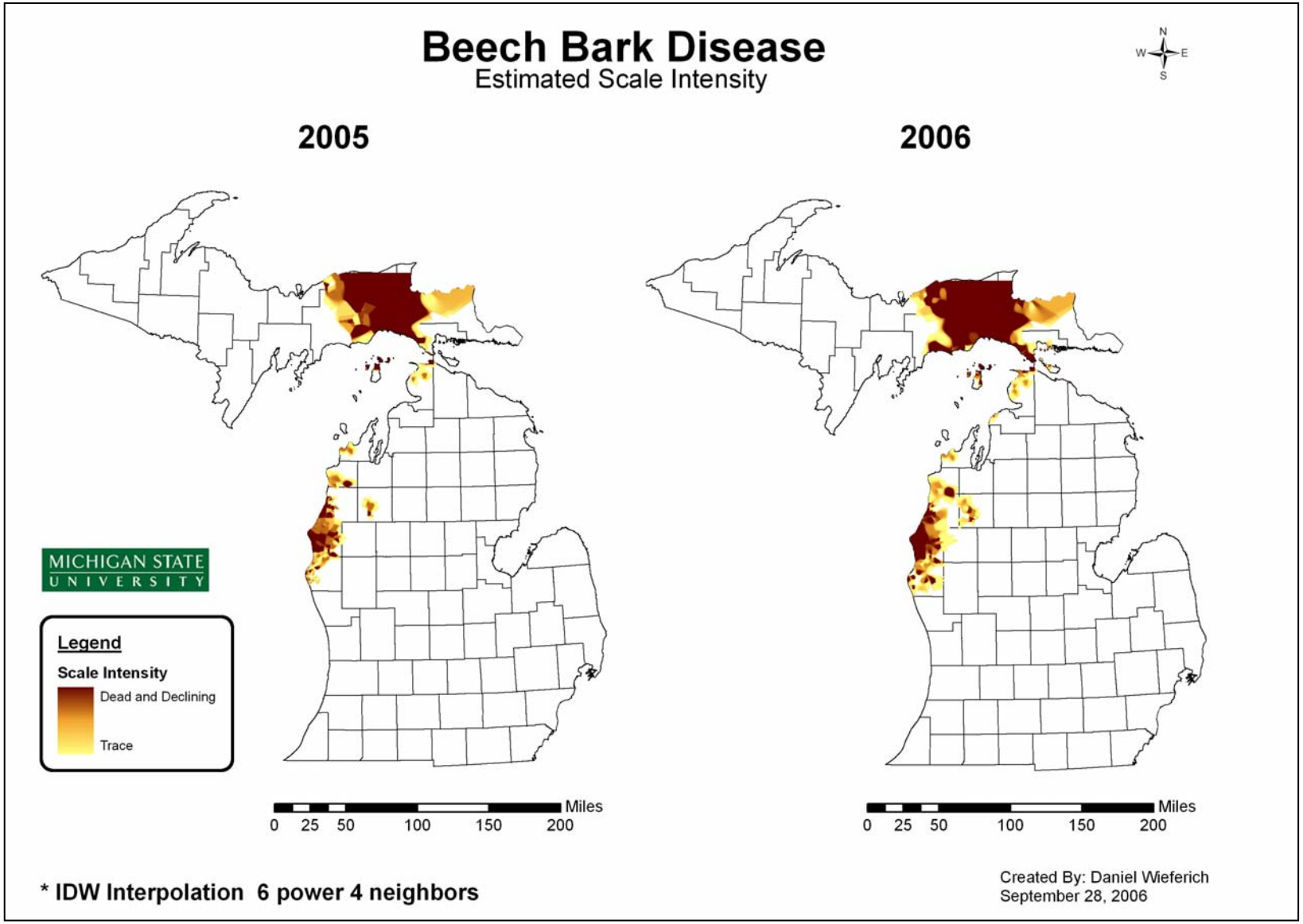

Figure 3.8.–Extent of beech bark disease in Michigan in 2005–06 (Unpublished DNR data).

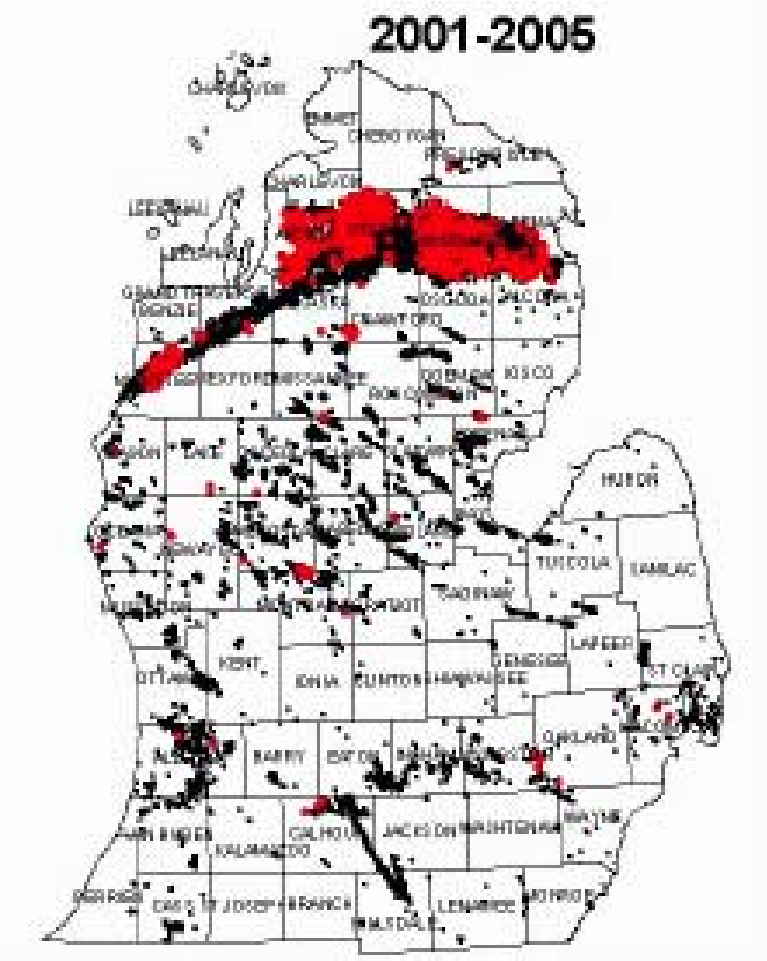

Figure 3.9.–Distribution of oil and gas wells in Michigan (Unpublished DNR data 2006).

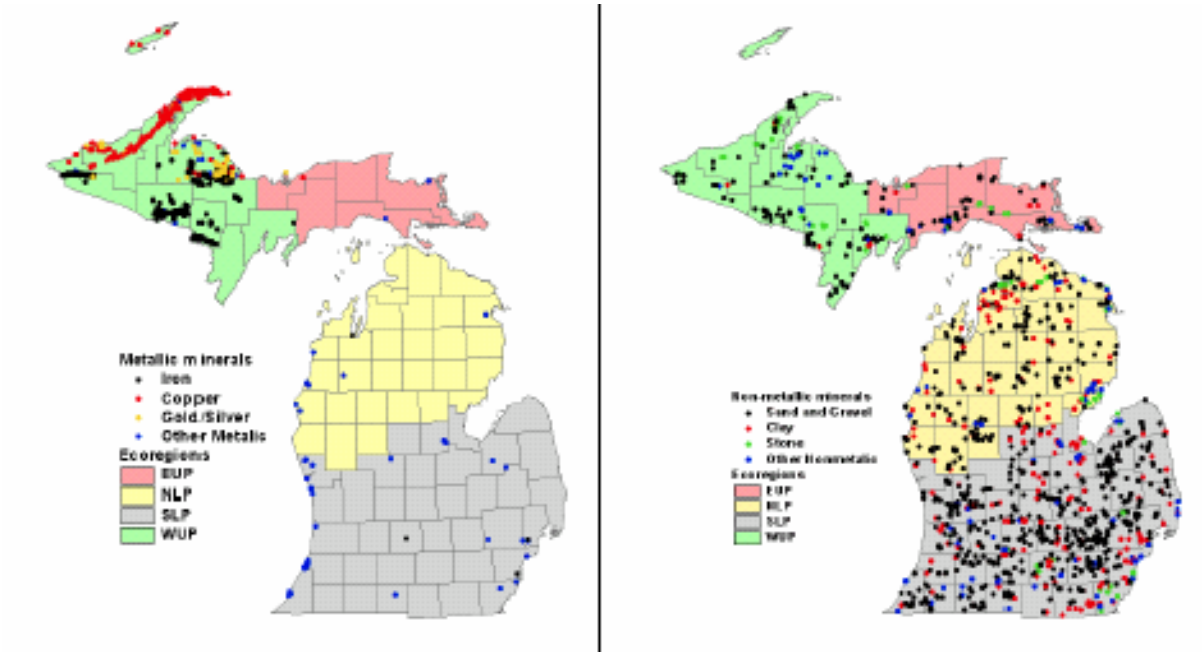

Figure 3.10.–Distribution of metallic and nonmetallic mineral occurrences in Michigan (U.S. Geological Survey 2005).

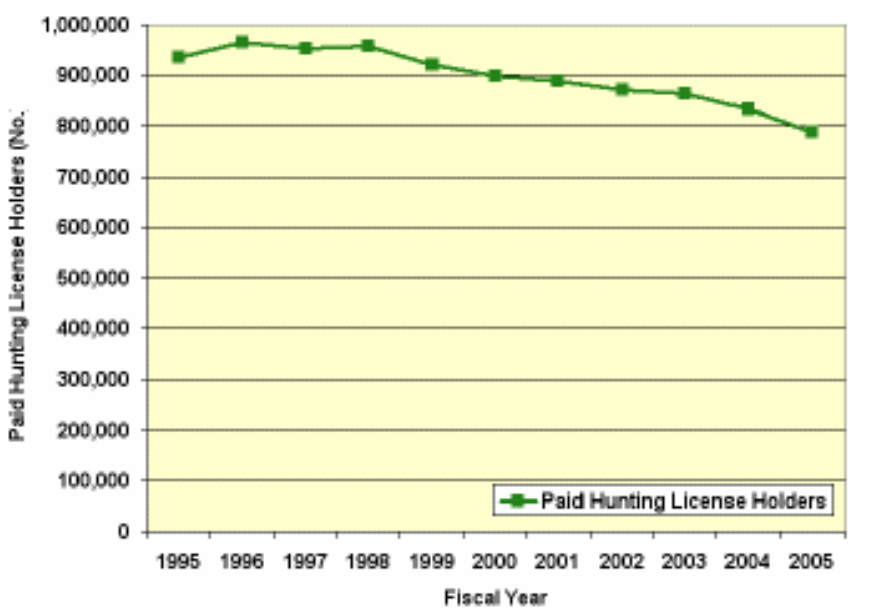

Figure 3.11.–Number of paid hunting license holders in Michigan, 1995–2005 (Frawley 2004 and unpublished DNR data).

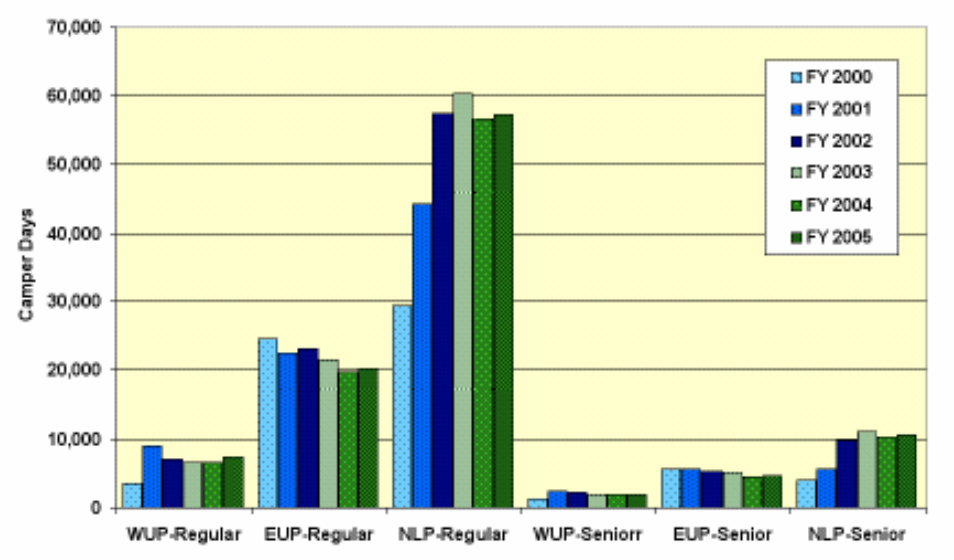

Figure 3.12.–Camper days at state forest campgrounds (Unpublished DNR data, 2000–05).

Table 3.1.–Hierarchy of ecological units (Cleland et al. 1997).

Planning and analysis scale	Ecological units	Purpose, objectives, and general use
Ecoregion	Domain	broad applicability for modeling and sampling
Global	Division	strategic planning and assessment
	Province	international planning
Continental		
Regional		
Subregion	Section	strategic, multiforest, statewide, and multiagency analysis and assessment
	Subsection	
Landscape	Landtype association	forest or area-wide planning, and watershed analysis
Land Unit	Landtype	project and management area planning and analysis
	Landtype phase	
Hierarchy can be expanded by user to smaller geographical areas and more detailed ecological units if needed.		very detailed project planning

Table 3.2.–Change in acreage of forestland from circa 1800 to circa 2000 (Michigan Natural Features Inventory 1998; DNR 2001; U.S. Forest Service 2003).

Michigan forestland	Circa 2000		Circa 1800		Change	
	Acreage	Percent	Acreage	Percent	in acres	in percent
aspen—birch	3,163,200	16.5	292,266	0.8	2,870,934	982.3
black ash swamp	680,700	3.6	280,705	0.8	399,995	142.5
cedar swamp	1,351,700	7.1	1,254,055	3.6	97,645	7.8
eastern red cedar	11,500	0.1	0	0.0	11,500	0.1
exotic pine—spruce—fir	178,600	0.9	0	0.0	178,600	0.9
hemlock	118,800	0.6	4,714,602	13.5	-4,595,802	-97.5
jack pine	715,300	3.7	596,836	1.7	118,464	19.8
mixed conifer swamp	701,200	3.7	4,290,553	12.3	-3,589,353	-83.7
mixed hardwood swamp	834,900	4.4	1,421,462	4.1	-586,562	-41.3
mixed oak savanna	1,500	0.0	1,061,564	3.0	-1,060,064	-99.9
mixed oak—hickory	2,612,500	13.7	2,306,373	6.6	306,127	13.3
mixed pine—oak	352,700	1.8	543,562	1.6	-190,862	-35.1
n. hardwoods	4,971,900	26.0	7,503,633	21.4	-2,531,733	-33.7
oak/pine barrens	11,400	0.1	1,101,424	3.1	-1,090,024	-99.0
red pine	886,000	4.6	70,889	0.2	815,111	1,149.8
red/jack pine	0	0.0	515,819	1.5	-515,819	-100.0
s. hardwoods	1,520,400	8.0	5,845,677	16.7	-4,325,277	-74.0
spruce—fir—cedar	557,700	2.9	823,253	2.4	-265,553	-32.3
white pine	278,600	1.5	69,141	0.2	209,459	302.9
white pine—mixed hardwoods	164,500	0.9	1,185,681	3.4	-1,021,181	-86.1
white—red pine	0	0.0	1,132,097	3.2	-1,132,097	-100.0
Totals	19,113,100	100	35,009,592	100	15,896,492	-45.4

Table 3.3.–Volume of growth, mortality, and removals by forest type in Michigan (cubic feet; U. S. Forest Service 2004).

Forest type	Net growth	Total			Ratio			
		Mortality	Removals	Mortality & removals	Growth to total mortality & removal	Growth to mortality	Growth to removal	Mortality to removal
aspen	97,155,271	38,588,139	28,354,437	66,942,576	1.5	2.5	3.4	1.4
balsam fir	11,585,489	4,457,673	3,062,002	7,519,675	1.5	2.6	3.8	1.5
balsam poplar	10,250,811	4,898,801	4,549,407	9,448,208	1.1	2.1	2.3	1.1
birch	10,866,444	2,777,660	4,190,290	6,967,950	1.6	3.9	2.6	0.7
black spruce	12,686,731	4,475,210	1,676,417	6,151,627	2.1	2.8	7.6	2.7
eastern white pine	17,918,165	6,143,081	4,262,651	10,405,732	1.7	2.9	4.2	1.4
jack pine	15,825,810	4,921,821	6,468,687	11,390,508	1.4	3.2	2.4	0.8
lowland hardwoods	47,781,350	22,492,477	9,729,340	32,221,817	1.5	2.1	4.9	2.3
n. hardwoods	336,790,958	65,659,426	106,332,030	171,991,456	2.0	5.1	3.2	0.6
n. white cedar	63,210,804	18,223,174	8,843,103	27,066,277	2.3	3.5	7.1	2.1
oak association	102,259,347	23,600,309	35,593,811	59,194,120	1.7	4.3	2.9	0.7
other	50,379,435	12,217,305	43,658,218	55,875,523	0.9	4.1	1.2	0.3
other softwoods	13,689,768	2,661,175	1,632,679	4,293,854	3.2	5.1	8.4	1.6
red pine	98,362,980	8,496,913	23,377,993	31,874,906	3.1	11.6	4.2	0.4
tamarack	7,572,606	1,482,076	1,802,507	3,284,583	2.3	5.1	4.2	0.8
white spruce	11,072,824	1,254,013	2,246,652	3,500,665	3.2	8.8	4.9	0.6
Total	923,279,499	224,530,493	291,229,106	515,759,599	1.8	4.1	3.2	0.8

Note: Comparisons to older FIA reports are not valid due to changes in inventory methods and definitions.

Table 3.4.–Change in acreage by cover type of state forestland for 1988–2006 (Unpublished DNR inventory data 2006).

	Acreage			Percent			Change	
							Absolute	Percent
Cover type	1988	1997	2006	1988	1997	2006	1988–06	from 1988
aspen association	893,279	909,964	884,822	23.2	23.1	22.5	-8,457	-0.9
balsam poplar swamp	52,536	60,641	71,655	1.4	1.5	1.8	19,119	36.4
bedrock	1,066	1,218	1,065	0.0	0.0	0.0	-1	-0.1
black spruce swamp	69,082	68,145	68,636	1.8	1.7	1.7	-446	-0.6
bog or marsh	49,045	43,267	35,163	1.3	1.1	0.9	-13,882	-28.3
cedar swamp	187,115	206,954	228,397	4.9	5.3	5.8	41,282	22.1
emergent marsh	93,285	113,866	113,355	2.4	2.9	2.9	20,070	21.5
grassland	177,114	151,514	125,288	4.6	3.8	3.2	-51,826	-29.3
hemlock	12,580	14,810	17,479	0.3	0.4	0.4	4,899	38.9
jack pine	401,705	375,220	367,034	10.4	9.5	9.3	-34,671	-8.6
local name	7,611	16,611	6,544	0.2	0.4	0.2	-1,067	-14.0
lowland hardwoods	107,890	121,442	135,912	2.8	3.1	3.5	28,022	26.0
mixed swamp conifers	260,426	263,205	261,183	6.8	6.7	6.6	757	0.3
northern hardwoods	499,262	503,371	508,302	12.9	12.8	12.9	9,040	1.8
non stocked	30,499	32,665	22,791	0.8	0.8	0.6	-7,708	-25.3
oak association	243,010	246,966	243,691	6.3	6.3	6.2	681	0.3
paper birch	55,246	47,395	35,462	1.4	1.2	0.9	-19,784	-35.8
red pine	235,249	263,945	279,973	6.1	6.7	7.1	44,724	19.0
sand dune	729	795	1,106	0.0	0.0	0.0	377	51.7
scrub-carr wetland	201,154	193,822	197,448	5.2	4.9	5.0	-3,706	-1.8
spruce fir	65,281	51,718	51,504	1.7	1.3	1.3	-13,777	-21.1
tamarack swamp	16,540	20,732	22,256	0.4	0.5	0.6	5,716	34.6
treed bog	60,594	60,430	62,692	1.6	1.5	1.6	2,098	3.5
upland brush	43,351	46,657	53,008	1.1	1.2	1.3	9,657	22.3
water	36,173	43,980	47,751	0.9	1.1	1.2	11,578	32.0
white pine	55,703	77,428	93,568	1.4	2.0	2.4	37,865	68.0
Totals	3,855,525	3,936,761	3,936,085	100.0	100.0	100.0	80,560	2.1

Table 3.5.–Change in cover type circa 1800 to 2006 by acreage and relative cover (Michigan Natural Features Inventory 1998; MDNR 2006).

	circa 1800		2006		Change	
Cover type	Acreage	Percent	Acreage	Percent	in acres	in percent
aspen—birch forest	52,541	1.3	920,284	23.4	867,743	1651.6
bedrock	1,174	0.0	1,065	0.0	-109	-9.3
cedar swamp	219,348	5.5	228,397	5.8	9,049	4.1
grassland	3,715	0.1	125,288	3.2	121,573	3272.8
hemlock (C1800 hemlock/white pine/ yellow birch)	345,242	8.7	17,479	0.4	-327,763	-94.9
jack pine (C1800 jack pine/red pine) forest	400,793	10.1	367,034	9.3	-33,759	-8.4
lake/river	24,025	0.6	47,751	1.2	23,726	98.8
mixed conifer swamp (including 2006 black spruce and tamarack)	874,952	22.0	352,075	8.9	-522,877	-59.8
mixed hardwood and black ash swamp	26,023	0.7	207,567	5.3	181,544	697.6
mixed pine—oak forest (2006 oak)	72,176	1.8	243,691	6.2	171,515	237.6
muskeg/bog	124,775	3.1	97,855	2.5	-26,920	-21.6
nonstocked—local name	0.0	0.0	29,335	0.7	29,335	100.0
northern hardwoods[a]	1,017,565	25.6	508,302	12.9	-509,263	-50.0
oak—pine barrens	13,215	0.3	0.0	0.0	-13,215	-100.0
pine barrens	88,070	2.2	0.0	0.0	-88,070	-100.0
red pine forest	20,798	0.5	279,973	7.1	259,175	1246.2
red pine—white pine forest	385,600	9.7	0.0	0.0	-385,600	-100.0
sand dune	202	0.0	1,106	0.0	904	447.1
shrub swamp/emergent marsh	56,808	1.4	310,803	7.9	253,995	447.1
spruce—fir (C1800 spruce—fir—cedar) forest	136,148	3.4	51,504	1.3	-84,644	-62.2
upland brush	0.0	0.0	53,008	1.3	53,008	100.0
white pine forest	19,536	0.5	93,568	2.4	74,032	379.0
white pine—mixed hardwood forest	84,832	2.1	0.0	0.0	-84,832	-100.0
white pine—white oak forest	3,096	0.1	0.0	0.0	-3,096	-100.0
Totals	3,970,634	100.0	3,936,085	100.0	-34,549	-0.9

[a] Includes circa 1800 beech–sugar maple–hemlock, sugar maple–basswood, sugar maple–hemlock, and sugar maple–yellow birch cover types.

Table 3.6.–Acreage of aspen stocking on state forestland for 1988 and 2006 (Unpublished DNR inventory data). BA= basal area.

Aspen	Year of entry 1988	2006	change	% change
saw timber				
poorly stocked (10–39 sq ft ba)	584	290	-294	-50.30
medium stocked (40–69 sq ft ba)	3,705	2,314	-1,391	-37.50
well stocked (70+ sq ft ba)	15,159	11,964	-3,195	-21.10
pole timber				
poorly stocked (10–39 sq ft ba)	38,029	42,519	4,490	11.80
medium stocked (40–69 sq ft ba)	113,449	94,845	-18,604	-16.40
well stocked (70+ sq ft ba)	280,581	201,780	-78,801	-28.10
seedling-sapling				
poorly stocked (17–39%)	8,328	9,241	913	11.00
medium stocked (40–69%)	60,031	55,460	-4,571	-7.60
well stocked (70+%)	368,235	459,412	91,177	24.80
nonstocked (<17%)	5085	6997	1912	37.60
Totals	893,186	884,822	-8,364	-0.90

Table 3.7.–Acreage of primary understory types by deciduous cover type for 2006 (Unpublished DNR inventory data).

	Deciduous cover type					
Understory type	Aspen	Balsam poplar	Oak	Paper birch	Lowland hardwoods	Northern hardwoods
not typed	43					
aspen	355,919	898	19,868	755	1,589	7,932
balsam poplar	355	13,466			329	77
bedrock	55					
black spruce	2,111	566		86	431	107
bog or marsh	770	46	182	4	18	
cedar swamp	1,432	696		119	521	21
emergent marsh	158	411		14	811	130
grassland	37,362	871	2,355	13	303	3,206
hemlock	50		19	43	166	635
jack pine	6,760	51	8,431		39	496
local name	0		206		28	16
lowland hrdwds	21,356	5,470	6,855	296	73,833	513
lowlnd brush	14,434	15,526	70	795	21,018	203
mxd swmp cnfr	1,785	6,848	20	978	10,823	325
n. hardwoods	123,316	2,205	67,307	8,196	3,033	440,363
nonstocked	81,092	3,234	7,181	823	3,465	8,007
oak	25,331	154	75,571	209	907	2,293
paper birch	656	93	51	1,170	12	110
red pine	4,476	59	3,725	120	3	320
sand dune	21		6			9
spruce fir	127,927	20,390	1,302	20,209	16,027	34,898
tamarack swmp	236		13	7	3	4
treed bog	23				45	
upland brush	52,043	510	13,413	563	544	3,960
water	0				190	
white pine	27,111	161	37,116	1,062	1,774	4,677
Totals	884,822	71,655	243,691	35,462	135,912	508,302

Table 3.8.–Volume of growth, mortality, and removals by forest type on state forestland (cubic feet; U. S. Forest Service 2004).

Forest type	Net growth	Total			Ratio			
		Mortality	Removals	Mortality & removals	Growth to total mortality & removals	Growth to mortality	Growth to removal	Mortality to removal
aspen	31,211,525	13,289,132	8,653,131	21,942,263	1.4	2.3	3.6	1.5
balsam fir	831,537	894,708	2,483,711	3,378,419	0.2	0.9	0.3	0.4
balsam poplar	2,361,134	107,493		107,493	22.0	22.0		
birch	680,411	100,149		100,149	6.8	6.8		
black spruce	3,645,520	462,736	260,625	723,361	5.0	7.9	14.0	1.8
eastern white pine	3,749,075	224,683	1,626,573	1,851,256	2.0	16.7	2.3	0.1
jack pine	8,166,780	1,477,137	4,785,955	6,263,092	1.3	5.5	1.7	0.3
lowland hardwoods	4,006,664	4,606,812	1,043,107	5,649,919	0.7	0.9	3.8	4.4
n. hardwoods	47,310,414	8,318,374	14,330,576	22,648,950	2.1	5.7	3.3	0.6
n. white cedar	8,999,115	6,286,292		6,286,292	1.4	1.4		
oak	13,602,270	5,045,683	11,025,935	16,071,618	0.8	2.7	1.2	0.5
other	9,959,890	2,315,081	2,241,017	4,556,098	2.2	4.3	4.4	1.0
other softwoods	507,269		129,311	129,311	3.9		3.9	0.0
red pine	19,796,560	2,447,612	7,537,372	9,984,984	2.0	8.1	2.6	0.3
tamarack	2,956,935	682,358		682,358	4.3	4.3		
white spruce	3,547,143							
Total	163,451,578	46,692,865	58,353,650	105,046,515	1.6	3.5	2.8	0.8

Note: Comparisons to older FIA reports are not valid due to changes in inventory methods and definitions.

Table 3.9.–Acreage of northern hardwoods stocking on state forestland 1988 and 2006 (Unpublished DNR inventory data). BA= basal area.

Northern hardwoods	Year of entry 1988	2006	change	% change
saw timber				
poorly stocked (10–39 sq ft BA)	741	1,553	812	109.60
medium stocked (40–69 sq ft BA)	5,732	6,984	1,252	21.80
well stocked (70+ sq ft BA)	62,359	130,612	68,253	109.50
pole timber				
poorly stocked (10–39 sq ft BA)	16,115	8,382	-7,733	-48.00
medium stocked (40–69 sq ft BA)	59,263	38,885	-20,378	-34.40
well stocked (70+ sq ft BA)	343,907	306,692	-37,215	-10.80
seedling-sapling				
nonstocked (<17%)	813	112	-701	-86.20
poorly stocked (17–39%)	841	1,011	170	20.20
medium stocked (40–69%)	4,332	5,321	989	22.80
well stocked (70%+)	5,159	8,750	3,591	69.60
Totals	499,262	508,302	9,040	1.80

Table 3.10.–Acreage of northern hardwoods basal area (BA) stocking on state forestland 1988–2006 (Unpublished DNR inventory data).

	Inventory		
Northern hardwoods	1979–88	1988–97	1997–2006
Total acres	499,262	503,371	508,302
BA <60	56,803	47,601	42,958
BA 60	34,750	29,874	25,260
BA 70	46,154	40,432	52,295
BA 80	66,590	66,719	89,042
BA 90	78,969	79,332	76,281
BA 100	68,015	73,568	71,696
BA 110	58,483	64,817	54,132
BA 120	43,641	44,922	43,397
BA 130	22,861	28,013	26,877
BA 140	10,898	15,539	14,755
BA >150	12,098	12,554	11,609

Table 3.11.–Acreage of primary understory types by conifer cover types for 2006 (Unpublished DNR inventory data).

	Conifer cover type								
Understory type	Black spruce	Cedar swamp	Hemlock	Jack pine	Mixed swamp conifers	Red pine	Spruce fir	Tamarack swamp	White pine
not typed									
aspen	132	768	107	9,531	698	18,229	2,660	3	7,312
balsam poplar	9	654	32	78	604	38	289	1	140
bedrock		5		72		50			30
black spruce	46,394	2,786	121	13,524	6,824	5,062	344	2,055	2,799
bog or marsh	728	120		98	107	502	16	16	17
cedar swamp	426	57,248	248	29	7,209	1	146	929	32
emergent marsh	8	261		304	265			129	38
grassland	151	389	104	10,590	1,343	3,341	1,556	45	514
hemlock		41	2,787		203	63			106
jack pine	141			195,754	29	13,563	66	4	1,078
local name				175		10			
lowland hardwoods	287	14,029	369	1,668	9,264	1,706	347	237	1,014
lowland brush	4,706	20,424	118	1,514	40,958	470	757	8,143	275
mixd swamp conifers	6,042	67,507	1,551	418	138,870	656	552	2,473	1,337
n. hardwoods	231	1,263	3,270	11,979	2,818	44,432	1,896	167	10,562
nonstocked	3,259	16,578	1,763	41,007	7,882	53,380	4,389	619	3,110
oak	48	3		42,743	23	25,762		14	1,113
paper birch	21	187		55	19	79	64		96
red pine				8,428		55,036	11		362
sand dune		12			59				
spruce fir	5,835	45,156	6,331	6,148	42,489	13,255	37,104	1,331	21,067
tamarack swmp	34	359		44	192	35	35	6,000	7
treed bog	32			137	16				
upland brush	87	553	54	10,065	861	7,743	1,004	62	974
water		30							
white pine	65	24	624	12,673	450	36,560	268	28	41,585
Totals	68,636	228,397	17,479	367,034	261,183	279,973	51,504	22,256	93,568

Table 3.12.–Acreage of jack pine stocking on state forestland 1988 and 2006 (Unpublished DNR inventory data). BA= basal area.

	Year of entry			
Jack pine	1988	2006	change	% change
saw timber				
poorly stocked (10–39 sq ft BA)	58	380	322	555.20
medium stocked (40–69 sq ft BA)	633	1,590	957	151.20
well stocked (70+ sq ft BA)	1,427	1,804	377	26.40
pole timber				
poorly stocked (10–39 sq ft BA)	34,832	22,071	-12,761	-36.60
medium stocked (40–69 sq ft BA)	86,857	47,570	-39,287	-45.20
well stocked (70+ sq ft BA)	141,609	97,378	-44,231	-31.20
seedling-sapling				
nonstocked (<17%)	16,594	22,900	6,306	38.00
poorly stocked (17–39%)	15,001	10,656	-4,345	-29.00
medium stocked (40–69%)	45,379	28,020	-17,359	-38.30
well stocked (70%+)	59,315	134,665	75,350	127.00
Totals	401,705	367,034	-34,671	-8.60

Table 3.13.–Acreage of red pine stocking on state forestland 1988 and 2006 (Unpublished DNR inventory data). BA= basal area.

Red pine	Year of entry 1988	2006	change	% change
saw timber				
poorly stocked (10–39 sq ft ba)	4,574	6,815	2,241	49.00
medium stocked (40–69 sq ft ba)	13,562	24,148	10,586	78.10
well stocked (70+ sq ft ba)	36,631	71,477	34,846	95.10
pole timber				
poorly stocked (10–39 sq ft ba)	7,615	6,292	-1,323	-17.40
medium stocked (40–69 sq ft ba)	20,672	18,455	-2,217	-10.70
well stocked (70+ sq ft ba)	91,300	125,570	34,270	37.50
seedling-sapling				
nonstocked (<17%)	1,208	1,985	777	64.30
poorly stocked (17–39%)	3,462	672	-2,790	-80.60
medium stocked (40–69%)	15,374	3,010	-12,364	-80.40
well stocked (70+%)	40,851	21,549	-19,302	-47.20
Totals	235,249	279,973	44,724	19.00

Table 3.14.–Acreage of mixed swamp conifer stocking on state forestland 1988 and 2006 (Unpublished DNR inventory data). BA= basal area.

Mixed swamp conifer	Year of entry 1988	2006	change	% change
saw timber				
poorly stocked (10–39 sq ft ba)	25	30	5	20
medium stocked (40–69 sq ft ba)	91	139	48	52.7
well stocked (70+ sq ft ba)	878	1,441	563	64.1
pole timber				
poorly stocked (10–39 sq ft ba)	23,214	22,576	-638	-2.7
medium stocked (40–69 sq ft ba)	56,543	59,333	2,790	4.9
well stocked (70+ sq ft ba)	150,459	160,181	9,722	6.5
seedling-sapling				
nonstocked (<17%)	493	382	-111	-22.5
poorly stocked (17–39%)	3,344	1,364	-1,980	-59.2
medium stocked (40–69%)	13,642	6,045	-7,597	-55.7
well stocked (70+%)	11,737	9,692	-2,045	-17.4
Totals	260,426	261,183	757	0.3

Table 3.15.–Acreage of oak stocking on state forestland 1988 and 2006 (Unpublished DNR inventory data). BA= basal area.

Oak	Year of entry 1988	2006	change	% change
saw timber				
poorly stocked (10–39 sq ft ba)	6,077	11,911	5,834	96.0
medium stocked (40–69 sq ft ba)	15,159	32,646	17,487	115.4
well stocked (70+ sq ft ba)	22,306	49,984	27,678	124.1
pole timber				
poorly stocked (10–39 sq ft ba)	9,168	7,455	-1,713	-18.7
medium stocked (40–69 sq ft ba)	48,458	28,525	-19,933	-41.1
well stocked (70+ sq ft ba)	119,916	74,920	-44,996	-37.5
seedling-sapling				
nonstocked (<17%)	2,665	761	-1,904	-71.4
poorly stocked (17–39%)	2,689	4,617	1,928	71.7
medium stocked (40–69%)	9,230	16,021	6,791	73.6
well stocked (70+%)	7,342	16,851	9,509	129.5
Totals	243,010	243,691	681	0.3

Table 3.16.–Acreage of northern white cedar stocking on state forestland 1988 and 2006 (Unpublished DNR inventory data). BA= basal area.

Northern white cedar	Year of entry 1988	2006	change	% change
saw timber				
poorly stocked (10–39 sq ft ba)	17	56	39	229.4
medium stocked (40–69 sq ft ba)	323	306	-17	-5.3
well stocked (70+ sq ft ba)	2,586	5,944	3,358	129.9
pole timber				
poorly stocked (10–39 sq ft ba)	8,981	9,026	45	0.5
medium stocked (40–69 sq ft ba)	26,623	23,734	-2,889	-10.9
well stocked (70+ sq ft ba)	132,701	179,241	46,540	35.1
seedling-sapling				
nonstocked (<17%)	188	289	101	53.7
poorly stocked (17–39%)	876	294	-582	-66.4
medium stocked (40–69%)	2,898	1,981	-917	-31.6
well stocked (70+%)	11,922	7,526	-4,396	-36.9
Totals	187,115	228,397	41,282	22.1

Table 3.17.–Acreage of white pine stocking on state forestland 1988 and 2006 (Unpublished DNR inventory data). BA= basal area.

White pine	Year of entry 1988	2006	change	% change
saw timber				
poorly stocked (10–39 sq ft ba)	2,711	3,882	1,171	43.2
medium stocked (40–69 sq ft ba)	7,793	11,412	3,619	46.4
well stocked (70+ sq ft ba)	16,792	26,628	9,836	58.6
pole timber				
poorly stocked (10–39 sq ft ba)	1,665	3,586	1,921	115.4
medium stocked (40–69 sq ft ba)	5,892	11,654	5,762	97.8
well stocked (70+ sq ft ba)	12,917	30,418	17,501	135.5
seedling-sapling				
nonstocked (<17%)	0	23	23	
poorly stocked (17–39%)	584	373	-211	-36.1
medium stocked (40–69%)	2,008	1,675	-333	-16.6
well stocked (70+%)	5,341	3,917	-1,424	-26.7
Totals	55,703	93,568	37,865	68.0

Table 3.18.–Acreage of hemlock stocking on state forestland 1988 and 2006 (Unpublished DNR inventory data). BA= basal area.

Hemlock	Year of entry 1988	2006	change	% change
saw timber				
poorly stocked (10–39 sq ft ba)	32	124	92	287.5
medium stocked (40–69 sq ft ba)	353	432	79	22.4
well stocked (70+ sq ft ba)	5,239	7,845	2,606	49.7
pole timber				
poorly stocked (10–39 sq ft ba)	42	135	93	221.4
medium stocked (40–69 sq ft ba)	457	561	104	22.8
well stocked (70+ sq ft ba)	6,270	8,382	2,112	33.7
seedling-sapling				
nonstocked (<17%)				
poorly stocked (17–39%)				
medium stocked (40–69%)	64			
well stocked (70+%)	123			
Totals	12,580	17,479	4,899	38.9

Table 3.19.–Volume of timber sales (in cords) of major cover types from 1997 to 2005 (Unpublished DNR timber sale data).

Fiscal year	Total[a]	Aspen	Jack pine	Northern hardwoods	Oak	Red pine	Sum of 5 types	% of Total
				Volume (cords)				
1997	766,648	209,230	161,981	132,890	76,192	94,004	674,298	89
1998	812,514	213,746	136,411	140,151	82,251	139,770	712,328	89
1999	664,358	182,418	71,931	146,191	90,312	92,368	583,220	90
2000	747,635	163,069	125,624	162,106	101,472	98,347	650,619	90
2001	630,376	157,991	90,370	119,063	75,232	97,737	540,394	87
2002	758,022	154,554	139,690	157,959	94,619	90,863	637,686	85
2003	640,213	151,222	93,705	142,536	74,163	102,331	563,957	89
2004	713,710	175,676	120,979	148,413	76,328	97,297	618,693	88
2005	805,949	203,473	129,911	173,257	74,970	122,727	704,338	88
average	726,603	179,042	118,956	146,952	82,838	103,938	631,726	87
% of total		25	16	20	11	14		
				Acres				
1997	56,972	11,312	11,182	14,319	6,715	7,866	51,394	92
1998	58,316	10,670	8,591	15,543	7,156	10,297	52,256	91
1999	52,036	9,246	6,267	15,687	6,958	8,215	46,372	92
2000	58,241	8,724	9,379	17,979	7,552	8,361	51,994	92
2001	45,608	7,943	6,094	11,414	6,003	8,022	39,477	88
2002	57,687	7,847	11,267	16,090	7,377	7,109	49,690	87
2003	46,318	7,673	6,216	15,254	4,917	7,050	41,110	90
2004	49,057	9,119	8,246	13,492	6,540	7,170	44,565	92
2005	55,606	10,064	8,776	15,990	6,638	8,257	49,726	90
average	53,316	9,177	8,446	15,085	6,651	8,039	47,398	89
% of total		17	16	28	12	15		
				Volume/acre (cords/acre)				
1997	13.5	18.5	14.5	9.3	11.3	12.0	13.1	
1998	13.9	20.0	15.9	9.0	11.5	13.6	13.6	
1999	12.8	19.7	11.5	9.3	13.0	11.2	12.6	
2000	12.8	18.7	13.4	9.0	13.4	11.8	12.5	
2001	13.8	19.9	14.8	10.4	12.5	12.2	13.7	
2002	13.1	19.7	12.4	9.8	12.8	12.8	12.8	
2003	13.8	19.7	15.1	9.3	15.1	14.5	13.7	
2004	14.5	19.3	14.7	11.0	11.7	13.6	13.9	
2005	14.5	20.2	14.8	10.8	11.3	14.9	14.2	
average	13.6	19.5	14.1	9.7	12.5	12.9	13.3	

[a] Total of all major and minor cover types.

Table 3.20.–Volume of timber sales (in cords) of minor cover types from 1997 to 2005 (Unpublished DNR timber sale data).

Fiscal year	Total[a]	Not coded	Paper birch	Cedar	Swamp hardwoods	Spruce fir	Hemlock	Lowland poplar	Mixed swamp conifer	Black spruce	Tamarack	White pine
						Volume (cords)						
1997	766,648	12,718	11,565	1,616	6,829	14,176	3,792	15,664	12,853	2,848		9,394
1998	812,514	9,906	20,930	2,063	6,494	10,491	1,056	10,452	19,315	3,885	427	14,617
1999	664,358	14,963	14,959	945	10,096	7,317		7,065	14,306	353		9,912
2000	747,635	22,333	13,224	991	5,741	8,691	1,775	11,110	15,118	2,871		13,681
2001	630,376	10,847	11,370	2,562	10,139	11,176	2,330	10,601	7,135	7,059	445	15,569
2002	758,022	8,193	17,640	1,683	13,814	21,083	817	31,748	5,362	957	1,424	17,078
2003	640,213	7,731	13,279	484	10,946	12,613	1,148	9,099	7,308	2,924	429	9,016
2004	713,710	7,014	9,968	616	6,649	9,474	1,225	4,566	3,003	3,294	2,116	15,453
2005	805,949	3,545	13,420	940	8,241	11,383	438	10,918	5,762	8,451	2,737	11,746
average	726,603	10,805	14,040	1,322	8,772	11,822	1,572	12,358	10,018	3,627	1,263	12,941
						Acres						
1997	56,972	1,280	717	96	445	768	222	839	249	199		692
1998	58,316	842	1,268	105	361	720	95	574	324	248	22	1,340
1999	52,036	1,451	1,081	65	780	474		412	305	145		772
2000	58,241	1,541	744	74	383	604	104	739	296	242		1,267
2001	45,608	812	651	197	800	582	164	710	383	500	19	1,244
2002	57,687	743	832	152	1,005	1,248	100	1,789	363	78	93	1,491
2003	46,318	470	675	27	710	781	125	534	491	202	49	704
2004	49,057	435	537	68	427	586	90	303	198	204	169	1,100
2005	55,606	432	767	61	691	720	29	639	362	591	194	783
average	53,316	890	808	94	622	720	116	727	330	268	91	1,044
						Volume/acre						
1997	13.5	9.9	16.1	16.9	15.3	18.4	17.1	18.7	51.6	14.3		13.6
1998	13.9	11.8	16.5	19.7	18.0	14.6	11.1	18.2	59.7	15.7	19.4	10.9
1999	12.8	10.3	13.8	14.5	12.9	15.4		17.1	47.0	2.4		12.8
2000	12.8	14.5	17.8	13.3	15.0	14.4	17.0	15.0	51.1	11.9		10.8
2001	13.8	13.4	17.5	13.0	12.7	19.2	14.2	14.9	18.6	14.1	23.4	12.5
2002	13.1	11.0	21.2	11.1	13.8	16.9	8.2	17.7	14.8	12.3	15.4	11.5
2003	13.8	16.5	19.7	17.7	15.4	16.2	9.2	17.0	14.9	14.5	8.8	12.8
2004	14.5	16.1	18.6	9.1	15.6	16.2	13.6	15.1	15.2	16.1	12.5	14.0
2005	14.5	8.2	17.5	15.5	11.9	15.8	15.1	17.1	15.9	14.3	14.1	15.0
average	13.6	12.1	17.4	14.1	14.1	16.4	13.6	17.0	30.4	13.6	13.9	12.4

[a] Total of all major and minor cover types.

Table 3.21.–Prohibited and restricted aquatic plant species.

	Common name	Scientific name
Prohibited	African oxygen weed	*Lagarosiphon major*
	Brazilian elodea	*Egeria densa*
	European frogbit	*Hydrocharus morsus-ranae*
	giant hogweed	*Heracleum mantegazzianum*
	giant salvinia	*Salvinia molesta, auriculata, biloba, or herzogii*
	hydrilla	*Hydrilla verticillata*
	Japanese knotweed	*Fallopia japonica*
	parrot's feather	*Myriophyllum aquaticum*
	water chestnut	*Trapa natans*
	yellow flag iris	*Iris pseudacorus*
	yellow floating heart	*Nymphoides peltata*
Restricted	curly leaf pondweed	*Potamogeton crispus*
	Eurasian watermilfoil	*Myriophyllum spicatum*
	flowering rush	*Butomus umbellatus*
	phragmites	*Phragmites australis*

Table 3.22.–Trends in the 10- and 20-year aspen age classes (Unpublished DNR inventory data).

Year	Age class	Acres	% of total	% of 2006
2006	10–20	195,327	22	–
	20–30	173,151	20	–
	sum	368,478	42	–
2016	10–20	86,986	10	45
	20–30	195,327	22	113
	sum	282,313	32	77
2026	10–20	86,986	10	45
	20–30	85,000	10	49
	sum	171,986	20	47

Table 3.23.–Percent of total county earnings from wildland-based industries, 1990 (U.S. Forest Service, unpublished data, 1993).

Region and county	Wildland w/government (%)		Wildland w/o government (%)	
	Direct	Direct plus indirect	Direct	Direct plus indirect
Western Upper Peninsula				
Baraga	7.0	14.6	6.7	14.3
Delta	24.0	57.9	23.6	56.2
Dickinson	11.0	26.6	11.3	26.6
Gogebic	23.0	48.4	19.8	41.1
Houghton	7.0	14.8	6.3	12.8
Iron	16.0	30.3	15.0	29.0
Keweenaw	35.0	65.6	23.6	43.0
Marquette	13.0	26.0	12.5	25.5
Menominee	14.0	31.8	13.8	31.8
Ontonagon	50.0	106.0	48.7	104.3
Eastern Upper Peninsula				
Alger	49.0	114.6	46.8	110.6
Chippewa	10.0	19.8	7.7	14.2
Luce	18.0	38.7	17.9	38.7
Mackinac	24.0	44.0	23.1	42.1
Schoolcraft	31.0	67.2	29.1	64.0
Northern Lower Peninsula				
Alcona	9.0	15.8	7.8	13.4
Alpena	11.0	24.2	10.7	24.1
Antrim	9.0	16.8	9.0	16.1
Arenac	12.0	21.1	12.1	20.6
Benzie	9.0	15.7	8.7	15.7
Charlevoix	5.0	9.2	5.0	9.2
Cheboygan	16.0	33.1	15.9	32.9
Clare	10.0	16.8	10.2	16.8
Crawford	25.0	53.5	24.7	52.6
Emmet	7.0	12.7	6.7	12.6
Gladwin	7.0	13.6	7.4	13.5
Grand Traverse	6.0	10.8	5.8	10.7
Iosco	5.0	8.5	4.3	8.0
Kalkaska	27.0	50.3	26.6	50.3
Lake	15.0	28.3	13.7	25.4
Leelanau	18.0	33.0	16.3	29.5
Manistee	15.0	32.8	14.4	32.3
Mason	4.0	7.3	3.4	6.7
Mecosta	2.0	4.2	2.2	4.0
Missaukee	10.0	21.4	10.2	21.0
Montmorency	30.0	55.2	29.8	55.1
Newaygo	2.0	4.3	2.1	3.8
Oceana	8.0	15.4	7.5	15.3
Ogemaw	9.0	16.4	8.7	16.1
Osceola	5.0	10.8	5.3	10.7

Table 3.23.–Continued.

Region and county	Wildland w/government (%)		Wildland w/o government (%)	
	Direct	Direct plus indirect	Direct	Direct plus indirect
Oscoda	14.0	26.0	12.5	22.9
Otsego	13.0	25.6	12.6	24.9
Presque Isle	30.0	60.0	29.3	59.4
Roscommon	16.0	27.7	15.7	27.7
Wexford	11.0	23.6	10.4	21.8

Table 3.24.–Area of state ownership rights (in acres; Unpublished DNR data). EUP = Eastern Upper Peninsula, NLP = Northern Lower Peninsula, SLP = Southern Lower Peninsula, WUP = Western Upper Peninsula.

Ecoregion	Surface only	Mineral and surface	Mineral only	Mixed ownership	Other rights	Totals
EUP	97,000	996,000	435,000	25,000	70,000	1,623,000
NLP	146,000	1,860,000	940,000	70,000	19,000	3,035,000
SLP	63,000	347,000	68,000	29,000	4,000	511,000
WUP	158,000	780,000	804,000	27,000	37,000	1,806,000
Statewide Total	464,000	3,983,000	2,247,000	151,000	130,000	6,975,000

Table 3.25.–DNR off-road vehicle and snowmobile license sales, 1998–2005 (Unpublished DNR data).

Year	Activity	
	ORV license sales	Snowmobile trail permits[a]
1998	104,745	No data
1999	146,039	No data
2000	146,039	263,091
2001	149,927	269,862
2002	164,005	243,090
2003	173,110	257,442
2004	185,745	252,176
2005	185,776	225,676

[a] Permits for 2000–03 are reported by fiscal year, permits for 2004–05 are reported by license year (9/1-5/31).

Statewide Management Direction

4.1 Desired Future Conditions, Goals, Objectives, Standards, and Guidelines

This section builds upon the discussions in the previous sections on forest history and current conditions and trends and incorporates this information with additional plans and guidance into specific statements of the DFC for the many uses and values of the state forest. The DFC statements and their supporting goals and objectives provide a means through which the DNRs long-term management objectives (as outlined in Section 1) can be achieved on a statewide basis. The DFC's, goals and objectives contained in the plan were developed by incorporating existing program direction and subsequent DNR staff and public review. In concert with more specific management area direction provided in Regional State Forest Management Plans, these goals and objectives will provide direction for the management of the state Forest.

The desired future conditions of DNR-managed forestlands are predicated upon a sustainable, ecosystem-based management philosophy. When achieved, the desired future conditions will enable all of the following (in no explicit order of priority):

1. Sustain fundamental ecological processes and functions that, in turn, support representative, diverse, and productive biological assemblages.
2. Provide for a variety of ecosystem services that help sustain human civilization.
3. Provide for a variety of sustainable human values that are derived from ecosystems; including economic, recreational, and intrinsic values and a wide array of resource outputs and forest-based products.

Standards and guidelines are included as tools for DNR staff to use in the achievement of these goals through the operational management of the state forest. Where standards originate from higher authority, they retain higher precedence than the contents of this plan. Monitoring criteria (discussed further in Section 6 and Appendix H) are provided as a tool for assessing progress toward sustainable resource management.

As previous discussed at the beginning of Section 3, there are many competing demands for human use of the state's forest resources, and provision of one use is always constrained by demands for other competing uses for the same resource. The desired future conditions, goals and objectives that are laid out in the following sections for the many uses of forest resource base are thus framed in terms of competing uses, where a particular use is adapted to become compatible with other uses. The content of this section should also be viewed within the context that budgetary and manpower resources will dictate the ability of the DNR to work toward the achievement of goals and objectives within desired timeframes.

4.1.1 Recreation Management

4.1.1.1 Boating and Fishing Access Sites

Desired future condition.–The state forest system provides a variety of Great Lakes, inland lake, and river access sites for various types and sizes of watercraft within the context of other ecological and socio-economic values.

Goals:

1. Existing Great Lakes, inland lake and river access sites on state forestlands will be maintained for public use.
2. New access sites will be developed in key areas of the state forest.

Objectives:

1. Evaluate and renovate existing water access facilities to meet the current ADA standards for handicap access.
2. Close river and stream access sites where unauthorized public use is causing harm to aquatic or terrestrial resources.
3. Evaluate the system for demand, uses, and resource protection and where necessary to develop, renovate or close public access sites.
4. Determine key access locations for future acquisition or development.

Standards:

1. DNR Policy and Procedure 30.32-01, Rights-of-Way to Water Frontage, issued July 11, 2005.
2. DNR Policy and Procedure 30.32-02, Fishing Sites – Development and Maintenance of, issued July 11, 2005.
3. FMFM Policy and Procedure 251, Sale and Removal of Timber, issued March 1, 2000.
4. Fisheries Division Policy and Procedure 02.01.004 Marinas and Docks.
5. Fisheries Division Policy and Procedure 02.02.010 Navigational Maintenance and Dredging.
6. 2008–12 Michigan State Comprehensive Outdoor Recreation Plan (Michigan Department of Natural Resources 2007).
7. DNR Forest Certification Work Instruction 1.5 – Social Impact Considerations and Public Involvement Processes.
8. DNR Forest Certification Work Instruction 3.2 – Best Management Practices Non-Conformance Reporting Instructions.
9. DNR Forest Certification Work Instruction 6.2 – Integrating Public Recreational Opportunities with Management on State Forest Lands.
10. Design Handbook for Recreational Boating and Fishing Facilities (States Organization for Boating Access 1996).
11. Parks and Recreation Division Boating Access Site Design Guides (Michigan Department of Natural Resources 2003a).
12. Parks and Recreation Division Harbor Development Standards Guidance (Michigan Department of Natural Resources 2003b).

Monitoring criteria.–

Statewide Criterion 4 - Recreation, Indicators 4.1, 4.5

4.1.1.2 Recreational Trails

Desired future condition.–The state forest system provides a variety of motorized (ORV and snowmobile) and nonmotorized (mountain bike, horse, skiing, and hiking) recreation trails and routes in a variety of settings, within the context of other ecological and socio-economic values.

Recreational trails will include a variety of looped and linear trails that are connected with recreation resources such as campground trailheads, and will range in accessibility from wheel chair accessible to primitive hiking trails.

Goals:

1. The existing trail system will be maintained, upgraded and further developed for continued use in a manner that meets program objectives, maintenance standards, provides safe access and use, connects with existing recreational resources and goods and service providers, promotes multiple use and minimizes resource damage and user conflicts.
2. Trails will be located in a variety of landscape settings, but will be developed with the goal of minimizing their effect on wildlife habitat.
3. Enhance program effectiveness and efficiency.

Objectives:

1. All trails will be developed and managed for multiple uses, while restricting specific uses on designated trails in order to minimize resource effect and damage, minimize effect on wildlife habitat, or for user safety.
2. On lands purchased using federal assistance funding for wildlife restoration, manage trails so as not to conflict with the purposes for which the land was purchased and is managed.
3. Conduct an assessment of trail use and users to determine concerns, data regarding the economic effects of use, and suggestions to improve Michigan's trail program.
4. Conduct trail and trailhead maintenance to DNR standards through DNR staff and through trail grant sponsors, volunteers and partners.
5. Where ecologically expedient, expand and secure the system of land and water trails to promote recreational, economic, transportation and health benefits through the use of partnerships, acquisition, easements or long-term leases.
6. Target expansion to link existing trails and form a cohesive network that includes effective use of existing forest roads and transportation corridors for compatible nonmotorized and motorized recreation links.
7. Cooperate and partner with existing and new nonprofit organizations (e.g. snowmobile and ORV organizations), other public land managers (U.S. Forest and National Park services), and road management agencies (Michigan Department of Transportation and county road commissions) in the maintenance and development of trail systems.
8. Evaluate and renovate existing trail facilities and construct and manage new trails and trailheads to meet demand, use, resource protection and universal access standards and guidelines.
9. Have no net loss of trail length.
10. Prepare and conduct timber harvest prescriptions in a manner that attempts to minimize obstructions and maintain aesthetic values along trails.
11. Close to public access and restore unauthorized access trails that cause harm to terrestrial and aquatic resources.
12. Enable and execute a concerted monitoring effort to identify, document and restore ORV damage to DNR-owned lands.

Standards:

1. Part 711, Recreation Improvement Fund, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
2. Part 721, Trailways System, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
3. Part 811, ORV Trail System, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
4. Part 821, Snowmobile Trail System, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
5. Part 831, Integrated Forest Recreation System, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
6. NRC Policy 2208, Off-Road Vehicle (ORV) Policy, issued June 9, 1994.
7. NRC Policy 2504, Recreation-Trails, Off-Road Vehicles, and Snowmobile Affairs, issued July 1, 1977.
8. DNR Policy and Procedure 37.25-04, Recreation-Trails, Off-Road Vehicles, and Snowmobile Affairs, issued July 11, 2005.
9. DNR FMFMD Policy and Procedure 232, Off-Road Vehicle Trails, Routes and Areas, issued December 20, 1987.
10. FMFMD Policy and Procedure 251, Sale and Removal of Timber, issued March 1, 2000.
11. DNR FMFMD Policy and Procedure 251a, Sale and Removals of Timber, Visual Management, issued February 28, 2002.
12. 2008–12 Michigan State Comprehensive Outdoor Recreation Plan (Michigan Department of Natural Resources 2007).
13. Michigan Off-Road Vehicle (ORV) Plan 2005.
14. Maintenance standards for ORV trails and routes are in accordance with IC1850 “Recreational and Snowmobile Trail Grant Handbook”, IC1990 “ORV Trail Improvement Fund Procedures Manual”, IC 1991 “DNRORV Trail and Route Maintenance Handbook” and IC 3600 “ORV Trail Maintenance Grant Application Information”.
15. DNR Forest Certification Work Instruction 6.2 – Integrating Public Recreational Opportunities with Management on State Forest Lands.
16. DNR Forest Certification Work Instruction 3.2 – Best Management Practices Non-Conformance Reporting Instructions.

Guidelines:

1. Consider interpretive signs, trails and other similar educational tools in forest management plans.

2. Explore cooperative projects with local conservation organizations.
3. Monitoring of the condition of the designated ORV system using random annual audits.

Monitoring criteria.–

Statewide Criterion 4 - Recreation, Indicators 4.2, 4.3

4.1.1.3 State Forest Campgrounds

Desired future condition.–The state forest system provides designated and dispersed camping opportunities, located in a variety of settings, within the context of other ecological and socio-economic values.

Goals:

1. State forest campgrounds will be continually evaluated for adequate accommodation based on demand, use, and resource protection needs.
2. All state forestlands will be available for dispersed camping, except for within one mile of a state forest campground or if in conflict with other management goals and objectives.

Objectives:

1. The existing system will be maintained and improved for continued public use.
2. Continually evaluate and upgrade existing campground facilities to meet the current ADA standards for handicap access.

Standards:

1. Part 742, Camp Registration Cards, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
2. Part 831, State Forest Recreation, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
3. FMFM Policy and Procedure 251, Sale and Removal of Timber, issued March 1, 2000.
4. 2008–12 Michigan State Comprehensive Outdoor Recreation Plan (Michigan Department of Natural Resources 2007).
5. DNR Forest Certification Work Instruction 6.2 – Integrating Public Recreational Opportunities with Management on State Forest Lands.

Monitoring criteria.–

Statewide Criterion 4 - Recreation, Indicator 4.4

4.1.1.4 Hunting, Trapping, Fishing, and Other Dispersed Recreation

Desired future condition.–The state forest system provides diverse opportunities for hunting, trapping, fishing, and other dispersed recreational opportunities (such as wildlife photography, birding, picking of wild fruit, etc.) for the public, within the context of other ecological and socio-economic values.

Goals:

1. Provide suitable dispersed areas to meet public desire for hunting and trapping activities for various game species.
2. Use hunting and trapping as game species population management tools.
3. Provide diverse public fishing opportunities, promote the value of recreational fishing, and contribute to public stewardship and understanding of natural resources.
4. Provide suitable areas to meet public desire for general dispersed recreational activities such as bird watching, berry and mushroom picking, and other similar activities.

5. Provide both road and roadless access to areas that support dispersed recreational activities.

Objectives:

1. Maintain habitat necessary to support fish and wildlife populations that provide opportunities for dispersed recreation.
2. Determine the kinds of angling provided by each inland lake, stream, and Great Lakes port and direct Fisheries Division activities in each watershed management unit to provide for fishing opportunity.
3. Develop fishing regulations that best distribute angling benefits among anglers and balance fishing quality with fishing intensity.
4. Develop and maintain fish hatchery and rearing pond capacities which can reliably and efficiently produce fish at low cost and in the varieties, sizes, and numbers called for in fish stocking targets.
5. Maintain genetically diverse wild or captive broodstock for the species and strains of fish needed for fishery management.
6. Produce and stock fish that are free of debilitating and lethal diseases, of good quality, and do not show symptoms of chronic stress.
7. Tag or mark a portion of fish produced to permit evaluation of fish performance and their contribution to fisheries of the Great Lakes region.
8. Stock or transfer fish according to fishery management plans and priorities in the manner and times which will produce optimal results at the lowest possible cost.
9. Develop informative materials (web or print based) related to fishing regulations, fishing access sites, fishery attributes, fish stocking locations.

Standards:

1. NRC Policy 2007, Deer Management, issued April 14, 1994.
2. NRC Policy 3108, Fish Stocking, issued January 1, 1977.
3. DNR Policy and Procedure 30.32-02, Fishing Sites – Development and Maintenance of, issued July 11, 2005.
4. 2008–12 Michigan State Comprehensive Outdoor Recreation Plan (Michigan Department of Natural Resources 2007).
5. DNR Forest Certification Work Instruction 1.5 – Social Impact Considerations and Public Involvement Processes.
6. DNR Forest Certification Work Instruction 6.2 – Integrating Public Recreational Opportunities with Management on State Forest Lands.
7. Fisheries Division Policy and Procedure 02.02.002 Artificial Structures for Inland Lakes.

Guidelines:

1. Impacts on dispersed recreational activities should be considered in all management decisions.
2. Fish Stocking Guidelines II, Fisheries Division Special Report 32, October 2004.

Monitoring criteria.–

Statewide Criterion 1 – Conservation of Biological Diversity, Indicators 1.2, 1.3
Statewide Criterion 2 – Water Quality, Indicators 2.1, 2.5

Statewide Criterion 3 – Social/Cultural/Spiritual, Indicators 3.1, 3.2, 3.3

Statewide Criterion 4 – Recreation, Indicators 4.1, 4.3, 4.4, 4.5, 4.6

Statewide Criterion 5 – Ownership patterns, Indicator 5.2

4.1.1.5 Areas Managed for Hunting

Desired future condition.–The state forest provides areas that are managed for hunting (such as floodings and grasslands) for the public, while also taking into consideration other ecological and socio-economic values.

Goals:

1. Provide areas to address the public desire for hunting activities that require specialized management for the maintenance of suitable habitat.

Objectives:

1. Classify all areas managed primarily for hunting as special conservation areas, where hunting is the over-riding resource management value.
2. Identify properties purchased with federal funds and to administer these areas in full compliance with federal requirements.

Standards:

1. Part 413, Transgenic and Non-Native Organisms, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
2. 2008–12 Michigan State Comprehensive Outdoor Recreation Plan (Michigan Department of Natural Resources 2007).
3. DNR Forest Certification Work Instruction 1.4 – Biodiversity Management on State Forest Lands
4. DNR Forest Certification Work Instruction 2.2 – Use of Pesticides and Other Chemicals on State Forest Lands
5. DNR Forest Certification Work Instruction 6.2 – Integrating Public Recreational Opportunities with Management on State Forest Lands

Monitoring criteria.–

Statewide Criterion 1 – Conservation of Biological Diversity, Indicators 1.2, 1.3

Statewide Criterion 4 – Recreation, Indicator 4.1

Guidelines:

1. Design new waterfowl floodings as landscape features, with minimal maintenance or operational requirements.
2. Discourage the construction of waterfowl floodings through the damming of streams.
3. Encourage wetland restoration projects for the construction of new waterfowl floodings. The damming or diking of artificial drains in conjunction with small pushouts is the preferred method of construction.
4. Where possible, use native plants for natural resource management on public lands. Naturalized plants may be used when native plants will not meet specific needs.

4.1.1.6 Visual Management

Desired future condition.–Manage the visual and aesthetic character of the state forest to present diverse scenic attributes while taking into consideration other ecological and socio-economic values.

Goals:

1. Where possible in the management of the working forest, maintain or enhance the general natural aesthetic character of the state forest, particularly in those areas associated with developed recreational facilities.
2. Evaluate and renovate existing overlook facilities to meet universal access standards and guidelines.
3. Maintain or enhance exceptional scenic vistas on roadsides, overlooks, waterfronts, and other special areas, and in the course of compartment review to appropriately code them as special conservation areas.

Objectives:

1. Seek to establish, maintain or enhance vegetated buffer zones around campgrounds, access sites, and trails systems.
2. Increase use of techniques such as shelterwood, seed-tree, single-tree, and group-tree selection methods, the employment of irregular timber sale boundaries, and retention of screens along roads to reduce to adverse effects of timber harvest upon visual and aesthetic quality values.
3. Consider the effect of proposed management prescriptions upon exceptional scenic vistas.

Standards:

1. DNR Forest Certification Work Instruction 6.2 – Integrating Public Recreational Opportunities with Management on State Forest Lands
2. DNR Forest Certification Work Instruction 7.1 – Timber Sale Preparation and Administration Procedures.
3. DNR FMFMD Policy and Procedure 251a, Sale and Removals of Timber, Visual Management, issued February 28, 2002.

Monitoring criteria.–

Statewide Criterion 3 – Social/Cultural/Spiritual, Indicators 3.2, 3.3

Statewide Criterion 4 – Recreation, Indicator 4.3

Statewide Criterion 5 – Recreation, Indicator 5.3

Guidelines:

1. Give aesthetic considerations to harvesting patterns, road placement, and landing designs where visual aesthetics are a concern (i.e., for scenic areas or vistas).
2. Implement green-up guidelines in preparation of state timber sales.
3. Use DNR FMFMD Form R4031-6, Pre-Timber Sale Checklist, for implementing visual management practices in timber sales.

4.1.2 Vegetation Management

4.1.2.1 Biodiversity

Desired future condition.–The state forest system conserves, restores, and protects native biodiversity by managing for diverse composition and structure in both forested and nonforested natural communities upon suitably adapted sites. Forested communities are healthy and sustainable, with natural ecological processes that are resilient to natural and human disturbances, supportive of a wide variety of terrestrial and aquatic wildlife species, and free of nonnative invasive plant and animal species, while providing for other ecological and socio-economic values.

Goals:

1. Manage the state forest to encourage natural disturbance processes, and within the context of the ecological potential maintain intact functional landscapes, ecosystems, and communities that will provide healthy and sustainable habitat for the broad range of Michigan's native plant and animal species.
2. Maintain a variety of successional states, diverse species composition, and balanced age and size class structure to enhance biological diversity.
3. Use community and species site suitability as a criterion for vegetation management.
4. Maintain, enhance, and restore within-stand structural and compositional diversity, consistent with the suitability of the site.
5. Seek to maintain, enhance, and restore habitat connectivity in forested landscapes, consistent with the inherent landscape potential.
6. Enhance and restore functioning landscape mosaics to provide habitat for the array of wildlife species that may be expected to occur in Michigan's state forests.

Objectives:

1. Identify the general distribution, quality, condition, and functionality for each of the 76 Michigan Natural Features Inventory natural community types known to the state (Appendix I).
2. Assess the quality, condition, and functionality of natural communities, their ecological processes and their potential for preservation into the next century, and to define conservation objectives and ecological criteria for each natural community type.
3. Identify social and economic trends and constraints to conserving biodiversity at the landscape level.
4. Use the Biodiversity Conservation Planning Process (Michigan Department of Natural Resources 2005a) to maintain representation of natural community types in the landscape.
5. As budgetary resources are available, employ the MNFI to survey all state forestlands to determine the location, quality, and condition of natural community types.
6. Use the Kotar Habitat Type Classification System (Burger and Kotar 2003) to make informed decisions on the site suitability of upland vegetation. Where the Kotar system is not currently available, soils, and other information will be used.
7. Increase structural and compositional diversity of native species of shrubs and trees within the associated landscape communities where they are naturally expected to be present, by emphasizing the retention of under-represented species in harvest areas.
8. Give special emphasis to the restoration of the mesic conifer component within mixed mesic conifer-deciduous communities.

9. Provide old field grassland habitat for various grassland-dependent species and species of greatest conservation need and consider establishing and maintaining open conditions in landscapes where open lands are lacking.
10. Give special emphasis to the expansion and restoration of savanna communities (such as dry sand prairies, pine barrens, oak-pine barrens, and Great Lakes barrens) within ecoregional landscapes.
11. Seek to achieve and maintain balanced age class distributions for even-aged managed cover types.
12. Seek to achieve and maintain adequate regeneration for uneven-aged cover types.
13. Maintain habitat corridors for wildlife species that are dependent upon habitat connectivity across a mosaic of cover types, or through contiguous cover by limiting fragmentation of forested landscapes.
14. Coordinate with other ownerships within regional landscapes on the conservation of High Conservation Value Areas.

Standards:

1. Part 351, Wilderness and Natural Areas, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the administrative rules thereof.
2. Part 413, Transgenic and Non-Native Organisms, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
3. DNR Forest Certification Work Instruction 1.4 – Biodiversity Management on State Forest Lands.
4. Biodiversity Conservation Planning Process (Michigan Department of Natural Resources 2005a).
5. Within-Stand Retention Guidance (Michigan Department of Natural Resources 2006b).
6. DNR Forest Certification Work Instruction 7.1 – Timber Sale Preparation and Administrative Procedures.

Monitoring criteria.–

Statewide Criterion 1 – Conservation of Biological Diversity, Indicators 1.1, 1.2, 1.3, 1.4

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicator 2.4

Statewide Criterion 3 – Social/Cultural/Spiritual, Indicator 3.2

Guidelines:

1. Conserve biological diversity and its associated values, water resources, soils and fragile ecosystems, and intact, high quality and functional landscapes (Ecological Reference Areas , High Conservation Value Areas, and Special Conservation Areas) using Conservation Area Management Guidelines (Michigan Department of Natural Resources 2005b).
2. Use the Natural Areas designation process to further biodiversity protection for appropriate areas not provided protection by other means.
3. Use Guidelines for Red Pine Management (Michigan Department of Natural Resources 2006a) in incorporating biodiversity needs into management of planted stands.
4. In forested ecosystems, apply DNR Within-Stand Retention Guidelines (Michigan Department of Natural Resources 2006b) to all silvicultural prescriptions to maintain or foster spatial and temporal diversity and complexity of stand structure.

5. Use DNR FMFMD Form R4031-6, Pre-Timber Sale Checklist, for documenting compliance with retention guidelines in planning forest prescriptions.
6. Use the "Process for Implementing Mesic Conifer Restoration on State Land" (Michigan Department of Natural Resources 2004a) when seeking to diversify species composition of deciduous forest cover types.
7. Apply draft Management Guidelines for Red-shouldered Hawks on state-owned lands in Michigan to upland and lowland hardwood forests in the northern Lower Peninsula.
8. Strive to preserve viable pools of native genetic stock, and to use a variety of genetically diverse and regionally adapted seed stock for reforestation and afforestation purposes.
9. Strive to ensure that ecological functions and values are maintained intact, enhanced or restored at the forest and stand level. Ecological functions include forest regeneration and succession, natural disturbance, and natural carbon, nutrient, and hydrologic cycles that affect the productivity of both forest and aquatic ecosystems. Ecological values include large mature and declining trees, shade trees for aquatic systems, snags for den and nest trees, den logs, terrestrial coarse dead wood, tip-up mounds and nurse logs, aquatic large woody debris, soil organic matter, and minimal sediment input and adequate organic energy input into aquatic systems.
10. Use results of ongoing forest health monitoring activities on state forestland, including annual aerial surveys, periodic pest- and host-specific detection and evaluation surveys for indigenous and exotic pests (e.g., redheaded pine sawfly, jack pine budworm, sirex woodwasp, and emerald ash borer) and long-term effect monitoring and analysis plot networks (Michigan Impact Monitoring System, beech bark disease, ash decline) for assessing threats to biodiversity.
11. When developed, apply biomass harvesting guidance to silvicultural treatments to maintain ecological functions and biodiversity within the context of sustainable forestry.

4.1.2.2 Forest Resources

Desired future condition.–The DNR works cooperatively with stakeholders and other public agencies to manage a stable forestland base and to offer a diverse assemblage of community types, tree species, successional stages, age classes, and forest products, while also providing for the conservation of biological diversity, forest health, and other ecological and socio-economic values.

Goals:

1. Prepare for harvest a minimum of 53,000 acres (approximately 700,000 to 750,000 cords) a year.
2. Evaluate opportunity to increase minimum wood fiber production within six months of the Director's approval of the Regional Forest Management Plans. Regional Forest Management Plans will be developed by December 31, 2008, per FSC and SFI Corrective Action Requests. Pursue improved IFMAP inventory tools and updates to forest management practices from the Forest Finance Authority and other project investments to increase production. Projects currently under way include the Red Pine Project, State Forest Inventory and Site Potential Database Completion, the Forest Cultural Resource Management Pilot Project, IFMAP Stage I and II Software Development and Woody Biomass Harvesting Guidance Development. These projects as well as other projects started in 2008 will provide an additional opportunity to update wood fiber production levels in 2010.
3. Maintain up-to-date, comprehensive information on forest inventories and engage in efforts to keep abreast of market conditions at the local, state, national, and international levels.
4. Actively manage the state forest for stable, long-term, sustainable timber production.
5. Actively manage the state forest for sustainable forest-based wood fiber, such as biomass.

6. Cooperate with the Michigan Department of Labor and Economic Growth and the Michigan Economic Development Corporation to promote and encourage forest products companies in Michigan, and attract new forest product companies to locate in the state, including bioenergy-based companies (e.g., wood pellets, biofuels).
7. Promote logger and other industry education programs, including education for new sustainable forestry practices.
8. For the purposes of providing a stable supply of fiber and diverse forest conditions, strive to achieve balanced-age and size-class distributions of commercial forest cover types across ecoregional landscapes (taking into account ERAs, HCVAs and in some cases SCAs).
9. Generally manage early-successional cover types (comprised of shade intolerant aspen, paper birch, jack and red pine, and black oak) as even-aged stands with balanced age-class distributions across the landscape, consistent with the suitability of the site.
10. Generally manage mid-successional cover types (comprised of intermediate shade tolerant white pine, yellow birch, white and red oak and black spruce) as all-aged stands with all-aged class distributions across the landscape, consistent with the suitability of the site.
11. Generally manage late-successional cover types (comprised of shade tolerant sugar maple, beech, hemlock, balsam fir, white cedar, and white spruce) as all-aged stands with all-aged class distributions across the landscape, consistent with the suitability of the site.
12. While also considering social and economic values, use ecological site potential as a guiding principle for determining the suitability of species habitats in forest vegetation management decisions.
13. Use the rates of growth and management objectives for pulpwood vs. sawlog production in the application of rotation lengths.
14. Strive to maintain and improve the provision of ecosystem services.

General Objectives:

1. Projections and sustainability of harvests are based upon inventory growth and regeneration data, site index models, and desired future conditions, while also dependent upon changing market and resource product demands.
2. Use the Kotar Habitat Type Classification System (Burger and Kotar 2003) to make informed decisions on the site suitability of upland forest vegetation. Where the Kotar system is not currently available, soils and other information will be used.
3. Once desired conditions of species composition and age-class structure have been achieved, demonstrate through harvest and growth records that the volume harvested during any 10-year span does not exceed the net growth accumulated over that same period.
4. Assess the severity and effect of cervid herbivory on forest regeneration.

Objectives for Specific Cover Types:

1. Aspen: Manage aspen primarily for pulpwood production. Work toward balancing the age class distribution of the aspen cover type by increasing prescriptions in the 30–39 and 40–49 year age classes over the next decade.
2. Aspen: On sites where aspen is well suited, prescribe and treat stands in the 70–89 year ages classes to preclude conversion to later successional types. Allow natural succession on 70–89 year aspen stands on sites where aspen is poorly suited and where Kotar analysis and developing understory composition indicates a proclivity for dominance of another cover type.

3. Northern hardwoods: Manage the northern hardwood cover type as all-aged stands with an emphasis on quality saw log production, while balancing economic productivity and biodiversity demands.
4. Northern hardwoods: Assess the costs and benefits of operating on a continuous inventory cycle for the management of northern hardwoods.
5. Northern Hardwoods: Where adequate seed trees are present, encourage the natural regeneration of hemlock within northern hardwood communities and to encourage the restoration and expansion of mixed hemlock/white pine and mixed hemlock/yellow birch communities within regional landscapes, through the employment of nurse logs and soil scarification. Where inadequate seed trees remain in areas where hemlock was historically present and where browse pressure is within limits favorable for successful recruitment, to under-plant hemlock in mesic northern hardwood and white pine communities.
6. Jack pine: Manage jack pine primarily for pulpwood production. Reduce the stock of over-mature jack pine in the 70–79 and 80–89 year ages classes and to reduce the acreage of harvests in the jack pine cover type to within the area regulation decade sum of approximately 40,000 acres, while operating within the framework of the Strategy for Kirtland's Warbler Habitat Management (Michigan Department of Natural Resources et al. 2001).
7. Red pine: Manage red pine primarily for quality pole and saw log production. Balance the age class distribution of the red pine cover type at approximately 25,000 to 30,000 acres per class, by increasing regeneration harvests to over 2,000 acres per year over the next decade.
8. Oak: Work toward retaining oak species for hard mast and saw log production and balancing the age class distribution of the oak cover type by increasing the number of regeneration cuts in the 70–79 and 80–89 year age classes.
9. Oak: Retain white pine or other mixed deciduous components in mixed oak stands.
10. Paper birch: Encourage the natural regeneration of paper birch cover type where adequate seed trees are present, through the employment of patch clearcuts followed by prescribed fire for suitable seedbed preparation.
11. Lowland hardwoods: Balance the age class distributions of lowland hardwood and balsam poplar cover types, by increasing harvests within the 60–69, 70–79, and 80–89 year age classes for balsam poplar and the 70–79 and 80–89 year age classes of even-aged lowland hardwood stands.
12. Hemlock/yellow birch: Encourage the retention and regeneration of hemlock and yellow birch within the lowland hardwood cover types through the employment of nurse logs and soil scarification.
13. Spruce-fir: Work toward greater balance in the age class distribution of the spruce-fir cover type, through increased harvests within the 70–79 and 80–89 year age classes.
14. Spruce-fir: Encourage the retention, restoration and expansion of spruce and fir within other cover types based upon site suitability, landscape and wildlife habitat considerations.
15. Northern white cedar: Work toward recruiting younger age classes of the northern white cedar cover type by encouraging regeneration through the judicious use of prescribed fire, vegetative reproduction (layering) and other experimental methods.
16. Tamarack: Encourage regeneration and the recruitment of younger age classes for the tamarack cover type.
17. Black spruce: Balance the age class distribution of the black spruce cover type by increasing harvests in the 70–79 and 80–89 year age classes, within the context of other DNR objectives including the provision of winter wildlife habitat.

18. Black spruce: Work toward recruiting younger age classes of the black spruce cover type by encouraging regeneration through the judicious use of prescribed fire and vegetative reproduction (layering).
19. Mixed swamp conifers: Balance the age class distribution of the mixed swamp conifer cover type by increasing harvests in the 70–79, 80–89, 90–99, and 100+ year age classes, within the context of other DNR objectives including the provision of winter wildlife habitat.
20. Mixed swamp conifers: Work toward recruiting younger age classes of the mixed swamp conifer cover type by encouraging regeneration through the judicious use of prescribed fire and vegetative reproduction (layering).
21. White pine: Where biodiversity goals do not preclude, increase regeneration harvests of the white pine cover type as planted stands reach the 100+ year rotational age class over the next decade.
22. White pine: Where advanced natural regeneration is already present in the understory, allow the recruitment of white pine within mixed oak, red pine, aspen and to a lesser extent jack pine stands. Where inadequate seed trees are present, to under-plant white pine in mesic northern hardwood and post-thinned red pine stands.

Objectives for Stakeholder Relations:

1. Carry out biennial surveys of forest products firms to facilitate the compilation of USDA Forest Service timber product output reports.
2. Meet with representatives of forest resource stakeholder groups and participate in associations of mutual interest (e.g., USDA Forest Service, Great Lakes Forestry Alliance, and Forest Management Advisory Council).
3. Participate in wood product use and marketing programs and meetings.
4. Maintain a wood products manufacturers' directory.
5. Endeavor to advance sustainable forestry practices on private, nonindustrial lands through collaboration with and support for assistance programs for such lands.
6. Participate in the Sustainable Forestry Initiative's Statewide Implementation Committee.
7. Collaborate with other major land owners in landscape-level plans when such opportunities arise.
8. Evaluate local and regional economic effects of DNR timber sales as part of DNR inventory and timber sale decision making processes.
9. Identify the nature and size of effects from conflicts over forest uses and values and possible resolutions to minimize these conflicts.
10. Maintain and communicate realistic appraisals of timber inventories and harvest trends.
11. Communicate the social, economic, and ecological benefits of a working forest as part of its sustainable forestry management.
12. Encourage the development of uses for salvaged ash trees by industry.

Standards:

1. Part 511, Commercial Forests, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the administrative rules thereof.
2. NRC Policy 2204, Reforestation, issued January 1, 1977.
3. NRC Policy 2207, Management of State Forests, issued May 11, 1979.
4. DNR Policy and Procedure 32.22-06, Forest Type Mapping Instructions and Type Symbols, issued July 11, 2005.

5. DNR Policy and Procedure 32.22-07, Forest Management, issued July 11, 2005.
6. DNR FMFMD Policy and Procedure 241, Reforestation, issued October 26, 1999.
7. DNR FMFMD Policy and Procedure 251, Sale and Removals of Timber, issued March 1, 2000.
8. DNR FMFMD Policy and Procedure 251a, Sale and Removals of Timber, Visual Management, issued February 28, 2002.
9. DNR FMFMD Policy and Procedure 441, Operations Inventory and Compartment Review Procedures, issued January 19, 2000.
10. DNR Forest Certification Work Instruction 1.5 – Social Impact Considerations and Public Involvement Processes.
11. DNR Forest Certification Work Instruction 1.6 – Forest Management Unit Analysis.
12. DNR Forest Certification Work Instruction 1.7 – State Forest Timber Harvest Trends.
13. DNR Forest Certification Work Instruction 2.1 – Reforestation.
14. DNR Forest Certification Work Instruction 7.1 – Timber Sale Preparation and Administration Procedures.

Monitoring criteria.–

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicators 2.1, 2.2, 2.6

Statewide Criterion 3 – Social/Cultural/Spiritual, Indicator 3.2

Statewide Criterion 5 – Ownership Patterns, Indicators 5.1, 5.3

Statewide Criterion 6 – Economic Health, Indicators 6.1, 6.2, 6.3

Statewide Criterion 7 – Institutional Processes, Indicator 7.1

Guidelines:

1. Use DNR Silvicultural Guidelines for developing management prescriptions.
2. Include in the compartment review process (Standard 3 above) an assessment of social, biological, and economic conditions to include:
   - Common vegetation cover types, animals, and their habitats
   - Unique, vulnerable, rare, and threatened plant communities
   - Sensitive, threatened and endangered species and their habitats
   - Water and fishery resources
   - Soil resources
   - Natural disturbance regimes
   - Habitat connectivity and landscape-level mosaics
   - Potential successional pathways, as identified using the Kotar Habitat Type Classification System (Burger and Kotar 2003).
3. The current ecological conditions supported by these factors should be compared with both historical conditions and desired future conditions within a landscape context along with consideration of social and economic values. The assessment should be used to develop management options and silvicultural practices that will achieve long-term desired future conditions for social and economic values and maintenance of the ecological functions and productivity of the forest.
4. Consider that landform, localized climate, soils, topographic aspect, growth-limiting nutrient factors, localized precipitation rates, and forest canopy cover can create micro-climates that possess different hydrologic properties and support different forest communities across the

forest landscape. The Kotar Habitat Type Classification System should be used to assist in determining site suitability when considering which tree species are best adapted to specific sites and local hydrologic conditions.

5. Manage red pine stands in accordance with the direction provided by Guidelines for Red Pine Management (Michigan Department of Natural Resources 2006a).
6. Apply DNR Within-Stand Retention Guidelines (Michigan Department of Natural Resources 2006b) to all silvicultural prescriptions to maintain or foster spatial and temporal diversity and complexity of stand structure.
7. Promote prompt reforestation and manage both early and late successional forests to provide carbon sequestration service to the biosphere.
8. The rate of harvest of forest products should not exceed levels that can be biologically sustained. One measure of the sustainability of harvest levels is based upon growth and regeneration data and rates of harvest and removals (less mortality), and limits are modified by desired future conditions of the forest.
9. The average size of clearcut harvests over the state forest system should not exceed 120 acres.
10. Follow Forest Certification Green-Up Guidelines (dated July 12, 2006), in the management and regeneration of all clearcut stands.
11. Clearcut harvests to remove dead or dying trees resulting from insect and disease epidemics, wildfire or other natural disturbances (salvage or sanitation harvests), or for special management areas (such as Kirtland's Warbler habitat) may require the implementation of alternative measures to comply with green-up guidelines and the SFI green-up performance measure, which must be justified and documented on the Pre-Timber Sale Checklist.
12. Use results of ongoing forest health monitoring activities on state forestland, including annual aerial surveys, periodic pest- and host-specific detection and evaluation surveys for indigenous and exotic pests (e.g., redheaded pine sawfly, jack pine budworm, sirex woodwasp, and emerald ash borer) and long-term monitoring and analysis plot networks (Michigan Impact Monitoring System, beech bark disease, ash decline) in developing management prescriptions.

4.1.2.3 Wildlife

Desired future condition.–The state forest provides a diversity of wildlife habitat necessary for meeting the needs of common, declining and rare wildlife species as part of sustainable ecosystems, while also taking into consideration the conservation of biodiversity and the provision of commercial and noncommercial forest and timber products, recreational opportunities, and other socio-economic benefits.

Goals:

1. Use an ecosystem-based conservation approach to provide diverse age and size classes and successional states for the habitat needs of wildlife and to effectively conserve rare, declining, and common species.
2. Provide healthy, sustainable populations of native wildlife species that support ecosystem functions and wildlife-based recreation.

Objectives:

1. Manage the state forest in a fashion that maintains or enhances the quality of habitat for species of greatest conservation need (Michigan's Wildlife Action Plan) within the long-term ecological potential of the landscape.
2. Strive to restore natural barren and savanna grassland systems as critical habitat for grassland dependent wildlife with the context of site suitability and other socio-economic values.
3. Provide old field grassland habitat for various grassland-dependent species and species of greatest conservation need and consider establishing and maintaining open conditions in landscapes where open lands are lacking.
4. Manage the vegetation on state forest to provide high quality habitats for game species to support hunting, trapping, and wildlife viewing within the long-term ecological potential of the landscape.
5. Manage the state forest to minimize the loss of habitat for early successional species (e.g., deer and grouse) by minimizing the loss of the aspen cover type over the next 10 years, within the context of site suitability and other socio-economic values.
6. Manage the state forest so that there is representation of early successional forested habitat in riparian zones for Woodcock and other species, within the context of other DNR objectives including beaver management policy, the maintenance of habitat connectivity in riparian management zones, site suitability, and social-economic values.
7. Manage multiple aspen age classes in close proximity to each other. Age classes should be balanced across ecological landscapes.
8. Manage jack pine within the framework of the Strategy for Kirtland's Warbler Habitat Management (Michigan Department of Natural Resources et al. 2001).
9. Manage the state forest to maintain production of hard mast in the landscape to support healthy wildlife populations.
10. Manage the cedar and lowland conifer cover types and adjacent uplands on state forest as habitat for deer and other wildlife species.
11. Preserve, enhance, or restore wildlife habitat features associated with dead wood, legacy trees, riparian areas, seasonal wetlands, caves, and rocks.
12. Manage habitat for cervids on the state forest to provide adequate browse for healthy populations of these species without significantly affecting the biodiversity, regeneration, composition and long-term sustainability of forest vegetation.

Standards:

1. DNR Policy and Procedure 32.22-07, Forest Management, issued July 11, 2005.
2. DNR Policy and Procedure 39.21-08, Wildlife Flooding Projects – Operation and Maintenance, issued July 11, 2005.
3. DNR Policy and Procedure 39.21-18, Wildlife - Procedure on Flooding Projects for Fish or Wildlife, issued July 11, 2005.
4. DNR Policy and Procedure 39.21-20, Beaver Management, issued July 11, 2005.
5. DNR Forest Certification Work Instruction 1.4 – Biodiversity Management on State Forest Lands.
6. DNR Forest Certification Work Instruction 2.1 – Reforestation.
7. DNR Forest Certification Work Instruction 3.1 – Forest Operations
8. DNR Forest Certification Work Instruction 7.1 – Timber Sale Preparation and Administrative Procedures.

Monitoring criteria.–

Statewide Criterion 1 – Conservation of Biological Diversity, Indicators 1.2, 1.3

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicators 2.1, 2.4

Guidelines:

1. Use Michigan's Wildlife Action Plan (Eagle et al. 2005) and Silvicultural Guidelines for developing management prescriptions for habitat of species of greatest conservation need.
2. In forested ecosystems, apply DNR Within-Stand Retention Guidelines (Michigan Department of Natural Resources 2006b) to all silvicultural prescriptions to maintain or foster spatial and temporal diversity and complexity of stand structure.
3. Commercial timber prescriptions should be the first option for manipulation of forest habitat, but noncommercial methods may be used on lands that have major wildlife values and needs.
4. When developed, apply biomass harvesting guidance to silvicultural prescriptions to maintain habitat treatments within the context of sustainable forestry.

4.1.2.4 Fisheries

Desired future condition.–Each watershed will provide holistic ecological functions and processes that are sustainable; aquatic habitats will have sustainable attributes that are important for maintaining aquatic life; aquatic habitats will support healthy and self-sustaining communities of plants and animals, fostering stable and appropriate ecosystem functions; and healthy and self-sustaining communities of plants and animals will provide desirable socio-economic benefits and services to current and future generations.

Goals:

1. To protect and maintain healthy aquatic environments and communities and to rehabilitate those that are degraded.
2. To provide diverse public fishing opportunities which maximize the value of recreational fishing to anglers.
3. To cultivate public stewardship of aquatic resources through scientific understanding of aquatic ecosystems, responsible human use of aquatic resources, and collaborative resource management.

Objectives:

1. Conduct a comprehensive statewide survey of habitats, fishes, and selected other aquatic species using a statistically sound 'status and trends' design.
2. Conduct ecological assessments of major fish stocks, defining discreteness of stocks, distributions, habitat preferences, movement patterns, survival rates, age structure, growth rates, reproductive rates, diet patterns, and occurrence and distribution of diseases.
3. Develop and manage databases and software in support of resource inventory surveys and fish stockings in Michigan's waters that incorporate spatial information and technologies.
4. Develop, deploy, and manage ecological classifications for inland waters and the Great Lakes, based on geographic information systems, to serve as a framework for inventories, management decision models, and reporting.
5. Develop measures to prevent losses of aquatic resources resulting from developmental projects and seek mitigation for any unavoidable losses.

6. Monitor occurrence and distribution of exotic species, evaluate their effects on aquatic communities, and cooperate in containment or control measures to avoid damages to aquatic resources.
7. Work with the departments of Environmental Quality and Community Health to monitor and minimize contaminant loads in fish, to minimize potential risks to publics, and to communicate risks clearly to publics.
8. Coordinate with the Michigan Department of Agriculture in regulating the aquaculture industry, and work to minimize effects of accidental releases, spread of fish diseases, and importation of unwanted species.
9. Provide technical support and guidance to citizens' groups and local governments for aquatic habitat and community protection and rehabilitation projects.
10. Provide input to DEQ regulatory processes regarding permits and developments within aquatic habitats and riparian areas.

Standards:

1. DNR Policy and Procedure 39.21-20, Beaver Management, issued July 11, 2005.
2. DNR Forest Certification Work Instruction 1.4 – Biodiversity Management on State Forest Lands.
3. DNR Forest Certification Work Instruction 3.1 – Forest Operations
4. Fisheries Division Policies and Procedures 02.01 Series on Construction Impact Assessment and 02.02 Series on Resource Management

Monitoring criteria.–

Statewide Criterion 1 – Conservation of Biological Diversity, Indicator 1.3

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicators 2.1, 2.3, 2.5, 2.7

Guidelines:

1. Evaluate and manage riparian areas in accordance with the direction provided by Evaluating Riparian Management Zones on State Lands – Approved Interim Guidelines (Michigan Department of Natural Resources 2004b).

4.1.2.5 Rare Communities

Desired future condition.–Rare communities are identified in the state forest, and their viability is enhanced and restored within the context of other ecological and socio-economic values.

Goals:

1. Maintain, enhance or restore natural species composition and ecological functions in natural communities with global or state element ranks of endangered (1), threatened (2), or rare (3).

Objectives:

1. Develop and implement strategies and conduct field surveys and assessments for rare communities on state forestlands.
2. Coordinate with other ownerships in the regional landscape on the conservation of High Conservation Value Areas.

Standards:

1. DNR Forest Certification Work Instruction 1.4 – Biodiversity Management on State Forest Lands.
2. DNR Forest Certification Work Instruction 3.1 – Forest Operations.

Monitoring criteria.–

Statewide Criterion 1 – Conservation of Biological Diversity, Indicator 1.1
Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicator 2.4

Guidelines:

1. Use community abstracts developed by the Michigan Natural Features Inventory as additional reference in the identification and management of rare communities.
2. Use the Biodiversity Conservation Planning Process at the ecoregional and FMU level of operations for the identification and review of potential rare communities and potential designation as HCVAs and ERAs.
3. Use Section 5.2.2 and 5.3 for additional management direction, standards and guidelines for the management of rare natural communities.

4.1.3 Watershed Management

4.1.3.1 Soil Resources

Desired future condition.–The state forest System has soils that are identified and mapped by the U.S. Department of Agriculture. Forest uses conserve and improve soil resources to support diverse ecosystems, minimize soil erosion into aquatic systems, and do not exceed the resiliency capacity of soil resources to recover from disturbances resulting form particular ecological or socio-economic uses.

Goals:

1. Manage the state forest to maintain or improve the fertility and productivity of soil resources.
2. Maintain soil biomass in forest management operations to serve as a global sink for carbon sequestration.

Objectives:

1. Implement best management Practices (BMPs) for all intrusive operations where there is a potential for soil disturbance.
2. Manage riparian areas to minimize the erosion of soil into aquatic systems.
3. Stabilize and restore sites with disturbed soil conditions.
4. Flag and buffer wetland areas from vehicle traffic.
5. Develop and apply biomass harvesting guidance that maintains soil nutrient cycling.

Standards:

1. Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

2. NRC Policy 4602, Soil Erosion and Sedimentation Control Procedures, issued January 1, 1977.
3. FMFMD Policy and Procedure 251, Sale and Removal of Timber, issued March 1, 2000.
4. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
5. DNR Forest Certification Work Instruction 3.2 – Best Management Practices Non-Conformance Reporting Instructions.
6. DNR Forest Certification Work Instruction 7.1 – Timber Sale Preparation and Administrative Procedures.

Monitoring criteria.–

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicators 2.6, 2.8

Guidelines:

1. Use DNR FMFMD Form R4031-6, Pre-Timber Sale Checklist, for implementing measures to mitigate adverse effects to soil resources during forest prescriptions.
2. Follow (Draft) Sustainable Soil and Water Quality Practices on Forest Land guidelines (Michigan Department of Natural Resources and Michigan Department of Environmental Quality 2007) to minimize the erosion of soil and organic matter, and the resultant loss in site productivity.
3. Improve soils by promoting the generation and maintenance of soil organic matter content, nutrient retention and cycling through the preservation of soil detritus upon the floor of forest stands, and avoid practices that erode or remove topsoil (O and A soil horizons).
4. Use soil maps and field investigation of possible soil inclusions to identify wet soils that are vulnerable to compaction and rutting, and avoid actions (such as harvesting during wet seasons) that will cause excessive soil disturbance.

4.1.3.2 Riparian Areas and Wetlands

Desired future condition.–The state forest system has watersheds and wetlands that are identified and mapped by the Michigan Department of Environmental Quality. The wetlands are resilient to natural and human induced disturbances, and in addition to socio-economic uses they provide ecosystem services.

Goals:

1. Manage riparian management zones to maintain and enhance natural aesthetic values and free-flowing conditions for warm, cool and coldwater streams, and for values to include water quality, aquatic habitat, recreation, forest products, wildlife habitats, travel corridors, threatened and endangered species, unique ecological communities, and cultural resources.
2. Manage, restore, and improve wetlands to ensure self-sustaining populations of associated fish and wildlife species.

Objectives:

1. Contribute to the statewide objective of restoring and/or creating 30,000 acres of wetlands contiguous with grasslands.
2. Identify naturally functioning wetland resources using Michigan Department of Environmental Quality inventory maps. Conserve, restore, or enhance wetlands with specific

priority given to the protection and restoration of Great Lakes coastal marsh, inland emergent marsh and wet prairie communities.

3. Advocate dam removal to restore rivers and streams to free-flowing conditions where nonproductive or unsafe dams are present.
4. Manage beaver populations to sustain pond habitat while minimizing adverse effects upon coldwater stream habitats and road and trail crossings.
5. Manage riparian areas located within designated state Natural River systems in accordance with adopted Natural River Plans.
6. Manage riparian areas located within designated Federal Wild and Scenic River systems in accordance with federal management plans.
7. Manage wetlands for water quality benefits, biodiversity values, wildlife habitat, and timber production.
8. Maintain seasonal wetlands and to restore any degraded conditions.

Standards:

1. All management activities within wetlands will comply with the requirements of Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
2. All management activities below the ordinary high water mark of inland streams will comply with the requirements of Part 301, Inland Lakes and Streams, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
3. All management activities within floodplains will comply with the floodplain regulatory authority found in Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
4. Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
5. NRC Policy 3402, Dam Removal and Disposition, issued September 7, 1979.
6. DNR Policy and Procedure 39.21-20, Beaver Management, issued July 11, 2005.
7. DNR FMFMD Policy and Procedure 251, Sale and Removal of Timber, issued March 1, 2000.
8. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
9. DNR Forest Certification Work Instruction 3.2 – Best Management Practices Non-Conformance Reporting Instructions.
10. DNR Forest Certification Work Instruction 7.1 – Timber Sale Preparation and Administrative Procedures.
11. Fisheries Division Policy and Procedures 02.01.001 Wetland Alterations; 02.01.002 Dams and Barriers; and 02.02.011 Riparian Vegetation Protection.

Monitoring criteria.–

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicators 2.1, 2.5, 2.7, 2.8

Guidelines:

1. Evaluate and manage riparian areas in accordance with the direction provided by Evaluating Riparian Management Zones on State Lands – Approved Interim Guidelines (Michigan Department of Natural Resources 2004b).

2. Use (Draft) Sustainable Soil and Water Quality Practices on Forest Land guidelines (Michigan Department of Natural Resources and Michigan Department of Environmental Quality 2007) when operating in riparian or wetland areas.
3. Use DNR FMFMD Form R4031-6, Pre-Timber Sale Checklist, for noting the presence of lakes, ponds, streams and wetlands, and implementing measures to mitigate adverse effects during forest prescriptions.

4.1.4 Rare Species

4.1.4.1 Federal and State Threatened and Endangered Species

Desired future condition.–The state forest provides sufficient habitat conditions suitable for the maintenance and expansion of federal and state threatened and endangered species populations. This includes specific habitat needs for plant and animal species that do not satisfactorily respond to landscape or ecosystem-based habitat conservation approaches.

Goals:

1. Cooperate with the U.S. Fish and Wildlife Service in the identification and recovery of federal listed threatened and endangered species that occur upon state forestlands.
2. Implement Michigan's Wildlife Action Plan (Eagle et al. 2005) to provide habitat for the conservation, protection, restoration, and propagation of all species of greatest conservation need, especially Michigan federal- and state-listed threatened and endangered species, while also taking into consideration other uses of the forest.
3. Protect all known occurrences of federal- and state-listed threatened and endangered species on state owned lands with primary emphasis directed toward the most viable occurrences.
4. Monitor the progress and status of all federal- and state-listed threatened and endangered species on state owned lands.
5. Work toward identifying research needs on state forestlands for federal- of state-listed species.
6. Develop and distribute effective outreach and conservation tools to state forestland stakeholders.

Objectives:

1. Avoid the taking of any federal- or state-threatened or endangered wildlife species in all situations, except under permit or as approved under a Habitat Conservation Plan.
2. Identify, protect, maintain, and/or enhance critical habitat essential for the health of threatened and endangered species populations.
3. Communicate known occurrences of federal- and state-listed species to land managers in all divisions prior to planned intrusive work activities.
4. Conduct field surveys of suitable habitats with other partners and volunteers to identify new occurrences of federal- or state-listed plant or animal species, evaluate recovery possibilities at discovered sites, and verify extent and status of historically documented sites.
5. Report locations of newly discovered species and previously unknown occurrences of all special concern species to the Michigan Natural Features Inventory.
6. Determine population status and habitat requirements and threats to federal- and state-listed species.

7. Evaluate effectiveness of management actions that address threats to federal- and state-listed species populations, such as habitat destruction and loss from increased development and recreation, industrial and agricultural effects, disease, predation, inadequate protection by existing laws, pollution, hydrological disruptions, and competition from introduced nonnatives.
8. Wherever possible, control competition and habitat alteration by invasive plants.
9. In association with partners, develop management guidelines and species recovery and habitat conservation plans for threatened and endangered species and their habitats.
10. Encourage the acquisition of lands to benefit the conservation and restoration of federal- and state-listed threatened and endangered species.
11. Develop and maintain communication with federal and state agencies, the Province of Ontario, local governments, tribal agencies, private landowners, land conservancies, and private sector agencies regarding the known presence, maintenance, and restoration of all known federal- and state-listed threatened and endangered species potentially occurring on their ownerships.
12. Provide training to DNR staff on threatened and endangered species identification and natural history.

Standards:

1. Part 365, Endangered Species Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
2. The Endangered Species Act of 1973, Public Law 93-205, 87 Stat. 884
3. Any activity on state forestland that may take a federal or state-threatened or endangered species must be coordinated with the DNR Endangered Species Coordinator. Permits are required for any activity that results in the take of a threatened or endangered species. Permits may be issued only for scientific, zoological, or educational purposes, or for propagation in captivity to ensure survival of a species. The DNR Endangered Species Program coordinates permit requirements for federal listed species with the U.S. Fish and Wildlife Service.
4. Specific location data of federal- and state-threatened and endangered species cannot be provided to the public without express approval of the DNR Endangered Species Coordinator. All comments regarding T & E species for Compartment Review should be placed in “locked comments” in the Operations Inventory database.
5. DNR Forest Certification Work Instruction 1.4 – Biodiversity Management on State Forest Lands.
6. DNR Forest Certification Work Instruction 3.1 – Forest Operations
7. DNR Forest Certification Work Instruction 7.1 – Timber Sale Preparation and Administrative Procedures.
8. Threatened and Endangered Species Recovery Plans

Monitoring criteria.–

Statewide Criterion 1 – Conservation of Biological Diversity, Indicators 1.1, 1.2, 1.3

Guidelines:

1. Consider restoration of degraded T&E habitat when such potential areas are identified.
2. Prior to development of management plans or the implementation of management prescriptions and when identification of a community type indicates the probability of a

federal- or state-listed plant or animal being in or near a proposed forest treatment, use the Michigan DNR Approach to the Protection of Rare Species and Rare Species Assessment, Guidelines for DNR staff on State Forest Lands (July 12, 2006).

3. Use DNR FMFMD Form R4031-6, Pre-Timber Sale Checklist, for noting the presence of threatened or endangered species, and implementing measures to mitigate adverse effects during forest prescriptions.
4. Apply draft Management Guidelines for Red-shouldered Hawks on State-owned Lands in Michigan to upland and lowland hardwood forests in the northern Lower Peninsula.
5. Use MNFI Species and Natural Community abstracts as additional reference in the identification and management of threatened and endangered species.
6. Refer conflicts, or potential conflicts, in the management of listed species to the DNR Endangered Species Program Coordinator for assistance.
7. Use the U.S. Fish and Wildlife Service, Region 9 Conservation Assessments and Approaches.
8. Implement survey and monitoring program protocols established for threatened and endangered species.
9. When completed and applicable, consider the Habitat Conservation Plan for karner blue butterflies in management planning and implementation.

4.1.4.2 Species of Special Concern

Desired future condition.–The state forest provides habitat suitable for the maintenance and expansion of Special Concern species populations, within the context of other ecological and socio-economic uses. This includes specific habitat needs for wildlife species that do not satisfactorily respond to landscape or ecosystem-based habitat conservation approaches.

Goals:

1. Implement Michigan's Wildlife Action Plan (Eagle et al. 2005) to provide habitat for the conservation, protection, restoration, and propagation of species of special concern, while also taking into consideration other uses of the forest.
2. Protect all known occurrences of species of special concern and their habitats on all state-owned lands.

Objectives:

1. Identify, protect, maintain, and/or enhance critical habitat essential for the health of special concern species.
2. Conduct field surveys of suitable habitats with other partners and volunteers to identify new occurrences of Special Concern plant or animal species, evaluate recovery possibilities at discovered sites, and verify extent and status of historically documented sites.
3. Report locations of newly discovered species and previously unknown occurrences of all special concern species to the Michigan Natural Features Inventory and the appropriate DNR Division.
4. Determine population status, habitat requirements, and threats to species of special concern.
5. Evaluate effectiveness of management actions that address threats to population of special concern species, such as habitat destruction and loss from increased development and recreation, industrial and agricultural effects, disease, predation, inadequate protection by existing laws, pollution, hydrological disruptions, and competition from introduced nonnatives.

6. Communicate through MNFI comments and compartment reviews the known occurrences of species of special concern to land managers in all divisions prior to planned intrusive work activities.
7. Avoid the taking of any species of Special Concern.
8. Develop management guidelines for species of special concern and their associated habitats using the best available science.
9. Eliminate competition from nonnative species whenever and wherever possible.
10. Provide training to DNR staff on species of special concern identification and natural history.

Standards:

1. DNR Forest Certification Work Instruction 1.4 – Biodiversity Management on State Forest Lands.
2. DNR Forest Certification Work Instruction 3.1 – Forest Operations
3. DNR Forest Certification Work Instruction 7.1 – Timber Sale Preparation and Administrative Procedures.

Monitoring criteria.–

Statewide Criterion 1 – Conservation of Biological Diversity, Indicators 1.1, 1.2, 1.3

Guidelines:

1. When and where possible, treat special concern and federal candidate species with similar management consideration as threatened and endangered species (as appropriate to federal or state listing).
2. When completed, consider Candidate Conservation Agreements with Assurances in management planning and implement whenever applicable.
3. Consider restoration of degraded habitat when such potential areas are identified.
4. Prior to development of management plans or the implementation of management prescriptions and when identification of a community type indicates the probability of a special concern plant or animal being in or near a proposed forest treatment, use the Michigan DNR Approach to the Protection of Rare Species and Rare Species Assessment, Guidelines for DNR staff on State Forest Lands (July 12, 2006).
5. Use DNR FMFMD Form R4031-6, Pre-Timber Sale Checklist, for noting the presence of species of concern, and implementing measures to mitigate adverse effects during forest prescriptions.
6. Use MNFI Species and Natural Community abstracts as additional reference in the identification and management of species of special concern.
7. Use the U.S. Fish and Wildlife Service, Region 9 Conservation Assessments and Approaches.

4.1.5 Land Ownership and Use Management

4.1.5.1 Easements

Desired future condition.–The state forest is managed to provide reasonable access for public or private purposes in the form of easements, subject to other ecological and socio-economic uses of the forest resource. The DNR holds conservation easements upon private lands to maintain ecological

values of landscape level forests and to provide public access to these lands for socio-economic purposes.

Goals:

1. Maintain easements which have been purchased for the purpose maintaining public access to forestlands or other facilities.
2. Preserve existing easements upon state forestland for uses such as private access and utility corridors.
3. Evaluate applications for new easements upon state forestland for fragmentation and biodiversity effects.
4. In coordination with planning efforts and/or partners, consider the use of conservation easements on commercial forest lands as one tool for achieving agreed upon social, economic or ecological values.

Objectives:

1. Where feasible, minimize forest fragmentation by using existing road right of ways for new utility easements.
2. Encourage clustering multiple easements into common corridors.
3. Use native or approved nonnative species for revegetation of right of ways.
4. Encourage mechanical versus chemical maintenance of right of ways.
5. Assess requests for easements across state-owned lands will be in accordance with the provisions of Parts 21 and 351 of the NREPA.

Standards:

1. Part 21, General Real Estate Powers, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
2. Part 351, Wilderness and Natural Areas, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
3. NRC Policy 4605 Easement for the Use of State Lands, issued December 8, 1994.
4. DNR Policy and Procedure 26.01-01, Use Permits and "Department as Lessor" Leases – Question and Answer Reference, issued January 13, 2005.
5. DNR Policy and Procedure 26.26-16, Permit and Easement Administration on State Lands, issued July 11, 2005.
6. DNR Policy and Procedure 28.46-05, Easement for the Use of State Lands, issued July 11, 2005.
7. DNR FMFMD Policy and Procedure 212, Easements, issued December 13, 1999.
8. DNR Forest Certification Work Instruction 2.2 – Use of Pesticides and Other Chemicals on State Forest Lands.
9. DNR Forest Certification Work Instruction 6.2 – Integrating Public Recreational Opportunities with Management on State Forest Lands.

Monitoring criteria.–

Statewide Criterion 5 – Ownership Patterns, Indicators 5.1, 5.2

Private lands conservation easement terms

Guidelines:

1. Relinquish jurisdiction of either existing DNR roads or rights-of-way for proposed roads or portions thereof to other agencies only through "due process", as provided by law. Such procedure should include the proper encumbrance of state land records through the issuance by the DNR of a duly executed easement designating the right-of-way alignment and width along with other pertinent information.

4.1.5.2 Use Permits and Surface Lease Uses

Desired future condition.–The state forest is managed to provide reasonable use through issuance of surface use permits and surface use leases, subject to resource and socio-economic values of the land.

Goals:

1. Subject to other management objectives, provide and maintain surface use permits and leases for use of forestland.

Objectives:

1. Provide consistent statewide review and appropriate fee determination process for applications to use state-owned lands.
2. Issue use permits that protect and enhance the public trust while providing for the use and enjoyment of those lands as outlined in the Natural Resources and Environmental Protection Act.
3. Issue use permits consistent with public interest and natural resource values.

Standards:

1. Part 5, Department of Natural Resources, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (MCL 324.502-503).
2. DNR Policy and Procedure 26.01-01, Use Permits and “Department as Lessor” Leases – Question and Answer Reference, issued January 13, 2005.
3. DNR Policy and Procedure 26.04-04, Use of State-Owned Lands Administered by the Michigan Department of Natural Resources, issued February 1, 2006.

Monitoring criteria.–

Statewide Criterion 4 – Recreation, Indicator 3.4

4.1.5.3 Acquisition and Disposal

Desired future condition.–Acquisition and disposal of land consolidates DNR ownership, improves access, habitat connectivity, and recreational opportunities, and protects unique natural resource and cultural values which are best held in long-term public ownership.

Goals:

1. Consolidate state ownership wherever possible.

Objectives:

1. Review all lands lying outside of dedicated state forest boundaries to determine which of those lands are not contributing sufficiently to the DNR mission to warrant their continued ownership by the DNR.
2. Exchange or sell those lands that are not contributing to the DNR mission to obtain land of greater natural resource or recreational value.
3. Purchase private land located within dedicated state forest boundaries, with a priority for acquisition of private inholdings from willing sellers.
4. Obtain mineral rights of severed surface lands within dedicated boundaries to improve the ability to manage property by controlling mineral development.
5. Assess proposals for acquisition and disposal of lands in accordance with provisions of the Natural Resources and Environmental Protection Act.

Standards:

1. Part 5, Department of Natural Resources, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (MCL 324.502a-503).
2. Part 19, Natural Resources Trust Fund, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (MCL 324.1901-1910).
3. Part 21, General Real Estate Powers, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (MCL 324.2101-2121 and 324.2130-2147).
4. NRC Policy 1042, Michigan Recreation Land Trust Fund, issued November 3, 1978.
5. NRC Policy 2626, Abandoned Railroad Rights-Of-Way, issued April 13, 1973.
6. NRC Policy 2627, Department Land Holdings, issued March 8, 2003.
7. DNR Policy and Procedure 26.01-01, Use Permits and "Department as Lessor" Leases – Question and Answer Reference, issued January 13, 2005.
8. DNR FMFMD Policy and Procedure 222, Land Acquisition, issued December 30, 1987.

Monitoring criteria.–

Statewide Criterion 5 – Ownership Patterns, Indicators 5.2, 5.3

4.1.5.4 Boundary Designation and Signage

Desired future condition.–State forestland has clearly defined boundaries which facilitate public land administration for all ecological and socio-economic values of the state forest.

Goals:

1. Manage the boundaries of the state forest for the mutual respect of both public and private lands.

Objectives:

1. Conduct surveys and place boundary signs clarifying the limits of concentrated recreation sites in order to prevent trespass upon private properties.
2. Provide notice of the area designation and of restricted activities by posting signs in appropriate locations along the borders of state Parks, wilderness areas, wild areas, and natural areas.

3. Designate timber sale boundaries adjacent to other ownerships with paint to avoid trespass.
4. Locate and survey all property corners on state land.
5. Protect surveyed property corners in the contract language of commercial and noncommercial forest prescriptions.

Monitoring criteria.–

Statewide Criterion 5 – Ownership Patterns, Indicators 5.2, 5.3

4.1.6 Minerals & Geology

4.1.6.1 Oil, Gas, and Metallic and Nonmetallic Mineral Development

Desired future condition.–The state forest provides for the extraction of oil, gas, and mineral resources for the benefit of people and the economy of the state without negatively affecting the sustainability of healthy ecosystems or other socio-economic values.

Goals:

1. Develop oil, gas, and metallic and nonmetallic minerals in a manner consistent with public interest and natural resource values and in a manner to ensure an optimum economic return to the state, competition for the acquisition of leases, protection of the environmental, recreational, and other uses of the land.

Objectives:

1. Manage state owned oil, gas and metallic and nonmetallic minerals in a manner that protects and enhances the public trust.
2. Encourage the private sector rather than the state to risk capital in exploration and development.
3. Seek to optimize revenue from state-owned oil, gas and metallic and nonmetallic resources, consistent with other natural resource management objectives and with consideration of other uses of the forest.
4. Maintain ecosystem integrity and function in areas of oil, gas, and metallic and nonmetallic development.
5. Leases for exploration or extraction of minerals shall be in accordance with the provisions of the Natural Resources and Environmental Protection Act, 1994 PA 451.
6. After extraction operations cease, complete restoration or reclamation of oil, gas, and metallic and nonmetallic mineral sites in accordance with plans that are required as a condition of the lease.

Standards:

1. Part 5, Department of Natural Resources, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (MCL 324.502-503).
2. Part 7, Forest and Mineral Resource Development, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (MCL 324.701-705).
3. Part 351, Wilderness and Natural Areas, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

4. NRC Policy 1042, Michigan Recreation Land Trust Fund, issued November 3, 1978.
5. DNR Policy and Procedure 26.04-04, Use of State-owned lands administered by the MDNR, issued February 1, 2006.
6. DNR Policy and Procedure 26.50-02, Underground Gas Storage Leases – State-owned Lands, issued July 11, 2005.
7. DNR Policy and Procedure 27.01-28, Retention of Mineral Rights, issued July 11, 2005.
8. DNR Policy 27.23-01, Great Lakes Bottomlands Leases – Sand, Gravel, Stone and Fill Material, issued March 11, 2005.
9. DNR Policy and Procedure 27.23-07, Gas Transmission and Distribution Lines – Reporting of Breaks in Gas Lines, issued July 11, 2005.
10. DNR Policy and Procedure 27.23-08, Sale or Reservation of Mineral and Allied Rights in Tax-Reverted Lands, issued July 11, 2005.
11. DNR Policy and Procedure 27.23-09, Nonmetallic Minerals on State Lands, issued July 11, 2005.
12. DNR Policy and Procedure 27.23-12, Metallic Minerals Leasing Policy –State-Owned Lands, issued July 11, 2005.
13. DNR Policy and Procedure 27.23-13, Oil and Gas Wellsite Applications – State-Owned Lands, issued July 11, 2005.
14. DNR Policy and Procedure 27.23-14, Oil and Gas Leasing Procedure, issued July 11, 2005.
15. DNR Policy and Procedure 27.23-15, Oil and Gas Lease Classification Procedure, issued July 11, 2005.
16. DNR Policy and Procedure 27.23-16, Minerals Management Procedures, issued July 11, 2005.
17. DNR Policy and Procedure 27.23-18, Oil and Gas Lease Maintenance Procedures, issued July 11, 2005.
18. Fisheries Division Policy and Procedure 02.01.005 Mineral Lease Management
19. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
20. DNR Forest Certification Work Instruction 3.2 – Best Management Practices Non-Conformance Reporting Instructions.

Monitoring criteria.–

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicator 2.1

Statewide Criterion 6 – Economic Health, Indicators 6.1, 6.2

4.1.6.2 Unique Geologic Formations

Desired future condition.–Michigan's geologic features (including waterfalls, Great Lakes fossil beds, karst features, sand dunes, and the Lake Superior Syncline) provide an opportunity for education about the geology of Michigan and a variety of ecological and socio-economic values to the citizens of the state.

Goals:

1. Manage for protection, preservation, and the public trust identified unique geological features under state ownership.

Objectives:

1. Provide reasonable access to unique geological features while protecting them for future generations.

2. Protect and manage unique geological features that are co-located upon privately-owned property and upon DNR lands in a cooperative manner.
3. Recognize in ecoregional management plans unique geological features that are located entirely upon other public or privately-owned properties within the landscape.

Standards:

1. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
2. DNR Forest Certification Work Instruction 7.1 – Timber Sale Preparation and Administration Procedures.

Monitoring criteria.–

Statewide Criterion 3 – Social/Cultural/Spiritual, Indicator 3.2

Guidelines:

1. Use tools such as acquisition and purchase of development rights to protect unique geological formations that are co-located upon DNR and private property.
2. Use DNR FMFMD Form R4031-6, Pre-Timber Sale Checklist, for noting the presence of unique geological formations, and implementing measures to mitigate adverse effects during forest prescriptions.

4.1.7 Forest Pest Management

4.1.7.1 Native Species

Desired future condition.–The state forest is maintained in a healthy condition that minimizes loss of ecological and socio-economic productivity and values due to insect and disease infestations.

Goals:

1. Protect forest health by using Integrated Pest Management principles to monitor, detect, evaluate, and perform nonregulatory control of all forest pests on state lands, to reduce losses in ecological condition and forest productivity from reduced growth rates and increased mortality, and to improve the quality and quantity of forest resource commodity yields and noncommodity values by minimizing the negative effect of forest insects and disease.
2. Work cooperatively with multiple agencies (including MDA) to conduct pest detection, monitoring, and evaluation programs on private land while assisting private forest landowners regarding the need for control and appropriate control efforts and procedures.
3. Promote healthy and productive forest conditions by using silvicultural systems and prescriptions to lower natural susceptibility and vulnerability of timber stands to insect and disease outbreaks.
4. Use all appropriate tools and tactics in forest pest management to prevent economically significant pest damage without disrupting the environment.

Objectives:

1. Tolerate endemic levels of pest populations in order to minimize the use of chemical pesticides and biological control agents in the achievement of management objectives.

2. Prescribe salvage cuts through the compartment review process where forest stands are predisposed or subject to severe disease or insect infestations.
3. Identify potential pests and assess their potential effect upon identified key landownership values, state forest management objectives, and the management needs of forest stands.
4. Use surveys on both state and private forestland to regularly monitor pest populations, symptoms of insects and disease in stand conditions, and stresses which may predispose stands to secondary pests. Economically and socially sound alternatives will be recommended to minimize the effect of insect or disease problems.
5. Acquire and deliver pest management information that is credible, accurate, and scientifically valid to field staff.

Standards:

1. DNR Policy and Procedure 28.46-03, Pesticides and other Toxic and/or Persistent Chemicals – Use of in Department Programs, issued July 11, 2005.
2. DNR Forest Certification Work Instruction 2.2 – Use of Pesticides and other Chemicals on State Forest Lands.
3. DNR Forest Certification Work Instruction 2.3 – Integrated Pest Management and Forest Health.
4. DNR FMFMD Policy and Procedure No. 591, Forest Pest Management, dated June 14, 1988.
5. DNR FMFMD Policy and Procedure No. 592, Pesticide Use, dated October 26, 1999.
6. DNR FMFMD Policy and Procedure No. 593, Gypsy Moth Management Policy, dated June 14, 1988.

Monitoring criteria.–

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicator 2.1

Guidelines:

1. Report observations of insect and disease infestations using DNR FMFMD Form R4029-3, Forest Health Field Report.
2. Seek input from a variety of forest resource specialists and managers to fully implement Forest Pest Management.
3. Where disease infestation or fire/windthrow disturbance mortality is extensive, pre-salvage or salvage of forest products may be appropriate within the limits for downed woody debris prescribed by DNR Within-Stand Retention Guidance.
4. Use chemical pesticides when they are legal, reasonably cost effective, meet management objectives, and optimize the natural mortality factors in the ecosystem to reduce or maintain populations of organisms at tolerable or endemic levels. Economic, ecological, and social values will be used in determining tolerable levels.
5. Use alternatives to chemical pesticides when they are legal, reasonably cost effective, and available and meet management objectives. When chemical pesticides are used, the least-toxic, most effective, narrowest spectrum products labeled for the target species should be selected.
6. When using biological controls to kill pests, use only host specific predators, parasites and pathogens with proven effectiveness.
7. Use silvicultural management to manipulate the environment to make it more favorable for desirable plant growth and less favorable for pest growth.

8. Use cultural controls, such as good site selection, harvesting over-mature jack pine, or planting resistant varieties, to prevent pest populations from building to unacceptable levels.

4.1.7.2 Nonnative Invasive Species

Desired future condition.–The state forest is adequately protected from nonnative invasive plants, animals and diseases that degrade ecological and socio-economic values and productivity, or the biological effect of such species is mitigated to the extent possible. The biological effect of such species is mitigated to the extent possible.

Goals:

1. Prevent the introduction of new nonnative invasive plants, animals, and diseases into Michigan.
2. Use risk assessments to identify and prioritize which invasive species will be controlled and managed, and where such actions will be taken.
3. Where feasible, detect, monitor, and manage existing and new nonnative invasive plants, animals and diseases to mitigate effects and prevent spread to unaffected at-risk resources.
4. Strive to restore or rehabilitate affected areas.

Objectives:

1. Establish a regular review process with the U.S Department of Agriculture—Animal and Plant Health Inspection Service (USDA–APHIS) and other partners (such as Michigan Department of Transportation and DEQ) to conduct pathway and species risk assessments for nonnative invasive plants, animals and diseases, and to add or remove species from the priority list for regulatory or prevention action and for active control (where feasible and cost effective).
2. Work with the USDA–APHIS, the Michigan Department of Agriculture and other partners to minimize or close nonnative invasive pest pathways for priority species.
3. Based on risk assessment information, develop and implement best management practices, and contract and permit language for forest resource management to prevent, control, or minimize the spread of priority invasive species.
4. Develop statewide, regional and local maps of priority areas, ecosystems, and habitats placed at risk by nonnative invasive species.
5. Cooperate with MSU and other partners to synthesize, develop, and maintain a comprehensive database and distribution maps of nonnative invasive species.
6. Based on risk assessments, maps of priority areas, and distribution maps of invasive species, focus resources for prevention and control on priority species and areas.
7. Work with national, state, local, and university partners to establish, train, and certify a regional network of early detection develop rapid response incident teams that cross jurisdictional lines and have the authority to act quickly respond to newly detected infestations of priority species with appropriate control techniques.
8. Use the compartment review process to conduct detection and evaluation surveys for priority nonnative invasive forest plant, animal, and disease species and to assess the effectiveness of treatments.
9. Use forest management prescriptions for appropriate species-specific methods to eradicate undesired invasive plants and animals at priority sites, focusing efforts on outlier populations or high-effect species.

10. Where eradication of nonnative invasive species is not possible or cost effective, control such populations on priority sites using manual, mechanical, chemical, prescribed fire, or species specific biological means.
11. Monitor long-term nonnative invasive forest plant, animal, and disease species population trends.
12. Identify information gaps for managing invasive species and communicate to the research community.
13. Cooperate in detection, monitoring and evaluation programs on private lands while assisting private forest landowners regarding the need for appropriate control efforts and procedures and providing direction for available resources.
14. Develop tools to communicate current prevention and awareness information on nonnative invasive species to all public and private stakeholders.
15. Prioritize and develop native plant stock that is resistant to invasive insects and pathogens.
16. Expand use of preventive measures, such as requiring certified weed-free seed and other materials for restoration, requiring the use of certified weed-free hay, and controlling the unregulated movement of nonnative invasive species in firewood.

Standards:

1. Part 413, Transgenic and Non-Native Organisms, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
2. NRC Policy 2001, Non-Indigenous Aquatic Nuisance Species, issued March 11, 1993.
3. DNR Forest Certification Work Instruction 2.1 – Reforestation.
4. DNR Forest Certification Work Instruction 2.2 – Use of Pesticides and other Chemicals on State Forest Lands.
5. DNR Forest Certification Work Instruction 2.3 – Integrated Pest Management and Forest Health.
6. Fisheries Division Policy and Procedure 02.02.14 Aquatic Nuisance Control.

Monitoring criteria.–

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicator 2.1

Guidelines:

1. Report observations of nonnative species infestations using DNR FMFMD Form R4029-2 Gypsy Moth Egg Mass Survey, DNR FMFMD Form R4029-3 Forest Health Field Report, and DNR FMFMD Form R4029-4 Invasive Plant Report.
2. Where nonnative insects threaten the health and functioning of native ecosystems more immediate and proactive control methods may be appropriate.
3. Give preference to the planting of native species over nonnative tree and other plant species for restoration and rehabilitation projects.
4. Use the Michigan Invasive Plant Council website (http://invasiveplantsmi.org) as a reference for the formal list of invasive plants in Michigan, a full description of the listing process, and other invasive plant information and links.
5. Use the 'Invasive Plant Species of Michigan' pocket guide (Borland 2007) for the identification of invasive plant species.

4.1.8 Fire Management

4.1.8.1 Fuel Management

Desired future condition.–The state forest is managed to maintain fuel loads within the range of natural specific ecosystem variability in order to minimize adverse effect to ecological and socio-economic values.

Goals:

1. Reduce excessive fuel loads outside of the natural range of variability for specific community types to reduce the hazard of catastrophic wildfires to forest resources and public and private facilities.
2. Work with other fire agencies and local units of government to encourage land owners and residents within the wildland-urban interface to reduce excessive fuel loads and to establish "defensible space" landscapes around structures.

Objectives:

1. Prescribe salvage cuts where appropriate to reduce fuel loads in areas with extensive mortality due to disease or insect infestations, while also considering the biodiversity values associated with snags and large woody debris.
2. Reduce the potential for large crown fires in conifer species by reducing the occurrence of fuel ladders, excessive basal area, and inadequate crown spacing. The vegetation management program is the primary means by which this will be accomplished.
3. Identify "communities at risk" and "fire prone landscapes" as geographic areas of possible concern.

Standards:

1. DNR FMFMD Policy and Procedure 251, Sale and Removal of Timber, issued March 1, 2000.

Monitoring criteria.–

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicators 2.1, 2.4

Guidelines:

1. Through forest management prescriptions, strive to balance the retention of forest litter, large woody debris, and snags with a reduction of excessive fuel loads that can contribute to catastrophic stand fires, which result in the loss of biomass and the alteration of carbon balances.

4.1.8.2 Prescribed Fire

Desired future condition.–The state forest employs prescribed fire as a natural management tool, within the context of other ecological and socio-economic uses.

Goals:

1. Use prescribed fire as a natural tool for maintaining healthy conditions in fire-adapted ecosystems and landscapes.
2. Use prescribed fire to help maintain fuel breaks.

Objectives:

1. Prioritize all approved department prescribed burns by October 1st of each year.
2. Use prescribed burning in the forest stands to reduce competition for the growth of desired herbaceous and woody vegetation and for site preparation for forest regeneration.
3. Use prescribed burning in grassland areas to control encroachment by brush and trees.
4. Use prescribed burning in dedicated state Natural Areas and other areas of the state forest that contain communities where periodic fire is a natural ecologic process for the purpose of simulating natural conditions for the preservation or restoration of plant or wildlife species.
5. Use prescribed burning on other DNR-owned lands within the landscape (Parks and Wildlife divisions managed areas).
6. As determined by Operations Inventory/IFMAP prescriptions and within weather and budgetary constraints, attempt to conduct a minimum of 25 prescribed burns each year on the state forest.
7. Use prescribed fire to maintain fuel breaks on a 3–4 year rotation.
8. Conduct on an annual basis as many priority-one prescribed burns as possible to restore or maintain needed habitat and to prepare sites for forest regeneration work.

Standards:

1. NRC Policy 4208, Burning – Prescribed, issued January 1, 1977.
2. DNR Policy and Procedure 33.42-08, Prescribed Burning, issued July 11, 2005.
3. DNR Policy and Procedure 33.42-09, Wildfires in State Natural Areas, issued July 11, 2005.
4. DNR FMFMD Policy and Procedure 512, Annual Fire Plan, dated December 13, 1999.
5. DNR FMFMD Policy and Procedure 581, Prescribed Burning, undated.

Monitoring criteria.–

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicator 2.1

Guidelines:

1. Judiciously use prescribed fire in order to maintain and restore species biodiversity in fire adapted ecosystems.

4.1.8.3 Fire Prevention

Desired future condition.–The state forest is free from human-caused wildfire, in order to minimize adverse effect to ecological and socio-economic values.

Goals:

1. Reduce the number of human caused wildfires.
2. Reduce the risk of large crown fires in conifer cover types.

Objectives:

1. Work in conjunction with other wildfire agencies to raise the public awareness of wildfire conditions during periods of high wildfire danger.
2. Use prescribed burns in concert with silvicultural prescriptions for the purpose of reducing fuel loads before hazardous conditions are reached, especially to reduce the potential for large crown fires in conifer cover types.
3. Reduce the number of human caused wildfires through public education and the regulation of open burning with the issuance of burn permits.

Standards:

1. NRC Policy 4206, Burning - Control of Open Burning, issued June 8, 1989.
2. DNR FMFMD Policy and Procedure 521, Forest Fire Law, dated June 16, 1981.
3. DNR FMFMD Policy and Procedure 522, Control of Open Burning, dated June 16, 1981.
4. DNR FMFMD Policy and Procedure 561, Smokey Bear Costume, dated February 15, 2001.

Monitoring criteria.–

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicators 2.1, 2.4

4.1.8.4 Fire Suppression

Desired future condition.–The DNR protects the health and safety of the public by effectively coordinating the suppression of wildfires that occur upon all ownerships within a protection area, incorporating the need to protect private property and ecological and socio-economic values, and also ensuring the health and safety of firefighters.

Goals:

1. The DNR Forest, Mineral, and Fire Management Division functions as the lead agency in wildfire management in the state.
2. Forest, Mineral, and Fire Management Division field offices are staffed and equipped to provide wildfire suppression action as called for in Fire Management Plans.
3. Provide wildfire training to DNR firefighters and local fire department personnel per an agreement with the Michigan Fire Fighter's Training Council. All DNR firefighters will be trained to National Wildfire Coordinating Group standards as laid out in the Forest, Mineral, and Fire Management training standards.
4. Participate in state wide interagency wildfire organizations and the Great Lakes Forest Fire Compact.

Objectives:

1. Work in conjunction with other wildfire agencies to attempt to contain most wildfires to 10 acres or less in size.
2. Ensure that annual refresher training for DNR wildland firefighters includes familiarization with assigned wildland fire equipment.
3. Promote efforts designed to increase the capability of local fire departments, including programs such as the Volunteer Fire Assistance Program, Federal Excess Property Program,

GSA Purchasing Program and Fire Fighters Training Council Wildland Fire Training Programs.

4. Review employee training and qualification records annually to assure that they progress toward and maintain wildland fire suppression qualifications identified for them in the "Michigan Addendum to the National Wildfire Coordinating Group (NWCG) National Interagency Incident Management System (NIIMS) Wildland Fire Qualification System Subguide PMS 310-1".
5. Encourage DNR FMFM land managers and other DNR employees to maintain wildland fire qualifications and CDL qualifications.
6. Conduct wildfire detection according to daily fire danger levels.
7. On each wildfire incident under DNR jurisdiction, implement the Incident Command System to guarantee safe and effective conduct of the suppression effort.
8. Ensure that the Incident Commander conducts an After Action Review for all incidents that have at least 3 responding resources, and that the Marquette and Roscommon Incident Coordination Centers conduct an Administrative Fire Analyses for all Type 3 incidents managed by DNR.

Standards:

1. DNR Policy and Procedure 33.42-09, Wildfires in State Natural Areas, issued July 11, 2005.
2. DNR FMFMD Policy and Procedure 111, Field Office Staff/Hours of Work for Fire Control, dated May 19, 2004.
3. DNR FMFMD Policy and Procedure 141, Wildfire Training for Fire Departments, dated October 22, 1999.
4. DNR FMFMD Policy and Procedure 161, Physical Fitness Standards, dated February 17, 2000.
5. DNR FMFMD Policy and Procedure 512, Annual Fire Plan, dated December 13, 1999.
6. DNR FMFMD Policy and Procedure 511, Five-Year Unit Management Planning, undated.
7. DNR FMFMD Policy and Procedure 513, Administrative Fire Analysis, undated.
8. DNR FMFMD Policy and Procedure 514, Incident Command System
9. DNR FMFMD Policy and Procedure 521, Forest Fire Law, dated June 16, 1981.
10. DNR FMFMD Policy and Procedure 542, Fire Operations Involving Structures, dated March 24, 1988.
11. DNR FMFMD Policy and Procedure 572, Wildfires in State Natural Areas, dated March 15, 2001.
12. DNR Forest Certification Work Instruction 8.1 – MDNR Staff Training for State Forest Management.

Monitoring criteria.–

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicator 2.1

4.1.9 Transportation System

4.1.9.1 Road Maintenance

Desired future condition.–The forest road system will be maintained for operation within accepted safety and environmental standards, providing for a variety of socio-economic values of the state forest.

Goals:

1. Provide a means of inventorying road infrastructure and tracking the maintenance needs of the state forest road system.
2. Seek to minimize adverse effects upon inland stream, lake, and wetland resources during the maintenance of forest roads.
3. Minimize public safety hazards during the maintenance of forest roads.

Objectives:

1. Inventory and construct a GIS data layer for the entire DNR road system, to include a systematic number identification system for the entire network.
2. Implement a road maintenance database for use in reporting, prioritizing, tracking and repairing BMP violations and other road improvement needs.
3. Repair, re-route or close forest roads with soil erosion and sedimentation problems, failed bridges or culverts, or other public safety issues.
4. Maintain state forest roads in accordance with best management practices.
5. Within two years, develop a set of DNR road maintenance standards and a road maintenance policy/procedure for implementation statewide.
6. Minimize public safety hazards during road maintenance activity via signing, temporary closure, or other means.

Standards:

1. Fisheries Division Policy and Procedure 02.01.007 Stream Crossings (Bridges, Culverts, and Pipelines).
2. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
3. DNR Forest Certification Work Instruction 3.2 – Best Management Practices Non-Conformance Reporting Instructions.
4. DNR Forest Certification Work Instruction 3.3 – Road Closures.

Monitoring criteria.–

Statewide Criterion 2 – Ecosystem Condition and Productivity, Indicators 2.5, 2.8

Guidelines:

1. All road maintenance should conform to (Draft) Sustainable Soil and Water Quality Practices on Forest Land (Michigan Department of Natural Resources and Michigan Department of Environmental Quality 2007).

4.1.9.2 Road Closure

Desired future condition.–The extent of the state forest road system (both permanent and temporary roads) will be limited to that necessary to provide adequate access for management of the forest and for access for recreation and other ecological and socio-economic values.

Goals:

1. To minimize fragmentation, littering, and resource damage to the forest, consider closure of roads that are not needed for access or management purposes and that are not part of a designated trail system.
2. Close or re-route roads that pose threats to threatened or endangered species, cultural and historic sites, or sensitive sites such as unique geological areas.

Objectives:

1. Identify roads that are significantly contributing to forest fragmentation, public safety or environmental quality (persistent soil erosion and sedimentation to lakes, stream or wetlands).
2. Discuss proposed nonemergency road closures in the public forum of compartment review process.
3. Restrict vehicle access on roads where there is a high potential for damage to natural resources.
4. At the ecoteam level, evaluate proposals and make recommendations for road system closures and other transportation system management issues from a landscape perspective, and ensure uniform and consistent policy and practices are applied within all FMUs.

Standards:

1. DNR Policy and Procedure 26.26-22, Closing of Logging Roads Constructed on State-Owned Land - Region I and II, issued July 11, 2005.
2. DNR Policy and Procedure 26.26-24, Private and Public Roads; Road Closures Affecting use of State Lands; Reporting Road Closures, issued July 11, 2005.
3. DNR Forest Certification Work Instruction 3.2 – Best Management Practices Non-conformance Reporting Instructions.
4. DNR Forest Certification Work Instruction 3.3 – Road Closures.

Monitoring criteria.–

Statewide Criterion 1 – Conservation of Biological Diversity, Indicator 1.2

Statewide Criterion 3 – Social/Cultural/Spiritual, Indicator 3.3

Statewide Criterion 4 – Recreation, Indicator 4.2

Guidelines:

1. An emergency road closure may be invoked when there is a public safety and/or a significant environmental concern, which includes, but is not limited to: deep rutting or the potential for deep rutting, sediment flow into a stream, flooding, failure of a bridge, culvert failure that results in significant stream sedimentation, threats to threatened or endangered species, and threats to unique geological areas and special cultural or historic sites.

2. A road constructed by a permittee on an old unused logging road or at a new location may be temporarily closed by the permittee for specific days during the period the timber sale permit is in force providing they do not use the road. If the permittee uses the road for any purpose, it shall be open to the public. A road which shows evidence of use before reconstruction or repair shall not be closed, even though it is repaired by the permittee. Lack of shrub or tree growth shall be considered evidence of use.
3. Methods for effective closure of temporary roads should consider road obliteration as opposed to simply berming.

4.1.9.3 New Roads

Desired future condition.–The construction of new permanent and temporary roads in the state forest will be limited to those necessary to provide adequate access for management of the forest and for access for recreation and other ecological and socio-economic values.

Goals:

1. Consider environmental affects upon the maintenance of ecological processes, introduction of invasive species, effects on threatened and endangered species, and areas of high unique biodiversity in new road planning.
2. Consider the social and economic values associated with or affected by new road construction, which include: use, forest health, fire protection, recreation, cultural uses, historical sites, and the administration of state lands to protect the public health and safety, and private access.

Objectives:

1. Prevent further fragmentation of currently intact forest areas, minimize the number and length of new logging roads and skid trails and make such roads temporary in nature.
2. Discourage new permanent roads for use in accessing private holdings by crossing state forestlands.
3. Give consideration to long-term funding opportunities and obligations in the construction and maintenance of new roads.
4. Engineer and build new state forest roads in accordance with best management practices.
5. Assess new or temporary roads in a proposed or legally dedicated wilderness, wild area or natural area in accordance with the provisions of Part 351 of the NREPA.

Standards:

1. Part 351, Wilderness and Natural Areas, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
2. Fisheries Division Policy and Procedure 02.01.007 Stream Crossings (Bridges, Culverts, and Pipelines).
3. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
4. DNR Forest Certification Work Instruction 3.2 – Best Management Practices Non-Conformance Reporting Instructions.
5. DNR Forest Certification Work Instruction 7.1 – Timber Sale Preparation and Administrative Procedures.

Monitoring criteria.–

Statewide Criterion 1 – Conservation of Biological Diversity, Indicator 1.2

Statewide Criterion 3 – Social/Cultural/Spiritual, Indicator 3.3

Statewide Criterion 4 – Recreation, Indicator 4.2

Statewide Criterion 5 – Ownership Patterns, Indicators 5.2, 5.3

Guidelines:

1. Construction of all new roads should conform to (Draft) Sustainable Soil and Water Quality Practices on Forest Land (Michigan Department of Natural Resources and Michigan Department of Environmental Quality 2007).
2. Use DNR FMFMD Form R4031-6, Pre-Timber Sale Checklist, for implementing measures to mitigate adverse affects of new road construction during forest prescriptions.

4.1.10 Law Enforcement

4.1.10.1 General Law Enforcement

Desired future condition.–Enforcement of natural resource laws protect human health and safety, educate the public, and maintain the sustainability of Michigan's resources.

Goals:

1. An adequate force of Conservation Officers is trained and equipped to effectively enforce fish, game, and other environmental law and to provide hunting and recreational safety education programs throughout the state.
2. An adequate force of commissioned state forest officers is trained and equipped to provide additional law enforcement, public education, and protection of natural resources in the state forest.

Objectives:

1. Enforce ORV certification requirements for riders (MCL 324.81129) statewide once ORV safety education classes are readily available.
2. Strengthen enforcement of ORV laws by increased patrols by conservation officers, Forest Service law enforcement, state park officers, and county sheriffs.
3. Provide ORV license dealers with copies of ORV laws and safety information.
4. Review annual forest officer work plans with Law Enforcement Division work plans along with other DNR divisions and agencies.
5. Require that forest officers attend annual recertification and update sessions.
6. Ensure that forest officers work cooperatively with local law enforcement agencies and DNR Law Enforcement Division Conservation Officers to provide additional support and to enhance the forest officer's education and enforcement skills.

Standards:

1. DNR Policy and Procedure 35.41-01, Issuance of Law Enforcement Commissions to Department Employees other than Regular Conservation Officers, issued July 11, 2005.
2. DNR Policy and Procedure 33.42-01, Enforcement of Forest Fire Laws, issued July 11, 2005.

3. DNR Natural Resources Commission Policy 2208, Off-Road Vehicle (ORV) Policy, issued June 9, 1994.
4. Michigan Off-Road Vehicle (ORV) Plan 2005.

Monitoring criteria.–

Statewide Criterion 7 – Institutional Processes, Indicator 7.1

4.1.10.2 Contract Enforcement

Desired future condition.–DNR contracts for ecological and socio-economic uses of the state forest are legally constructed, competitively bid, promptly executed, and expeditiously enforced.

Goals:

1. Administration of timber sale contracts, contracts for the maintenance of recreational trails, pathways and routes, and other contracts is in accordance with DNR standards.

Objectives:

1. Employ multi-year, competitive bid options for ORV trail and route maintenance, including opportunities to allow for-profit entities to compete for trail maintenance contracts.
2. Prepare timber sale contracts (stumpage sales) in accordance with policy and procedure using the Timber Sale and the Vegetation Management System programs.
3. Monitor and enforce timber sale preparation contracts to ensure that the work meets the intent of the prescription, complies with safety requirements, and that the measurements meet the contract standards.

Standards:

1. DNR Forest Certification Work Instruction 7.1 – Timber Sale Preparation and Administration Procedures.
2. DNR Forest Certification Work Instruction 7.2 – Legal Compliance and Administration of Contracts.
3. Administrative Guide to State Government, Sections 500 and 600.
4. DNR Administrative Procedure 13.01 – Sections 1-19.

Monitoring criteria.–

Statewide Criterion 7 – Institutional Processes, Indicator 7.1

4.1.10.3 Trespass

Desired future condition.–Incidents of trespass are minimized to reduce adverse effect upon the ecological and socio-economic values of the state forest.

Goals:

1. Identify, document, and resolve incidents of trespass upon state forestlands through administrative remediation, compensation, or civil action in accordance with applicable procedures and statutes.

2. Law enforcement staff levels are adequate to effectively address trespass issues.
3. Improve methods of public education for land use rules.
4. DNR staff is aware of state forest boundary locations.

Objectives:

1. Educate all DNR land management staff on dealing with trespasses and administering/enforcing state land use rules, policy and procedures, and statutes.
2. Document and enter all trespasses into the Statewide Trespass Tracking System within 60 days of discovery, and to provide notification to trespassers within 90 days of discovery.
3. Within the constraints of fiscal resources, dedicate additional staff throughout the state to resolve pending trespass cases and other land use issues.
4. Cooperate with Law Enforcement Division and the forest officer program to increase law enforcement presence in addressing trespass cases.
5. Make publicly available in DNR offices copies of state land use rules, trespass procedures, and applicable statutes.
6. Assess trespass on state-owned lands in accordance with provisions of the Natural Resources and Environmental Protection Act.

Standards:

1. Part 21, General Real Estate Powers, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (MCL 324.2155-2158).
2. Natural Resource Commission Policies: 2207, 2612, 2702, 5501
3. DNR FMFMD Policy and Procedures 212-215
4. DNR Forest Certification Work Instruction 1.6 – Forest Management Unit Analyses
5. DNR Forest Certification Work Instruction 6.1 – Implementing Public Information and Education Opportunities on State Forests
6. DNR Forest Certification Work Instruction 7.2 – Legal Compliance and Administration of Contracts
7. DNR Policy and Procedure: Section 26 (various), 28-46.05, 32-22.07

Monitoring criteria.–

Statewide Criterion 7 – Institutional Processes, Indicator 7.1

4.1.11 Governmental and Stakeholder Relations

4.1.11.1 Tribal

Desired future condition.–The DNR seeks input from Native American tribes in the management of the ecological and socio-economic values of the state forest.

Goals:

1. Recognize Native American tribes as sovereign governments with a unique status as key partners in the protection and sustainable management of the natural resources and heritage of the state.

2. Honor all 1836 and 1842 treaty obligations with Native American tribes, within a government to government relationship, and adhere to the provisions of all court rulings pertaining thereto.
3. Expand systematic coordination, cooperation, and information sharing with tribal governments in the management of state forestlands, using a wide array of stakeholder, focus groups, and citizen advisory committees.

Objectives:

1. Expand systematic coordination, cooperation and information sharing with Native American Nations by inviting the tribes to fully participate in all ecoregional and forest planning processes.
2. Consider tribal rights reserved by treaty, spiritual, cultural values and practices, archaeological and heritage resources, and adjacent reservation and trust lands in ecoregional management plans.
3. DNR field staff will ensure that the federally-recognized tribes are included in ecoregional planning processes, invited to FMU open houses, notified of compartment reviews, and informed of the locations of upcoming year-of-entry compartments prior to the start of field inventory.
4. Notify the Tribal Historical Preservation Officers of any activities involving federal funding, which may affect tribal archeological sites or tribal cultural property.
5. Prior to initiating active management activities, DNR management staff will check with the Department of History, Arts, and Libraries, State Historic Preservation Office staff to determine if locations involve sites of historical significance such as tribal religious, cultural, or historical sites.

Standards:

1. 2007 Consent Decree for 1836 Treaty, dated November 2, 2007.
2. DNR Forest Certification Work Instruction 9.1 – Collaboration with tribes in Regard to Management of State Forest Lands.
3. All archeological, cultural, spiritual, and other sites of traditional interest related to Michigan tribes are considered confidential and proprietary information that is exempt from the Freedom of Information Act.

Monitoring criteria.–

Statewide Criterion 3 – Social/Cultural/Spiritual, Indicator 3.1
Statewide Criterion 7 – Institutional Processes, Indicator 7.2

4.1.11.2 Federal and Local Government

Desired future condition.–The DNR cooperates with federal and local units of governmental organizations in the management of the ecological and socio-economic values of the state forest.

Goals:

1. Expand systematic coordination, cooperation, and information sharing with both federal and local units of government in the management of state forestlands, using a wide array of stakeholder, focus groups, and citizen advisory committees.

2. Strive to strengthen and diversify local economies by supporting diversified forest uses and products. This should be accomplished efficiently and without compromising forest composition, structure, or ecological function.

Objectives:

1. Coordinate with federal agencies and managers in the regional landscape on the conservation of High Conservation Value Areas.
2. Encourage compliance by local units of government with Part 811, Off-Road Recreational Vehicles, of the NREPA, which limits ORV use and designated ORV trail/route/area access along streets and highways under local jurisdiction to the requirements of the state comprehensive ORV system plan.
3. Seek increased ORV funding for county sheriff departments to acquire appropriate ORV enforcement patrol equipment and to provide additional patrol hours.

Standards:

1. Part 811, Off-Road Recreational Vehicles, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (MCL 324.81131).
2. DNR Policy and Procedure 33.42-02, Extension of Federal Excess Property Program to Local Fire Departments, issued July 11, 2005.
3. DNR Policy and Procedure Series 15 – Federal.
4. DNR Policy and Procedure Series 20 – Grants Administration.
5. DNR Forest Certification Work Instruction 1.5 – Social Impact Considerations and Public Involvement Processes.
6. DNR Forest Certification Work Instruction 6.1 –Implementing Public Information and Educational Opportunities on State Forests.

Monitoring criteria.–

Statewide Criterion 7 – Institutional Processes, Indicator 7.2, 7.3

Guidelines:

1. Encourage the efficient use of the forest's multiple products and services to ensure economic viability and a wide range of environmental and social benefits, while taking into account environmental, social, and operational costs of production, and ensuring the investments necessary to maintain the ecological productivity of the forest.
2. Encourage multiple uses of forests and, where economically competitive, local processing of forest products, in line with efficient and ecologically-sound management and in collaboration with partners, forest policy, and procedures.

4.1.11.3 Nongovernmental Organizations

Desired future condition.–The DNR cooperates with nongovernmental organizations and citizens groups in the management of the ecological and socio-economic values of the state forest.

Goals:

1. Expand systematic coordination, cooperation, and information sharing with nongovernmental organizations in the management of state forestlands, using a wide array of stakeholder, focus groups, and citizen advisory committees.
2. Respond to public needs and concerns and capitalize on valuable public input to DNR initiatives. The effectiveness of the DNRs programs will be amplified by developing and maintaining professional relationships.

Objectives:

1. Coordinate with nongovernmental forest owners in the regional landscape on the conservation of High Conservation Value Areas.
2. Seek additional cooperators as grant recipients for maintenance and capital improvements of motorized ORV and snowmobile trail systems.
3. Continue to seek cooperative agreements with conservancies and other similar organizations for the purpose of conserving forestlands and other natural resources having significant ecological or social-economic values.
4. The department will develop a strategy for comprehensively reviewing its stakeholder input/participation mechanisms in order to identify and implement opportunities for improving overall stakeholder satisfaction with DNRs efforts at transparency.
5. Seek to make the compartment review open houses more effective by inviting all known stakeholders and contractors, and through improved public notification techniques.

Standards:

1. DNR Policy and Procedure 17.01-03, DNR Employee's Involvement with Stakeholder and Public Working Groups, issued May 24, 2005.
2. DNR Policy and Procedure Series 19 – Freedom of Information Act (FOIA).
3. DNR Policy and Procedure Series 20 – Grants Administration.
4. DNR Forest Certification Work Instruction 1.5 – Social Impact Considerations and Public Involvement Processes.
5. DNR Forest Certification Work Instruction 6.1 –Implementing Public Information and Educational Opportunities on State Forests.

Monitoring criteria.–

Statewide Criterion 7 – Institutional Processes, Indicators 7.2, 7.3

Guidelines:

1. Seek a diversity of public participation to measure and assess the social effects of forest management. Means of involvement range from routine FMU open houses, ongoing open compartment reviews through episodic and direct meetings by FMU staff with a wide array of stakeholders, focus groups, and citizen advisory committees.
2. Where there is no conflict with operational management plans, encourage the conduct of basic scientific research on state forestlands. Such research may be conducted by DNR research staff, or may be conducted in cooperation with public or private university staff and/or students, federal government agencies, or other private or nonprofit organizations.

3. In addition to maintaining and distributing appropriate written informational brochures and publications, use web pages to provide information and links to other information sources.

4.1.12 Research and Education

Desired future condition.–The DNR works cooperatively with state universities and private organizations to fund research that will further develop knowledge and methods for sustainable management of the ecological and socio-economic values of the state forest, and to promote public education and outreach opportunities regarding sustainable resource management.

Goals:

1. Partner with university or organizational research projects in the forestry, wildlife, and fisheries sciences that will further develop knowledge and methods for sustainable natural resource management.
2. Provide public educational programs and opportunities that help build public understanding and appreciation for the important processes linking landscapes, ecosystems, habitats, and biological assemblages, and the human values and services derived from these natural systems.
3. Develop education and outreach opportunities and materials that include a scientific understanding of collaborative and sustainable resource management issues, resulting in increased stewardship and conservation of the state's aquatic resources by future generations.
4. Provide results of research projects completed on state lands to DNR staff.

Objectives:

1. Encourage and fund innovative and cooperative research for experimental approaches to naturally regenerate hardwood (such as oak, ash, and birch) and lowland conifer (cedar and black spruce) tree species.
2. Prioritize research on species of greatest conservation need and their habitat relationships using Michigan's Wildlife Action Plan (Eagle et al. 2005) for guidance.
3. Use the Wildlife Division Request for Research Proposal Process and Wildlife Research Priorities list to prioritize funding of research on wildlife species and their habitat relationships.
4. Develop informative materials (web or print based) related to sustainable resource management, diseases and invasive species management, and other topics of public interest.
5. Produce an annual research report that informs staff of the status of research funded by the department and/or conducted on state forestlands, which includes a list of completed studies and links to reports.
6. Promote the public use of generally accepted forest management practices.
7. Support comprehensive research activities related to bioenergy and alternative fuels from biomass.

Standards:

1. DNR Policy and Procedure 17.54-06, Displays and Exhibits – Guidelines, issued July 11, 2005.
2. DNR FMFMD Policy and Procedure 243, Tree Improvement, dated October 26, 1999.

3. DNR FMFMD Policy and Procedure 271, Forest Research and Experimentation, dated February 1, 2000.
4. 2008-12 Michigan State Comprehensive Outdoor Recreation Plan (Michigan Department of Natural Resources 2007).
5. DNR Forest Certification Work Instruction 5.1 – Coordinated Natural Resource Management Research.
6. DNR Forest Certification Work Instruction 6.1 – Implementing Public Information and Educational Opportunities on State Forests.
7. Michigan's Wildlife Action Plan (Eagle et al. 2005).
8. DNR Wildlife Division, Request for Research Proposal Process.

Monitoring criteria.–

Statewide Criterion 4 – Recreation, Indicator 4.3

Statewide Criterion 7 – Institutional Processes, Indicator 7.2

4.1.13 Department Administration

Desired future condition.–The DNR has adequate administrative support to sustain the effectiveness of resource programs.

Goals:

1. Provide administrative support to the resource programs.

Objectives:

1. Plan, manage, and report the DNRs revenues, and expenditures to the general public and other governmental agencies as needed or requested.
2. Provide DNR-wide oversight related to planning, acquisition, maintenance, and reporting of DNR assets to the general public and other governmental agencies as needed or requested.
3. Hire qualified personnel who are representative of the work force.
4. Provide safe working conditions and appropriate training that facilitates employee productivity.
5. Ensure each employee understands their role in achieving the DNRs goals and objectives.
6. Develop and maintaining information services and systems that provide available information for required scientific management decisions and services.

Standards:

1. DNR Policy and Procedure Series 01 – General Administration.
2. DNR Policy and Procedure Series 02 – Revenue.
3. DNR Policy and Procedure Series 03 – Accounting.
4. DNR Policy and Procedure Series 04 – Inventory.
5. DNR Policy and Procedure Series 05 – Travel.
6. DNR Policy and Procedure Series 08 – Records Management.
7. DNR Policy and Procedure Series 13 – Procurement.

8. DNR Policy and Procedure Series 14 – DNR-Owned (or Personal) Vehicles, Motorized Equipment, and Aircraft.
9. DNR Policy and Procedure Series 16 – DNR Facilities Management.
10. DNR Policy and Procedure Series 17 – Communications.
11. DNR Policy and Procedure Series 18 – Automated Systems Security.
12. DNR Policy and Procedure Series 21 – Personnel Manual.
13. DNR Policy and Procedure Series 25 – Legal Services.
14. DNR Forest Certification Work Instruction 7.2 – Legal Compliance and Administration of Contracts.

Monitoring criteria.–

Statewide Criterion 7 – Institutional Processes, Indicator 7.1

Special Resource Area Management Direction

The department has used many mechanisms to identify areas that may have particular or special biological/ecological, social, or economic conservation objectives or values. For example, some state natural areas have been dedicated by Natural Resource Commission resolutions and the Sand Lakes Quiet Area was established using a land use order under the authority of the director. Some areas are managed through memorandums of understanding and statute such as the Strategy for Kirtland's Warbler Habitat Management (Michigan Department of Natural Resource et al. 2001). There are also areas that have been noted for their biodiversity potential through less formal mechanisms.

Over time it has become challenging to sift through naming conventions and designations to understand the broad range of conservation values within the state forest system. The Special Resource Area Management Direction section begins the process of collating and organizing these areas and their associated designations.

This section provides a description of areas of the state forest that have been identified as having specific or special resource attributes that are considered in management planning and activities. The majority of these areas are noted for renewable resource conservation values. However, some social and nonrenewable categories (e.g., concentrated recreation and mineral resource areas) have been included in order to document and track their purposes.

Areas with specific conservation values have been sorted into three primary categories: Special Conservation Areas, High Conservation Value Areas, and Ecological Reference Areas. Each category has a conservation value trait and a 'level of recognition' trait. Combined, the two traits determine whether an area is identified as a SCA, HCVA or ERA. It is anticipated that over time, areas will be moved between, added and removed from these categories based on conservation values and level of recognition.

Special Conservation Areas: are areas of the state forest that have one or more identified special conservation objectives, interests or elements. Conservation objectives listed in the SCA category have been identified through a variety of methods and mechanisms, and it is important to understand how the objective was determined. The type and strength of recognition (and possible management options) will vary depending on the process used to identify the conservation value. For example, some objectives are detailed in the land use orders of the director (force of law) while other may be identified through cooperative agreements (administrative direction). There are also objectives developed through department process or agreement (e.g., deer yards, potential old growth, and riparian buffers). The SCA category may also be used to document areas identified by an external group or organization, such as National Audubon Society's Important Bird Areas Program.

High Conservation Value Areas: are areas of the state forest that have been recognized for their contribution to specific conservation values, objectives, and ecological attributes or significant social values through a recognized DNR process. Examples of a recognized DNR process include legislation, administrative rule, and Director's and Natural Resource Commission orders. HCVAs include dedicated natural, wilderness or wild areas, natural rivers, species recovery plan areas such as Kirtland's Warbler management areas, and critical dune areas. Typically, HCVAs have had significant public participation and/or public review as part of the process.

Designated HCVAs are located only upon state forestlands, but it is important to coordinate conservation efforts of equivalent HCVA resources with other land owners throughout the landscape, including state parks and wildlife areas, national forests and parks, and corporate and other private

ownerships. The HCVA category is intended to address the FSC Regional Forest Stewardship Standard Principle 9, which requires the maintenance of High Conservation Value Forests.

Ecological Reference Areas: are areas that serve as models of ecological reference within the state. They are high quality examples of functioning ecosystems that are primarily influenced by natural ecological processes, and they may be located upon any land ownership in the state. For purposes of establishing a baseline, high quality natural communities that are defined by NatureServe and the MNFI system as global or state endangered (1), threatened (2), or rare (3) and with an element occurrence rank of A or B in the MNFI database serve as an initial set of ERAs. This ecological classification system was selected as a baseline because it is nationally and internationally acknowledged and used as a sound scientific system. The ERA category is intended to address the FSC Regional Forest Stewardship Standard Criterion 6.4, which requires the establishment of a system of protected areas across the landscape of all ownerships.

Identified ERAs, HCVAs, and SCAs will be managed to conserve, protect and/or to enhance the defined conservation objective or value. The methods used will vary depending upon the objective and type of designation. Methods can include active management or access for multiple resource values that are compatible with the defined conservation objective or value. Land managers, field staff, and stand examiners should use technical materials, program staff, and/or other references when assessing management options that are suitable for the specific conservation objective. All areas will be managed to protect the immediate natural resource values and human health and safety.

Areas that are designated as ERAs, HCVAs, and SCAs may overlap one another, and are not mutually exclusive. The DNR has developed maps that show the spatial extent of these areas across the landscape, but details of these maps lose clarity and meaning at a statewide scale and are most clearly represented at an ecoregional scale. Therefore, maps are only presented in regional state forest management plans and not in the State Forest Management Plan.

The starting point for reviewing SCAs is the operations inventory and compartment review process. The starting point for reviewing HCVAs and ERAs is the biodiversity conservation planning process. Both processes include public participation and consider nominations for inclusion, removal, or other changes to designations. Additional information regarding these areas can be found in the document Conservation Area Management Guidelines.

5.1 Special Conservation Areas

The SCA definition is purposefully broad to encompass a spectrum of conservation interests and elements. It is a descriptor that provides the land manager or stand examiner with natural resource information to make informed management decisions.

Although the SCA descriptor was developed for the state forest system, some of the categories are found on other DNR-managed lands and are recognized for their contribution to conservation, management and protection of special values. SCAs as of January 2007 are listed below. Adding, removing or changing the designation of an area of the state forest as a SCA is done primarily through the operations inventory/compartment review process.

5.1.1 Nondedicated Natural Areas and National Natural Landmarks

This SCA category contains areas that have been identified but are not legally dedicated as Natural Areas (NAs), as enabled by Part 351, Wilderness and Natural Areas, 1994 PA 451, as amended. There are multiple types of areas identified in the Natural Areas Strategic Plan. These include natural

areas, wilderness areas and wild areas that have been nominated or proposed for legal dedication; administratively recognized; under joint DNR–The Nature Conservancy Natural Areas Registry (TNC); National Natural Landmarks (NNLs); or dedicated by Natural Resources Commission (NRC) resolution. Some areas have overlapping identifiers. For example, the nominated Maxton Plains Natural Area in Chippewa County is also a TNC Registry site.

There are currently 6 natural areas upon 8,115acres of the state forest that are nominated or proposed for legal dedication. There are ten sites totaling 5,634 acres that are solely under TNC registry, one 3,182 acre NRC dedicated site, and one 1,527 acre administratively recognized site on the state forest (Table 5.1). There are five nominated or proposed wild areas totaling 5,298 acres in the state forest (Table 5.1). There are two recognized national natural landmarks on the state forest: the 11,664 acre Dead Stream Swamp NNL in the Cadillac and Roscommon forest management units and the 159 acre Roscommon Red Pines NNL in the Roscommon Forest Management Unit (Tables 5.1 and 5.3).

Natural areas provide recreational sites for persons who appreciate such site solely for their inherent or intrinsic value. They also provide valuable and important research and educational opportunities.

Management Direction

Natural Areas will be managed for identified conservation purposes, in accordance with statutory requirements and signed agreements until the agreements are revisited and/or they are evaluated under the formal Natural Areas process.

Identified conservation purposes are for primitive and unconfined types of recreation and the preservation of unusual flora and fauna, and biotic, geologic, scenic, or other similar features of educational or scientific value.

Proposed and nominated natural areas that have been evaluated through the formal natural areas review process and become legally dedicated will be designated as HCVAs.

A thorough inventory of floral and faunal species composition and community structure and the identification of natural ecological processes are a priority in these areas.

Stewardship activities include active maintenance and restoration, or simply allowing natural ecological processes to occur without interference. Monitoring of management activities is necessary to evaluate the effectiveness of stewardship activities.

Active management methods and techniques may include prescribed burns, invasive species control, brush control, planting of native plant species, and other forms of ecological restoration.

By statute, not more than 10% of lands under the control of the DNR may be dedicated as natural areas.

Standards:

1. Part 351, Wilderness and Natural Areas, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the administrative rules thereof.
2. NRC Policy 2704, Wilderness and Natural Areas, issued June 8, 1979.
3. DNR Policy and Procedure 26.27-04, Wilderness and Natural Areas, issued July 11, 2005.
4. Natural Areas Strategic Plan (Michigan Department of Natural Resources 2000b).
5. Land Use Order of the Director 4.16.

6. DNR Forest Certification Work Instruction 1.4 - Biodiversity Management on State Forest Lands.
7. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
8. Conservation Area Management Guidelines (Michigan Department of Natural Resources 2005).
9. DNR Wildlife Division Process for Nomination, Review and Dedication of Natural Areas, issued November 30, 2001.

Guidelines:

1. Use Conservation Area Management Guidelines (Michigan Department of Natural Resources 2005).
2. Maintain or restore natural areas and NNLs so as to preserve their natural ecological and social values.
3. Managing divisions develop site conservation and management plans for state natural areas and NNLs. Planned stewardship activities should be incorporated into annual work plans.
4. Employ the voluntary cooperation and support of interested citizens and conservation groups in the management of natural areas and NNLs.
5. Use field surveys and public nomination processes to identify representative areas with high quality natural communities and/or unique scenic or recreational features for consideration as potential wilderness, wild or natural areas.

5.1.2 Potential Old Growth Areas

In 1994 the Natural Resource Commission adopted an old growth addendum to the 1983 Statewide Resources Plan. The department has subsequently identified through the operations inventory/compartment review process approximately 310,000 acres as potential old growth. These stands were identified for a broad range of reasons and were coded in the Operations Inventory database as stand condition 8. Since the specific reasons were not always detailed in database records, it is difficult in some cases to articulate the values of the stand.

Management Direction

No vegetative treatments shall occur in areas currently identified in the Operations Inventory database as Stand Condition 8, potential old growth (for years of entry prior to 2008) until these stands are assessed in the context of ERAs, HCVAs, and SCAs.

For stands in year of entry 2008 and forward, potential old growth is managed for the identified objective until it is: 1) vetted through the biodiversity conservation planning process (BCPP) and given a specific designation and objective (as an ERA, HCVA, or other type of SCA) and is released from the potential old growth designation; or 2) it is released from the potential old growth designation via the compartment review process.

Once all potential old growth stand condition 8 designation areas have been assessed using the BCPP, this SCA category for potential old growth will no longer be used.

Standards:

1. DNR Forest Certification Work Instruction 1.4 - Biodiversity Management on State Forest Lands.

2. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
3. Biodiversity Conservation Planning Process (Michigan Department of Natural Resources 2005a)

Guidelines:

1. Use Conservation Area Management Guidelines (Michigan Department of Natural Resources 2005b).
2. Activities to protect immediate natural resource values (such as eradication of invasive pests and wildfire suppression) or human health and safety may be undertaken in stands coded as Stand Condition 8.

5.1.3 Coldwater Streams and Lakes

Trout streams and trout lakes are established by director's action and are those streams and lakes designated as trout resources by Fisheries Order 210 and Fisheries Order 200 respectively.

Cold water fisheries provide recreational resources that are significant components of many regional and local economies. Economic benefits range from direct expenditures for equipment and related supplies to indirect support of local hotels, restaurants, and other businesses. Many social and historical traditions are also associated with cold water resources and maintenance and preservation of these resources for future generations is of importance to our society.

Management Direction

The primary management direction for trout streams and trout lakes are for the maintenance and rehabilitation of water quality, aquatic habitat, and the preservation of unique ecological and cultural resources.

Active management activities may include: protection of high-quality coldwater habitats; rehabilitation of aquatic habitats through contemporary and sustainable approaches to channel habitat improvement that include reconnection of habitats through dam and culvert removal or modification; and riparian habitat management. In addition, construction and maintenance of access sites to increase opportunities for boating and fishing recreation will be strategically pursued. Habitat rehabilitation activities in inland lakes and streams are regulated by the Michigan Department of Environmental Quality.

Standards:

1. All management activities within inland lakes and streams will comply with the requirements of Part 301, Inland Lakes and Streams, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
2. Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
3. DNR Policy and Procedure 39.21-20, Beaver Management, issued July 11, 2005.
4. DNR FMFMD Policy and Procedure 251, Sale and Removal of Timber, issued March 1, 2000.
5. Fisheries Division Policies and Procedures 01.01.002 Dams and Barriers; 02.02.002 Artificial Structures for Inland Lakes; 02.02.011 riparian Vegetation Protection; 02.02.015 Soil Erosion and Sedimentation Control.

6. State Natural River Plans.
7. Fisheries Order 213.04 Criteria for Selection of Trout Streams with Gear Restriction Regulations.
8. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
9. DNR Forest Certification Work Instruction 3.2 – Best Management Practices Non-Conformance Reporting Instructions.

Guidelines:

1. Evaluate and manage riparian areas in accordance with the direction provided by evaluating riparian management zones on state lands – Approved Interim Guidelines (Michigan Department of Natural Resources 2004b).
2. Use Conservation Area Management Guidelines (Michigan Department of Natural Resources 2005).
3. Forest management activities adjacent to trout streams and lakes comply with the above standards, while also taking into consideration other uses of these lands.
4. Management prescriptions should maintain and restore forest canopy cover over stream corridors (riparian management zones), excepting habitat prescriptions for species of greatest conservation need.
5. Management prescriptions in or adjacent to springs, wetlands, or riparian management zones should incorporate (Draft) Sustainable Soil and Water Quality Practices on Forest Land (Michigan Department of Natural Resources and Michigan Department of Environmental Quality 2007) to limit soil disturbance and biomass removal on high gradient sites where the potential for soil erosion and sedimentation into aquatic systems is high.

5.1.4 Springs, Wetlands, and Riparian Areas

The general locations of wetlands and floodplains have been identified and are regulated by the Michigan Department of Environmental Quality. Springs, wetlands, and riparian zones are often areas of high biodiversity that provide unique habitat for a large number of obligate bird, mammal, reptile, and amphibian species.

Springs, wetlands, and riparian areas provide recreation sites that are of general high aesthetic quality. Riparian systems are recreational resources that are a significant component of many regional and local economies, particularly for the boating industries. Many social and historical traditions are associated with riparian resources and the maintenance and preservation of these resources for future generations is of importance to our society. Wetlands also provide pollution treatment and abatement services that are of large economic value to society.

Management Direction

The primary management direction is for the maintenance and improvement of water quality benefits, aquatic habitat, attenuation of flood flows, forest products, the preservation of unique ecological and cultural resources, and the provision of wildlife corridors and habitat connectivity.

Active management activities may include low-impact recreation, management and harvest of timber, wildlife habitat improvement, and wetland restoration. Occurrences of resource damage must be immediately identified and reported, and sufficient resources should be sought to take positive corrective actions.

Permits may be required from the DEQ, Land and Water Management Division (LWMD) for certain dredging, draining, filling, and construction or development activities in wetlands or floodplains. A permit from the DEQ, LWMD is always required form permanent or temporary bridges and culvert crossings of inland streams. Silvicultural practices and the harvesting for forest products in wetlands are exempt from permit requirements. The construction of forest roads in wetlands are exempt from permit requirements if there is no alternative road location and adverse effects upon wetlands are minimized.

Standards:

1. All management activities within wetlands will comply with the requirements of Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
2. All management activities below the ordinary high water mark of inland streams will comply with the requirements of Part 301, Inland Lakes and Streams, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
3. All management activities within floodplains will comply with the floodplain regulatory authority found in Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
4. Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
5. DNR Policy and Procedure 39.21-20, Beaver Management, issued July 11, 2005.
6. DNR FMFMD Policy and Procedure 251, Sale and Removal of Timber, issued March 1, 2000.
7. Fisheries Division Policies and Procedures 02.01.001 Wetland Alteration; 02.02.11 Riparian Vegetation Protection.
8. DNR Forest Certification Work Instruction 3.2 – Best Management Practices Non-Conformance Reporting Instructions.
9. DNR Forest Certification Work Instruction 7.1 – Timber Sale Preparation and Administrative Procedures.

Guidelines:

1. Management prescriptions in or adjacent to springs, wetlands, or riparian management zones assist in the maintenance of water quality, nutrient cycles, and habitat through conformance with Interim Guidelines for Evaluating Riparian Management Zones on State Lands – Approved Interim Guidelines (Michigan Department of Natural Resources 2004b).
2. Use Conservation Area Management Guidelines (Michigan Department of Natural Resources 2005).
3. Use DNR FMFMD Form R4031-6, Pre-Timber Sale Checklist, for noting the presence of lakes, ponds, streams and wetlands, and implementing measures to mitigate adverse effects during forest prescriptions.
4. Management prescriptions should maintain and restore forest canopy cover over stream corridors (riparian management zones), excepting habitat prescriptions for species of greatest conservation need.
5. Management prescriptions in or adjacent to springs, wetlands, or riparian management zones should incorporate (Draft) Sustainable Soil and Water Quality Practices on Forest Land (Michigan Department of Natural Resources and Michigan Department of Environmental Quality 2007) to limit soil disturbance and biomass removal on high gradient sites where the potential for soil erosion and sedimentation into aquatic systems is high.

6. Strive to maintain and restore functional wetland habitats (including muskeg, bogs, and vernal pools) within the matrix of the forest landscape.
7. Preserve and enhance wildlife habitat values associated with wetlands by maintaining, enhancing, or restoring natural hydrological regimes and structural characteristics such as adequate snags and downed woody debris.

5.1.5 Habitat Areas and Corridors

Habitat areas provide some specific need for the life cycle of wildlife species. They include waterfowl areas such as floodings, deer wintering complexes in lowland conifer communities, grassland openings and savannas. Habitat areas are distinct from dedicated species recovery areas (such as Kirtland's Warbler or Piping Plover areas described in Section 5.2.5) in that they are more general in nature, and are not primarily associated with threatened or endangered species that have species recovery plans developed in cooperation with federal agencies.

Habitat corridors are often associated with lowland riparian and wetland communities. Corridors provide connective cover habitats between different community types that are used by a wide variety of wildlife species whose life cycles require multiple habitat needs. They are increasingly important to maintain connectivity in highly fragmented forested landscapes.

High quality habitat areas and corridors are essential for maintaining populations of both game and nongame wildlife species, which is a primary social expectation of the public.

Management Direction

The primary management direction for habitat areas is for maintenance of existing habitat, restoration of degraded habitats, and expansion of specific habitats (including mesic conifers and grasslands/savannas) as agreed upon in compartment review.

The primary management direction for corridors is for the maintenance of existing corridors and the expansion or restoration of additional corridors in order to increase habitat connectivity within the landscape to the extent practical.

Standards:

1. DNR Forest Certification Work Instruction 1.4 – Biodiversity Management on State Forest Lands.
2. DNR Forest Certification Work Instruction 1.6 – Forest Management Unit Analysis.

Guidelines:

1. In already fragmented landscapes, maximize habitat connectivity to the extent possible at the landscape level, by creating habitat corridors and protecting riparian management zones, by maintaining variability in the size and patterns of harvests, and through restoration plantings.
2. Where possible, use native plants for natural resource management on public lands. Naturalized plants may be used when native plants will not meet specific needs.
3. Where possible, cooperate with partners in the landscape to maintain and restore habitat connectivity.

5.1.6 Archaeological Sites

By statute, property rights of archaeological artifacts and sites are reserved to the State of Michigan and are protected and administered by Department of History, Arts, and Libraries. In addition, archaeological sites have intrinsic social value. Their identification, protection, and preservation are an important public interest in our society.

Management Direction

The primary management objective for archaeological sites is for the identification, protection, and preservation of sites of cultural and historical significance.

Sites may be identified by natural heritage data from the Michigan History, Arts, and Libraries, State Historic Preservation Office, and Office of the State Archaeologist. Sites or possible sites may be discovered in the course of normal field work in previously unknown locations. These sites should be reported to the Office of the State Archaeologist.

Standards:

1. All management activities will comply with protection authority found in Part 761, Aboriginal Records and Antiquities, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
2. DNR FMFMD Policy and Procedure 251, Sale and Removal of Timber, issued March 1, 2000.
3. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
4. Sites of archeological, historical or cultural interests are confidential in nature and are protected from public disclosure, since they are exempt from the Freedom of Information Act.

Guidelines:

1. Heritage data from the State Historic Preservation Office can be used for identifying and protecting sites that possess unique historical, archeological qualities. Such information may be confidential in nature, and is not always appropriate for public disclosure. Where the integrity of the site will not be compromised by public disclosure, such areas may present educational opportunities.
2. Notify Tribal Historical Preservation Officers of any activities which may affect tribal archeological sites or tribal cultural property.
3. Notify the State Historic Preservation Office of all compartment review plans or other activities that may affect sites of historical significance, and of all potential archaeological sites that are discovered by field staff.
4. Invite the participation of concerned groups in collaborative planning and implementation of forest management activities, so that cultural and historic sites may be protected from damage or interference.
5. Protect and maintain identified archaeological and historic features during the course of routine forest planning and operations, in order to provide continued public access to these resources.

5.1.7 Cultural and Customary Use Areas

Cultural and customary use areas include areas that possess and provide significant values and purposes for Native American tribes and other various ethnic or religious groups, or sites that have been traditionally used by tribes and the public for specific purposes, such as maple syrup, wild fruit, and other plant gathering areas and habitats.

Cultural and customary use areas have intrinsic social value, and the maintenance and preservation of these resources for future generations is of importance to our society.

Management Direction

The primary management objective for cultural and customary use areas is to protect and maintain identified areas for public and tribal use, and to provide general areas for public and tribal use in the course of routine forest operations.

Standards:

1. 2007 Consent Decree for 1836 Treaty, dated November 2, 2007.
2. DNR Forest Certification Work Instruction 1.5 – Social Impact Considerations and Public Involvement Processes.
3. DNR Forest Certification Work Instruction 6.2 – Integrating Public Recreational Opportunities with Management on State Forest Lands.
4. DNR Forest Certification Work Instruction 9.1 – Collaboration with Tribes in Regard to Management of State Forest Land.

Guidelines:

1. Long-term tribal cultural use areas should be identified through direct contact with tribal representatives in the compartment review process.
2. Protect and maintain identified cultural use areas during the course of routine forest planning and operations, in order to provide continued tribal and public access to these resources.
3. Consider general customary use areas (e.g., wild fruit and mushroom habitats) as secondary objectives in management plans, incidental to primary management objectives.

5.1.8 Visual Management Areas

The state forest provides aesthetic values that have important social and economic benefits to many local communities. These include general social appreciation of areas such as exceptional scenic vistas. Fall color tours are also an important component of many regional and local economies, with significant direct support of local hotels, restaurants, and other tourist-related businesses. The maintenance and preservation of scenic resources for future generations is of importance to our society.

Management Direction

The primary management objective for visual management areas is for maintenance and improvement of aesthetic values. Examples include scenic vistas, scenic or natural beauty roads, and lakeshore areas. Management objectives of these areas should be for the maintenance, improvement, or restoration of aesthetic values, as framed within the context of ecosystem management principles.

Standards:

1. Part 357, Natural Beauty Roads, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
2. DNR FMFMD Policy and Procedure 251, Sale and Removal of Timber, issued March 1, 2000.
3. DNR Forest Certification Work Instruction 1.5 – Social Impact Considerations and Public Involvement Processes.
4. DNR Forest Certification Work Instruction 6.2 – Integrating Public Recreational Opportunities with Management on State Forest Lands.

Guidelines:

1. Consider visual management areas as the primary objective for areas of exceptional aesthetic value.
2. Consider aesthetic factors and conditions in the general forest (especially in forested areas immediately adjacent to major public roads) in management plans.

5.1.9 Concentrated Recreation Areas

Concentrated recreation areas are those facilities that are designed and maintained for routine or heavy recreational use, including state forest campgrounds, motorized and nonmotorized trails, trailheads, staging areas, and public access sites. Many of these areas have had long term historic use which has led to the more formal establishment of recreation facilities.

Concentrated recreational resources provide the basis for significant components of many regional and local economies. Economic benefits range from direct expenditures for equipment and related supplies to indirect support of local hotels, restaurants, and other businesses. Many social and historical traditions are also associated with recreational resources and the maintenance and preservation of these resources for future generations is of importance to our society.

Note: concentrated recreation areas have been identified as a SCA category for purposes of tracking within the current database. It is expected to be a transitional category until a more suitable designator is developed.

Management Direction

The primary management objectives for concentrated recreation areas are for the maintenance and improvement of existing recreational facilities, public health and safety (through provision of potable water and sanitation facilities), resource protection and water quality (through erosion control and sanitation), and fire safety (through use of designated campground fire rings).

Management of these areas should consider ecological, social, and economic values and uses. When appropriate for ecological (for protection of land or water resources) and social (due to lack of use or over-use) reasons concentrated recreation resources may be closed or relocated.

Standards:

1. Part 125, Campgrounds, of Article 12, Environmental Health, of the Public Health Code Act, 1978 PA 368, as amended.

2. 2008-12 Michigan State Comprehensive Outdoor Recreation Plan (Michigan Department of Natural Resources 2007).
3. DNR FMFMD Policy and Procedure 251, Sale and Removal of Timber, issued March 1, 2000.
4. DNR Forest Certification Work Instruction 6.2 – Integrating Public Recreational Opportunities with Management on State Forest Lands.

Guidelines:

1. Seek to maintain the number and improve the quality of concentrated recreation facilities for use by the public.
2. Developed recreation facilities (trails, campgrounds, trailheads, and boating access sites) should be evaluated for closure or possible re-location if they are no longer providing a public use; if they are jeopardize public safety; or if the facility is compromising land and water resources and resource protection measures are most effectively addressed through closure.

5.1.10 Mineral Resource Areas

Mineral resources in the form of oil, natural gas, metallic and nonmetallic minerals provide the basis for significant components of many regional and local economies, and also provide for a portion of the energy and resource needs of our society. Royalties from leases of such resources upon state-owned lands also provide a large amount of income for the Natural Resource Trust Fund, which provides the means for acquisition of properties containing significant natural resources or which are in-holdings within the larger matrix of the state forest.

Note: Mineral management areas have been identified as a SCA category for purposes of tracking within the current database. It is expected to be a transitional category until a more suitable designator is developed.

Management Direction

The primary management objective for mineral resource areas is to develop minerals in a manner which does not damage or impair the ecological functions and values in the surrounding area. Mineral extraction has a finite life. After extraction operations cease, restoration or reclamation of oil, gas and metallic and nonmetallic mineral sites shall be accomplished in accordance with plans that are required as a condition of the lease.

Standards:

1. See standards in sections 4.1.6.1 and 4.1.6.2.

Guidelines:

1. Use adequate reclamation plans to continue or return a mineral extraction site's contribution to the ecological profile of adjacent areas.

5.1.11 Great Lakes Islands

A considerable portion of the biological diversity unique to Michigan is supported by the nearly 600 islands contained within Michigan's borders. Great Lakes islands provide significant habitat for

numerous other species, including many rare plants and animals, several of which are endemic or largely restricted to the Great Lakes region. Due to their isolation, islands provide good examples of many Great Lakes-associated natural communities and ecosystems, and thus have potential to provide insights for understanding the consequences of human disturbance on the increasingly fragmented ecosystems of the mainland.

Management Direction

The primary management objectives for islands encompass a wide range of purposes, and are outlined in Standard 1 below. These objectives range from the protection of ecological and natural functioning ecosystems with strict limitations on any human effects; to the identification and management of significant historical and archaeological sites listed in or eligible for the National Register of Historic Places; to the provision of opportunities for intensive recreational and vegetation management activities. The degree of human effects should decrease in proportion to the increasing ecological and/or historical sensitivity.

The DNR will consider the economic effect of island development (or lack of development) on islands or nearby communities when developing management plans. In most instances, such consideration shall not override ecological or historical values. The human carrying capacity on state owned islands shall be considered in management plans.

Management plans will be developed with formal opportunity for participation by other divisions within the DNR, as well as affected governmental agencies and local units of government, the Department of State, and citizens. The DNR will coordinate planning activities across ownership boundaries, and with the adjacent states and Canadian provinces near those islands being incorporated into a management plan.

Standards:

1. NRC Policy 2005, Island Management, issued February 10, 1994.
2. DNR Policy and Procedure 29.20-05, Management of State Owned Island Properties, issued July 11, 2005.

Guidelines:

1. Use the series of Michigan Natural Features Inventory reports entitled “Biological Inventory for Conservation of Great Lakes Islands” as a basis for the identification of community types and significant biodiversity areas in island management plans (Michigan Natural Features Inventory 1999, 2000a, 2000b, 2002a and 2002b).
2. Use community abstracts developed by the Michigan Natural Features Inventory as additional reference in the identification and management of Great Lakes Islands.
3. Manage historic and archaeological sites in accordance with section 5.1.6 of this plan.

5.1.12 Contiguous Resource Areas

There are state forestlands adjacent to other land ownerships which are managed for specifics objectives and values. For example, there are state forest parcels adjacent to state parks, federal parks, national wildlife refuges, conservancy lands, and private lands such as the Huron Mountain Club. Management goals for these parcels may or may not be similar or complementary to those of the state forest.

Public lands, forests, and parks of all ownerships are resources that have a positive influence upon regional and local economies. These influences include the provision of raw material for the forest products industry as well as being a basis for regional recreational and tourism industries. This category recognizes the importance of landscape-level coordination between ownerships.

Management Direction

The primary management objectives for state forestlands contiguous with such ownerships is to unify management goals within a landscape context by coordinating similar management purposes and minimizing conflicts from dissimilar management purposes. This is particularly necessary where High Conservation Value Areas are located or co-located upon adjacent lands.

An example of this is the inland buffer zone that is established around the fee-title boundary of the Pictured Rocks National Lakeshore, where a specially zoned buffer area is recognized by both the National Parks Service and the DNR and is considered in management plans for both organizations.

Standards:

1. DNR Forest Certification Work Instruction 1.5 – Social Impact Considerations and Public Involvement Processes.

Guidelines:

1. Consider special management purposes, goals, and objectives for contiguous lands in the management of contiguous state forestlands, so that management goals may be complimentary where possible.
2. Consider proposed management within a landscape context.

5.1.13 Wild and Scenic Rivers

Wild and scenic rivers preserve in a free-flowing condition a selection of our state's finest river systems for the use and enjoyment of current and future generations. Wild and scenic rivers are established under authority of the National Wild and Scenic Rivers Act, Public Law 90-542, as amended. The process for establishing a wild and scenic river includes nomination, development of a management plan, public hearings and action by the U.S. Congress. Each wild and scenic river has a river specific federal management plan, and state agencies may enter into written cooperative agreements with the administering federal agency for the management of Wild and Scenic Rivers that are upon state-owned lands.

There are 18 miles of federal designated wild and scenic rivers that are located within the state forest, including portions of the East Branch Tahquamenon, Indian, Manistee, Ontonagon, Paint, Pere Marquette, Pine and Presque Isle rivers. Portions of the Au Sable, Pine, and Pere Marquette wild and scenic rivers are co-designated as state natural rivers.

The maintenance of wild and scenic rivers is important for the recreational fishery and recreational boating industries, which are significant economic sectors for many areas of the state.

Management Direction

The primary management objectives for wild and scenic rivers are for boating and fishing recreation, fish and wildlife habitat and corridors, and for aesthetic, floodplain and water quality values.

Where wild and scenic rivers are co-designated as state natural rivers, the management direction in Section 5.2.3 is to be followed.

Standards:

1. The National Wild and Scenic Rivers Act, Public Law 90-542; 16 U.S.C. 1271-1287.
2. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
3. General Memorandum of Understanding between the State of Michigan, Department of Natural Resources and the Forest Service, United States Department of Agriculture concerning Plan Preparation and Management of the Pere Marquette National Scenic River Area, dated June 17, 1980.

Guidelines:

1. Use interim Guidelines for Evaluating Riparian Management Zones on State Lands (Michigan Department of Natural Resources 2004b).

5.1.14 Research and Military Areas

These areas provide facilities and lands specifically dedicated for research, or other purposes. They include the 5,847 acre Forest Fire Experiment Station, the 12,000 acre Houghton Lake Wildlife Research Area, the Beaver Islands Archipelago Wildlife Research Area (that includes most of Garden Island, all of High and Hog islands, all state-owned land on Beaver, South Fox and North Fox islands), the Cusino Wildlife Research Area, the 3,000 acre Hunt Creek Fisheries Research Station, the 125 acre Wyman Nursery, and over 144,000 acres of military lands.

Management Direction

The primary management objectives for these areas are to manage them for their dedicated purposes. For the Forest Fire Experiment Station the focus of management is for research, development and testing of equipment and methodologies for fighting wildfires, this being in accordance with direction given to the department by the Conservation Commission in 1933.

For the wildlife research areas the amount of research has diminished in recent years and the focus of management has shifted to also encompass that of the other state game and wildlife areas. In addition to supporting research necessary to restore wildlife, management of these areas will also focus on providing, protecting and enhancing wildlife habitat, allowing for the management of wildlife populations while providing for the associated recreation of hunting and trapping. When necessary, these sites may be used by the division for the construction of buildings or other structures to meet wildlife restoration needs.

For the Fisheries Research Station the focus is to manage land use activities and human disturbance through the experimental modification of terrestrial and aquatic habitats that enable studies of these effects upon fish community dynamics. The Hunt Creek Fisheries Research Station is closed to public fishing.

For the state nursery the focus of management is for providing improved and genetically diverse seed stock for reforestation and afforestation of the state forest, through the management and harvest of seed trees and the growth of tree seedlings.

The management focus for military lands is dependent upon the means of acquisition and concomitant rights, and the stipulations of lease and management agreements with the Department of Military and Veterans Affairs for military use (Table 5.2).

Standards:

1. DNR Policy and Procedure 39.21-08, Wildlife Flooding Projects – Operation and Maintenance, dated July 11, 2005.
2. DNR Policy and Procedure 39.21-18, Wildlife – Procedure on Flooding Projects for Fish or Wildlife.
3. DNR FMFMD Policy and Procedure 242, State Forest Nursery, dated October 26, 1999.
4. DNR FMFMD Policy and Procedure 243, Tree Improvement, dated October 26, 1999.
5. DNR FMFMD Policy and Procedure 621, Equipment Preparation and Operation, dated June 29, 1981.
6. DNR FMFMD Policy and Procedure 651, Equipment Advisory Board, dated July 7, 1981.

Guidelines:

1. None.

5.2 High Conservation Value Areas

HCVAs are areas that have been recognized for their contribution to specific conservation values, objectives and ecological attributes, or significant social values through a recognized DNR process. Examples of recognized DNR processes include NRC orders, DNR director's orders, and Legislative action (i.e., statute). These processes all have a public involvement or participation component. Consideration of additional types of High Conservation Value Areas will be accomplished through periodic revision of this plan and the public input mechanisms that are associated with the revision and review process.

Note: The operations inventory/compartment review process also has a public involvement/participation component but it is not being used to establish HCVAs. It is used to identify SCAs that may become HCVAs in future planning iterations.

The DNR website provides direction on the processes for recommendation specific areas as High Conservation Value Areas.

5.2.1 Legally Dedicated Natural Areas, Wilderness, or Wild Areas

Legally dedicated natural areas, wilderness or wild areas are established under authority of Part 351, Wilderness and Natural Areas, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended .

Within the state forest system, there are currently seven legally dedicated NAs totaling 3,446 acres (Table 5.3). There are four other legally dedicated NAs upon other DNR-managed lands in the northern Michigan landscape: the Presque Isle River and the Union Springs Scenic Sites in the Porcupine Mountains Wilderness State Park; the Thompson's Harbor NA in the Thompson's Harbor State Park; and the Wagner Falls Scenic Site. These NAs total 1,791 acres.

There are currently no legally dedicated wilderness or wild areas located upon the state forest. There is one legally dedicated wilderness area that is located upon other DNR lands in the northern Michigan landscape, that being the 42,903 acre Porcupine Mountains Wilderness Area in the Porcupine Mountains Wilderness State Park.

Natural areas, wilderness and wild areas provide recreational sites for persons who appreciate such undeveloped areas for their inherent or intrinsic ecological values, by offering unique opportunities for solitude or primitive and unconfined types of recreation. In this manner they can provide economic opportunities for local communities. They also provide valuable and important research and educational opportunities.

Management Direction

Per statute, not more than 10% of lands under the control of the DNR may be dedicated as natural areas, wilderness, or wild areas.

The primary management objectives for NAs are for recreation and the preservation of flora and fauna, or biotic, geologic or scenic features of educational or scientific value.

A thorough inventory of floral and faunal species composition and community structure and the identification of natural ecological processes are a priority in these areas.

Stewardship activities in NAs are limited by statute, but include active maintenance and restoration, or allowing natural ecological processes to occur without interference. Active management methods and techniques may include prescribed burns, invasive species control, brush control, planting of native plant species, and other forms of ecological restoration. Monitoring of management activities is necessary to evaluate the effectiveness of stewardship activities.

The primary management objectives for wilderness and wild areas are for recreation, and for ecological, geological, scientific, scenic, or natural history values.

Stewardship activities in wilderness and wild areas are minimal and generally limited by statute to allowing natural ecological processes to occur without interference.

Standards:

1. Part 351, Wilderness and Natural Areas, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the administrative rules thereof.
2. NRC Policy 2704, Wilderness and Natural Areas, issued June 8, 1979.
3. DNR Policy and Procedure 26.27-04, Wilderness and Natural Areas, dated July 11, 2005.
4. Land Use Order of the Director 4.41.
5. Natural Areas Strategic Plan (Michigan Department of Natural Resources 2000b).
6. DNR Forest Certification Work Instruction 1.4 - Biodiversity Management on State Forest Lands.
7. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
8. DNR Wildlife Division Process for Nomination, Review and Dedication of Natural Areas, issued November 30, 2001.

Guidelines:

1. Use Conservation Area Management Guidelines (Michigan Department of Natural Resources 2005).
2. Maintain or restore natural areas, wilderness and wild areas so as to preserve their natural ecological and social values.
3. Develop site conservation and management plans for state natural areas and incorporate planned stewardship activities into annual work plans.
4. Employ the voluntary cooperation and support of interested citizens and conservation groups in the management of natural areas, wilderness and wild areas.
5. Use field surveys and public nomination processes to identify representative areas with high quality natural communities and/or unique scenic or recreational features for consideration as potential wilderness, wild or natural areas.

5.2.2 Biodiversity Stewardship Areas

Biodiversity Stewardship Areas (BSAs) are a network of areas where the primary purpose of management is the conservation of high quality natural communities, and the native biological diversity contained therein. The Biodiversity Conservation Planning Process will be used to review and recommend areas for inclusion in this network. The process has a public participation component.

Management emphasis has recently shifted from a narrow focus upon conserving or restoring native old growth forests to a more holistic view of conserving and restoring some portion of the native biological diversity of Michigan. This can be done by conserving and restoring functional representative native ecosystems comprised of a natural mosaic of early-successional, mid-successional, and late-successional or climax structural communities that provide the diverse habitats needed to support viable populations of native species. An area or landscape designated for biodiversity conservation management should be functional by maintaining focal species, communities, systems and supporting ecological processes within their natural ranges of variability. Designation on DNR-administered lands will take into account existing designations on other ownerships.

The maintenance of native biodiversity and functional ecosystems is vitally important for sustaining a host of social and economic values, ranging from ecosystem-based tourism to support of functional ecosystems from which many economic resources (e.g., vegetative fiber, wildlife, and fisheries) and social values (e.g., recreation, ecosystem services, cultural uses) are derived.

Management Direction

The management objective is to identify a system with multiple representation of native species and MNFI natural community types, in sufficient number, distribution and quality to ensure their long-term persistence (for a minimum of 100 years).

Staff will seek to identify natural communities of both high quality and degraded natural condition, including those areas having high abundance of rare, threatened, or endangered species or where the natural community itself is rare or imperiled. If necessary, a consultation or field assessment with MNFI staff is appropriate.

Once identified, management prescriptions should be implemented to maintain, enhance or restore the natural structural composition and ecological function of BSAs.

Standards:

1. DNR Forest Certification Work Instruction 1.4 - Biodiversity Management on State Forest Lands.
2. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
3. Biodiversity Conservation Planning Process (Michigan Department of Natural Resources 2005a).

Guidelines:

1. Use community and species abstracts developed by the Michigan Natural Features Inventory as additional reference in the identification and management of natural communities for biodiversity stewardship purposes.
2. Use the Biodiversity Conservation Planning Process Phase I Report at the ecoregional and FMU level of operations for guiding the review of potential BSAs.
3. Once assessment through the biodiversity conservation planning process has occurred, limit forest treatments in designated late-successional climax structural communities to those that will maintain, enhance or restore natural ecological structure and processes and native biodiversity values.
4. Allow or emulate natural disturbance patterns.
5. Use prescribed fire where it is a natural process of a particular community.

5.2.3 Natural Rivers

Natural rivers are established under authority of Part 305, Natural Rivers, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. The process for establishing a natural river and the natural river district (land adjacent to the river) includes nomination, development of a management plan, public hearings and action by the DNR director. Each Natural River has a river specific approved management plan and administrative rules.

Natural Rivers preserve, protect and enhance our state's finest river systems for the use and enjoyment of current and future generations. Natural rivers are located on both public and private lands. There are eleven natural rivers that are partially located in the state forest: the Fox and Two Hearted rivers in the Upper Peninsula; and the Au Sable, Betsie, Boardman, Jordan, Pere Marquette, Pigeon, Pine, Rifle and Upper Manistee rivers in the northern Lower Peninsula. The dedicated zoning district of these natural rivers covers 45,049 acres of the state forest.

The maintenance of natural rivers is important for the recreational fishery and recreational boating industries, which are significant economic sectors for many areas of the state.

Management Direction

The primary management objectives for natural rivers are for boating and fishing recreation, fish and wildlife habitat and corridors, and for aesthetic, floodplain and water quality values.

Commercial harvest in the native vegetation buffer (a 10,450 acre subset of the zoning district) is generally prohibited in order to retain trees that provide cover, large woody debris, and aesthetic values. Exceptions for proposed harvest prescriptions should follow the appropriate natural river management plan and associated administrative rules.

Standards:

1. Part 305, Natural Rivers, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the administrative rules thereof.
2. DNR Policy 2703, Natural Rivers, issued March 8, 1978.
3. DNR Policy and Procedure 26.27-03, Natural Rivers, issued July 11, 2005.
4. DNR Policy and Procedure 39.21-20, Beaver Management, issued July 11, 2005.
5. DNR FMFMD Policy and Procedure 251, Sale and Removal of Timber, issued March 1, 2000.
6. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
7. State Natural River Plans.

Guidelines:

1. Recreational related structures should be limited within natural river zones.
2. Use interim Guidelines for Evaluating Riparian Management Zones on state lands (Michigan Department of Natural Resources 2004b).

5.2.4 Critical Dunes

Critical dunes are established under authority of Part 353, Sand Dunes Protection and Management, Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. Critical dunes are located upon both public and private lands throughout northern Michigan. There are 15 critical dune areas on state forestlands that provide a total of 9,290 acres of habitat, with additional acres located upon other public and private lands throughout northern Michigan. Many state parks, national lakeshores and coastal areas of the state forest contain exemplary occurrences of sand dunes (parabolic, perched, linear, and traverse dunes). Rare community types include open dunes, wooded dune and swale complexes, sand/gravel beaches, interdunal wetlands, and Great Lakes barrens.

These features are a significant drawing force for many popular forms of recreation and the presence of these features are a considerable factor in many local economies throughout the state.

Management Direction

The primary management objectives for critical dunes are the maintenance of dune ecosystems, the preservation of rare habitats and species, and for low-impact recreation.

Management needs to recognize the ecological factors that are essential to the creation and maintenance of dunes, which include: a presence of abundant sand; strong winds blowing in a relatively consistent direction; water level fluctuation of Great Lakes; and vegetation to accumulate and stabilize sand. Activities that disrupt or destroy any of these factors are undesirable and can threaten the long-term viability of dune ecosystems.

A permit from DEQ is required for developmental (including contour changes), silvicultural, and recreational activities in areas identified as critical dunes. Commercial timber management and nondesignated ORV use is not allowed within critical dune areas without a DEQ Permit.

Where resource preservation is compatible with recreational uses, existing programs should be continued and new programs should be implemented to offer these social and economic services to the public.

Standards:

1. Part 353, Sand Dunes Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the administrative rules thereof.
2. DNR Forest Certification Work Instruction 1.4 - Biodiversity Management on State Forest Lands.
3. DNR Forest Certification Work Instruction 3.1 – Forest Operations.

Guidelines:

1. Protect, enhance, and restore rare and imperiled natural communities located within critical dune areas.
2. Design recreational facilities for low-impact use and should blend with the natural character of dune features.
3. Limit access trails and incorporate boardwalks and stairs for traversing areas sensitive to disruption or with high slopes that are prone to erosion.
4. Take positive action to control and direct pedestrian use which can cause severe disruption to natural dune processes.
5. Limit vegetation management in critical dunes to enhancement or restoration work.
6. Where significant disruption to ecological processes has occurred, take corrective action to restore natural processes.
7. Implement programs to eradicate invasive plants and animals which can cause severe disruption of natural dune processes.

5.2.5 Designated Critical Habitat

Species recovery plans have been developed in cooperation with the U.S. Fish and Wildlife Service and with other federal land managing entities such as the U.S. Forest Service, for various threatened and endangered species. The intent is to increase and stabilize the populations of specific species to levels and conditions where threats to their continued existence are satisfactorily mitigated. This is typically done through management of critical habitat.

Critical habitat areas are designated for the Kirtland's Warbler and Piping Plover, both federal- and state-endangered bird species. There are 17 Kirtland's Warbler management areas on state forestland, totaling 142,644 acres. There are 6 Piping Plover critical habitat areas on state forestland, totaling 8,217 acres.

Nesting areas for other species such as the Bald Eagle and Red-shouldered Hawk are also identified for some areas of the state forest.

Significant economic potential for ecotourism is often present in local communities in the vicinity of dedicated species recovery areas, particularly for endemic species such as the Kirtland's Warbler.

Management Direction

Designated critical habitat areas in the state forest, as prescribed in land use orders of the director, will be managed in accordance with approved species recovery plans.

Secondary objectives, such as timber, other commodity production, or recreation access are constrained by limitations and vegetative objectives as specified in the recovery plan.

Standards:

1. Part 365, Endangered Species Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.
2. The Endangered Species Act of 1973, Public Law 93-205, 87 Stat. 884
3. The DNR will cooperate with the U.S. Fish and Wildlife Service and other pertinent public and private organizations in the management of designated critical habitat areas.
4. Land Use Orders of the Director 3.8, 3.9, 3.10 and 4.29.
5. DNR Forest Certification Work Instruction 1.4 - Biodiversity Management on State Forest Lands.
6. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
7. Strategy for Kirtland's Warbler Habitat Management (Michigan Department of Natural Resources et al. 2001).
8. 2003 Piping Plover Recovery Plan.
9. 2006 (Draft) Karner Blue Habitat Conservation Plan.
10. 2006 (Draft) Eastern Massasauga Candidate Conservation Agreement with Assurances.

Guidelines:

1. Use species abstracts developed by the Michigan Natural Features Inventory as additional reference in the management of dedicated species recovery areas.
2. Follow Forest Certification Green-Up Guidelines (dated July 12, 2006), in the management and regeneration of Kirtland's Warbler recovery areas.

5.2.6 Dedicated Management Areas

Dedicated management areas are established through the land use orders of the director for specific purposes. There are currently thirteen dedicated management areas in the state forest (Table 5.4).

The primary uses of these areas include dispersed, nonintrusive recreation, such as hunting, trapping, wildlife viewing, hiking, cross country skiing, and snowshoeing.

These uses also have a positive influence upon the local economies in which they are located. Forest management prescriptions are permissible, within the consideration of all ecological and socio-economic values and uses. These also make a contribution to local economies in the form of forest products. The primary social-economic management objective for dedicated management areas is to continue to maintain and improve the quality of such resources is for nonmotorized, dispersed recreation.

Management Direction

The primary management objective for dedicated management areas is a function of their dedicated purpose as stated in the land use orders of the director. Dedicated and prohibited uses as stated in the specific land use order shall provide the basis of management direction for each area. Management direction shall also be provided by any management plan developed for each specific area.

Standards:

1. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
2. DNR Forest Certification Work Instruction 6.2 – Integrating Public Recreational Opportunities with Management on State Forest Lands.
3. Sand Lakes Quiet Area Management Plan, dated December 21, 1982.
4. Land Use Orders of the Director 3.21, 4.16, 4.19a, 4.20, 4.24 and 4.25.

Guidelines:

1. Use permissions and limitations contained in approved management plans to guide management activities within dedicated management areas.

5.2.7 Coastal Environmental Areas

Coastal environmental areas (CEAs) have been established under authority of Part 323, Shorelands Protection and Management, Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. CEAs are located upon both public and private lands throughout the state. There are 33 dedicated CEAs upon the state forest that total approximately 1,280 acres, concentrated in Alpena, Mackinac, Chippewa, Delta and Baraga counties.

Preservation of coastal marshes within CEAs is important for the protection and maintenance of habitat for reptiles and amphibians, critical fisheries spawning and refuge habitat, as well as providing habitat for migratory and nonmigratory bird species. Studies and surveys conducted by the department and others have recorded over 25 fish species, 12 mammal species, and 131 bird species using these valuable coastal habitats. In addition, typically unseen and overlooked species which are equally essential for maintaining healthy fish and wildlife populations are also provided protection under this coastal designation. Many EAs contain rare Great Lakes marshes, but other important habitats such as upland ridges and islands are also included.

The maintenance of viable populations of fish and bird species are important for the recreational and commercial fishery and recreational hunting industries, and for migratory bird watching, which are significant economic sectors for these and many other areas of the state.

Management Direction

The primary management objective for CEAs is for fisheries and migratory bird habitat and for ecological values in compliance with the statute and promulgated administrative rules.

Standards:

1. Part 323, Shorelands Protection and Management, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the administrative rules thereof.
2. Fisheries Division Policies and Procedures 02.01.006 Shoreline Modification; Coastal Wetland Protection.
3. DNR Forest Certification Work Instruction 1.4 – Biodiversity Management on State Forest Lands.
4. DNR Forest Certification Work Instruction 3.1 – Forest Operations.

5. A permit from the Michigan Department of Environmental Quality is required for dredging, filling, grading, other alterations of the soil, alterations of the natural drainage, alteration of vegetation used by fish or wildlife, or both, including timber harvest in identified colonial bird nesting areas and the placement of permanent structures in EAs. Activities which do not require a permit include maintenance of existing dikes, and timber harvest if outside a colonial bird nesting area.
6. Commercial timber management will not occur within EAs.

Guidelines:

1. Where significant disruption to ecological processes has occurred, take corrective action to restore natural processes.
2. Implement programs to eradicate invasive plants and animals in CEAs, which can cause severe disruption of coastal wetland ecology.
3. Design recreational facilities for low-impact use and blend them with the natural character of the shoreline.
4. Limit access trails and incorporate boardwalks for traversing areas sensitive to disruption.

5.3 Ecological Reference Areas

ERAs serve as native reference systems concerning natural ecological conditions and processes. ERAs may occur upon any ownership—be they public or private lands. Public lands include federal or state forests, parks or game areas/refuges.

The baseline set of ERAs were established using a nationally recognized biological inventory system (NatureServe) and database (Michigan Natural Feature Inventory). They are framed in the context of the natural community types (Appendix I). The baseline set of ERAs is comprised of known high quality examples of natural communities that have an element occurrence rank A or B with global or state ranks of endangered (1), threatened (2) or rare (3). There are currently approximately 226,074 acres designated as ERAs across on all ownerships in the state, with 42,128 acres located on state forestland.

Aside from their ecological values, ERA uses also include socio-economic uses such as recreation, research and education.

The baseline set of ERAs along with future additions, removals or modifications will be reviewed using the biodiversity conservation planning process.

Management Direction

The primary management objectives for ERAs are to identify, assess, preserve and enhance/restore natural ecological conditions and processes.

A thorough inventory of floral and faunal species composition and community structure and the identification of natural ecological processes are a priority in ERAs.

Management activities or prescriptions in ERAs are restricted to those that maintain or enhance the defined attributes and values, and those activities that protect the immediate natural resources values or human health and safety.

Management activities may include active maintenance and restoration, or simply allowing natural ecological processes to occur without interference. Active management methods and techniques may include prescribed burns, invasive species control, brush control, planting of native plant species, and other forms of ecological restoration.

Standards:

1. DNR Forest Certification Work Instruction 1.4 - Biodiversity Management on State Forest Lands.
2. DNR Forest Certification Work Instruction 3.1 – Forest Operations.
3. Biodiversity Conservation Planning Process (Michigan Department of Natural Resources 2005a).

Guidelines:

1. Use the Biodiversity Conservation Planning Process Phase I Report at the ecoregional and FMU level of operations for guiding the review of potential ERAs.
2. Use Conservation Area Management Guidelines (Michigan Department of Natural Resources 2005).
3. Encouraged and allowed to continue the function of natural ecological processes.
4. Where significant disruption to ecological processes has occurred, take corrective action to restore natural processes.
5. Implement programs to eradicate invasive plants and animals which can cause severe disruption to native communities.
6. Use community abstracts developed by the Michigan Natural Features Inventory as additional reference in the identification and management of ERAs.

Table 5.1.–State forest areas managed as natural areas (in acres; DNR data).

Site name	Type of area	Recognition	Management unit	County	Acres
Carney Fen	natural area	NLD	Escanaba	Menominee	3,510
Crawford Red Pines	TNC natural area registry	TNC	Grayling	Crawford	120
Crisp Point	TNC natural area registry	TNC	Newberry	Luce	102
Crow River Mouth	TNC natural area registry	TNC	Sault Ste. Marie	Mackinac	517
Dead Stream Swamp	national natural landmark	NNL	Roscommon/ Cadillac	Roscommon/ Missaukee	11,664
Deer Park Site	TNC natural area registry	TNC	Newberry	Luce	100
Duck-Mud Lake Chain site	TNC natural area registry	TNC	Gaylord	Cheboygan	237
Jordan River	natural area	NLD	Gaylord	Antrim	1,570
Lake Sixteen	TNC natural area registry	TNC	Atlanta	Presque Isle	181
Little Presque Isle	natural area	NLD, AR	Gwinn	Marquette	544
Little Presque Isle	wild area	NLD, AR	Gwinn	Marquette	15
Marsh Lakes	TNC natural area registry	TNC	Newberry	Chippewa	31
Maxton Plains	natural area	NLD, 2-TNC	Newberry	Chippewa	2,076
McMahon Lake Strangmoor	TNC natural area registry	TNC	Newberry	Luce	3,928
Pigeon River State Forest—Dog Lake	wild area	NLD	Pigeon River Country	Cheboygan	659
Pigeon River State Forest—Pine Tract	natural area	NLD	Pigeon River Country	Cheboygan	180
Pigeon River State Forest—Grindstone Creek	wild area	NLD	Pigeon River Country	Cheboygan	160
Point Detour	TNC natural area registry	TNC	Escanaba	Delta	484
Rocking Chair Lakes	natural area	PLD, AR	Gwinn	Marquette	235
Seiner's Point	wild area and TNC natural area registry	PLD, TNC, AR	Sault Ste. Marie	Mackinac	2,649
Shakey Lakes	natural area	AR	Escanaba	Menominee	1,527
South Branch of the Au Sable River area	natural area	NRC	Grayling	Crawford	3,182
Tahquamenon Island	TNC natural area registry	TNC	Newberry	Chippewa	3
Vermilion Point	TNC natural area registry	TNC	Newberry	Chippewa	112
Wilderness State Park	wild area	PLD	Gaylord	Emmet	1,815
				Total acres:	35,601

Note: NLD = Nominated for Legal Dedicated, PLD = Proposed for Legal Dedication, AR = Administratively Recognized, NRC = Natural Resource Commission Resolution, TNC = The Nature Conservancy Registry.

Table 5.2.–Management permissions for military lands (DNR data).

Classification and county	Approximate acres	Management permissions
Hanson Reserve lands Crawford	14,067	Military training has precedence over resource management activities. Permanent military encampment and maneuver area. The DNR manages the forest, game and fish resources, as long as management activities do not conflict with military needs. Hunting is prohibited.
Military Board lands Crawford and Kalkaska	18,146	Military training has precedence over resource management activities. The DNR will coordinate all prescribed activities with the National Guard to ensure they are compatible with military training needs. Lands are open to hunting.
Military lease lands Crawford and Otsego	56,769	Military training has precedence over resource management activities. The DNR will coordinate all prescribed activities with the National Guard to ensure they are compatible with military training needs. No permanent buildings or improvements allowed.
10-year management agreement lands Crawford and Kalkaska	43,541	MDNR management activities take precedence on these lands, with consideration of making management activities compatible with national guard training needs. Military camping and maneuvers permitted. No high intensity live ammunition firing or heavy equipment use except for designated tank trails.
DMA acquired lands Crawford	11, 938	DNR has jurisdiction for hunting and forest management.

Table 5.3.–Legally-dedicated natural areas in the state forest (in acres; DNR data).

Site name	Type of area	Recognition	Management unit	County	Acres
Besser	natural area	LD	Atlanta	Presque Isle	89
Bois Blanc Island—mixed forest	natural area	LD	Gaylord	Mackinac	993
Bois Blanc Island—Snake Island/Mud Lake	natural area and TNC natural area registry	LD TNC	Gaylord	Mackinac	272
Bois Blanc Island—north shore	natural area	LD	Gaylord	Mackinac	833
Laughing Whitefish Falls Scenic Site	natural area	LD	Gwinn	Alger	364
Little Brevort Lake Scenic Site	natural area	LD	Sault Ste. Marie	Mackinac	736
Roscommon Red Pines Nature Study Area	natural area and national natural landmark	LD NNL	Roscommon	Roscommon	159
				Total acres:	3,446

Table 5.4.–Dedicated management areas in the state forest (in acres; DNR data).

Area	Forest management unit	Land use order	Acreage
Baraga Plains Waterfowl Management Area	Baraga	3.21	2,503
DeWard Tract	Traverse City, Gaylord, and Grayling	4.9	4,441
Gladwin Field Trial Area	Gladwin	4.19a	4,749
Green Timber Management Unit	Pigeon River Country	4.34	6,258
Jordan River Valley	Gaylord	4.8	21,304
Kawkawlin Creek Flooding	Gladwin	4.32	2,742
Lame Duck Foot Access Area	Gladwin	4.20	13,818
Little Presque Isle Property	Gwinn	4.30	3,134
Mason Tract	Grayling	4.16	4,353
Munuscong Wildlife Area	Sault Ste. Marie	4.14	14,700
Sand Lakes Quiet Area	Traverse City	4.25	2,996
Simmons Woods	Sault Ste. Marie	4.28	10,352
Skegemog Lake Wildlife Area	Traverse City	4.24	2,421
		Total acres:	93,771

Monitoring, Review, and Revision

6.1 Management Review System

The DNR state forest management review process for recording, evaluating, and reporting nonconformances with the forest certification standards and related DNR forest certification work instructions is described in the Forest Certification Work Instruction 1.2 – Management Review Process for Continual Improvement in the Management of Forest Resources. The work instruction describes internal audit schedules, annual forest certification surveillance audits, field management reviews, and procedures for implementing improvements.

The Statewide Council will conduct an annual management review to evaluate the results of the annual state forest operations audits. These reviews will evaluate the effectiveness of work instructions and areas of nonconformance, and determine what changes are necessary to continually improve operations. The review will be based upon the following:

1. Internal Audits of Forest Management Units. All fifteen FMUs receive initial audits of their operations to record, evaluate, and report nonconformances with forest certification standards and related work instructions at all levels of the department. FMUs receive internal audits on a 3-year cycle with five FMUs being audited per year, in accordance with a schedule to be issued by the DNR Statewide Council. FMFM district supervisors and WD management unit supervisors must monitor implementation of internal audit corrective action plans and report pending or continuing nonconformance at the annual management review.
2. Annual Forest Certification Surveillance Audits will be conducted by certified FSC and SFI auditors to assess the conformance of DNR operations with forest certification standards (Appendix A).
3. Field Management Reviews of the Annual Forest Certification Audit results will be conducted to evaluate field operations and DNR programs on a statewide basis. A report will be drafted for submission to the Statewide Council (SWC), addressing the conformance of DNR operations with the forest certification standards, and providing recommendations for improvement.

The SWC will approve changes necessary to continually improve conformance with work instructions. DNR division chiefs are responsible for implementing approved recommendations.

6.2 Plan Monitoring

There are many existing planning processes that have varying degrees of monitoring components. Monitoring needs to be well-integrated at all levels of management, at statewide, ecoregional and management unit levels. Some are propelled by the annual budgetary process, including federal grants programs. Others are programmatically driven, such as the annual Timber Sale Preparation Plan of Work process, FMU analyses, the biodiversity conservation planning process, and annual fire plans. Some are ad hoc and project oriented or dependent upon the appointment and perpetuation of various teams.

Monitoring shall be conducted to assess the condition of the state forest, compliance with forest certification standards for sustainability, the degree to which management goals, objectives, and desired future conditions have been achieved, deviations from management plans, and the social and ecological effects of management activities. Additionally, FSC Principle 8 requires monitoring for the following elements of forest management:

1. The yield of all forest products harvested.
2. Growth rates, regeneration, and condition of the forest.
3. Composition and observed changes in flora and fauna.
4. Environmental and social effects of harvesting and other operations.
5. Cost, productivity, and efficiency of forest management.

FSC Principle 9 requires annual monitoring to assess the effectiveness of actions taken to maintain or enhance High Conservation Value Area attributes.

Many DNR programs and processes provide guidance for monitoring and reporting of these elements (Table 6.1). A brief summary of each program follows.

The USFS Forest Inventory and Analysis program provides a statewide assessment of cover type growth and removals through harvesting and natural mortality and an assessment of the state's forest-based economy. The assessment occurs every 5 years.

The Forest Health Monitoring Program includes a system of statewide survey plots that are part of a nationwide Forest Health Monitoring Program in partnership with the Environmental Protection Agency, the U.S. Forest Service and the University of Michigan.

HCVA/ERA monitoring protocols are being developed on a compartment year-of-entry basis, in conjunction with the development of site specific management plans. Monitoring of the conditional quality of ERAs and the biodiversity stewardship areas category of HCVA is also accomplished under contract with staff from the Michigan Natural Features Inventory.

Forest Management Unit analyses provide an annual landscape-level assessment of the compositional and structural trends of the major cover types of forest vegetation.

The State Forest Timber Harvest Trends Report describes recent state forest harvest trends and the factors which influence them, and provides a basis for management review and reporting on timber harvest levels.

The Wildlife Division conducts field abundance surveys for both game and nongame species on an annual basis. These include surveys for many mammal, bird, and amphibian species to determine population trends.

The Timber Sale Monitoring Program is directed by Forest Certification Work Instruction 7.1 Timber Sale Preparation and Administration Procedures. Monitoring of timber sale contract specifications is conducted by DNR field staff using a Timber Sale Contract – Field Inspection Report (R-4050).

The DNR FMFMD monitors use trends for state forest camping, off-road vehicle, and snowmobile recreation programs through registrations, and trail permits. State forest recreation use and revenue trends are reported to the Michigan Legislature and Natural Resource Commission on an annual basis.

Statewide criteria, indicators and metrics apply to the entire landscape of the state but can be used to monitor some management elements of the state forest (Appendix H).

6.3 Plan Revision

Management processes need to be adjusted or changed when results of the field management reviews and monitoring indicate that the management goals and objectives that are necessary for the

attainment of a desired future conditions are not being achieved for a specific ecological, social or economic value. Required changes in management processes shall be incorporated into the revision and implementation of subsequent revisions of statewide, regional and FMU-level management plans.

Aggregated data for projected acreages and expected treatments for cover types will be added as an appendix after completion of the Regional State Forest Management Plans. Thereafter, operational components of statewide and regional management plans will be reviewed and revised as necessary, but at a minimum of every five years. Strategic components of statewide and regional management plans are to be reviewed and if necessary revised or updated at the completion of each 10-year compartment review cycle. If management review or monitoring results indicate the need for modification of the plan within a shorter time period, the plan may be revised before the 5- and 10-year requirements.

Plan revision will be initiated by the DNR and accomplished using a public process.

Table 6.1.–DNR monitoring requirements and monitoring programs.

Monitoring requirements	Monitoring programs								
	USFS forest inventory and analysis (FIA)	Forest health monitor program	HCVA and ERA monitor protocol	Forest management unit analyses	State forest timber harvest trends report	WLD game and nongame surveys	Timber sale monitor program	Recreation monitoring programs	Statewide criteria (including indicators)
Yield of all forest products harvested					X		X	X	1, 2, 4, 6
Growth rates, regeneration, and condition of the forest	X	X							1, 2, 5
Composition and observed changes in flora and fauna	X			X		X			1, 2
Environmental and social impacts of harvesting and other operations	X				X				2, 3, 4, 6
Cost, productivity, and efficiency of forest management							X		2, 6, 7
Effectiveness of actions to maintain or enhance high conservation value area attributes			X						1, 3

Glossary

Acre – A measure of land that occupies 43,560 square feet; (about 207 feet X 207 feet.) There are 640 acres in a square mile.

Area Regulation – An indirect method of roughly determining the amount of forest product to be annually or periodically harvested, on the basis of the total stocked area.

Barrens – Land with poor soil and dominated by herbaceous vegetation with very few shrubs or trees.

Biodiversity – The spectrum of life forms and the ecological processes that support and sustain them. Biological diversity occurs at four interacting levels—genetic, species, community, and ecosystem. The variety of living organisms considered at all levels of organization, from genetics through species, to higher taxonomic levels, also; the term encompasses the variety of habitats and ecosystems supporting the organisms, as well as the processes occurring within those systems.

Coarse Filter Approach – A conservation strategy focused on addressing the habitat needs of wildlife (by definition, both aquatic and terrestrial species) to more effectively conserve rare, declining, and common species statewide.

Carbon Sequestration – A term describing processes that remove carbon from the atmoshere. This can occur through a variety of means to artificially capture and store carbon, as well as enhancing natural sequestration processes in forests and oceans. These actions are intended to help mitigate global warming.

Cervid – An animal of the cervidae family, which in Michigan includes white-tailed deer, elk, and moose.

Community – An assemblage of species living together in a particular area, at a particular time, in a prescribed habitat. Communities usually bear the name of their dominant plant species, but include all the microbes, plants, and animals living in association with the dominant plant species at a given time. A grouping of organisms which exist in the same general place and have mutual interactions.

Compartment – Blocks of state forestland that range from 1500 to 3000 acres in size. The size of a compartment is designed to facilitate systematic examination and treatment on a regular basis.

Conserve, Conserving, and Conservation – 1. Management of renewable natural resource with the objective of sustaining its productivity in perpetuity while providing for human use compatible with the sustainability of the resource; **2.** The process and measures for restoring natural biological diversity through management efforts, in order to protect, restore, and enhance as much of the variety of native plant and animal species and communities as possible in quantities and distributions that provide for the continued existence and normal functioning of native species and communities, including the viability of populations throughout the natural geographic distributions of native species and communities.

DBH – Diameter at breast height (4½ feet) which is the standard height for measuring tree diameter.

Desired Future Condition – A statement that provides a broad vision for the future state of the forest.

Ecological Reference Areas (ERAs) – Areas that serve as models of ecological reference within the state and may be located on any forestland ownership. They are high quality examples of functioning ecosystems that are primarily influenced by natural ecological processes. ERAs are defined as areas that have a natural community classification global or state rank of G1, G2, G3, S1, S2, S3 and an element occurrence rank A or B. (Natural Community Rank and Element Occurrence in Michigan are determined by Michigan Natural Features Inventory using the internationally recognized heritage methodology.) The initial set of ERAs is based on MNFIs current list of known high quality natural community sites (See Conservation Area Management Guidance). Additional ERAs will be identified through the biodiversity conservation planning process.

Ecology – The study of the linkages of organisms or groups of organisms and their environment, both biotic and abiotic.

Ecosystem – A dynamic and natural complex of living organisms interacting with each other and with their associated nonliving elements in the environment.

Ecosystem Diversity – The distinctive assemblages of species and ecological processes that occur in difference physical settings of the biosphere.

Ecosystem management – A process that integrates physical, chemical, biological, and ecological principles, along with economic and social factors, into a comprehensive strategy aimed at protecting and enhancing sustainability, diversity, and productivity of a system.

Ecosystem Services – Processes by which the natural environment produces resources that are useful to people, including maintenance of air and water quality, groundwater recharge, conservation of soil resources, nutrient cycling, carbon sequestration, provision of habitat and biodiversity, and attenuation of drought and flood conditions.

Ecoregion – Areas of relatively homogeneous ecological systems. Ecoregions are usually based on patterns of land use, topography, present and potential natural vegetation, and soils. Ecoregion designations are used by resource managers to develop logical, regional strategies for land acquisition and management.

Eco-unit – Geographic areas containing similar ecological patterns and processes whose boundaries closely align with Michigan's ecoregions. They were established by the DNR for organizing and administering assessment, planning, facilitating, and updating of regional ecosystem management activities. Four eco-units were established—Western Upper Peninsula. Eastern Upper Peninsula, Northern Lower Peninsula, and Southern Lower Peninsula. These four eco-units apply to all divisions. Representatives from each division will contribute to regional ecosystem planning, assessment, and monitoring at the eco-unit level.

Eco-Unit Team – A team of DNR employees composed primarily of management unit supervisors from each division along with additional support personnel who are mandated to plan and coordinate management of an eco-unit using ecosystem management principles.

Edaphic – Related to or caused by particular soil conditions.

Endemic – Indigenous to (native) or characteristic of a particular restricted geographical area.

Edge Habitat – The outermost band of habitat that surrounds a forest patch which has a species composition and structure that is significantly different from the interior of the patch. Edges can be a few to several hundred feet wide depending on environmental factors.

Endangered Species – Any plant or animal species defined through the Endangered Species Act of 1976 as being in danger of extinction throughout all or a significant portion of its range, and published in the Federal Register, or a species that is in imminent peril of extinction or extirpation.

Extent – In the use of describing an indicator the term extent refers to both area and distribution.

Fine Filter Approach – A conservation strategy used when particular species do not respond positively to habitat or ecosystem-based conservation (coarse filter) approaches, and additional management specifically directed toward their unique requirements is necessary. These unique species include those that respond to very specific changes within their habitat or ecosystem; species for which degradation or loss of habitat is not the primary threat; and species that do not share habitat associations with other species of greatest conservation need, and, therefore, may not be adequately conserved through efforts addressing species assemblages.

Forest – An ecosystem characterized by a more or less dense and extensive tree cover, often consisting of stands varying in characteristics such as species composition, structure, age class, and associated processes, and commonly including meadows, streams, fish, and wildlife. A plant community or predominantly trees and other woody vegetation growing more or less closely together, its related flora and fauna, and the values attributed to it.

Forest Patch – An area on the landscape differing in appearance from its surroundings. Patches may be due to natural (e.g., soil type) or anthropogenic (e.g., development) factors. Woodlots or residential development are examples of patches within a landscape.

Forest Road – A hard surface road, travel, or dirt road, or other route capable of travel by a 2-wheel drive, 4-wheel conventional vehicle designed for highway use, except an interstate, state, or county highway. Forest roads may be permanent or temporary, and include haul roads, logging trails, and skid trails.

Forest Trail – A designated path or way capable of travel only by a vehicle less then 50 inches in width.

Forest Treatments – Activities taken to modify the composition or structure of a forest stand to meet management objectives; such activities include commercial thinning or clearcut harvests, prescribed burns, noncommercial mechanical removal of undesired species, regeneration or understory planting, and deliberate inaction.

Forest Type – A classification of forestland based on the species forming a plurality of live tree stocking.

Genetic Diversity – The differences in genetic composition within and among populations of a given species.

Geographic Information Systems or Science (GIS) – A system designed for the collection, storage, and analysis of objects and phenomena where geographic location is an important characteristic. The study of this system is Geographic Information Science.

Goal – A concise statement which provides the means for the achievement of desired future conditions. Management goals may be short- or long-term in nature. Long-term management goals are necessary to help achieve desired future conditions.

Guideline – A nonmandatory means by which goals are achieved.

Habitat – The place where an organism lives and its surrounding environment including its biotic and abiotic components. Habitat includes everything an organism needs to survive.

Habitat Type System – A classification that uses the floristic composition of plant community (understory species as well as trees) as an integrated indicator of those environmental factors that affect species reproduction, growth, competition, and therefore, community development.

High Conservation Value Areas (HCVAs) – Areas (including ERAs) that have been recognized for their contribution to specific conservation objectives or attributes through a recognized DNR process such as legislation, administrative rule, Director's and Natural Resource Commission orders but not including the Open House/Compartment Review process. Examples of recognized processes include Dedicated Natural, Wilderness or Wild Areas, Natural Rivers, and the Strategy for Kirtland's Warbler Habitat Management (Michigan Department of Natural Resources et al. 2001).

Hydric – Wet

Hypsithermal – The period of maximum climatic warmth during an interglacial period.

Interior Habitat – Habitat within the interior of a forest patch that is removed from edge habitat, that is necessary for the persistence of certain forest plant and animal species, by providing insulation from edge effects such as noise, wind, solar radiation, and increased predation.

Integrated Pest Management – The maintenance of destructive agents, including insects at tolerable levels, by the planned use of a variety of preventative, suppressive, or regulatory tactics and strategies that are ecologically and economically efficient and socially acceptable.

Karst – A type of terrain usually formed on carbonate rock (limestone and dolomite) where groundwater has dissolved the rock to enlarged openings and form a subsurface drainage system of caverns and sinkholes.

Lake Superior Syncline – A syncline is a geological term for a fold in the rocks of the Earth's crust in which the layers or beds dip inwards, thus forming a trough-like structure with a sag in the middle. The Lake Superior Syncline forms portion of the lake basin, extending from northern Wisconsin to the tip of the Keweenaw Peninsula of Michigan and into Ontario, Canada. The edges of the syncline are visible in the unique bedrock formations of the Keweenaw Peninsula and Isle Royale.

Landscape – An area composed of adjacent and interacting ecosystems that are related because of geology, land forms, soils climate, biota, and human influences.

Landscape Scale – The appropriate spatial or temporal scale for planning, analysis, and improvement of management activities to achieve ecosystem management objectives.

Lacustrine – Found or formed in lakes.

Legacy Tree – A mature tree that is retained on a site after harvesting or natural disturbance to provide a biological legacy.

Mesic – Moderately moist.

Monitoring – The daily, seasonal, annual, or longer term collection and analysis of environmental and social data.

Monitoring Criteria – A measure by which the progress toward the attainment of sustainable management goals and desired future conditions are assessed.

Moraine – A mass of rock, gravel, and soil deposited directly by a glacier.

Objective – A concise, time-specific statement of measurable planned results that respond to pre-established goals. Objectives are more specific and concrete than goals.

Off-Road Vehicle (ORV) – A motor driven off-road vehicle capable of cross-country travel without benefit of a road or trail, on or immediately over land, snow, ice, marsh, swampland, or other natural terrain. ORV includes, but is not limited to, a multi- track or multi-wheel drive vehicle, an all-terrain vehicle (ATV), a motorcycle or related 2-wheel, 3-wheel, or 4-wheel vehicle, an amphibious machine, a ground effect air cushion vehicle, or other means of transportation deriving motive power from a source other than muscle or wind.

Old Growth – As defined by the Natural Resources Commission on 12/8/94, old-growth forests are those that approximate the structure, composition, and functions of native forests. These native conditions generally include more large trees, canopy layers, standing snags, native species, and dead organic material, involve more complex ecological processes, and undergo more gradual change than do young or intensively managed forests. Native forest conditions in Michigan also included ecologically important unforested openings, early successional stages, and extensive areas of catastrophic, or frequent disturbance.

Poletimber – A live tree of commercial species at least 5.0 inches DBH, but smaller than sawtimber size. Harvested poletimber is sometimes referred to as cordwood.

Potential Old Growth – Areas inventoried and designated with a stand condition code of 8 within operations inventory for consideration as old growth.

Public – A group of people sharing a common interest or common characteristic—snowmobilers, or residents of a county.

Rare Species – Species that have a limited range, or a limited number of individuals. This could include species found in very low numbers throughout their range, or species that may have large local populations, but only a small number of total populations.

Removal Cut – Removal of overstory trees from a small understory trees so as to release the understory stand that are less than 20 years of age.

Resource assessment – The determination of the significance, importance, or value of a resource or a set of resources.

Riparian Area – The area of transition between aquatic and terrestrial ecosystems in which the terrestrial ecosystem influences aquatic and vice-versa.

Riparian Management Zone – The defined area consciously managed to protect functions and values of riparian areas. It may be a subset of, may equal, or may exceed beyond the riparian area.

Sapling – A live tree 1.0 to 5.0 inches DBH.

Sawtimber – A live tree of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs 8 feet or longer and meeting regional specifications for freedom from defect. Softwoods must be at least 9.0 inches DBH and hardwoods must be at least 11.0 inches DBH.

Seasonal Wetlands – Poorly drained, shallow depressions that may have standing water for a few weeks each year, but that are usually dry for much of the growing season.

Seed Tree Harvest – Most trees are removed from a stand, leaving a small number of designated seed trees.

Shelterwood Harvest – A cut designed to develop tree crowns in the remainder of the stand in preparation for another cut to be made in about ten years that will result in regeneration.

Silvicultural Criteria – The assemblage of abiotic and biotic factors (such as landform, soils, climate, life history characteristics of tree species, disease, and insect pathogens) that when considered together govern establishment, growth, composition, health, and quality of forests. In practical application, when silvicultural criteria are met they trigger a management action.

Site Index – A numerical indicator of site quality based on tree height at a specified age used as coordinates for interpolating site index from a specially prepared set of graphed curves for a given species of tree.

Spatial Scale – The geographical size of a community, ecosystem, or study. Spatial scale can range from a microsite such as an underside of a leaf on the forest floor, to a forest, to a larger landscape. Operationally, spatial scale refers to the geographic extent at which certain processes operate within the environment. This could be the scale at which nutrients recycle in a wetland to the patterns of deer migration in the Upper Peninsula.

Special Concern Species – Species that have a limited range, or a limited number of individuals, so much so they are on the verge of becoming threatened or endangered.

Species – A group of individuals that can interbreed successfully with one another, but not with members of other groups. Plants and animals are identified as belonging to a given species based on similar morphological, genetic, and biochemical characteristics.

Special Conservation Areas (SCAs) – Special conservation areas are areas of state forestland that have had one or more conservation objectives, interests, or elements identified. The type and strength of recognition will vary depending on the process used to identify the conservation value. Some SCA designations will have the force of law, (such as areas identified in land use orders of the director), some will be by cooperative agreement (such as National Natural Landmarks with the National Park Service), some will be by department process or agreement (such as deer yards, potential old growth, and riparian buffers), and some will be identified by an external group or organization (such as Audubon's Important Bird Areas).

Species Diversity – The richness and variety of native species in an area. It includes not only the number of species in the area, but also their relative abundance and spatial distribution. Species richness is one component of species diversity, but not the only determinant.

Soil Detritus – Small pieces of dead and decomposing plants and animal that add organic matter, nutrients, and structure to the organic surface horizon of soils.

Stakeholder – Individuals or groups affected by and/or having an interest in the management of Michigan's natural resources and DNR programs. state, tribal, and local government agencies, academic institutions, the scientific community, nongovernmental entities including environmental, agricultural, and conservation organizations, trade groups, commercial interests, private landowners, and citizens.

Standard – A standard is a mandatory means by which goals are achieved. The intended purpose for standards is to reference procedures and laws that provide existing direction for the achievement of goals

Stand Condition 8 – One of many codes used in DNR Operations Inventory to describe the condition of a stand. Prior to the 2008 year of entry, the code stand condition 8 was used to designate forest areas as potential old growth. As of the 2008 year of entry, this designation has been changed to encompass other biodiversity values and includes areas designated as Special Conservation Areas (of which old growth is a component), High Conservation Value Areas, and Ecological Reference Areas.

Statewide Council (SWC) – A team composed of all the DNR division chiefs who meet periodically to plan and discuss policy, coordination, cooperation, and implementation of department programs.

Succession – The natural change in vegetation over time in the absence of disturbance or the artificial change in vegetation due to natural or human-caused disturbance.

Sustainable/Sustainability – Maintenance of healthy, functioning ecosystems capable of providing goods, services, and processes upon which human welfare ultimately depends. Also, implied is the idea that the actions of the current generation will not diminish the resources and opportunities available to future generations.

Temporal scale – The time required to complete a study, a life history event or ecological process. Temporal scale can vary from a few seconds for biochemical reactions to thousands of years for ecosystem development. Operationally, temporal scale refers to the time extent certain processes operate in the environment. (The apparent spatial-operational scale of an ecological process will often change as the temporal-observational scale changes in the same process).

Threatened species – A plant or animal species likely to become endangered throughout all or a significant portion of its range within the foreseeable future.

Witness Trees – Trees marked with blazes by Government Land Office surveyors during the original survey of the state, to establish the location for township and section lines and township, section and quarter section corners. They are also known as line or bearing trees.

Xeric – Dry or desert like.

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Appendices

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Appendix A.–Sustainable Forestry Act

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Act No. 125
Public Acts of 2004
Approved by the Governor
May 28, 2004
Filed with the Secretary of State
May 28, 2004
EFFECTIVE DATE: May 28, 2004

STATE OF MICHIGAN
92ND LEGISLATURE
REGULAR SESSION OF 2004

Introduced by Reps. Casperson, Stahl, Pastor, Sheen, Walker, Pappageorge, Shackleton, Amos, Nofs, Meyer, Huizenga, Nitz, Palsrok, Palmer, Emmons, LaJoy, Voorhees, Moolenaar, Ward, Bisbee, Hune, Farhat, Mortimer, Hummel, Caswell, Robertson, Shaffer, DeRoche, Julian, Taub, Richardville, Vander Veen, Brandenburg, Acciavatti, Drolet and Bradstreet

ENROLLED HOUSE BILL No. 5554

AN ACT to amend 1994 PA 451, entitled "An act to protect the environment and natural resources of the state; to codify, revise, consolidate, and classify laws relating to the environment and natural resources of the state; to regulate the discharge of certain substances into the environment; to regulate the use of certain lands, waters, and other natural resources of the state; to prescribe the powers and duties of certain state and local agencies and officials; to provide for certain charges, fees, and assessments; to provide certain appropriations; to prescribe penalties and provide remedies; to repeal certain parts of this act on a specific date; and to repeal certain acts and parts of acts," by amending the heading to part 525 and section 52501 (MCL 324.52501), as added by 1995 PA 57, and by adding sections 52502, 52503, 52504, 52505, and 52506.

The People of the State of Michigan enact:

PART 525 SUSTAINABLE
FORESTRY ON STATE FORESTLANDS

Sec. 52501. As used in this part:
(a) "Breast height" means 4.5 feet from highest ground at the base of the tree.
(b) "Certification" means a process where an independent third party organization assesses and evaluates forest management practices according to the standards of a certification program resulting in an issuance of a certificate of compliance or conformity.
(c) "Certification program" means a program that develops specific standards that measure whether forest management practices are consistent with principles of sustainable forestry.
(d) "Conservation" means the wise use of natural resources.
(e) "Diameter class specifications" means a classification of trees based on the diameter at breast height.
(f) "Plan" means the forestry development, conservation, and recreation management plan for state forests as provided for in section 52503.
(g) "Reforestation" means adequate stocking of forestland is assured by natural seeding, sprouting, suckering, or by planting seeds or seedlings.
(h) "Residual basal area" means the sum of the cross-sectional area of trees 4 inches or greater in diameter measured at breast height left standing within a stand after a harvest.
(i) "State forest" means state land owned or controlled by the department that is designated as state forest by the director.
(j) "Sustainable forestry" means forestry practices that are designed to meet present and future needs by employing a land stewardship ethic that integrates the reforestation, managing, growing, nurturing, and harvesting of trees for useful products with the conservation of soil, air and water quality, wildlife and fish habitat, and visual qualities.

Sec. 52502. The department shall manage the state forest in a manner that is consistent with principles of sustainable forestry and in doing so shall do all of the following:
(a) Manage forests with consideration of its economic, social, and environmental values by doing all of the following:
(*i*) Broaden the implementation of sustainable forestry by employing an array of economically, environmentally, and socially sound practices in the conservation of forests, using the best scientific information available.
(*ii*) Promote the efficient utilization of forest resources.
(*iii*) Broaden the practice of sustainable forestry by cooperating with forestland owners, wood producers, and consulting foresters.
(*iv*) Plan and manage plantations in accordance with sustainable forestry principles and in a manner that complements the management of and promotes the restoration and conservation of natural forests.
(b) Conserve and protect forestland by doing all of the following:
(*i*) Ensure long-term forest productivity and conservation of forest resources through prompt reforestation, soil conservation, afforestation, and other measures.
(*ii*) Protect the water quality in streams, lakes, and other waterbodies in a manner consistent with the department's best management practices for water quality.
(*iii*) Manage the quality and distribution of wildlife habitats and contribute to the conservation of biological diversity by developing and implementing stand and landscape-level measures that promote habitat diversity and the conservation of forest plants and animals including aquatic flora and fauna and unique ecosystems.
(*iv*) Protect forests from wildfire, pests, diseases, and other damaging agents.
(*v*) Manage areas of ecologic, geologic, cultural, or historic significance in a manner that recognizes their special qualities.
(*vi*) Manage activities in high conservation value forests by maintaining or enhancing the attributes that define such forests.
(c) Communicate to the public by doing all of the following:
(*i*) Publicly report the department's progress in fulfilling its commitment to sustainable forestry.
(*ii*) Provide opportunities for persons to participate in the commitment to sustainable forestry.
(*iii*) Prepare, implement, and keep current a management plan that clearly states the long-term objectives of management and the means of achieving those objectives.
(d) Monitor forest management by promoting continual improvement in the practice of sustainable forestry and monitoring, measuring, and reporting performance in achieving the commitment to sustainable forestry.
(e) Consider the local community surrounding state forestland by doing both of the following:
(*i*) Require that forest management plans and operations comply with applicable federal and state laws.
(*ii*) Require that forest management operations maintain or enhance the long-term social and economic well-being of forest workers and local communities.

Sec. 52503. (1) The department shall adopt a forestry development, conservation, and recreation management plan for state owned lands owned or controlled by the department. Parks and recreation areas, state game areas, and other wildlife areas on these lands shall be managed according to their primary purpose. The department may update the plan as the department considers necessary or appropriate. The plan and any plan updates shall be consistent with section 52502 and shall be designed to assure a stable, long-term, sustainable timber supply from the state forest as a whole.
(2) The plan and any plan updates shall include all of the following:
(a) An identification of the interests of local communities, outdoor recreation interests, the tourism industry, and the forest products industry.
(b) An identification of the annual capability of the state forest and management goals based on that level of productivity.
(c) Methods to promote and encourage the use of the state forest for outdoor recreation, tourism, and the forest products industry.
(d) A landscape management plan for the state forest incorporating biodiversity conservation goals, indicators, and measures.
(e) Standards for sustainable forestry consistent with section 52502.
(f) An identification of environmentally sensitive areas.
(g) An identification of the need for forest treatments to maintain and sustain healthy, vigorous forest vegetation and quality habitat for wildlife and environmentally sensitive species.
Sec. 52504. (1) After the plan is adopted under section 52503, the department shall harvest timber from the state forest and other state owned lands owned or controlled by the department in compliance with the plan and any plan updates.
(2) Unless otherwise dedicated by law, proceeds from the sale of timber from the state forest and other state owned lands owned or controlled by the department shall be forwarded to the state treasurer for deposit into the forest development fund established pursuant to section 50507.

Sec. 52505. (1) The department shall seek and maintain third-party certification that the management of the state forest and other state owned lands owned or controlled by the department satisfies the sustainable forestry standards of at least 1 credible nonprofit, nongovernmental certification program and this part.
(2) Beginning January 1, 2006, the department shall ensure that the state forest is certified as provided for in subsection (1).
(3) Beginning the effective date of the amendatory act that added this section, the department shall commence a review and study to determine the appropriateness of certifying parks and recreation areas, state game areas, and other wildlife areas on state owned lands owned or controlled by the department. Not later than 1 year after the effective date of the amendatory act that added this section, the department shall report and recommend to the legislature the appropriateness and feasibility of certifying those lands.

Sec. 52506. By January 1 of each year, the department shall prepare and submit to the commission of natural resources, the standing committees of the senate and the house of representatives with primary jurisdiction over forestry issues, and the senate and house appropriations committees a report that details the following from the previous state fiscal year:
(a) The number of harvestable acres in the state forest as determined by the certification program under section 52506.
(b) The number of acres of the state forest that were harvested and the number of cords of wood that were harvested from the state forest.
(c) The number of acres of state owned lands owned or controlled by the department other than state forestlands that were harvested and the number of cords of wood that were harvested from those lands.
(d) Efforts by the department to promote recreational opportunities in the state forest.
(e) Information on the public's utilization of the recreational opportunities offered by the state forest.
(f) Efforts by the department to promote wildlife habitat in the state forest.
(g) The status of the plan and whether the department recommends any changes in the plan.
(h) Status of certification efforts required in section 52505 and, beginning in 2006, a definitive statement of whether the department is maintaining certification of the entire state forest.
(i) A description of any activities that have been undertaken on forest pilot project areas described in section 52511.

Enacting section 1. This amendatory act does not take effect unless all of the following bills of the 92nd Legislature are enacted into law:
(a) Senate Bill No. 1023.
(b) Senate Bill No. 1024.

This act is ordered to take immediate effect.

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Appendix B.–Excerpts of planning principles from the FSC standards

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Principle 7—Management Plan

A management plan -- appropriate to the scale and intensity of the operations -- shall be written, implemented, and kept up to date. The long-term objectives of management, and the means of achieving them, shall be clearly stated.

7.1. The management plan and supporting documents shall provide:

a) Management objectives.
b) Description of the forest resources to be managed, environmental limitations, land use and ownership status, socio-economic conditions, and a profile of adjacent lands.
c) Description of silvicultural and/or other management system, based on the ecology of the forest in question and information gathered through resource inventories.
d) Rationale for rate of annual harvest and species selection.
e) Provisions for monitoring of forest growth and dynamics.
f) Environmental safeguards based on environmental assessments.
g) Plans for the identification and protection of rare, threatened and endangered species.
h) Maps describing the forest resource base including protected areas, planned management activities and land ownership.
i) Description and justification of harvesting techniques and equipment to be used.

Applicability Note: The management plan may consist of a variety of documents not necessarily unified into a single planning document but which represents an integrated strategy for managing the forest within the ecological, economic, and social limitations of the land. The plan includes a description and rationale for management elements appropriate to the scale, intensity, and goals of management, and may include:

Silvicultural systems
Regeneration strategies
Maintenance of structural and species diversity
Pest control (disease, insects, invasive species, and vegetation)
Soil and water conservation
Methods and annual rates of harvest, by species and products
Equipment and personnel needs
Transportation system
Fire management
Prescribed fires
Wildfires
Fish and wildlife and their habitats (including nongame species)
Nontimber forest products
Methods and annual rates of harvest, by species and products
Regeneration strategies
Socioeconomic issues
Public access and use
Conservation of historical and cultural resources
Protection of aesthetic values
Employee and contractor policies and procedures
Community relations
Stakeholder notification
Public comment process
For public forests, legal and historic mandates

American Indian issues
Protection of legal and customary rights
Procedures for integrating tribal concerns in forest management
Management of sites of special significance
Special management areas
High Conservation Value Forests
Riparian management zone
Set asides of samples of representative existing ecosystems
Sensitive, rare, threatened, and endangered species protection
Other protected areas
Landscape level analyses and strategies

7.1.a. Management objectives

7.1.a.1. A written management plan is prepared that includes the landowner's short-term and long-term goals and objectives (ecological, social, and economic). The objectives are specific, achievable, and measurable.

7.1.a.2. The management plan describes desired future conditions that will meet the long-term goals and objectives and that determine the silvicultural system(s) and management activities to be used.

7.1.b. Description of forest resources to be managed, environmental limitations, land use and ownership status, socioeconomic conditions, and profile of adjacent lands

7.1.b.1. The management plan describes the timber, fish and wildlife, harvested nontimber forest products, soils, and noneconomic forest resources.

7.1.b.2. The management plan includes descriptions of special management areas; sensitive, rare, threatened, and endangered species and their habitats; and other ecologically sensitive features in the forest.

7.1.b.3. The management plan includes a description of past land uses and incorporates this information into the vision, goals, and objectives.

7.1.b.4. The management plan identifies the legal status of the forest and its resources (e.g., ownership, usufruct rights (see Glossary), treaty rights, easements, deed restrictions, and leasing arrangements).

7.1.b.5. The management plan identifies relevant cultural and socioeconomic issues (e.g., traditional and customary rights of use, access, recreational uses, and employment), conditions (e.g., composition of the workforce, stability of employment, and changes in forest ownership and tenure), and areas of special significance (e.g., ceremonial and archeological sites).

7.1.b.6. The management plan incorporates landscape-level considerations within the ownership and among adjacent and nearby lands, including major bodies of water, critical habitats, and riparian corridors shared with adjacent ownerships.

7.1.c. Description of silvicultural and/or other management system

7.1.c.1. Silvicultural system(s) and prescriptions are based on the integration of ecological and economic characteristics (e.g., successional processes, soil characteristics, existing species composition and structures, desired future conditions, and market conditions). (see also sub-Criterion 6.3.a)

7.1.c.2. Prescriptions are prepared prior to harvesting, site preparation, pest control, burning, and planting and are available to people who implement the prescriptions.

7.1.d. Rationale for the rate of annual harvest and species selection
7.1.d.1. Calculations for the harvests of both timber and nontimber products are detailed or referenced in the management plan and are based on net growth, yield, stocking, and regeneration data. (see also 5.6.b)
7.1.d.2. Species selection meets the social and economic goals and objectives of the forest owner or manager and leads to the desired future conditions while maintaining or improving the ecological composition, structures, and functions of the forest.
7.1.d.3. The management plan addresses potentially disruptive effects of pests, storms, droughts, and fires as they relate to allowable cut.

7.1.e. Provisions for monitoring forest growth and dynamics (see also Principle 8)
7.1.e.1. The management plan includes a description of procedures to monitor the forest.

7.1.f. Environmental safeguards based on environmental assessments (see also Criterion 6.1.)

7.1.g. Plans for the identification and protection of rare, threatened, and endangered species. (see also Criterion 6.3.)

7.1.h. Maps describing the forest resource base including protected areas, planned management activities, and land ownership.
7.1.h.1. The management plan includes maps of such forest characteristics as: relevant landscape-level factors; property boundaries; roads; areas of timber production; forest types by age class; topography; soils; riparian zones; springs and wetlands; archaeological sites; areas of cultural and customary use; locations of sensitive, rare, threatened, and/or endangered species and their habitats; and designated High Conservation Value Forests.

7.1.i. Description and justification of harvesting techniques and equipment to be used. (see also Criterion 6.5)
7.1.i.1. Harvesting machinery and techniques are discussed in the management or harvest plan and are specifically matched to forest conditions in order to minimize damage.
7.1.i.2. Conditions for each timber sale are established by a timber sale contract or written harvest prescription and accompanying timber sale map.

7.2. The management plan shall be periodically revised to incorporate the results of monitoring or new scientific and technical information, as well as to respond to changing environmental, social and economic circumstances.
7.2.a. Operational components of the management plan are reviewed and revised as necessary or at least every 5 years. Components of the long-term (strategic) management plan are revised and updated at the end of the planning period or when other changes in the management require it. (see also Criterion 8.4)

7.3. Forest workers shall receive adequate training and supervision to ensure proper implementation of the management plans.
7.3.a. The forest owner or manager assures that workers are qualified to implement the management plan (see also Criterion 4.2).
7.3.b. The management plan is understandable, comprehensive, and readily available to field personnel.

7.4. While respecting the confidentiality of information, forest managers shall make publicly available a summary of the primary elements of the management plan, including those listed in Criterion 7.1.

Applicability Note: Forest owners or managers of private forests may withhold proprietary information (e.g., the nature and extent of their forest resource base, marketing strategies, and other financial information). (see also Criterion 8.5)

7.4.a. A management plan summary that outlines management objectives (from sub-Criterion 7.1.a.), whether on private lands or the land pool under a resource manager, is available to the public at a reasonable fee. Additional elements of the plan may be excluded, to protect the security of environmentally sensitive and/or proprietary information.

7.4.b. Managers of public forests make forestry-related information easily accessible (e.g., available on websites) for public review, including that required by Criterion 7.1.

Appendix C.–Excerpts of planning objectives from the SFI standards

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Objective 1. To broaden the implementation of *sustainable forestry* **by ensuring long-term harvest levels based on the use of the** *best scientific information* **available.**

Performance Measure 1.1. *Program Participants* shall ensure that long-term harvest levels are sustainable and consistent with appropriate *growth-and-yield models* and written plans.

Indicators:
1. A long-term resource analysis to guide forest management planning at a level appropriate to the size and scale of the operation, including
a. a periodic or ongoing forest *inventory*;
b. a *land classification* system;
c. soils *inventory* and maps, where available;
d. access to *growth-and-yield modeling* capabilities;
e. up-to-date maps or a *geographic information system (GIS)*;
f. recommended sustainable harvest levels; and
g. a review of nontimber issues (e.g., pilot projects and economic incentive programs to promote water protection, carbon storage, or *biological diversity conservation*).
2. Documentation of annual harvest trends in relation to the sustainable forest management plan.
3. A forest *inventory* system and a method to calculate growth.
4. Periodic updates of *inventory* and recalculation of planned harvests.
5. Documentation of forest practices (e.g., planting, fertilization, and thinning) consistent with assumptions in harvest plans.

Objective 12. To broaden the practice of *sustainable forestry* **by encouraging the public and forestry community to participate in the commitment to** *sustainable forestry* **and publicly report progress.**

Performance Measure 12.3. *Program Participants* with forest *management responsibilities on public lands* shall participate in the development of *public land* planning and management processes.

Indicators:
1. Involvement in *public land* planning and management activities with appropriate governmental entities and the public.
2. Appropriate contact with local stakeholders over forest management issues through state, provincial, federal, or independent collaboration.

Objective 13. To promote continual improvement in the practice of *sustainable forestry* **and monitor, measure, and report performance in achieving the commitment to** *sustainable forestry***.**

Performance Measure 13.1. *Program Participants* shall establish a management review system to examine findings and progress in implementing the SFI Standard, to make appropriate improvements in *programs*, and to inform their employees of changes.

Indicators:
1. System to review commitments, *programs*, and procedures to evaluate effectiveness.
2. System for collecting, reviewing, and reporting information to management regarding progress in achieving SFI Standard *objectives* and *performance measures*.
3. Annual review of progress by management and determination of changes and improvements necessary to continually improve SFI conformance.

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Appendix D.–List of DNR forest certification work instructions

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Work Area Group 1—Plan, Monitor, and Review

1.1 Strategic Framework for Sustainable Management of State Forest Land
1.2 Management Review Process for Continual Improvement in the Management of Forest Resources
1.3 Regional State Forest Management Plan Development
1.4 Biodiversity Management on State Forest Lands [1]
1.5 Social Impact Considerations and Public Involvement Processes [1]
1.6 Forest Management Unit Analyses [1]
1.7 State Forest Timber Harvest Trends

Work Area Group 2—Forest Regeneration and Chemical Use

2.1 Reforestation [1]
2.2 Use of Pesticides and Other Chemicals on State Forest Lands [1]
2.3 Integrated Pest Management and Forest Health [1]

Work Area Group 3—Best Management Practices

3.1 Forest Operations [1]
3.2 Best Management Practices Non–Conformance Reporting Instructions [1]
3.3 Road Closures [1]

Work Area Group 4—Deleted and integrated with WAG 7

Work Area Group 5—Research

5.1 Coordinated Natural Resource Management Research

Work Area Group 6—Education and Recreation

6.1 Implementing Public Informational and Educational Opportunities on State Forests [1]
6.2 Integrating Public Recreational Opportunities with Management on State Forest Lands [1]
6.3 SFI Involvement and the Michigan State Implementation Committee

Work Area Group 7—Integrated Implementation and Contracting

7.1 Timber Sale Preparation and Administration Procedures [1]
7.2 Legal Compliance and Administration of Contracts [1]

Work Area Group 8—Training

8.1 MDNR Staff Training for State Forest Management

Work Area Group 9—Tribal Issues

9.1 Collaboration with Tribes in regard to management of State Forest Land [1]

[1] This work instruction is directly pertinent to and is required to be used by field staff in the course of daily forest operations.

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Appendix E.–DNR management unit boundaries

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DNR Forest, Mineral, and Fire Management Division (FMFM)

The mission of Forest, Mineral, and Fire Management Division is to provide for the protection, integrated management and responsible use of a healthy productive forest and mineral resource base for the social, recreational, environmental, and economic benefit of the people of the State of Michigan. This includes direct day-to-day management of Michigan's state forest.

Operational management of the state forest is largely conducted at the forest management unit (FMU) level (Figure E1). There are 15 FMUs. Management planning is also conducted on an ecoregional basis, following political boundaries that roughly follow the ecoregional boundaries. There are three ecoregions that coincide with the area containing the state forest system: the Northern Lower Peninsula; the Eastern Upper Peninsula; and the Western Upper Peninsula.

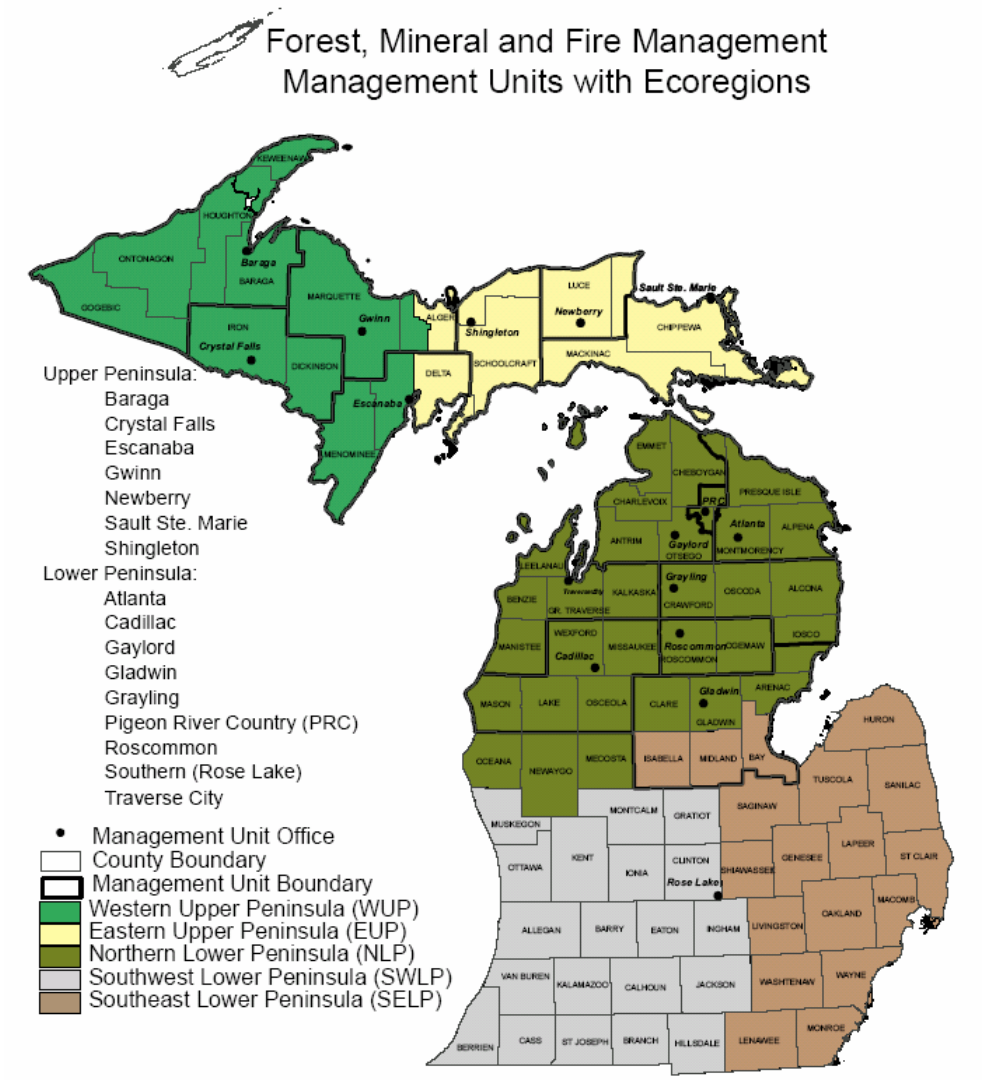

Figure E1.–FMFM state forest management units and ecoregions.

DNR Wildlife Division

The mission of the Wildlife Division is to enhance, restore, and conserve the state's wildlife resources, natural communities, and ecosystems for the benefit of Michigan's citizens, visitors, and future generations. Wildlife personnel have the primary responsibility for the management and regulation of bird and mammal populations and their habitats, but also have the lead responsibility for rare species which include plants, insects, amphibians, reptiles, and fish. There are eight Wildlife Division management units (Figure E2), five of which contain state forestlands.

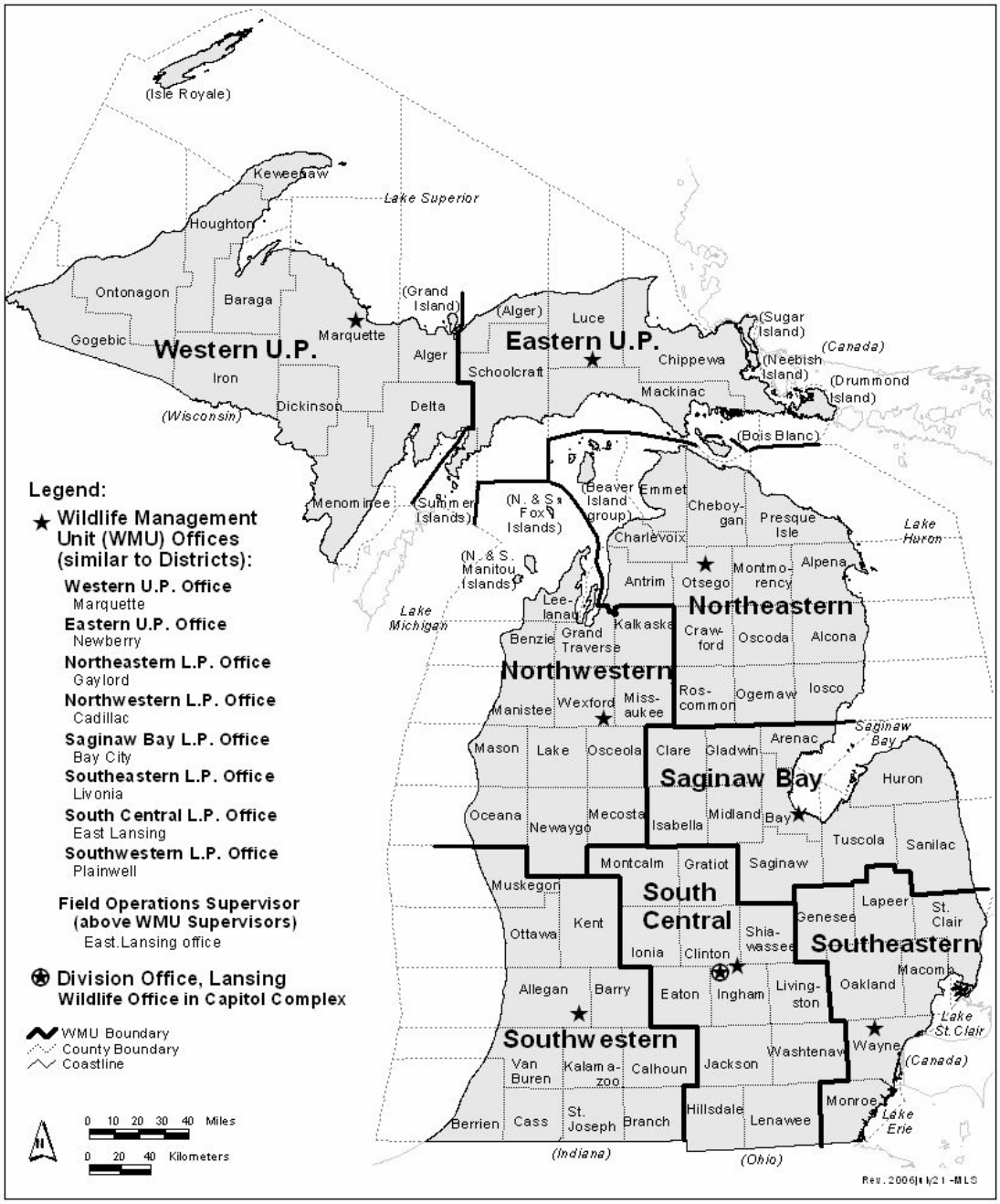

Figure E2.–Wildlife Division management units.

DNR Fisheries Division

The mission of Fisheries Division is to protect and enhance all forms of aquatic life and the habitats on which they depend, and to provide for wise use of these resources for benefit of the people of Michigan. Fisheries Division is responsible for the management of all fish species, all other aquatic organisms, and their habitats across the broad spectrum of all ownerships in the state. Because landscape processes are integrally linked with aquatic habitat and because of the biotic interdependency between upstream and downstream habitats, Fisheries Division is organized on the basis of basins and watersheds. There are four Great Lakes basins (Erie, Huron, Michigan, and Superior) and each is divided into fisheries management units that are organized on the basis of watershed boundaries (Figure E3).

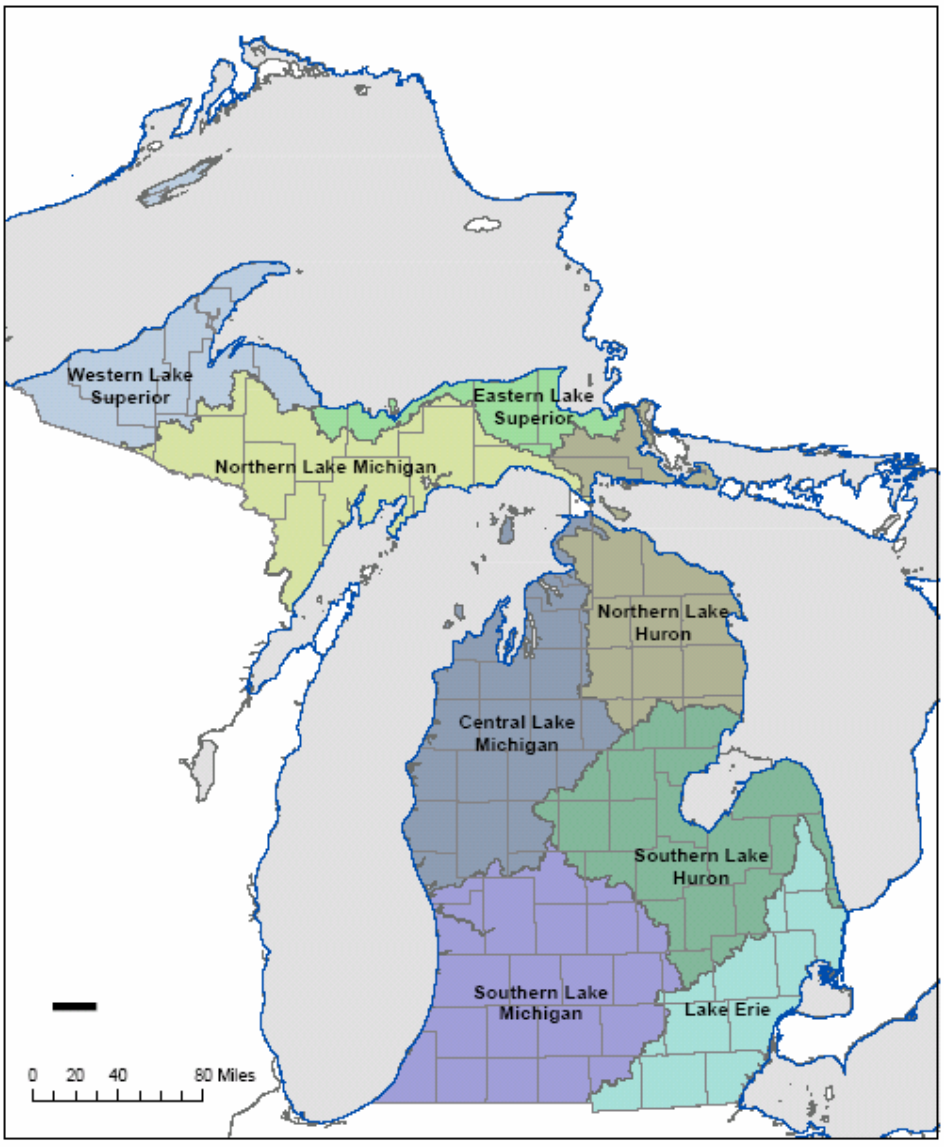

Figure E3.–Fisheries Division management units.

DNR Parks and Recreation Division

The mission of Parks and Recreation Division (PRD) is to acquire, protect, and preserve the natural, historic, and cultural features of Michigan's unique resources and provide public recreation and educational opportunities. The division is organized into eight management districts (Figure E4). The PRD is the primary land manager of the state park system, which consists of 97 parks covering 265,000 acres (Figure 1.2). PRD also owns and administers 15 Great Lakes public mooring facilities and approximately 738 inland waters boat-launching facilities statewide, and has helped fund the development of approximately 445 other inland waters boat launch sites operated by local units of government and other divisions within the department.

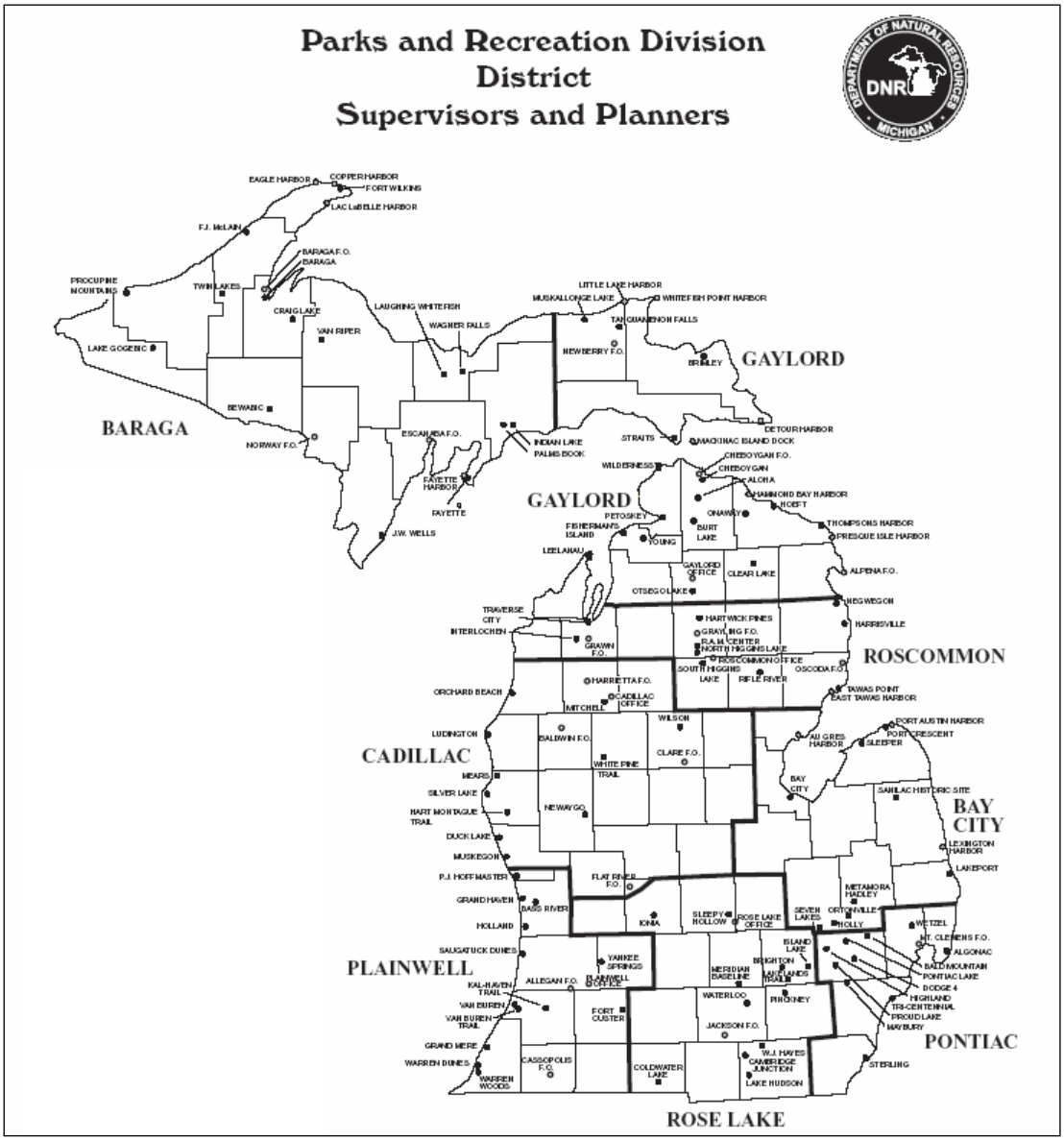

Figure E4.–Parks and Recreation Division management districts.

DNR Law Enforcement Division

The mission statement of the Law Enforcement Division is to protect Michigan's natural resources and the environment, and the health and safety of the public through effective law enforcement and education. Law Enforcement Division is responsible for enforcement of fish and wildlife laws, and other enforcement activities to protect fish and wildlife resources and habitat, and to promote and maintain Michigan's natural resources base, economy, and quality of life. Other enforcement activities include: 1) environmental protection, enforcement, and investigation; 2) habitat protection (e.g., protection of forests, wetlands, sand dunes, lakes and streams, and parks); 3) protection of recreation facilities and persons who recreate on DNR lands and facilities; 4) recreational safety education and enforcement; 5) protection of threatened and endangered species (plant and wildlife); and 6) oversight of those who seek to alter the environment. The Law Enforcement Division is organized into 10 districts (Figure E5).

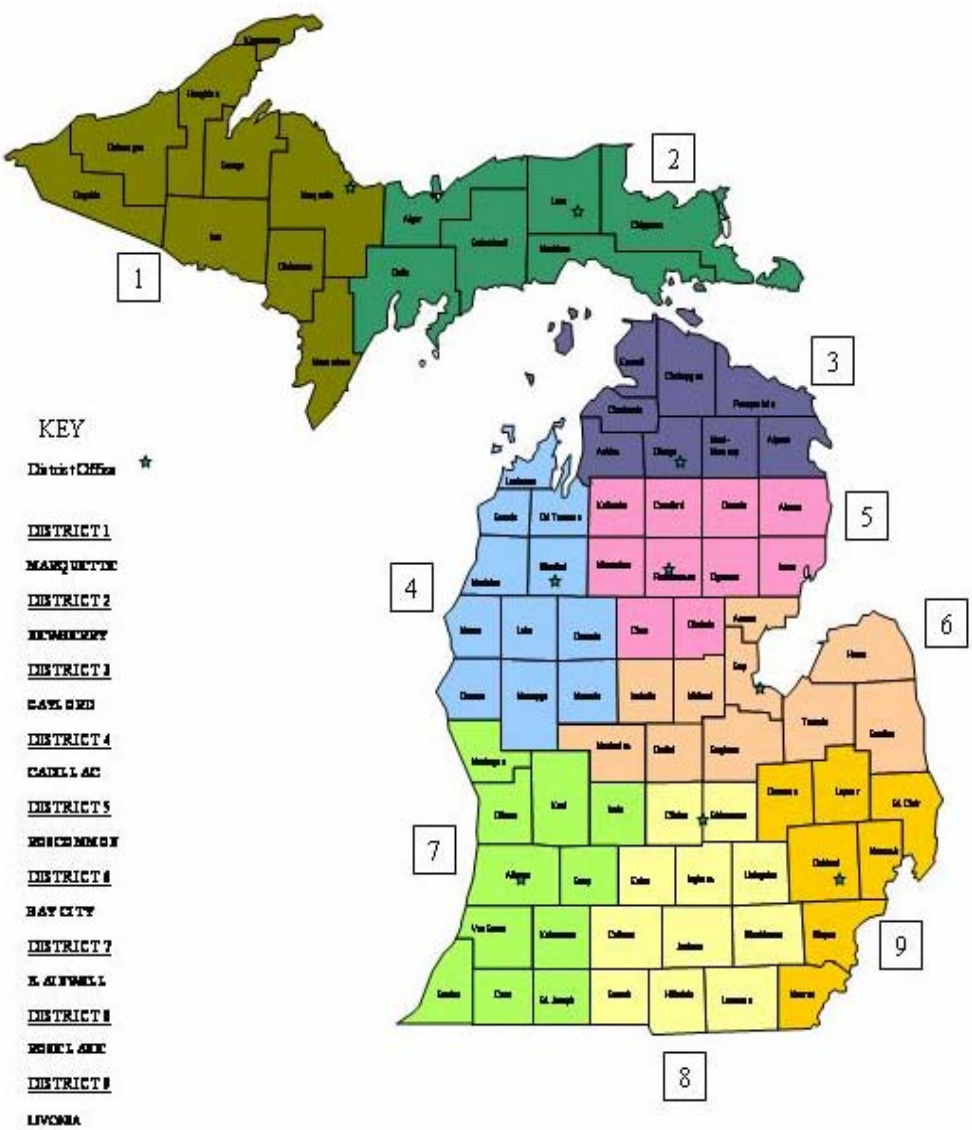

Figure E5.–Law Enforcement Division districts.

Federal Land Ownership

The major federal lands in Michigan are principally composed of the national forests, national parks, and national wildlife refuges, which are managed by the USDA Forest Service, the USDI Park Service, and the USDI Fish and Wildlife Service respectively. The largest land holdings are the three national forests, which total over 2.9 million acres. There are three major national parks totaling approximately 674,000 acres and national wildlife refuges total over 112,000 acres.

These federal lands are located adjacent to or in close proximity to extensive areas of state-owned lands (Figure 1.2), mostly in the northern two-thirds of Michigan. Effectively holistic management of lands on a landscape scale requires cooperation between state and federal land managers. Interactions range from broad, long-range landscape-level planning (e.g., species recovery plans), through coordination of recreation infrastructure and policies (e.g., trail designation and use), to short-term tactical projects (e.g., fire prevention and suppression).

Private Lands

As of 2003, private individuals own 45% of all timberland in the state. Cooperative management with private ownerships within the matrix of public ownership is critical for the effective management of resources, such as timber, game and nongame wildlife habitat, aquatic habitats, and recreation. To this end, the DNR is a cooperative partner in a number of initiatives that focus on the sustainable management of private land resources.

There are 49 land trusts and conservancies located throughout Michigan. The organizations hold title or conservation easements on thousands of acres containing rare and unique habitats and natural communities. In turn, the DNR also holds conservation easements on lands owned by conservancies.

Corporate lands have been traditionally associated with those primarily owned by the forest products industry. A recent trend has seen a significant divestiture of timberland by the forest products industry and a corresponding increase in timberland under the ownership of timberland investment management organizations. The majority of these corporate lands are enrolled in the Commercial Forest Program.

The Commercial Forest Program provides a property tax reduction to individual or corporate private landowners as an incentive to retain and manage forestland for long-term timber production. Landowners in this program agree to provide public access for hunting, trapping, and fishing and to develop, maintain, and manage the land as commercial forest through planting, natural reproduction, or other silvicultural practices. There are approximately 2.2 million acres listed in this program under the ownership of nearly 1,300 private landowners. Landowners include private individuals, clubs, forest industry, and other corporations.

The DNR has developed a Forest Stewardship Program that assists landowners with the development of Forest Stewardship management plans for their private forestlands. The Michigan Forestland Enhancement Program is an important tool that augments the Forest Stewardship Program by providing financial assistance for encouraging the long-term sustainability of nonindustrial private forestlands.

Finally, the DNR Landowner Incentive Program helps private landowners create and manage habitat for species that are rare or declining by providing advice, management plans, and funding to qualified individuals and organizations throughout the state.

Appendix F.–Forest type composition of DNR forestland by ecoregion

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Table F-1.–Northern Lower Peninsula Ecoregion forest types in 2006 by management unit (acres; unpublished DNR inventory data).

Cover type	Statewide total	Atlanta	Cadillac	Gaylord	Gladwin	Grayling	Pigeon River	Roscommon	Traverse City	Ecoregion total	Percent of state
aspen	884,822	67,702	70,805	67,622	83,030	62,642	28,752	69,995	70,078	520,626	58.8
balsam poplar swmp	71,655	24,417	1,579	8,521	1,689	1,943	809	425	1,906	41,289	57.6
bedrock	1,065	5								5	0.5
black spruce swamp	68,636	2,400	387	929	113	1,767	667	1,117	287	7,667	11.2
bog or marsh	35,163	1,984	2,221	1,390	3,500	989	73	5,454	1,149	16,760	47.7
cedar swamp	228,397	18,331	6,427	14,375	2,561	6,276	5,320	6,899	7,359	67,548	29.6
emergent marsh	113,355	2,819	3,077	3,537	7,527	1,688	1,975	13,349	1,918	35,890	31.7
grassland	125,288	6,508	7,902	12,063	4,302	8,891	2,942	4,832	12,707	60,147	48.0
hemlock	17,479	226	282	247	54	12	289	380	97	1,587	9.1
jack pine	367,034	25,296	21,198	13,280	14,591	73,864	4,438	51,761	29,459	233,887	63.7
local name	6,544	26	79	57	255	4,240	78	294	319	5,348	81.7
lowland hardwoods	135,912	9,165	11,628	6,019	36,562	3,302	2,056	10,612	13,598	92,942	68.4
lowland brush	197,448	12,510	9,511	11,771	18,315	3,311	2,598	12,984	6,147	77,147	39.1
mixed swamp conifers	261,183	16,588	7,707	20,068	1,378	6,074	11,269	19,906	10,962	93,952	36.0
northern hardwoods	508,302	16,573	16,200	93,857	2,250	12,455	17,652	1,465	46,847	207,299	40.8
non stocked	22,791	2,298	778	2,279	1,412	5,087	235	2,264	2,439	16,792	73.7
oak	243,691	27,069	36,361	11,589	23,764	54,254	3,364	42,698	30,583	229,682	94.3
paper birch	35,462	1,611	67	2,220	131	474	640	434	165	5,742	16.2
red pine	279,973	28,923	21,237	30,314	8,741	21,542	12,181	17,717	40,790	181,445	64.8
sand dune	1,106	76	37	123		7			44	287	25.9
spruce fir	51,504	1,253	1,196	1,168	445	615	864	1,172	1,744	8,457	16.4
tamarack swamp	22,256	2,034	730	2,491	399	846	154	250	442	7,346	33.0
treed bog	62,692	752	673	160	88	400	413	1,263	912	4,661	7.4
upland brush	53,008	4,585	4,171	6,672	341	8,379	2,231	1,994	16,925	45,298	85.5
water	47,751	2,399	2,627	3,031	4,740	1,559	1,166	3,787	3,308	22,617	47.4
white pine	93,568	4,087	8,903	3,001	2,725	3,812	4,883	5,859	11,959	45,229	48.3
Total	3,936,085	279,637	235,783	316,784	218,913	284,429	105,049	276,911	312,144	2,029,650	51.6

Table F-2.–Eastern Upper Peninsula Ecoregion forest types in 2006 by management unit (acres; unpublished DNR inventory data).

Cover type	Statewide total	Newberry	Sault Ste Marie	Shingleton	Ecoregion total	Percent of state
aspen	884,822	22,764	65,435	34,589	122,788	13.9
balsam poplar swamp	71,655	4,515	15,866	2,045	22,426	31.3
bedrock	1,065		79	56	135	12.7
black spruce swamp	68,636	11,272	10,003	15,578	36,853	53.7
bog or marsh	35,163	3,438	5,784	2,785	12,007	34.1
cedar swamp	228,397	19,034	51,801	28,675	99,510	43.6
emergent marsh	113,355	23,275	8,809	37,677	69,761	61.5
grassland	125,288	4,743	12,486	24,766	41,995	33.5
hemlock	17,479	2,249	1,822	3,059	7,130	40.8
jack pine	367,034	59,823	1,750	43,432	105,005	28.6
local name	6,544	253	80	232	565	8.6
lowland hardwoods	135,912	7,540	5,724	7,290	20,554	15.1
lowland brush	197,448	20,951	23,727	32,187	76,865	38.9
mixed swamp conifers	261,183	33,291	16,921	19,135	69,347	26.6
northern hardwoods	508,302	37,745	43,164	48,345	129,254	25.4
non stocked	22,791	592	995	2,043	3,630	15.9
oak	243,691	1,968	1,188	1,704	4,860	2.0
paper birch	35,462	3,915	9,344	4,160	17,419	49.1
red pine	279,973	23,880	16,197	37,699	77,776	27.8
sand dune	1,106	504	137	138	779	70.4
spruce fir	51,504	2,921	8,136	3,339	14,396	28.0
tamarack swamp	22,256	1,480	3,495	3,106	8,081	36.3
treed bog	62,692	33,154	7,069	4,291	44,514	71.0
upland brush	53,008	2,896	2,643	708	6,247	11.8
water	47,751	6,355	4,506	4,056	14,917	31.2
white pine	93,568	17,888	3,674	15,340	36,902	39.4
Total	3,936,085	346,446	320,835	376,435	1,043,716	26.5

Table F-3.–Western Upper Peninsula Ecoregion forest types in 2006 by management unit (in acres; unpublished DNR inventory data).

Cover type	Statewide total	Baraga	Crystal Falls	Escanaba	Gwinn	Ecoregion total	Percent of state
aspen	884,822	15,030	123,240	31,794	71,344	241,408	27.3
balsam poplar swamp	71,655		1,967	3,902	2,071	7,940	11.1
bedrock	1,065	74	536	1	314	925	86.9
black spruce swamp	68,636	2,292	6,043	4,202	11,579	24,116	35.1
bog or marsh	35,163	869	1,279	399	3,849	6,396	18.2
cedar swamp	228,397	2,316	8,224	29,660	21,139	61,339	26.9
emergent marsh	113,355	2,179	1,179	2,634	1,712	7,704	6.8
grassland	125,288	2,736	9,907	2,203	8,300	23,146	18.5
hemlock	17,479	2,732	194	2,611	3,225	8,762	50.1
jack pine	367,034	7,630	3,056	130	17,326	28,142	7.7
local name	6,544	42	5	161	423	631	9.6
lowland hardwoods	135,912	2,537	2,408	8,468	9,003	22,416	16.5
lowland brush	197,448	7,666	17,284	6,078	12,408	43,436	22.0
mixed swamp conifers	261,183	10,856	43,889	9,213	33,926	97,884	37.5
northern hardwoods	508,302	62,406	43,751	17,846	47,746	171,749	33.8
non stocked	22,791	930	733	288	418	2,369	10.4
oak	243,691	1,545	1,469	2,807	3,328	9,149	3.8
paper birch	35,462	3,999	2,864	504	4,934	12,301	34.7
red pine	279,973	496	9,280	3,524	7,452	20,752	7.4
sand dune	1,106	12			28	40	3.6
spruce fir	51,504	7,423	7,090	4,750	9,388	28,651	55.6
tamarack swamp	22,256	1,716	648	3,728	737	6,829	30.7
treed bog	62,692	5,087	744	3,208	4,478	13,517	21.6
upland brush	53,008	212	143	555	553	1,463	2.8
water	47,751	2,011	4,068	1,174	2,964	10,217	21.4
white pine	93,568	256	4,275	2,338	4,568	11,437	12.2
Total	3,936,085	143,052	294,276	142,178	283,213	862,719	21.9

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Appendix G.–Age class distributions by forest type on DNR forestland

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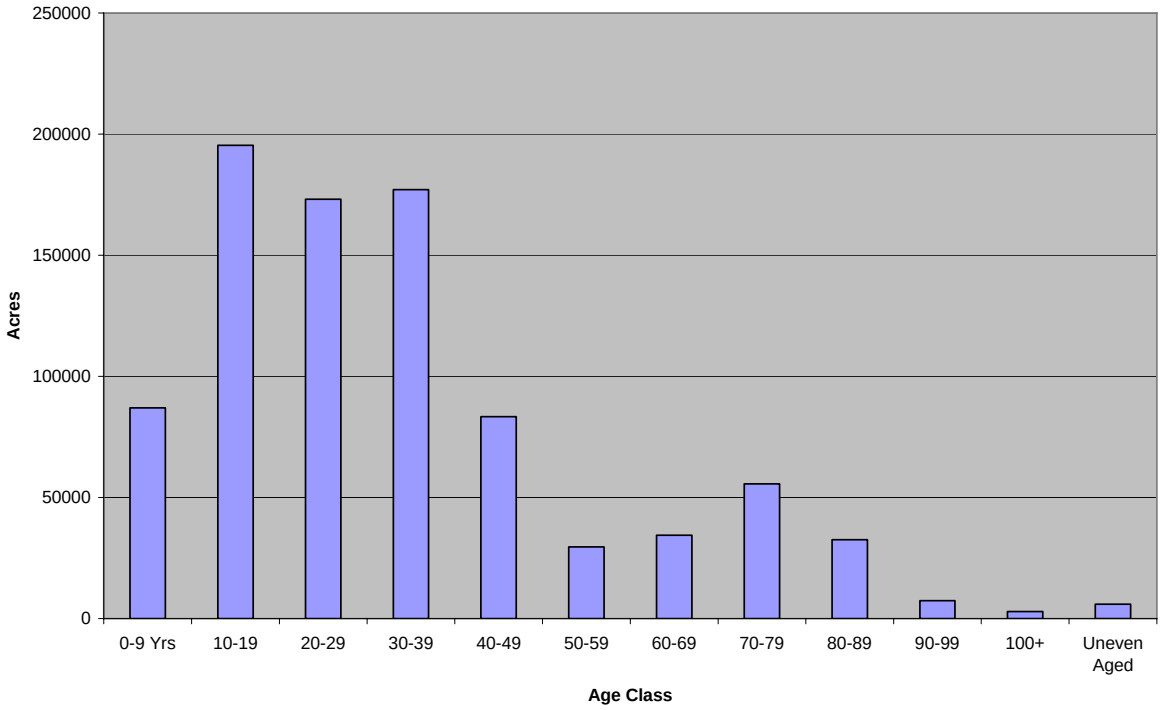
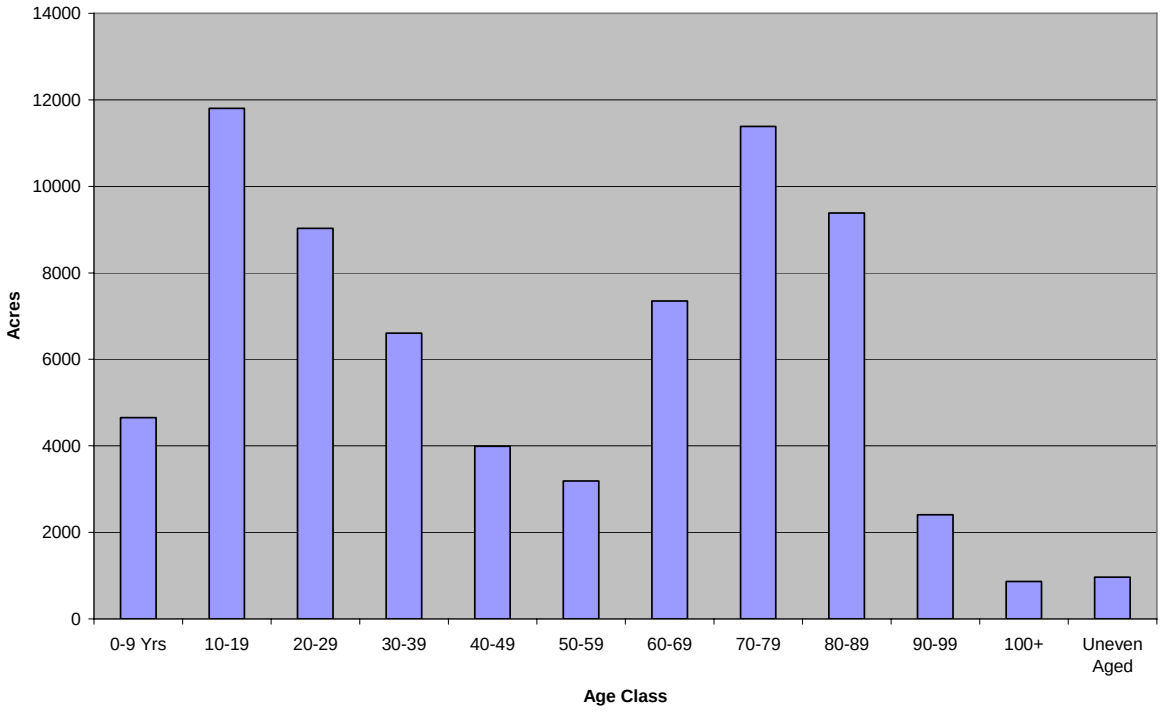
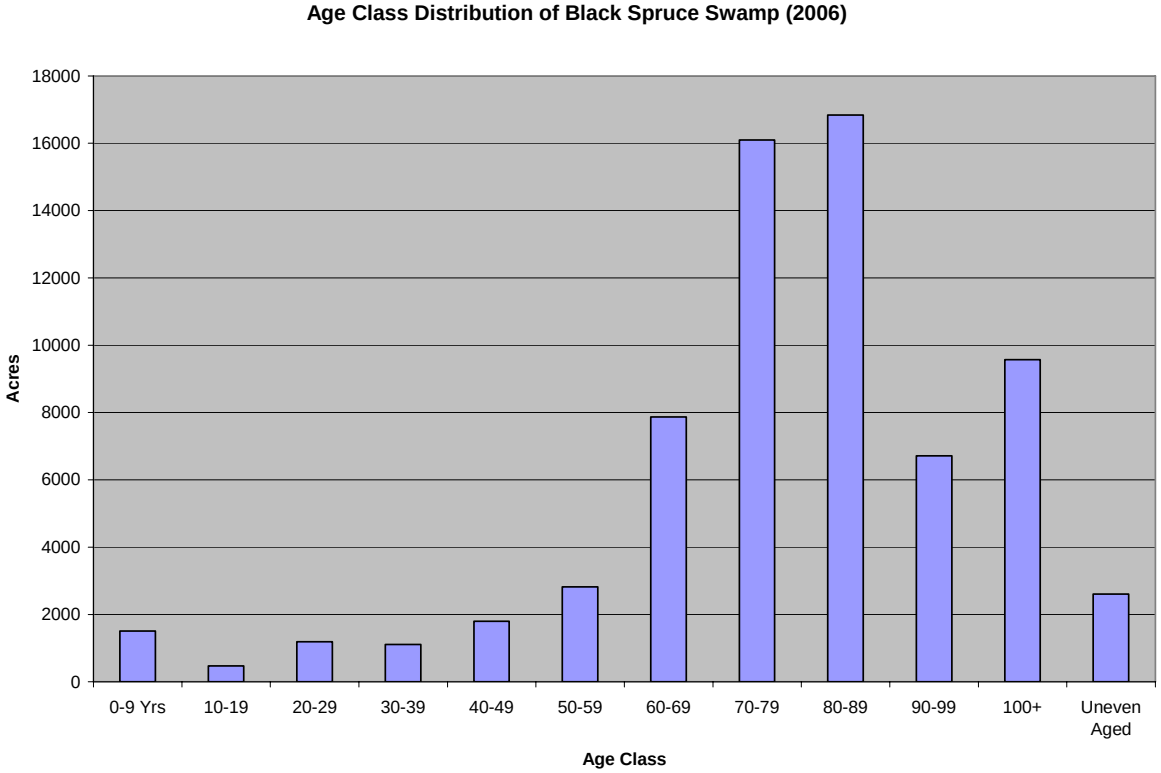
Age Class Distribution for Aspen (2006)

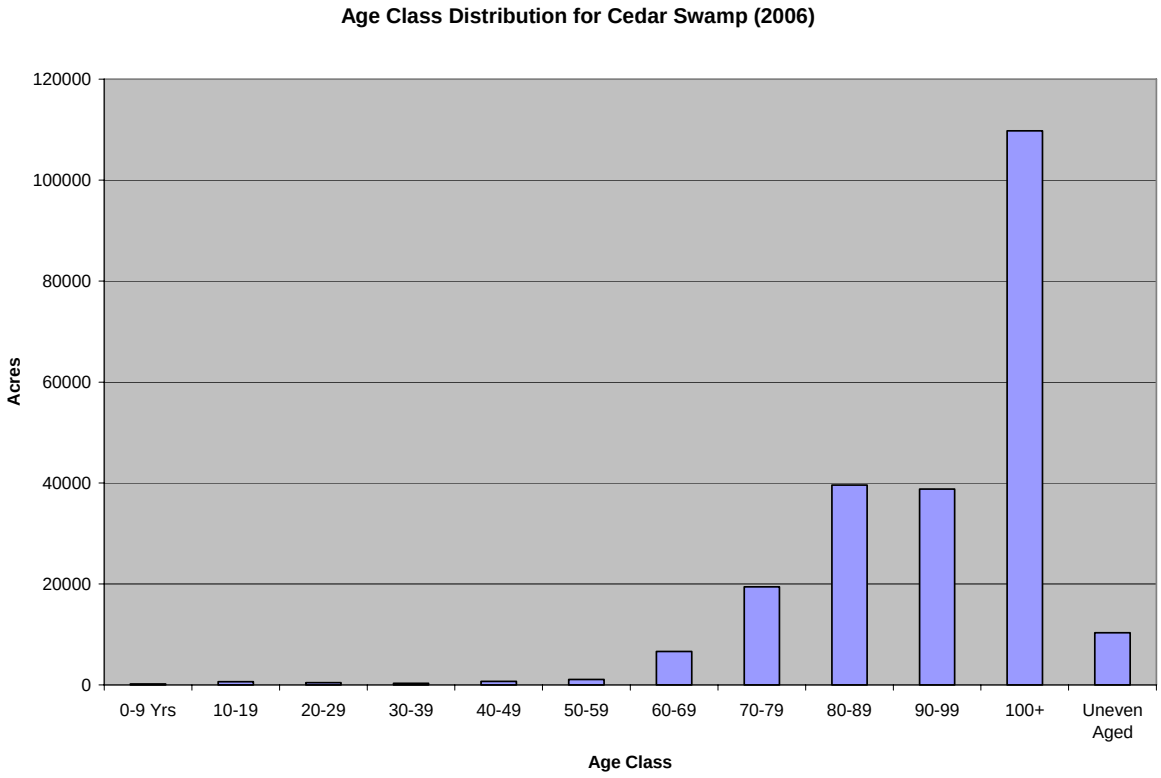


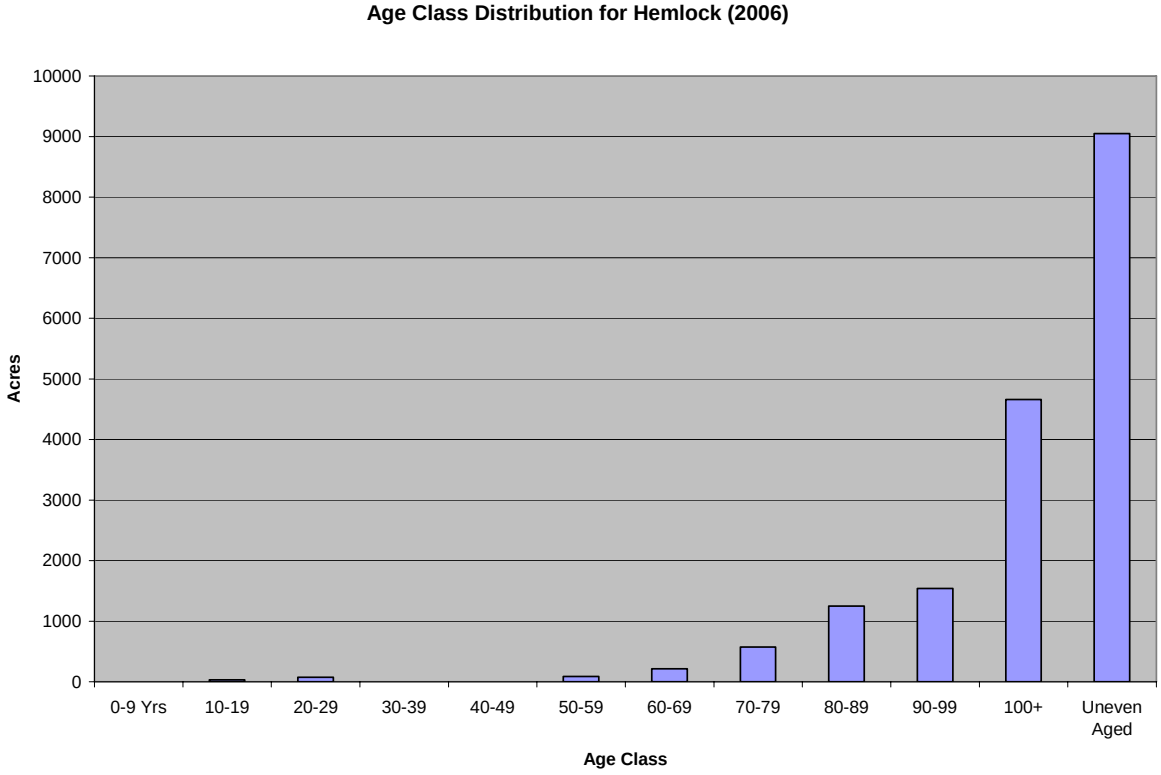
Age Class Distribution for Balsam Poplar Swamp (2006)

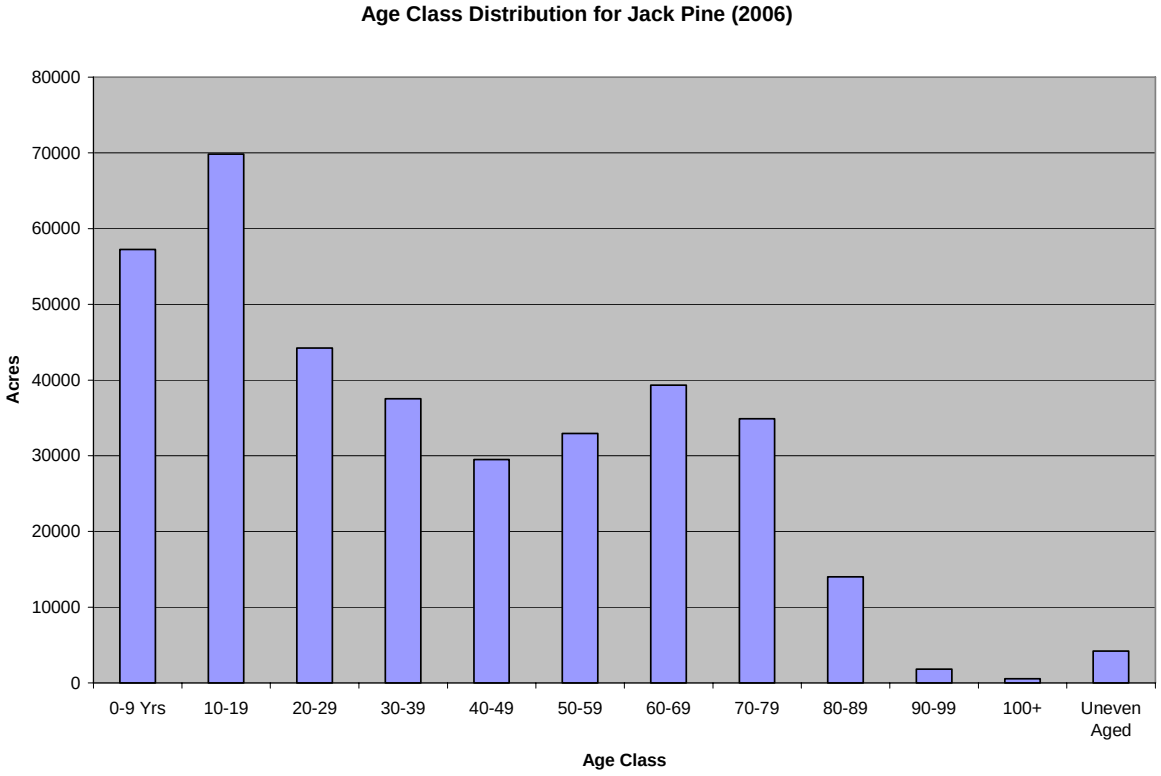


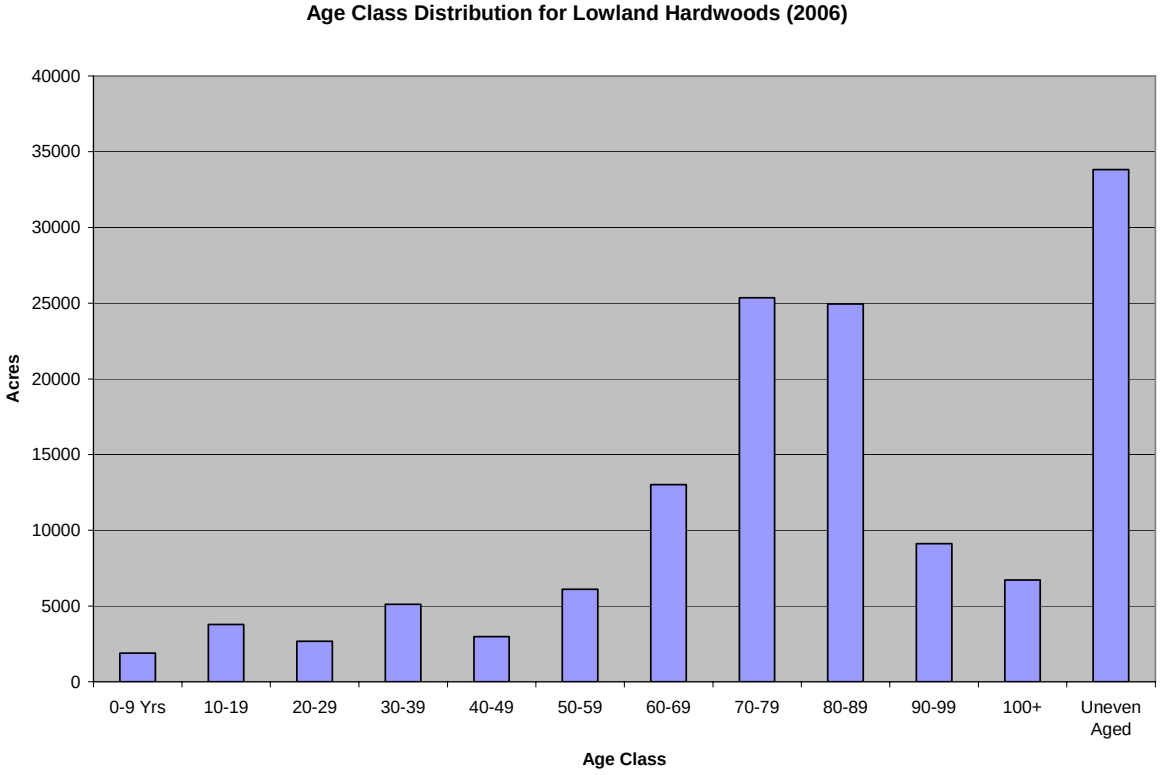

Age Class Distribution for Paper Birch (2006)
12000
10000
8000
6000
4000
2000
0
Acres
0-9 Yrs
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90-99
100+
Uneven Aged
Age Class


Age Class Distribution of Black Spruce Swamp (2006)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Acres
0-9 Yrs
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90-99
100+
Uneven Aged
Age Class

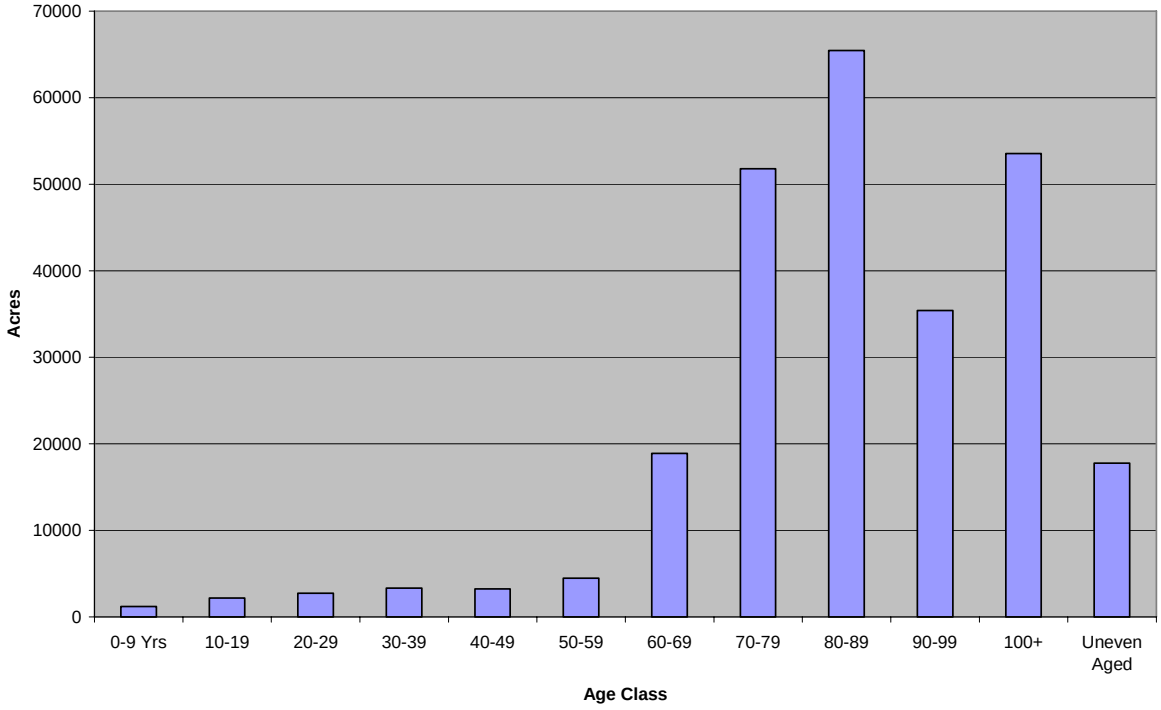

Age Class Distribution for Cedar Swamp (2006)
120000
100000
80000
60000
40000
20000
0
Acres
0-9 Yrs
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90-99
100+
Uneven Aged
Age Class


Age Class Distribution for Hemlock (2006)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Acres
0-9 Yrs
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90-99
100+
Uneven Aged
Age Class

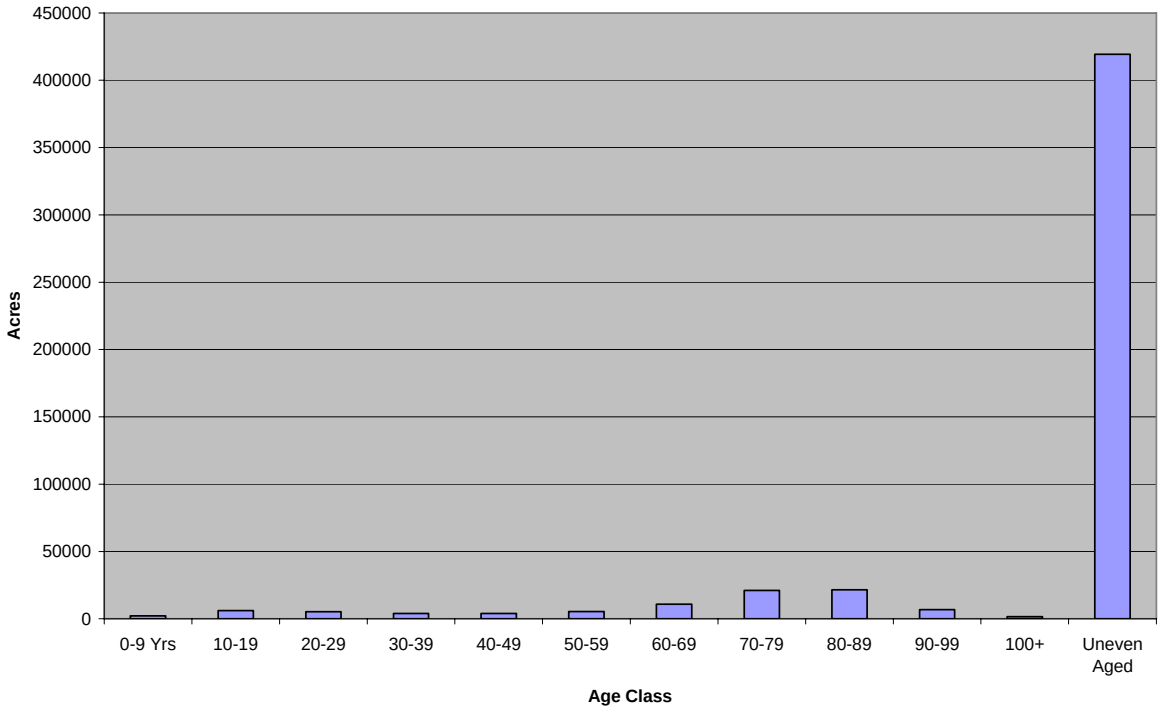

Age Class Distribution for Jack Pine (2006)
Acres
80000
70000
60000
50000
40000
30000
20000
10000
0
0-9 Yrs
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90-99
100+
Uneven Aged
Age Class

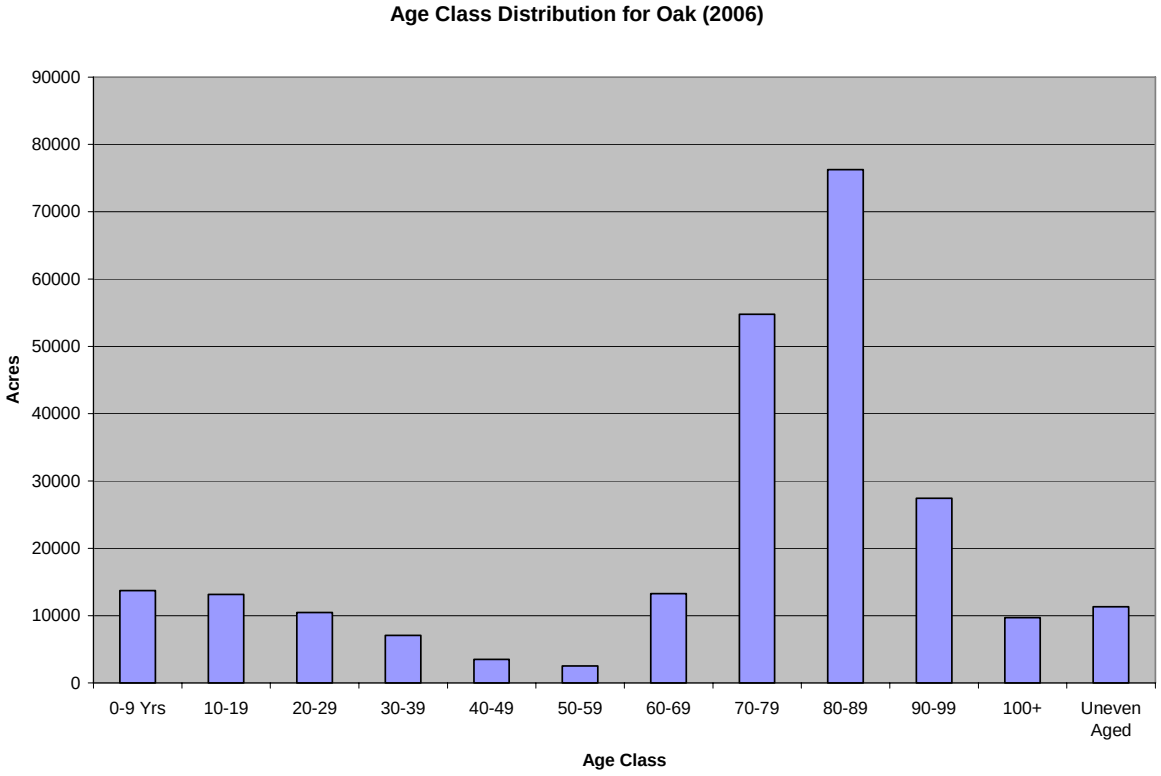

Age Class Distribution for Lowland Hardwoods (2006)
Acres
40000
35000
30000
25000
20000
15000
10000
5000
0
0-9 Yrs
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90-99
100+
Uneven Aged
Age Class

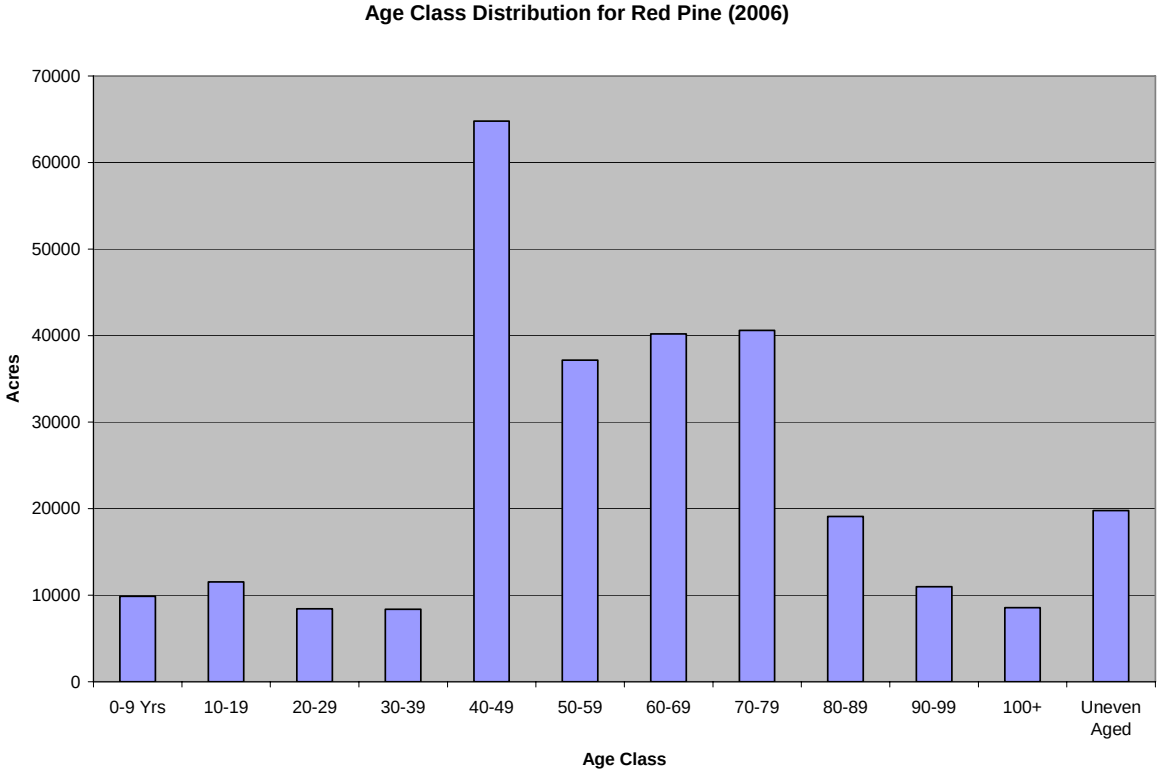
Age Class Distribution for Mixed Conifer Swamp (2006)



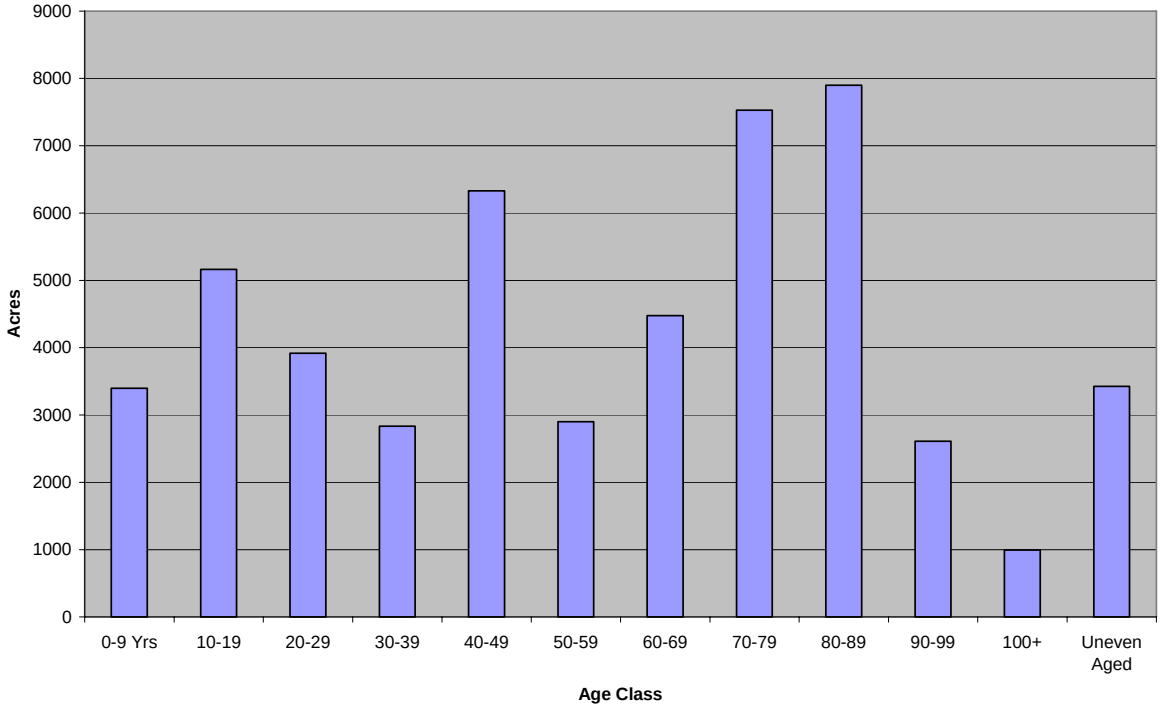
Age Class Distribution of Northern Hardwoods (2006)



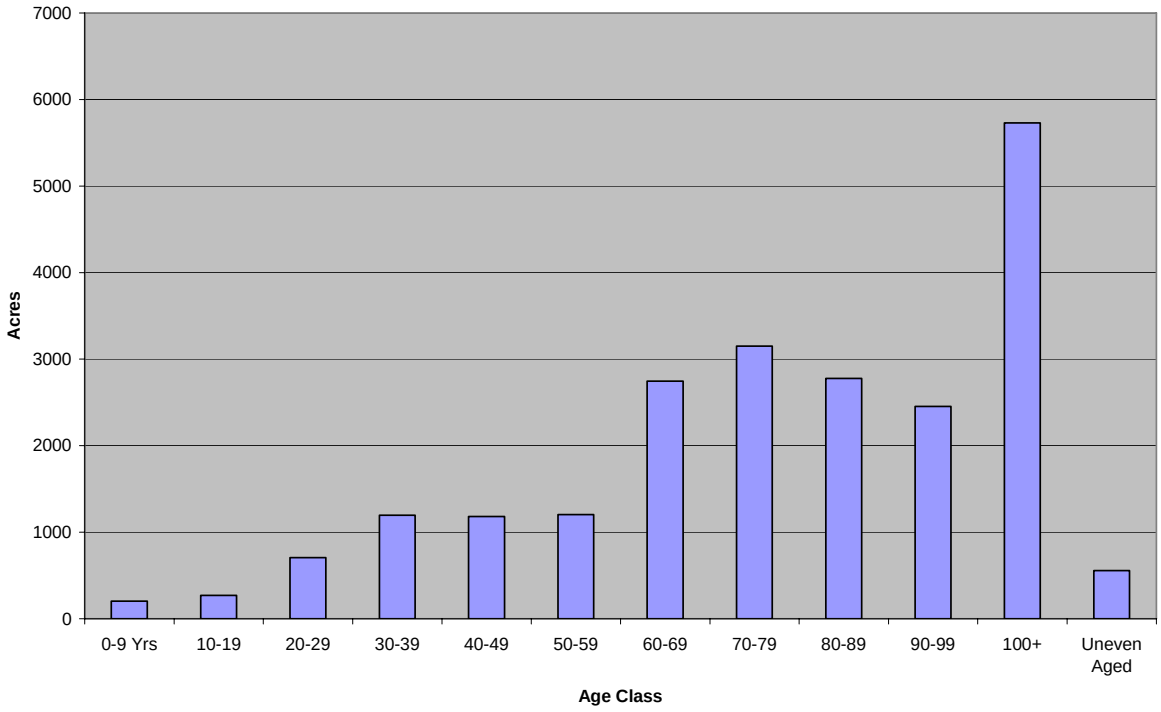

Age Class Distribution for Oak (2006)
Acres
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
0-9 Yrs
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90-99
100+
Uneven Aged
Age Class

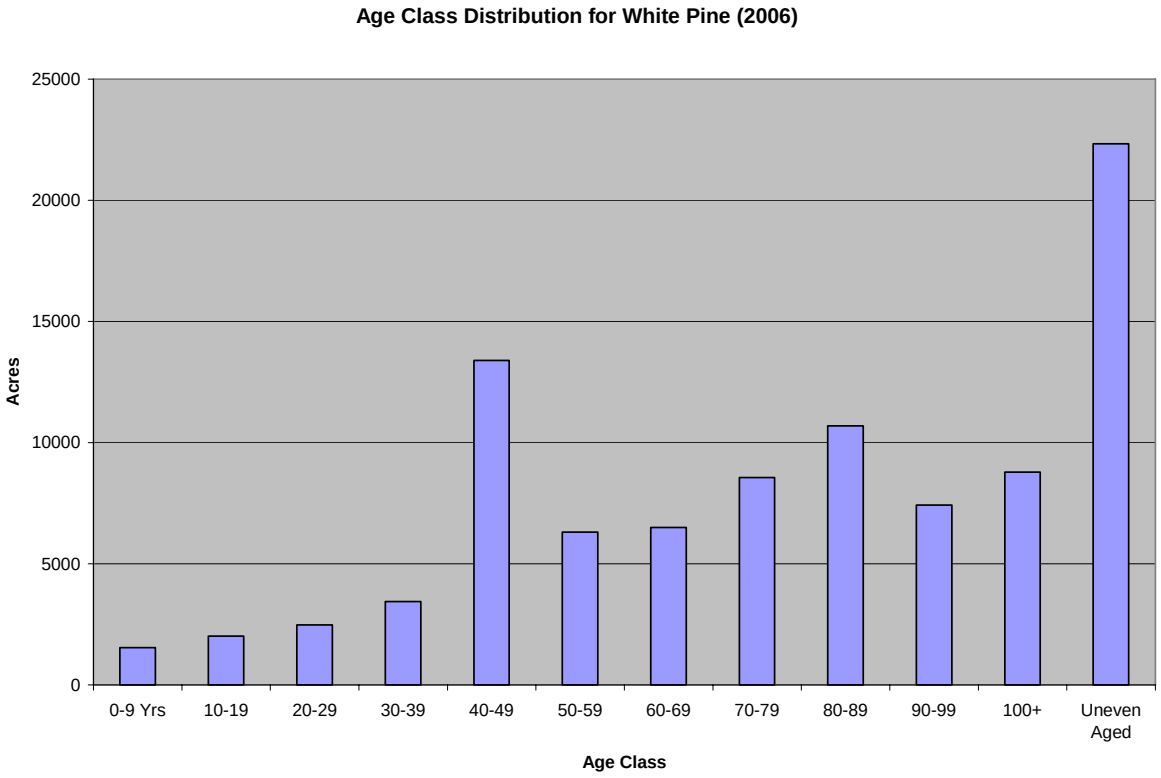

Age Class Distribution for Red Pine (2006)
Acres
70000
60000
50000
40000
30000
20000
10000
0
0-9 Yrs
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90-99
100+
Uneven Aged
Age Class

Age Class Distribution for Spruce Fir (2006)



Age Class Distribution for Tamarack (2006)




Age Class Distribution for White Pine (2006)
25000
20000
15000
10000
5000
0
Acres
0-9 Yrs
10-19
20-29
30-39
40-49
50-59
60-69
70-79
80-89
90-99
100+
Uneven Aged
Age Class

Appendix H.–Core set of statewide criteria and indicators

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Criteria and Indicators (C&I) provide a framework for gathering data and for evaluating the importance, status, and sustainability of the management of complex landscapes. Criteria define broad categories of capacity, goals or processes that are essential to sustainable resource management. Criteria address biological diversity, ecosystem condition and productivity, social, cultural and spiritual values, recreation values, ownership patterns, economic health, institutional processes that support forest conservation and sustainable management.

Indicators monitor how a system operates or functions. Any indicator by itself provides limited information about the system as a whole. To effectively monitor a complex system, such as a forest, more than one indicator may be required. The different values held by people about the environmental, social, and economic spheres of forests may also require a diverse set of indicators to depict the many facets of forests and forest management. The information derived from monitoring changes in common indicators contributes to an improved understanding of the consequences of earlier decisions, which leads to informed decision making processes for sustainable forest management.

Metrics are used to identify data needed to measure indicators. They provide the means to measure or describe various aspects of the indicators, and are a tool used for monitoring the progress toward achieving sustainable forest management. Metrics, therefore, need to be discrete, explicit and easy to quantify. The purpose of a metric is to:

1. measure the condition of a resource,
2. measure the level of stress or pressure on a resource,
3. provide a direct measure of a management action taken to either improve conditions or reduce stress on a resource, or
4. measure the outcome of management.

The nonachievement of a metric or a significant change in a trend measured by a metric provides an indication that management processes may need to be adjusted or changed to meet management goals and objectives necessary to achieve a sustainable desired future condition for a specific ecological, social or economic value.

No criterion, indicator or metric alone can provide an adequate measure of forest sustainability. The criteria considered together provide a more comprehensive picture of the status of forests and their management. The C&I used will likely be adapted over time to reflect experience gained with their use, new research findings, advances in technology, and public understanding of forests.

A core set of C&I for DNR-managed lands were developed to provide a standardized statewide basis for planning and monitoring. All ecoteams will use the below core set of Criteria and Indicators (C&I) in Ecoregional Resource Plans. Ecoteams may not delete core metrics, however, reflecting the unique character and values of their regions they may develop additional indicators and metrics. Before an ecoteam adds metrics, lead division(s) for completing the metrics must be identified. The lead division(s) will be responsible for coordinating the collection and analysis of data; obtaining the funding for staff time, materials, services, or contracts needed to measure the metric; reporting the metric by a self-defined deadline; and updating the metric at a self-defined frequency.

The core set of C&I will be evaluated for revision in accordance with the plan review and revision requirements provided in Chapter 6, whereby the DNR may seek to add additional metrics or to remove metrics that do not provide an effective measure of an indicator. Proposed additions or removals of metrics will be reviewed by the Statewide Resource Planning Team to obtain consensus of the resource divisions. Within this context, the lead division(s) for a metric will have the option to alter the metric to make it practical, technologically feasible, cost effective, or scientifically

defensible. Prior to adopting a metric for inclusion, the lead division(s) will: describe the purpose and primary use of the metric; define and set boundaries for the metric; identify the unit(s) of measure that will be reported; set the date for when the completed metric will be reported; set the frequency at which the metric will be updated; and determine the tier level. Metrics will be included in the core or ecoregional sets upon approval by the Statewide Council.

The extent, scope, and limits of criteria & indicator metrics will be clearly defined in all Ecoregional Resource Plans and any other plans or guidance documents that discuss these metrics. The scope of the core set of statewide criteria & indicator metrics include:

1. gathering information on a statewide basis (where applicable) from a variety of existing data sources;
2. providing information on a statewide basis and may be broken down by ecoregion where applicable and where the robustness of the data is not compromised;
3. gathering information related to all land ownerships, whether state-owned, public, corporate, or private lands;
4. application to any and all land cover community types; and
5. use for monitoring purposes by the ecoteams, divisions, and DNR workgroups, as needed.

Data are not currently available for the effective measurement of all metrics. The core C&I metrics have been categorized into tiers based upon the availability of data and the frequency with which the DNR can commit to measure specific metrics (Table E1). The measurement of metrics may also be subject to DNR workforce and budgetary constraints, whereby the DNR has the option to cease collecting, analyzing, or reporting a metric due to changes in priorities, funding, availability of data, or scientific understanding. There are four tiers of metric measurement:

Tier 1: Metrics for which the DNR or others have databases available, and that are measured with short periodicity. Data collected more frequently than on a yearly basis will be reported annually. Examples include: USGS hydrologic data from stream gauges, acres and volumes of forest timber, lake and stream surveys for status and trends.

Tier 2: Metrics for which the DNR or others have databases available, but which are measured at a longer periodicity (every 5-10 years). Metrics will be reported when updated data become available. These could be items that are contracted out to universities as graduate student research. Examples include: Forest Inventory Analysis (FIA) data, large lake surveys, stock-recruitment relationships of specific fish stocks.

Tier 3: Metrics for which the DNR or others have the means to measure, but the data sources are inconsistent and only partially available. The DNR will be responsible for reporting only that portion of the data that are currently available. Examples include: resource inventories and population distribution and trends.

Tier 4: Metrics that the DNR would like to measure, but does not currently have the means to do. The DNR will not measure these metrics until data sources or funding become available. These metrics would likely be measured or assembled by a contractor, university, or special project within the DNR. Examples include: large scale genetic or population investigations.

The core set of criteria, indicators, and metrics are:

Criterion 1—Conservation of Biological Diversity

Biological diversity, or biodiversity, is the variability among living organisms and the ecological systems of which they are a part. Biodiversity can be measured at the landscape, ecosystem, species and genetic levels. Each level of biodiversity has three components: 1) Compositional diversity -the number of elements within a system; 2) Structural diversity -the variety of patterns within a system; and 3) Functional diversity -the number of ecological processes within a system. The conservation of biodiversity ensures that all ecosystems maintain their integrity, continue to be productive and are able to adapt to changing conditions.

Indicator 1.1—The extent of uncommon or rare natural features.

Identification and recognition of uncommon geological sites, plant and animal species, and ecological communities can make a difference between success and failure at sustaining our heritage and protection of natural systems over the long run.

Metric 1.1.1 Percent and extent of rare natural communities relative to historical conditions.

Metric 1.1.2 Percent and extent of uncommon geophysical features relative to historical conditions.

Metric 1.1.3 Percent and extent of uncommon hydro-physical features relative to historical conditions (e.g., aquifers, artesian wells, springs, waterfalls, and recharge zones).

Indicator 1.2—The extent of landscape and ecosystem diversity.

The number of patches, their characteristics, size, shape and connectivity determines the complexity of landscapes. Ecosystem diversity is the kind and number of ecosystems in an area. Landscape diversity is the variety of ecosystems across a landscape, and reflects the patterns of association of ecosystems with one another and the recurrence of these patterns in a given landscape. The impacts of change in landscapes are expressed through shifts in ecosystem diversity.

Metric1.2.1 Percent and extent of vegetation types relative to historical conditions.

Metric1.2.2 Number of natural community types.

Metric 1.2.3 Distribution of natural community types.

Metric 1.2.4 Percentage, area and representativeness of vegetation types in designated protected areas of natural and scientific interest.

Metric 1.2.5 Level of fragmentation, connectivity, shape, size, and spatial distribution of vegetation types.

Indicator 1.3—The extent of species population diversity.

Species diversity refers to the number and relative abundance of species found in an area. The impacts of change in ecosystems are expressed through shifts in species biodiversity.

Metric 1.3.1 Distribution, dispersion, and population trends of focal species.

Metric 1.3.2 Absolute and relative abundance of vegetation types and their importance as habitat for focal species.

Metric 1.3.3 Trends in habitat of focal species.

Metric 1.3.4 Species classified as threatened, endangered, rare, or vulnerable, their population trends and habitat condition.

Metric 1.3.5 Species richness of plants and animals within representative ecosystems.

Indicator 1.4—The extent of genetic diversity.

Genetic diversity includes the range of genetic characteristics found within a species and among different species.

Metric 1.4.1 Proportion of forest area as plantations using native vs. nonnative genotypes.

Metric 1.4.2 Proportion of water bodies with native vs. nonnative fish-stock genotypes in both inland and Great Lakes waters.

Metric 1.4.3 Proportion of water bodies with fishery sustained by natural reproduction.

Metric 1.4.4 Herbaceous native vs. nonnative species plantings on roads, trails, easements, openings, savannas, grasslands, and wetlands on managed lands.

Criterion 2—Ecosystem Condition and Productivity

Ecosystem condition is a measure of relative freedom from stress and the relative level of physical/biological energy within an ecosystem. Ecosystem productivity refers to the rate of production of biomass (organic matter) within an ecosystem. This results from interactions between plants, animals and micro-organisms or biotic components and abiotic factors such as soil, water and climate. Sustainable productivity is dependent upon the ability of ecosystems to recover from or adapt to both natural and human-induced disturbances. A healthy and diverse ecosystem is more resilient in its ability to respond or adapt to, or to recover from these disturbances in its environment.

Indicator 2.1—The scope, scale, and intensity of disturbance and stress.

Ecosystems are dynamic and are constantly subject to changes in composition and structure. Many of these changes are adaptations to disturbance. Disturbances generally cause ecosystems to revert to earlier successional stages or establish new patterns of succession. Fundamental to the continued health, vitality and productivity of ecosystems are their ability to adapt to the various stresses placed upon them. Disturbances may be part of natural ecological cycles or the result of human activities. Human-induced stress and disturbance include introduced (exotic) species, prescribed burning, fire suppression, populations out of balance with available habitat, pollution, and land-use practices. Natural disturbances include native insects, high wind events, flooding, and fire.

Metric 2.1.1 Area and severity of insect and disease infestation.

Metric 2.1.2 Area and severity of flooding, drought, wind, and fire activity.

Metric 2.1.3 Presence, extent, and number of invasive exotic species.

Metric 2.1.4 Area and location by county of severe mammalian herbivory.

Metric 2.1.5 Area and intensity of timber harvest by type.

Metric 2.1.6 Area and intensity of timber salvage by type.

Metric 2.1.7 Number and distribution of active and nonrestored mineral and nonmineral extraction sites per township.

Metric 2.1.8 Miles and density of utility corridors and numbers of communication structures.

Metric 2.1.9 Miles of undeveloped Great Lakes, inland lakes, rivers, and stream shoreline.

Metric 2.1.10 Mean concentration of Chlorophyll A during annual growing season in inland lakes.

Metric 2.1.11 Miles of streams designated as priority for beaver-trout management per DNR Policy 39.21-20.

Indicator 2.2—The extent and change of biomass.

Biomass is the total mass of organic matter in all living organisms within a specific unit area, such as an ecosystem. It is an integrating measure of ecosystem condition, providing a measure of the productivity, health and vitality of all species and habitat types. Evidence that the condition of habitat types is constant or improving indicates that they are being managed in a sustainable way.

Metric 2.2.1 Volume, net annual growth, mortality, and removals by forest type and age class.

Indicator 2.3—The extent and type of structure within aquatic ecosystems.

Vegetation and other biotic and abiotic materials provide the physical structure within which most organisms live. Ecosystem structure is the variety of patterns within a system, and includes the presence and arrangement of these physical structures in three-dimensional space. Species richness in some taxa is correlated with ecosystem community structure.

Metric 2.3.1 Alteration of surface and sub-surface geology of valley segment.

Metric 2.3.2 Alteration of surface and sub-surface hydrology of valley segment.

Metric 2.3.3 Number and location of lake and stream restoration projects.

Indicator 2.4—The extent and type of structure within upland and wetland ecosystems.

Vegetation and other biotic and abiotic materials provide the physical structure within which most organisms live. Ecosystem structure is the variety of patterns within a system, and includes the presence and arrangement of these physical structures in three-dimensional space. Species richness in some taxa is correlated with ecosystem community structure.

Metric 2.4.1 Tree size: basal area per acre/hectare for different forest cover types.

Metric 2.4.2. Distribution of cliffs, outcrops, sinks and glacial erratics.

Metric 2.4.3 Snags per area, basal area, mean DBH, and decay class.

Metric 2.4.4 Large woody debris per area, mean DBH, and decay class.

Metric 2.4.5 Number of vegetative species and structural diversity by age class for forested systems.

Indicator 2.5—Condition of water quality.

Long-term productivity and resilience of habitats, and a potable water supply for humans and wildlife, are dependent upon abundant and clean water resources. Management policies that address stream crossings, watershed management and riparian areas help to maintain water flow patterns, water levels and water quality, and ensure that the condition of aquatic ecosystems are maintained and improved.

Metric 2.5.1 Distribution and acres of lakes and miles of streams of artificial nutrification (nitrates and phosphates).

Metric 2.5.2 Pesticide and contaminant residue concentrations in surface water as measured by fish advisories and eagle nesting success.

Metric 2.5.3 Percentage of impervious surface in watersheds.

Indicator 2.6—Carbon cycle and greenhouse gas emissions.

The carbon cycle represents an important set of processes linking plant and animal communities with climate change. The release or removal of CO_2 to and from the atmosphere impacts global ecological cycles. Forests, wetlands, and water bodies can act as either sinks (a vigorous and growing forest) or sources for atmospheric carbon, depending on whether they are primarily storing carbon or releasing it. Knowledge of the influence of natural disturbances and human intervention on this role can indicate the type of forest practices required for sustainable management.

Metric 2.6.1 Area of forest permanently, semi-permanently, or temporarily converted to nonforest land use (Also see Indicator 5.3 Land Use).

Metric 2.6.2 Changes in carbon pool in vegetative biomass.

Metric 2.6.3 Number of wildfire acres and fuels reported by county and township.

Metric 2.6.4 Trends in metric tons of greenhouse gas emissions by region or county.

Indicator 2.7—Variance in and type of disruption of hydrological cycles.

Hydrological cycles involve the movement of water from the atmosphere to the surface of the earth in the form of precipitation; from soils to streams to lakes to the atmosphere; and from soil to plants to the atmosphere. Because of their vast area in the state, forests play a major role in Great Lakes hydrological cycles. Changes in forestland cover and management influence the storage and movement of water and the timing of the various components of the hydrological cycle. Forests can influence stream and river hydrographs by regulating the flow of water into wetlands, streams and lakes. Consequently, sustainable forest management plays a crucial role in contributing to the regulation of the hydrological cycle.

Metric 2.7.1 Number, distribution, and acres of impoundments affected by natural and artificial water control structures.

Metric 2.7.2 Surface area of lakes and wetlands.

Metric 2.7.3 Total flow data for rivers and streams.

Indicator 2.8—Effectiveness of soil conservation.

The long-term productivity and resilience of forests and other habitats are dependent upon the maintenance of appropriate levels of soil oxygen, nutrients, organic matter, and water. In order to ensure that terrestrial and aquatic ecosystems are maintained and improved, management policies must be implemented that provide for specific management practices or the protection of sensitive sites.

Metric 2.8.1 Miles and width of vegetated riparian corridors.

Metric 2.8.2 Number and location by county of soil erosion and sedimentation BMP violations.

Metric 2.8.3 Number, location by county, type, and funding for soil erosion and sedimentation restoration projects.

Metric 2.8.4 Trends in soil quality as measured by pH by eco-region.

Criterion 3—Social/Cultural/Spiritual

Social/Cultural.–The Northern Lower and Upper Peninsula ecoregions in which the state forest is located are predominantly rural, natural resource rich regions of Michigan with large amounts of public forestland. Current social values rely on tourism, recreation, and resource extraction based on the existing natural resources. Life styles and values of the people of this region are strongly connected to its natural resources. Therefore, sustainability of these natural resources is essential to the social and cultural fabric of the region.

Spiritual.–Spiritual values or existence values are personal feelings and sentiments that natural resources stir within the human spirit. This criterion is concerned with the continued ability of the resources to provide these values. Because spiritual values are personal in nature and to a large degree intangible, the indicators pertain primarily to ecosystem features of that appeal to the senses or address the ability of people to use those resources.

Indicator 3.1—Extent of archaeological and historical sites.

Resource management planning takes into account the identification and protection of known unique or significant Native American and Euro-American social, cultural, or spiritual sites.

Metric 3.1.1 Number of known archaeological sites. (More weight can be given to sites that are on the National Register of Historic Places. This register includes prehistoric sites as well.)

Metric 3.1.2. Number (presence, extent, location) of area(s) of historical/cultural significance. (Many times these areas may show no signs of their significance, (e.g., a Native American Indian trail corridor where the trail is no longer visible), or a spot at which a meeting or discovery took place.)

Indicator 3.2—Extent of undeveloped natural resources.

The existence and maintenance of large undeveloped forests or other similar resources at landscape scales are a significant influence upon social/cultural/spiritual values.

Metric 3.2.1 Size and distribution of natural, wilderness, and wild areas and the allowed use of those areas.

Indicator 3.3—Extent and type of aesthetics landscapes.

The visual or aesthetic quality of natural landscapes are a significant influence upon social/cultural/spiritual values (see also metrics under **Indicator 2.1**).

Metric 3.3.1 Number of designated access opportunities to view scenic vistas or wildlife.

Metric 3.3.2 Miles of road by use class, distribution, and density

Indicator 3.4—Extent and type of traditional uses for cultural forest products (e.g., berries, syrup, mushrooms, black ash, cattails, etc.).

The use of cultural forest products is a form of recreation that originates from historic needs for subsistence. These activities continue to exist for both subsistence and pure recreation. While they do not serve as a significant basis for segments of the state and local economies, they do provide a foundation for traditional social well being. Level of participation and potential resource impacts are also important to consider.

Metric 3.4.1 Number of traditional harvest festivals across the state – blueberry, morel mushrooms, thimbleberry etc.

Metric 3.4.2 Number of special use permits, (e.g., firewood, Christmas greens (Lycopodium), seeds, cones).

Metric 3.4.3 Extent of tribal gathering activities, (e.g., black ash, bark, berries, medicinal plants, commercial vs. subsistence).

Metric 3.4.4 Amounts, kinds, and impacts of medicinal plant gathering.

Metric 3.4.5 Kinds of and numbers of membership in nonforest product producer organizations.

Criterion 4—Outdoor Recreation

The ability to maintain and strengthen the quality of leisure pursuits in the access of resources and amenities while minimizing social or environmental degradation.

Indicator 4.1—Type, extent and quality of hunting, trapping, and fishing.

Hunting, trapping, and fishing are important forms of recreation that originate from historic needs for subsistence. These activities continue to exist for both purposes of subsistence and pure recreation. They serve as a significant basis for large segments of the state and many local economies, as well as for providing a foundation for traditional social well being.

Metric 4.1.1 User days per activity.

Metric 4.1.2 Number of animals testing positive for pathogens.

Metric 4.1.3 Population indices for selected species.

Metric 4.1.4 Estimated harvest by selected species.

Metric 4.1.5 Amount and locations by county of commercial forestlands, changes in status.

Metric 4.1.6 Satisfaction of recreational experience for selected programs.

Indicator 4.2—Extent, type, and quality of designated trail use – motorized and nonmotorized (hiking, ORV, snowmobile, skiing, equestrian).

Trails that are designated for authorized hiking, ORV, snowmobile, skiing, and equestrian uses are significant locations for recreation that form a significant basis for large segments of the state and many local economies, as well as providing a foundation for traditional social well being.

Metric 4.2.1 Amount of money and other resources (hours of staff and volunteer time) available for infrastructure, and trail maintenance and development.

Metric 4.2.2 User days per activity.

Metric 4.2.3 Miles of trail systems by trail ownership and management type.

Metric 4.2.4 Accident trends per activity per season.

Metric 4.2.5 Satisfaction of recreational experience for selected programs.

Indicator 4.3—Nature Appreciation and Education

One measure for nature appreciation and education is the existence of places where people can interact with natural communities that exist in perpetuity, and where natural processes occur to some degree, such as natural areas, wilderness areas, high conservation value areas, and ecological reference areas.

Metric 4.3.1 Miles of public Great Lakes, inland lakes, and stream shoreline.

Metric 4.3.2 Percentage, area, and representativeness of vegetative types in areas of natural and scientific interest.

Metric 4.3.3 Existence and level of nature oriented and eco-tourism activities, (e.g., guiding and interpretive services for kayaking, canoeing, birding, elk viewing, wildlife viewing, hunting, fishing, photography, backpacking etc.).

Metric 4.3.4 Satisfaction of recreational experience for selected programs.

Indicator 4.4—Extent, type, and quality of camping – including dispersed and designated site camping. (Refer also to social economic assessment contract.)

Camping is an important form of recreation that originates from historic needs for shelter while traveling through a natural setting. Camping activities of both forms are a significant basis for large segments of the state and many local economies, as well as providing a foundation for traditional social well being.

Metric 4.4.1 Number, type, and distribution of campground facilities – rustic, modern, semi-modern, and cabin rentals.

Metric 4.4.2 Number of campsites by type in public and private campgrounds.

Metric 4.4.3 User days by campground and campsite.

Metric 4.4.4 Number of dispersed camps per year.

Metric 4.4.5 Satisfaction of recreational experience for selected programs.

Indicator 4.5—Extent, type and quality of water recreation – motorized and nonmotorized (including swimming, scuba diving, kayaking, etc.).

Water recreation is an important form of recreation that has roots in historic modes of transportation and for fulfilling needs for exercise and adventure. Both forms of water recreation are a significant basis for large segments of the state and many local economies, as well as providing a foundation for traditional social well being.

Metric 4.5.1 Trends in water activity user days (e.g., power/sail boating, jet-skis, canoes, rafting/tubing, kayaking, swimming, snorkeling, fishing, water skiing, boat races, cruise ships, and sail boarding, etc.).

Metric 4.5.2 Trends in water recreation equipment sales.

Metric 4.5.3 Trends in commercial water recreation operators.

Metric 4.5.4 Number of water access sites and boat slips by type and capacity for watercraft and available amenities.

Metric 4.5.5 Change in status of water body designation and use.

Metric 4.5.6 Satisfaction of recreational experience for selected programs.

Indicator4.6—Public land open to outdoor recreation.

Trends in all land open to outdoor recreation, not just forestland.

Metric 4.6.1 Amount of public land open to outdoor recreation, by agency (e.g., federal, state, local conservancy, and conservation easement lands).

Criterion 5 Ownership Patterns

The pattern and distribution of ownership and use of lands greatly affects the ability to sustain natural resources. Management options, resource demand and ecological processes are affected by how the land is managed, fragmented, and patterned. Successful sustainable management depends upon the degree of functional connectivity across ownerships, boundaries, and landscapes.

Indicator 5.1—Degree of stewardship.

Stewardship is the practice of carefully managing land usage and associated resources to ensure natural systems are maintained or enhanced for use by future generations.

Metric 5.1.1 Number, acres, and distribution of Forest Stewardship, Conservation Reserve Program, Qualified Forest Program, American Tree Farm, Commercial Forest, Landowner Incentive Program, private land management plans, and percent of private ownership with management plans.

Metric 5.1.2 Number of acres and location by county of private land with public conservation easements.

Metric 5.1.3 Number, kinds, and acres by county of conservation easements.

Metric 5.1.4 Number, kinds, and acres by county of cooperative planning "agreements" across ownerships, (e.g., Clay Lake Plains Plan, Two Hearted River Watershed Plan, Les Cheneaux Economic Forum, Munuscong Watershed Plan, and St. Mary's River Plan).

Metric 5.1.5 Numbers, acres, and percentage of forested lands certified by county for sustainable forestry by ownership.

Indicator 5.2—Extent of accessibility to public lands.

The extent to which a parcel or area of land can be reached and used by people.

Metric 5.2.1 Number by county of access easements to public lands.

Metric 5.2.2 Number of acres and location by township of public land without access landlocked by private ownerships.

Metric 5.2.3 Trends in numbers and location by county of barrier free facilities.

Indicator 5.3—Degree of stability of land use.

The stability of land use or large-scale trends in land use can have direct effect upon the landscape resources base from which social/cultural/spiritual values are derived.

Metric 5.3.1 Percent of forestland and nonforest land by county.

Metric 5.3.2 Acres of forestland converted to developed land.

Metric 5.3.3 Amount of ownership fragmentation and parcelization of land.

Metric 5.3.4. Number and size of forested parcels added to or removed from the Commercial Forest Program.

Metric 5.3.5 Distribution of forestland ownership by acres.

Metric 5.3.6 Percent change by ownership class.

Criterion 6—Economic Health

A wide range of goods and services are derived by and from managing natural resources in the northern Lower and Upper peninsulas of Michigan. In addition to the traditional forest products sector, the resource base supports mining, commercial fishing, and an ever-growing tourist and recreation industry. These goods and services create jobs and provide economic stability to the region.

Indicator 6.1—Extent and trends of local and community economic health.

Trends in planning and investment are important gauges of sustainable natural resource management and in local and community economic health (see also social economic assessment contract).

Metric 6.1.1 Number of local economic development plans.

Metric 6.1.2 Trends in job/income/employment/retirement data.

Metric 6.1.3 Contribution of the resource use to gross domestic product of all sectors of the economy.

Metric 6.1.4 Diversity of forest economic activity.

Metric 6.1.5 Capital outlay and investment trends.

Indicator 6.2—Extent of nontimber economic benefits of the forest.

The extent of nontimber economic benefits are an important gauge of sustainable natural resource management and in local and community economic health (see also social and economic assessment contract).

Metric 6.2.1 Number of recreation and tourism jobs/economic activity.

Metric 6.2.2 Total expenditures by individuals by select activity.

Metric 6.2.3 Value and jobs/economic activity related to mineral, oil, and gas extraction.

Indicator 6.3—Extent and type of timber and wood products produced.

The extent and type of timber and wood products are important gauges of sustainable natural resource management and in local and community economic health (see also social and economic assessment contract).

Metric 6.3.1 Timber volume, growth, and mortality by county.

Metric 6.3.2 Timber harvest by species by county.

Metric 6.3.3 Value and volume of wood products by county.

Metric 6.3.4 Number of jobs/economic activity (e.g., logging, hauling, and mills).

Criterion 7—Institutional Processes

Institutional processes address the legal and institutional framework for the application of ecosystem management. They address the policies, legislation, regulations, and guidelines that drive and direct ecosystem practices; and direct how institutions cooperate with others in the application of ecosystem management. Institutional processes include the quality and quantity of opportunities for public involvement in ecosystem planning leading to resource management decisions.

Indicator 7.1—Extent of the legal framework for ecosystem management.

The framework should include the existence and/or application of laws, regulations, policies, and guidelines for land management. The framework should also consider and meet legal obligations with respect to duly established Native American treaty rights. (Note the metrics here are very important to the public based on the public meetings that were held).

Metric 7.1.1 Presence of and compliance with land management laws and regulations based on continued Forest Certification management review system, Natural Resource Commission and other open meetings, and stake holder reports.

Metric 7.1.2 Presence of and compliance with wildlife management laws and regulations.

Metric 7.1.3 Presence of and compliance with recreation laws and regulations.

Metric 7.1.4 Presence of and compliance with fisheries management laws and regulations.

Metric 7.1.5 Presence of and compliance with Native American treaty rights.

Metric 7.1.6 Presence of and compliance with department and division policies, procedures, and guidelines.

Metric 7.1.7 Number and extent of laws that reference ecosystem management.

Indicator 7.2—Extent of an institutional framework.

An effective institutional framework is necessary to implement ecosystem management processes effectively.

Metric 7.2.1 Trends in public participation processes.

Metric 7.2.2 The number of public advisory committees.

Indicator 7.3—Extent of resources allocated for ecosystem management values.

Sufficiency of resources is necessary to effectively implementation ecosystem management processes.

Metric 7.3.1 Resources allocated within the department for ecosystem management planning and monitoring.

Metric 7.3.2 Participation in external planning efforts (e.g., National Forest Plan revisions).

Metric 7.3.3 Expenditure of resources and dedicated funds for implementation of “on-the-ground” projects.

Metric 7.3.4 Expenditure of resources and dedicated funds for research in ecosystem management.

Table H1.–Tiered criterion and indicators metrics. Organizations in parentheses represent contributing sources of data.

Core metric	Tier	Measurement frequency	Lead division
1.1.1 Percent and extent of rare natural communities relative to historical conditions.	4	annually	FMFM (MNFI)
1.1.2 Percent and extent of uncommon geophysical features relative to historical conditions.	4	NA	FMFMD
1.1.3 Percent and extent of uncommon hydro-physical features relative to historical conditions (e.g., aquifers, artesian wells, springs, waterfalls, recharge zones).	4	NA	FD
1.2.1 Percent and extent of vegetation types relative to historical conditions.	3	5 years	FMFMD (MNFI)
1.2.2 Number of natural community types.	1	5 years	FMFMD (MNFI)
1.2.3 Distribution of natural community types.	4	NA	FMFMD (BIODIV TEAM)
1.2.4 Percentage, area and representativeness of vegetation types in designated protected areas of natural and scientific interest.	3	annually	FMFMD (WLD, BIODIV TEAM)
1.2.5 Level of fragmentation, connectivity, shape, size, and spatial distribution of vegetation types.	4	NA	WLD (MNFI)
1.3.1 Distribution, dispersion and population trends of focal species.	3	annually	WLD (FD)
1.3.2 Absolute and relative abundance of vegetation types and their importance as habitat for focal species.	3	annually	WLD (FD)
1.3.3 Trends in habitat of focal species.	3	5 years	WLD (FD)
1.3.4 Species classified as threatened, endangered, rare, or vulnerable, their population trends and habitat condition.	3	2 years	WLD, FD
1.3.5 Species richness of plants and animals within representative ecosystems.	4	NA	FMFM (WLD, FD, MNFI)
1.4.1Proportion of forest area as plantations using native vs. nonnative genotypes.	3	5 years	FMFMD
1.4.2 Proportion of water bodies with native vs. nonnative fish-stock genotypes in both inland and Great Lakes waters.	1	5 years	FD
1.4.3 Proportion of water bodies with fishery sustained by natural reproduction.	1	annually	FD
1.4.4 Herbaceous native vs. nonnative species plantings on roads, trails, easements, openings, savannas, grasslands, and wetlands on managed lands.	4	5 years	WLD (FMFMD, PRD)

Table H1.–Continued.

Core metric	Tier	Measurement frequency	Lead division
2.1.1 Area and severity of insect and disease infestation.	1	annually	FMFMD
2.1.2 Area and severity of flooding, drought, wind, and fire activity.	3	5 years	FMFMD
2.1.3 Presence, extent and number of invasive exotic species.	4	NA	FMFMD (MDA)
2.1.4 Area and location by county of severe mammalian herbivory.	4	NA	FMFMD
2.1.5 Area and intensity of timber harvest by type.	1	annually	FMFMD
2.1.6 Area and intensity of timber salvage by type.	2	annually	FMFMD
2.1.7 Number and distribution of active and nonrestored mineral and nonmineral extraction sites per township.	2	5 years	FMFMD
2.1.8 Miles and density of utility corridors and numbers of communication structures.	3	10 years	FMFMD (OLAF)
2.1.9 Miles of undeveloped Great Lakes, inland lakes, rivers, and stream shoreline.	3	10 years	FD
2.1.10 Mean concentration of Chlorophyll A during annual growing season in inland lakes.	1	annually	FD
2.1.11 Miles of streams designated as priority for beaver-trout management per DNR Policy 39.21-20.	4	NA	FD (WLD)
2.2.1 Volume, net annual growth, mortality, and removals by forest type and age class.	1	annually	FMFMD
2.3.1 Alteration of surface and sub-surface geology of valley segment.	2	10 years	FD
2.3.2 Alteration of surface and sub-surface hydrology of valley segment.	1	as necessary	FD
2.3.3 Number and location of lake and stream restoration projects.	2	as necessary	FD
2.4.1 Tree size: basal area per acre/hectare for different forest cover types.	1	annually	FMFMD
2.4.2. Distribution of cliffs, outcrops, sinks, and glacial erratics.	3	5 years	FMFMD
2.4.3 Snags per area, basal area, mean DBH, and decay class.	3	annually	FMFMD
2.4.4 Large woody debris per area, mean DBH and decay class.	4	NA	FMFMD
2.4.5 Number of vegetative species and structural diversity by age class for forested systems.	1	annually	FMFMD

Table H1.–Continued.

Core metric	Tier	Measurement frequency	Lead division
2.5.1 Distribution and acres of lakes and miles of streams of artificial nutrification (nitrates and phosphates).	1	annually	FD
2.5.2 Pesticide and contaminant residue concentrations in surface water as measured by fish advisories and Eagle nesting success.	1	annually	FD
2.5.3 Percentage of impervious surface in watersheds.	2	10 years	FD
2.6.1 Area of forest permanently, semi-permanently, or temporarily converted to nonforest land use (Also see Indicator 5.3 Land Use).	2	5 years	FMFMD
2.6.2 Changes in carbon pool in vegetative biomass.	2	5 years	FMFMD
2.6.3 Number of wildfire acres reported by county and township.	3	annually	FMFMD
2.6.4 Trends in metric tons of greenhouse gas emissions by region or county.	2	10 years	FMFMD (DEQ)
2.7.1 Number, distribution, and acres of impoundments with artificial water control structures.	3	10 years	FD (WLD)
2.7.2 Surface area of lakes and wetlands.	2	10 years	FD
2.7.3 Total flow data for rivers and streams.	1	annually	FD
2.8.1 Miles and width of vegetated riparian corridors.	4	NA	FMFMD
2.8.2 Number and location by county of soil erosion and sedimentation BMP violations.	1	annually	FMFMD
2.8.3 Number, location by county, type, and funding for soil erosion and sedimentation restoration projects.	1	annually	FD
2.8.4 Trends in soil quality as measured by pH by eco-region	4	NA	FMFMD
3.1.1 Number of known archaeological sites. (More weight can be given to sites that are on the National Register of Historic Places. This register includes prehistoric sites as well.)	3	5 years	FMFMD (SHPO)
3.1.2. Number (presence, extent, location) of area(s) of historical/cultural significance. Many times these areas may show no signs of their significance (e.g., a Native American Indian trail corridor where the trail is no longer visible, or a spot at which a meeting or discovery took place).	3	10 years	FMFMD (SHPO)
3.2.1 Size and distribution of natural, wilderness and wild areas and the allowed use of those areas.	1	annually	FMFMD (WLD)
3.3.1 Number of designated access opportunities to view scenic vistas and/or wildlife.	3	10 years	FMFMD (WLD, PRD)

Table H1.–Continued.

Core metric	Tier	Measurement frequency	Lead division
3.3.2 Miles of road by use class, distribution and density	1	annually	FMFMD
3.4.1 Number of traditional harvest festivals across the state – blueberry, morel mushrooms, thimbleberry etc.	2	5 years	FMFMD (MEDC)
3.4.2 Number of special use permits (e.g., firewood, Christmas greens (Lycopodium), seeds, cones).	1	annually	FMFMD (WLD)
3.4.3 Extent of tribal gathering activities, e.g. black ash, bark, berries, medicinal plants—commercial vs. subsistence.	4	NA	FMFMD (WLD)
3.4.4 Amounts, kinds, and effects of medicinal plant gathering.	4	NA	FMFMD
3.4.5 Kinds of and numbers of membership in nonforest product producer organizations.	4	NA	FMFMD
4.1.1 User days per activity.	1	annually	WLD (FD)
4.1.2 Proportion or number of animals testing positive for pathogens, or number of diseases or pathogens for which there are active surveillance programs.	1	annually	WLD (FD)
4.1.3 Population indices for selected species.	4	NA	WLD (FD)
4.1.4 Estimated harvest by selected species.	4	NA	WLD (FD)
4.1.5 Amount and locations by county of commercial forestlands, changes in status.	1	annually	FMFMD
4.1.6 Satisfaction of recreational experience for selected programs.	3	annually	WLD, FD (LED)
4.2.1 Amount of money and other resources (hours of staff and volunteer time) available for infrastructure and trail maintenance and development.	1	annually	FMFMD (PRD, WLD)
4.2.2 User days per activity.	3	10 years	FMFMD (PRD, WLD)
4.2.3 Miles of trail systems by trail ownership and management type.	1	annually	FMFMD (PRD)
4.2.4 Accident trends per activity per season.	1	annually	LED
4.2.5 Satisfaction of recreational experience for selected programs.	4	NA	FMFMD (PRD, WLD, LED)
4.3.1 Miles of public Great Lakes, inland lakes, and stream shoreline.	3	10 years	FD
4.3.2 Percentage, area and representativeness of vegetative types in areas of natural and scientific interest.	3	5 years	FMFMD (WLD, BIODIV TEAM)

Table H1.–Continued.

Core metric	Tier	Measurement frequency	Lead division
4.3.3 Existence and level of nature oriented and eco-tourism activities (e.g., guiding and interpretive services for kayaking, canoeing, birding, elk viewing, wildlife viewing, hunting, fishing, photography, backpacking etc.).	4	NA	FMFMD (MEDC)
4.3.4 Satisfaction of recreational experience for selected programs.	4	NA	Office of Communications
4.4.1 Number, type, and distribution of campground facilities – rustic, modern, semi-modern, cabin rentals.	1	annually	FMFMD (PRD)
4.4.2 Number of campsites by type in public and private campgrounds.	1	annually	FMFMD (PRD, DEQ)
4.4.3 User days by campground and campsite.	1	annually	FMFMD (PRD)
4.4.4 Number of dispersed camps per year.	1	annually	FMFMD
4.4.5 Satisfaction of recreational experience for selected programs.	4	NA	FMFMD, PRD (WLD, LED)
4.5.1 Trends in water activity user days (e.g., power/sail boating, jet-skis, canoes, rafting/tubing, kayaking, swimming, snorkeling, fishing, water skiing, boat races, cruise ships, sail boarding, etc.).	3	10 years	LED (MSU)
4.5.2 Trends in water recreation equipment sales and registrations.	1	annually	PRD
4.5.3 Trends in commercial water recreation operators.	4	NA	LED
4.5.4 Number of water access sites and boat slips by type and capacity for watercraft and available amenities.	1	annually	PRD
4.5.5 Change in status of water body designation and use.	2	5 years	LED
4.5.6 Satisfaction of recreational experience for selected programs.	4	NA	PRD (FMFMD, LED)
4.6.1 Amount of public land open to outdoor recreation in Michigan, by agency.	1	annually	FMFMD (PRD, WLD)
5.1.1 Number, acres, and distribution of Forest Stewardship, Conservation Reserve Program, Qualified Forest Program, American Tree Farm, Commercial Forest and Landowner Incentive Program private land management plans, and percent of private ownership with management plans.	4	NA	FMFMD (WLD)
5.1.2 Number of acres and location by county of private land with public conservation easements.	3	5 years	FMFMD (WLD)

Table H1.–Continued.

Core metric	Tier	Measurement frequency	Lead division
5.1.3 Number, kinds, and acres by county of conservation easements.	3	5 years	FMFMD
5.1.4 Number, kinds, and acres by county of cooperative planning "agreements" across ownerships (e.g., Clay Lake Plains Plan, Two Hearted River Watershed Plan, Les Cheneaux Economic Forum, Munuscong Watershed Plan, St. Mary's River Plan).	2	5 years	FMFMD
5.1.5 Numbers, acres, and percentage of forested lands certified by county for sustainable forestry by ownership.	4	NA	FMFMD
5.2.1 Number by county of access easements to public lands.	2	5 years	FMFMD (OLAF)
5.2.2 Number of acres and location by township of public land without access landlocked by private ownerships.	2	10 years	FMFMD (OLAF)
5.2.3 Trends in numbers and location by county of barrier free facilities.	3	10 years	FMFMD (PRD)
5.3.1 Percent of forestland and nonforest land by county.	2	10 years	FMFMD
5.3.2 Acres of forestland converted to developed land.	4	NA	FMFMD
5.3.3 Amount of ownership fragmentation and parcelization of land.	3	10 years	FMFMD (OLAF)
5.3.4. Number and size of forested parcels added to or removed from the Commercial Forest Program.	1	annually	FMFMD
5.3.5 Distribution of forestland ownership by acres.	2	10 years	FMFMD
5.3.6 Percent change by ownership class.	2	10 years	FMFMD
6.1.1 Number of local economic development plans.	2	10 years	FMFMD (DLEG)
6.1.2 Trends in job/income/employment/retirement data.	2	10 years	FMFMD (DLEG)
6.1.3 Contribution of the resource use to gross domestic product of all sectors of the economy.	2	10 years	FMFMD (DLEG)
6.1.4 Diversity of forest economic activity.	2	10 years	FMFMD (DLEG)
6.1.5 Capital outlay and investment trends.	2	10 years	FMFMD (DLEG)
6.2.1 Number of recreation and tourism jobs/economic activity.	2	10 years	FMFMD
6.2.2 Total expenditures by individuals by select activity.	2	10 years	FMFMD
6.2.3 Value and jobs/economic activity related to mineral, oil, and gas extraction.	2	10 years	FMFMD
6.3.1 Timber volume, growth, and mortality by county.	2	10 years	FMFMD

Table H1.–Continued.

Core metric		Tier	Measurement frequency	Lead division
6.3.2	Timber harvest by species by county.	2	10 years	FMFMD
6.3.3	Value and volume of wood products by county.	2	10 years	FMFMD
6.3.4	Number of jobs/economic activity (e.g., logging, hauling, and mills).	2	10 years	FMFMD
7.1.1	Presence of and compliance with land management laws and regulations based on continued Forest Certification management review system, Natural Resource Commission and other open meetings, and stake holder reports.	1	annually	FMFMD
7.1.2	Presence of and compliance with wildlife management laws and regulations.	2	5 years	LED (WLD)
7.1.3	Presence of and compliance with recreation laws and regulations.	2	5 years	LED (PRD, FMFMD)
7.1.4	Presence of and compliance with fisheries management laws and regulations.	2	5 years	LED (FD)
7.1.5	Presence of and compliance with Native American treaty rights.	1	annually	FMFMD
7.1.6	Presence of and compliance with department and division policies, procedures, and guidelines.	3	5 years	FMFMD (All DNR)
7.1.7	Number and extent of laws that reference ecosystem management.	2	10 years	FMFMD
7.2.1	Trends in public participation processes.	3	5 years	FMFMD (All DNR)
7.2.2	The number of public advisory committees.	2	5 years	FMFMD (All DNR)
7.3.1	Resources allocated within the department for ecosystem management planning and monitoring.	2	5 years	FMFMD (All DNR)
7.3.2	Participation in external planning efforts (e.g., National Forest plan revisions).	2	10 years	FMFMD (All DNR)
7.3.3	Expenditure of resources and dedicated funds for implementation of “on-the-ground” projects.	3	annually	FMFMD (All DNR)
7.3.4	Expenditure of resources and dedicated funds for research in ecosystem management.	3	annually	FMFMD (All DNR)

Appendix I.–Michigan's natural communities

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Table I.1.–Michigan's natural communities.

Communities	State rank
Palustrine Marsh	
Coastal plain marsh	S2—imperiled because of rarity
Emergent marsh	S4—secure
Great lakes marsh	S3—rare or uncommon
Inland salt marsh	S1—critically imperiled because of extreme rarity
Interdunal wetland	S2—imperiled because of rarity
Intermittent wetland	S3—rare or uncommon
Northern wet meadow	S4—secure
Southern wet meadow	S3—rare or uncommon
Submergent marsh	S4—secure
Palustrine Prairie	
Lakeplain wet prairie	S1—critically imperiled because of extreme rarity
Lakeplain wet-mesic prairie	S1—critically imperiled because of extreme rarity
Wet prairie	S2—imperiled because of rarity
Wet-mesic prairie	S2—imperiled because of rarity
Wet-mesic sand prairie	S1—critically imperiled because of extreme rarity
Palustrine Fen	
Prairie fen	S3—rare or uncommon
Northern fen	S3—rare or uncommon
Patterned fen	S2—imperiled because of rarity
Poor fen	S3—rare or uncommon
Palustrine Bog	
Bog	S4—secure
Muskeg	S3—rare or uncommon
Palustrine Forest	
Floodplain forest	S3—rare or uncommon
Hardwood-conifer swamp	S3—rare or uncommon
Northern hardwood swamp	S3—rare or uncommon
Poor conifer swamp	S4—secure
Rich conifer swamp	S3—rare or uncommon
Rich tamarack swamp	S3—rare or uncommon
Southern hardwood swamp	S3—rare or uncommon
Wet-mesic flatwoods	S2—imperiled because of rarity
Palustrine Shrub	
Inundated shrub swamp	S3—rare or uncommon
Northern shrub thicket	S5—demonstrably secure and essentially ineradicable under present conditions
Southern shrub-carr	S5—demonstrably secure and essentially ineradicable under present conditions
Palustrine/Terrestrial	
Wooded dune and swale complex	S3—rare or uncommon
Terrestrial Forest	
Boreal forest	S3—rare or uncommon
Dry northern forest	S3—rare or uncommon

Table I.1.–Continued.

Communities	State rank
Dry southern forest	S3—rare or uncommon
Dry-mesic northern forest	S3—rare or uncommon
Dry-mesic southern forest	S3—rare or uncommon
Mesic northern forest	S3—rare or uncommon
Mesic southern forest	S3—rare or uncommon
Terrestrial Savanna	
Bur oak plains	SX—apparently extirpated
Lakeplain oak openings	S1—critically imperiled because of extreme rarity
Oak barrens	S1—critically imperiled because of rarity
Oak openings	S1—critically imperiled because of extreme rarity
Oak-pine barrens	S2—imperiled because of rarity
Pine barrens	S2—imperiled because of rarity
Terrestrial Prairie	
Dry sand prairie	S2—imperiled because of rarity
Dry mesic prairie	S2—imperiled because of rarity
Hillside prairie	S1—critically imperiled because of extreme rarity
Mesic prairie	S1—critically imperiled because of extreme rarity
Mesic sand prairie	S1—critically imperiled because of extreme rarity
Terrestrial Primary	
Alvar	S1—critically imperiled because of rarity
Great lakes barrens	S2—imperiled because of rarity
Northern bald	S1—critically imperiled because of extreme rarity
Open dunes	S3—rare or uncommon in the state
Sand and gravel beach	S3—rare or uncommon
Sinkhole	S2—imperiled because of rarity
Granite bedrock glade	S2—imperiled because of rarity
Limestone bedrock glade	S2—imperiled because of rarity
Volcanic bedrock glade	S2—imperiled because of rarity
Granite bedrock lakeshore	S2—imperiled because of rarity
Limestone bedrock lakeshore	S2—imperiled because of rarity
Sandstone bedrock lakeshore	S2—imperiled because of rarity
Volcanic bedrock lakeshore	S2—imperiled because of rarity
Limestone cobble lakeshore	S3—rare or uncommon
Sandstone cobble lakeshore	S3—rare or uncommon
Volcanic cobble lakeshore	S3—rare or uncommon
Granite cliff	S2—imperiled because of rarity
Limestone cliff	S2—imperiled because of rarity
Sandstone cliff	S2—imperiled because of rarity
Volcanic cliff	S2—imperiled because of rarity
Granite lakeshore cliff	S2—imperiled because of rarity
Limestone lakeshore cliff	S2—imperiled because of rarity
Sandstone lakeshore cliff	S2—imperiled because of rarity
Volcanic lakeshore cliff	S1—critically imperiled because of rarity
Terrestrial Subterranean	
Cave	S1—critically imperiled because of rarity