Letter from the State Forester
The state forest system of Pennsylvania, approximately 2.2 million acres of forestland, comprises 13 percent of the forested area in the Commonwealth. This great expanse of forestland provides a wealth of benefits to Pennsylvanians, including wildlife and aesthetic beauty, vital timber products, water purification, valuable revenue from gas extraction, and a variety of healthful recreational opportunities. Balancing the various uses, resources, and values of state forest land requires a thoughtful and deliberate approach to management. Since 1955, the Bureau of Forestry has been developing State Forest Resource Management Plans (SFRMPs) that guide our management and communicate our management principles and goals to the public. While society continues to place increasing needs on state forest land, such as greater recreational use and resource extraction, the forest is also under pressure from environmental stressors, such as climate change and invasive plants, insects, and disease. In light of these challenges, the bureau must carefully plan its management of state forest land to ensure sustainable ecological, social, and economic benefits now and for future generations.

The draft 2015 SFRMP upholds the policies set forth in our Strategic Plan – Penn’s Woods – and builds upon the principles of ecosystem management that were outlined in that document. Ecosystem management can simply be defined as a holistic approach to resource management where the interdependency of biological and non-biological systems and cycles is the focus. In this approach, humans are considered part of the ecosystem, and human needs and impacts must be taken into account when developing management strategies. Upon the foundation of Penn’s Woods and previous SFRMPs, the bureau has built an array of principles, goals, and objectives which will move the forest into the future. The draft 2015 SFRMP is the first update of the SFRMP in eight years. One accomplishment of this draft SFRMP is to memorialize the various planning and management activities that the bureau has undertaken over the past eight years into one comprehensive document. These include the accomplishment of meeting our first decade targets in the harvest allocation model, successfully implementing the Deer Management Assistance Program across the state forest system, adapting to the effects of Marcellus and other shale-gas development, and developing management plans for the influences of hemlock wooly adelgid and emerald ash borer. The draft 2015 SFRMP also provides points of emphasis for future management, such as climate change, conservation of wild character, prescribed fire, lakes, river islands, cultural resources, and communication via social media and interpretative opportunities. We attempted to make the draft SFRMP more useable and accessible, both for staff reference and for public consumption.

An important part of the SFRMP development process is the incorporation of public input. To initiate the planning process for the draft 2015 SFRMP, the bureau conducted a public opinion survey, to which we had over 3,250 respondents. This fall, the open public comment period and series of public meetings will provide additional opportunities for the citizens of Pennsylvania to have a say in how their forestland is managed.

The draft 2015 SFRMP provides a broad framework that leaves the bureau poised for the development of district-level plans in upcoming years. District-level plans will have increased focused on local resources and values, and the development process for district-level plans will include additional avenues for public input.

The draft 2015 SFRMP is the culmination of months of hard work to encapsulate all the efforts and priorities of the bureau, and it sets the course for sustainable management of state forest land for years to come.

I hope you find this draft informative, and we look forward to your feedback.

Dan Devlin
State Forester
# Table of Contents

## Introduction ........................................ 1
   The State Forest System .......................... 1
   Purpose of the State Forest Resource Management Plan .......... 2
   Planning Foundations ............................. 3

## Organization and Management ..................... 7
   Forest Districts .................................... 7
   Central Office ..................................... 8

## Ecosystem and Landscape Management Considerations .......... 11
   Introduction ....................................... 11
   Biodiversity Conservation ........................ 13
   Biodiversity Goal and Objectives ................. 14
   Fragmentation and Connectivity ................. 14
   Forest Connectivity and Fragmentation Goal and Objectives .... 16
   Climate Change .................................... 16
   Climate Change Goals and Objectives ............ 18
   Wild Character ..................................... 19
   Wild Character Goal ................................ 21
   Adjoining Land Strategy ......................... 21
   Adjoining Lands Goal and Objectives ............ 22
   Acquisitions Strategy ............................. 22
   Acquisitions Goal and Objectives ............... 23
   Old Growth ......................................... 23
   Old-Growth Goals and Objectives ............... 25

## Land Inventories, Delineations, Classifications, and Designations .... 26
   Classification and Typing ......................... 26
   State Forest Management Zoning ................. 29
   Planning and Operational Areas .................. 37
   Reference and Analysis Areas ................... 38
   Supra Management Areas .......................... 39
   Land Inventories, Delineations, Classifications, and Designations Goals and Objectives ............ 41

## Monitoring and Adaptive Management .................. 42
   Inventory .......................................... 42
   Shale-Gas Monitoring Program .................... 44
   Implementation Monitoring ....................... 44
   Research .......................................... 44
   Adaptive Management ............................. 45

## Project Planning and Review ...................... 46
   State Forest Environmental Reviews .......... 46
   Pennsylvania Natural Diversity Inventory ........ 46
   Timber Sale Planning ............................. 47
   Prescribed Fire Planning ........................ 48

## Communications .................................. 50
   Media ............................................. 52
   Education, Interpretation, and Outreach .......... 53
   Key Messages ...................................... 54
   Forest Demonstration Sites ....................... 56
   Public Engagement ................................ 56
   Communications Management Principle .......... 58
   Guidelines, Tools, and Resources ............... 59
   Monitoring ........................................ 59

## Timber and Forest Products ....................... 60
   History of Timber in Pennsylvania ............... 61
   Timber Condition on State Forest Lands ............ 62
   Timber Management on State Forest Lands .......... 66
   Timber Revenues .................................. 76
   Non-Timber Forest Products ....................... 76
   Timber and Forest Products Management Principle .......... 76
   Guidelines, Tools, and Resources ............... 80
   Monitoring ........................................ 81
   Critical Research Needs ........................ 81

## Native Wild Plants ............................... 82
   Jurisdictional Responsibility .................... 83
   Plant Diversity and Communities ............... 83
   Rare, Threatened, and Endangered Species and Communities .... 86
   Management of Native Plants on State Forest Land .......... 88
   Native Wild Plants Management Principle ........ 90
   Guidelines, Tools, and Resources ............... 91
   Monitoring ........................................ 91
   Critical Research Needs ........................ 91

## Wildlife ........................................... 94
   Wildlife Diversity on State Forest Lands .......... 95
   Wildlife Inventory and Planning ................ 95
   Wildlife Habitat on State Forest Lands ............ 96
   Managing for Wildlife Habitat Diversity ............. 96
   Wildlife Species Management on State Forest Lands .......... 104
   Threats to Wildlife Species on State Forest Lands .......... 106
   Wildlife Species of Concern on State Forest Lands .......... 107
   Wildlife Management Principle ................... 108
   Guidelines, Tools, and Resources ............... 109
   Monitoring ........................................ 111
   Critical Research Needs ........................ 111

## Water Resources ................................ 112
   The Value of Water on State Forest Lands .......... 113
   Rivers and Streams ................................ 114
   Lakes and Ponds .................................. 115
   River Islands ...................................... 115
   Water Supply ...................................... 116
   Impaired Water Bodies ............................. 116
   Aquatic Invasive Species ......................... 117
   Aquatic Community Classification ................. 117
   Water Management Principle ...................... 119
   Guidelines, Tools, and Resources ............... 120
   Monitoring ........................................ 121
   Critical Research Needs ........................ 121

## Soils ................................................ 122
   Soils and Forest Management .................... 123
   Soils on State Forest Lands ..................... 124
   Soils Management Principle ..................... 126
   Guidelines, Tools, and Resources ............... 127
   Monitoring ........................................ 127
   Critical Research Needs ........................ 127

## Geologic Resources .............................. 128
   Geology and Landscapes ........................ 129
   Unique Geologic Features ....................... 130
   Geologic Resource Extraction .................... 130
   Oil and Gas Development ......................... 131
   Geologic Resources Management Principle .......... 141
   Guidelines, Tools, and Resources ............... 142
   Monitoring ........................................ 142
   Critical Research Needs ........................ 142

## Wildland Fire ..................................... 144
   History of Wildland Fire in Pennsylvania .......... 145
   Wildfire Risk ..................................... 146
   The Effects of Fire in Pennsylvania ............. 146
   Wildfire Management ................................ 148
   Prescribed Fire .................................... 149
   Wildland Fire Management Principle ............. 150
   Guidelines, Tools, and Resources ............... 151
   Monitoring ........................................ 151
   Critical Research Needs ........................ 151

## Forest Health ..................................... 152
   Forest Insects and Disease ....................... 153
   Invasive Plants ................................... 156
   Other Forest Health Threats ..................... 159
   Forest Health Management Principle ............. 161
   Guidelines, Tools, and Resources ............... 162
   Monitoring ........................................ 164
   Critical Research Needs ........................ 165

## Recreation ........................................ 166
   History of Recreation on State Forests .......... 167
   Recreation Opportunities ....................... 168
   Recreation Experiences ......................... 174
   Recreation Management Principle ............... 179
   Guidelines, Tools, and Resources ............... 180
   Monitoring ........................................ 183
   Critical Research Needs ........................ 183

## Infrastructure .................................... 184
   Infrastructure Management ....................... 185
   Infrastructure on State Forest Land ............. 186
   Infrastructure Management Principle ............ 188
   Guidelines, Tools, and Resources ............... 189
   Monitoring ........................................ 189
   Critical Research Needs ........................ 189

## Cultural and Historic Resources .................. 190
   Cultural and Historic Resources Management Principle .......... 193
   Guidelines, Tools, and Resources ............... 193

---

### Forest Health

- **History of Timber in Pennsylvania**: 61
- **Timber Condition on State Forest Lands**: 62
- **Timber Management on State Forest Lands**: 66
- **Timber Revenues**: 76
- **Non-Timber Forest Products**: 76
- **Timber and Forest Products Management Principle**: 76
- **Guidelines, Tools, and Resources**: 80
- **Monitoring**: 81
- **Critical Research Needs**: 81

### Native Wild Plants

- **Jurisdictional Responsibility**: 83
- **Plant Diversity and Communities**: 83
- **Rare, Threatened, and Endangered Species and Communities**: 86
- **Management of Native Plants on State Forest Land**: 88
- **Native Wild Plants Management Principle**: 90
- **Guidelines, Tools, and Resources**: 91
- **Monitoring**: 91
- **Critical Research Needs**: 91

### Wildlife

- **Wildlife Diversity on State Forest Lands**: 95
- **Wildlife Inventory and Planning**: 95
- **Wildlife Habitat on State Forest Lands**: 96
- **Managing for Wildlife Habitat Diversity**: 96
- **Wildlife Species Management on State Forest Lands**: 104
- **Threats to Wildlife Species on State Forest Lands**: 106
- **Wildlife Species of Concern on State Forest Lands**: 107
- **Wildlife Management Principle**: 108
- **Guidelines, Tools, and Resources**: 109
- **Monitoring**: 111
- **Critical Research Needs**: 111

### Water Resources

- **The Value of Water on State Forest Lands**: 113
- **Rivers and Streams**: 114
- **Lakes and Ponds**: 115
- **River Islands**: 115
- **Water Supply**: 116
- **Impaired Water Bodies**: 116
- **Aquatic Invasive Species**: 117
- **Aquatic Community Classification**: 117
- **Water Management Principle**: 119
- **Guidelines, Tools, and Resources**: 120
- **Monitoring**: 121
- **Critical Research Needs**: 121

---

### Soils

- **Soils and Forest Management**: 123
- **Soils on State Forest Lands**: 124
- **Soils Management Principle**: 126
- **Guidelines, Tools, and Resources**: 127
- **Monitoring**: 127
- **Critical Research Needs**: 127

### Geologic Resources

- **Geology and Landscapes**: 129
- **Unique Geologic Features**: 130
- **Geologic Resource Extraction**: 130
- **Oil and Gas Development**: 131
- **Geologic Resources Management Principle**: 141
- **Guidelines, Tools, and Resources**: 142
- **Monitoring**: 142
- **Critical Research Needs**: 142

### Wildland Fire

- **History of Wildland Fire in Pennsylvania**: 145
- **Wildfire Risk**: 146
- **The Effects of Fire in Pennsylvania**: 146
- **Wildfire Management**: 148
- **Prescribed Fire**: 149
- **Wildland Fire Management Principle**: 150
- **Guidelines, Tools, and Resources**: 151
- **Monitoring**: 151
- **Critical Research Needs**: 151

### Forest Health

- **Forest Insects and Disease**: 153
- **Invasive Plants**: 156
- **Other Forest Health Threats**: 159
- **Forest Health Management Principle**: 161
- **Guidelines, Tools, and Resources**: 162
- **Monitoring**: 164
- **Critical Research Needs**: 165

### Recreation

- **History of Recreation on State Forests**: 167
- **Recreation Opportunities**: 168
- **Recreation Experiences**: 174
- **Recreation Management Principle**: 179
- **Guidelines, Tools, and Resources**: 180
- **Monitoring**: 183
- **Critical Research Needs**: 183

### Infrastructure

- **Infrastructure Management**: 185
- **Infrastructure on State Forest Land**: 186
- **Infrastructure Management Principle**: 188
- **Guidelines, Tools, and Resources**: 189
- **Monitoring**: 189
- **Critical Research Needs**: 189

### Cultural and Historic Resources

- **Cultural and Historic Resources Management Principle**: 193
- **Guidelines, Tools, and Resources**: 193
The State Forest System

The state forest system of Pennsylvania, approximately 2.2 million acres of forest land in 48 of Pennsylvania’s 67 counties, comprises 13 percent of the forested area in the commonwealth. Pennsylvania’s state forest represents one of the largest expanses of public forest land in the eastern United States, making it a truly priceless public asset.

Pennsylvania’s state forests support the state’s wood products industry, which has roughly $11.5 billion in annual sales, overall total economic impact estimated at $19 billion, and employment of approximately 58,000 people. With the discovery of natural gas reserves beneath state forests, the forest lands also provide economic benefits to the commonwealth through leasing for natural gas development, supplying approximately $100 million in annual revenue from lease agreements and gas royalties, and additionally contributing to local communities.
When viewed from another perspective, the state forest represents a 2 million acre water treatment plant and air purification system. Additionally, these forests provide recreational opportunities and resources, as well as an aesthetic setting that is vital for Pennsylvania’s tourism industry. And, when taken as a whole, the state forest is the largest publicly owned habitat for plants and animals in the commonwealth of Pennsylvania. Our state forest system is a combination of these resources, uses, values, and more.

Pennsylvania’s state forests have been under formal management by the Bureau of Forestry (bureau) since 1955 with the development of State Forest Resource Management Plans (SFRMPs) that focused primarily on timber and water resources. These initial plans changed over time, with major revisions to incorporate new knowledge and reflect changing management philosophies. The 1970 plan brought the “multiple use” concept to state forest management. The 1985 plan evolved to “multiple resource management,” which recognized values and components of the forest as resources beyond economic use. In the 2003 plan, and its update in 2007, efforts evolved to an ecosystem management-based approach, with a goal of forest sustainability to provide an array of resources, uses, and values for current and future generations. This philosophy continues today in the bureau’s sixth planning generation and aims to balance and manage the many uses and values of the state forest system within the context of a healthy, diverse, functioning ecosystem.

**Purpose of the State Forest Resource Management Plan**

Perhaps now more than ever, thoughtful and deliberate planning is necessary to ensure the sustainability of the commonwealth’s state forest system. Society continues to place more demands on the forest system, while, at the same time, the system is under mounting pressure from increased recreational use; resource extraction; a host of invasive plants, insects, and diseases; the effects of a changing climate; and myriad influences that have affected its overall health. The state forests are remarkably healthy and resilient; however, to ensure their capacity to provide sustainable ecological, social, and economic resources into the future, the bureau must plan carefully how it manages the forest and balances its uses and values.

The SFRMP is the primary instrument that the bureau uses to plan, coordinate, and communicate its management of the state forest system. By relating the broad policies of the bureau’s strategic plan to focused goals and objectives and specific operational guidelines, the SFRMP lays the groundwork for ensuring that the overarching goal of state forest management — ensuring sustainability — is achieved.

The plan has two primary roles. First, it provides a framework for bureau staff to approach its work and make management decisions. The SFRMP provides important context and background to management issues and ensures continuity of knowledge and direction within the organization. While the plan provides goals and objectives, it is not a prescriptive manual. The SFRMP provides a framework for forest managers to make management decisions and professional judgments that ensure sustainability across the system as a whole.

The second and equally important role of the SFRMP is to communicate to stakeholders — the citizens of Pennsylvania, who are the owners of the state forest system — how their forest is being managed. The SFRMP helps facilitate a shared understanding of management approaches, context, and goals and objectives. By following a periodic revision cycle, the plan continues to evolve to account for changes in resource conditions and stakeholder values and expectations. The SFRMP is a continued reflection of this ongoing process that is necessary to ensure innovative and adaptive management to modern, complex forest resource management issues. Additionally, supporting resource plans and guidelines are developed continuously to provide tailored management for specific resources and operations.
Planning Foundations

Legal Authority

Pennsylvania Constitution
Article I, Section 27 of the Pennsylvania Constitution provides as follows:

Sec. 27. Natural Resources and the Public Estate
“The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic, and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the commonwealth shall conserve and maintain them for the benefit of all the people.”

Conservation and Natural Resources Act
The Department of Conservation and Natural Resources (DCNR) was created by the act of June 28, 1995 (P.L. 89, No. 18) (71 P.S. §§ 1340.101-1340.1103), known as the Conservation and Natural Resources Act. The act, which sometimes is referred to as Act 18, took effect on July 1, 1995.

The legal authorization for the establishment, use, and control of state forest land is contained in the Conservation and Natural Resources Act, Section 302.

The purpose of the act, as stated in § 1340.101, was to create a new department to serve as a cabinet-level advocate for our state parks, forests, rivers, trails, greenways, and community recreation and heritage conservation programs and to provide more focused management of the commonwealth’s recreation, natural, and river environments. The primary mission of DCNR is to maintain, improve, and preserve state parks; to manage state forest lands to assure their long-term health, sustainability, and economic use; to provide information on Pennsylvania’s ecological and geologic resources; and to administer grant and technical assistance programs that will benefit rivers conservation, trails and greenways, local recreation, regional heritage conservation, and environmental education programs across Pennsylvania.

Act 18 provided DCNR with a variety of powers and duties regarding state forest land, including the acquisition of new state forest land; sale of timber on state forest land; leasing of oil, gas, and mineral rights on state forest land; protection of all forest land in the commonwealth from forest fires, insects, and disease; and provision of advice and assistance to private forest landowners on forestry issues.

Wild Resource Conservation Act
Originally, the Wild Resource Conservation Act (WRCA) of June 23, 1982 (P.L. 597, No. 170) established a procedure for the conservation, classification, and protection of wild flora, and imposed that power on what was then the Department of Environmental Resources. Later, Act 18 conveyed the WRCA responsibilities onto the new DCNR. Pennsylvania Code Title 17 Chapter 45, the Conservation of Pennsylvania Native Wild Plants, is DCNR’s effort to carry out the responsibility of the WRCA. Since the DCNR Bureau of Forestry’s mission includes the conservation of native wild plants, the responsibility of implementing Chapter 45 and the WRCA has been the Bureau of Forestry’s role. Through this authority, the bureau cooperates with biologists and collects scientific information about plant species that may be of conservation concern and classifies them based
on their rarity throughout the state. This act also permits
the bureau to designate wild plant sanctuaries on state
and private lands and issue plant collection permits for
threatened, endangered, or vulnerable species.

**State Forest Rules and Regulations (Title 17 Pa. Code)**
Act 18 requires DCNR to adopt regulations to implement
the statutes it administers. Regulations that had been
adopted by the former Department of Environmental
Resources were renumbered to reflect the transfer of powers
and duties to the DCNR under Act 18.

Title 17 of the Pennsylvania Code contains the regulations
and statements of policy of DCNR. They are as follows:

Chapter 1. General Provisions
Chapter 15. Transfer or Exchange of State Park Land —
Statement of Policy
Chapter 17. State Park Natural Areas — Statement of Policy
Chapter 21. State Forests
Chapter 25. Transfer or Exchange of State Forest Land —
Statement of Policy
Chapter 27. State Forest Natural Areas — Statement of Policy
Chapter 29. Campsites — Statement of Policy
Chapter 41. Rivers Conservation — Statement of Policy
Chapter 43. Prevention of Railroad-Caused Forest Fires
Chapter 45. Conservation of Pennsylvania Native
Wild Plants
Chapter 47. Drilling Water Wells
Chapter 51. Snowmobile and All-Terrain Vehicle Registration
and Operation
Chapter 61. Land and Water Conservation Fund —
Statement of Policy

**Executive Orders**
Because DCNR is a cabinet-level agency under the
governor’s jurisdiction, executive orders are sometimes
used as a tool to implement management policies that affect
the state forest system. The bureau aims to implement
executive orders in a way consistent
with its mission.

Examples of executive orders currently in place include:

1990-7. Interagency River Island Task Force
2015-03. Leasing of State Forest and State Park Land for Oil
and Gas Development

**Bureau of Forestry Strategic Plan
and Mission Statement**
The bureau has a strategic plan — *Penn's Woods: Sustaining
our Forests* — to address the long-term sustainability of the
commonwealth’s forest resources. Penn’s Woods contains
overarching policies that guide state forest management. A
primary focus of the strategic plan is the recognition that
state forest management should be guided by an ecosystem
management approach, which is articulated in the bureau’s
mission statement:

The mission of the bureau is to ensure the long-term health,
viability, and productivity of the commonwealth’s forests
and to conserve native wild plants.

The bureau will accomplish this mission by:

- Managing state forests under sound ecosystem
  management, to retain their wild character and
  maintain biological diversity while providing pure water,
  opportunities for low-density recreation, habitats for forest
  plants and animals, sustained yields of quality timber, and
  environmentally sound utilization of mineral resources.
- Protecting forest lands, public and private, from
damage and/or destruction by fires, insects, diseases,
and other agents.
• Promoting forestry and the knowledge of forestry by advising and assisting other government agencies, communities, landowners, forest industry, and the general public in the wise stewardship and utilization of forest resources.

• Protecting and managing native wild flora resources by determining status, classifying, and conserving native wild plants.

Forest Sustainability: The Overarching Goal of State Forest Management

Based on the bureau’s mission statement, sustainability is the overarching goal of state forest management. Sustainability is a complex idea involving economic, environmental, and social factors. The term “forest sustainability” implies the continued existence and use of forests to meet human physical, economic, and social needs; the desire to preserve the health of forest ecosystems in perpetuity; and the preservation of options for future generations while meeting the needs of the present.

Sustainability concerns the interactions between humans and forests. Forests are defined as ecosystems dominated by trees, but with other components such as shrubs, herbs, mammals, birds, insects, microscopic creatures, soil, air, water, and the interactive processes that bind them together. The concept of sustainability incorporates the knowledge that forests play a major role in sustaining human health and welfare.

While sustainability is a concept that can have different meanings, the bureau relies on accepted indicators to gauge progress toward achieving it. The Montreal Process Working Group was formed in 1994 as an intergovernmental response to the pressing need for sustainable forest management. One of its first tasks was to develop and implement internationally agreed-upon criteria and indicators for the conservation and sustainable management of temperate and boreal forests.

To further refine the Montreal Process, the bureau cooperated with USDA Forest Service and the Northeast Area Association of State Foresters to develop a set of criteria and indicators that relate specifically to the temperate forests of the northeastern United States. The bureau uses these criteria and indicators to monitor, measure, and periodically report on progress toward sustainability.

State Forest Resource Management Plan: Principles, Goals, and Objectives

The SFRMP is comprised of several introductory chapters, followed by a series of 12 resource chapters that focus on the variety of resources, uses, and values of state forest land. The resource chapters are the following:

• Communications
• Timber and Forest Products
• Native Wild Plants
• Wildlife
• Water Resources
• Soils
• Geologic Resources
• Wildland Fire
• Forest Health
• Recreation
• Infrastructure
• Cultural Resources

Each resource chapter contains principles, goals, and objectives related to its respective topic. The role of the principles, goals, and objectives outlined in the SFRMP is to interpret how ecosystem management and sustainability are to be understood in the context of the state forest and to describe the directions and activities the bureau plans to undertake. Thus, the components of the SFRMP outline the “roadmap” to our vision for the future of the state forests.

Principles reflect the policies in Penn’s Woods, our strategic planning effort to address the issues of long-term
sustainability of our forest resources. They are general declarations that broadly describe values, understandings, paradigms, and operational mandates. While developed to provide a durable, long-term framework for planning and decision-making, principles will be assessed within each planning iteration based on their continued relevance or appropriateness under social, economic, and ecological considerations.

**Goals** break down the principle into manageable pieces. Goals are target future conditions to work toward. They are used to provide directions in which operations and resources can be focused. Goals provide “desirable destinations” to be reached if the general thrust of our policies and mission statement are to be realized. Goals also are designed to provide long-term relevance and guidance for the agency, though they too will be revisited, assessed, and revised as needed through the planning process.

Each goal is followed by **objectives**. Objectives are the attainable means to achieve a goal, stated so that they can be measured or evaluated over time. They provide specific guidance for management decisions that contribute most effectively to accomplishing their associated goal.

Objectives should be measurable and attainable. The development of actions to meet objectives specified in the plan is accomplished on the district level or within program areas. Assessment of objectives and the status of their attainment also is an integral part of the iterative planning process.

**Resource Management Conflicts**
While the SFRMP is a goal-driven plan, the bureau recognizes that not every goal or objective can be achieved in every instance. The limits of ecological systems; the diversity of public opinions and values; and the bureau’s mission and mandates sometimes can create situations where management goals conflict. In these cases, forest managers must use their professional judgment, weighing all of these considerations and also the state forest system as a whole. In many cases, management goals may conflict on one particular tract, but system-wide they can be accommodated and even complementary. In all cases, the bureau seeks to minimize management conflicts through public input, management planning, and stakeholder communications.
**Bureau of Forestry Guidelines**

Generally, guidelines are sets of recommendations, directives, and/or information put forth to assist in determining a correct course of action. They are offered as a tool to implement the bureau’s mission, goals, and objectives at an operational level and serve as an extension of the SFRMP. The bureau’s guidelines often are individually tailored to specific resources or operational activities, such as white-tailed deer guidelines or silviculture guidelines, so they frequently occur in independent documents. By existing separately, the guidelines can be updated and revised without changing the SFRMP, making the SFRMP more concise. One aim of the current SFRMP is to serve as a depot where one can reference and access the various bureau guiding documents. At the end of each chapter is a “Guidelines, Tools, and Resources” section where the relative chapter guidelines can be accessed easily.

**Organization and Management**

State forest management is administered through a cooperative effort involving field staff in 20 forest districts located throughout Pennsylvania and a Central Office located in Harrisburg.

**Forest Districts**

For the purposes of administering bureau programs on the ground, Pennsylvania is divided into 20 forest districts. Field operations in each forest district are supervised by a district forester and conducted by a staff that varies in size according to the specific circumstances found in the district.

Each district is responsible for protecting all forest land within the district from fire, destructive insects, and disease. The district staff promotes wild plant conservation and private forest land conservation and stewardship. The staff provides for the protection, administration, and management of state forest lands within the district.

<table>
<thead>
<tr>
<th>State Forest Name</th>
<th>District</th>
<th>Acreage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michaux</td>
<td>1</td>
<td>86,642</td>
</tr>
<tr>
<td>Buchanan</td>
<td>2</td>
<td>71,753</td>
</tr>
<tr>
<td>Tuscarora</td>
<td>3</td>
<td>96,054</td>
</tr>
<tr>
<td>Forbes</td>
<td>4</td>
<td>59,613</td>
</tr>
<tr>
<td>Rothrock</td>
<td>5</td>
<td>96,249</td>
</tr>
<tr>
<td>Galitzin</td>
<td>6</td>
<td>24,437</td>
</tr>
<tr>
<td>Bald Eagle</td>
<td>7</td>
<td>193,813</td>
</tr>
<tr>
<td>Clear Creek</td>
<td>8</td>
<td>16,122</td>
</tr>
<tr>
<td>Moshannon</td>
<td>9</td>
<td>190,040</td>
</tr>
<tr>
<td>Sproul</td>
<td>10</td>
<td>307,139</td>
</tr>
<tr>
<td>Pinchot</td>
<td>11</td>
<td>41,664</td>
</tr>
<tr>
<td>Tiadghton</td>
<td>12</td>
<td>146,703</td>
</tr>
<tr>
<td>Elk</td>
<td>13</td>
<td>218,261</td>
</tr>
<tr>
<td>Corplanter</td>
<td>14</td>
<td>1,490</td>
</tr>
<tr>
<td>Susquehannock</td>
<td>15</td>
<td>260,223</td>
</tr>
<tr>
<td>Tioga</td>
<td>16</td>
<td>161,891</td>
</tr>
<tr>
<td>William Penn</td>
<td>17</td>
<td>1,429</td>
</tr>
<tr>
<td>Weiser</td>
<td>18</td>
<td>28,112</td>
</tr>
<tr>
<td>Delaware</td>
<td>19</td>
<td>83,519</td>
</tr>
<tr>
<td>Loyalsock</td>
<td>20</td>
<td>114,516</td>
</tr>
</tbody>
</table>

**Penn Nursery**

The bureau operates a field nursery that is responsible for the production of forest tree seedlings, as well as signs and picnic tables for use on state forest and park lands.

Forest districts normally are staffed by a varying complement including a district forester, assistant district foresters, foresters, forest rangers, administrative assistants, clerical support, and maintenance positions.
Central Office

Central Office includes the Director (State Forester), three Assistant Directors, and eight Program Areas. Central office staff provide state-wide leadership on bureau policies and management and also provide direction, support, and technical assistance to the Forest Districts.

State Forester’s Office

The State Forester’s Office coordinates the overall operations of the bureau, including budgeting and program direction. Forest resource planning also is housed within this office. The State Forester’s Office is overseen by the director of the Bureau of Forestry, also known as the state forester. The state forester directs the planning, development, implementation, coordination, and evaluations of commonwealth-wide forestry programs. These include management of the 2.2 million acres of state forest land for a continuous supply of timber, clean water, low-density recreation, and environmentally sound utilization of

Figure 1. Map of state forest districts.

Figure 2. Typical Forest District structure.
mineral resources. This position also is responsible for management of the native wild plant program; providing technical assistance to private forest landowners, local governments, and forest industry; and the protection of all forests from fire, insect, and disease. The state forester serves as an advocate for responsible forest stewardship and conservation on a local, national, and international basis.

The state forester’s office is divided into five basic administrative units under the state forester’s direction: Resource Planning and Information, Forestry Services, Community and Private Forest Stewardship, Forest Resources, and Business Services.

**Resource Planning and Information Division**

The Resource Planning & Information Division acts as staff support to the executive office of the bureau (state forester and assistant state foresters). The division is responsible for several efforts that cross program areas, including planning, policy development, GIS support, inventory and monitoring, and information/communication coordination. The division is responsible for developing and maintaining comprehensive resource inventories and management plans for each of the 20 state forest districts in cooperation with the district managers and other program areas. The division also coordinates strategic planning efforts and special projects such as Forest Stewardship Council certification, the shale-gas monitoring program, and Ecosystem Management Advisory Committee facilitation. The division is responsible for administering the bureau’s land acquisition program, natural and wild area designations, high conservation value forest planning, GIS systems, and information and communication efforts. The division is comprised of four sections: the Forest Resource Planning Section, the Inventory and Monitoring Section, the Geospatial Applications Section, and the Communications Section.

**Silviculture Section**

The Silviculture Section administers the silviculture and timber management programs on the 2.2 million acres of state forest land, including developing silviculture and timber management guidelines and procedures, training field foresters, monitoring all silviculture treatments and timber sale activities, and processing all timber sale contracts and receipts. The section also is responsible for the regeneration program on state forest land, including the allocation and disbursement of regeneration funds. The section also provides silvicultural and timber management assistance to other state agencies on lands under their jurisdiction, when requested.
Minerals Division
The Minerals Division is responsible for administering the management of geologic resources on state forest and park lands and under navigable waters owned by the commonwealth. Geologic resources include oil, natural gas, groundwater, coal, and other hard minerals. The division performs evaluations of these resources, as well as managing the leasing, exploration, and production activities of lessees and operators and managing industry activity on commonwealth lands where the commonwealth does not own the subsurface rights. It also manages water well drilling programs on these lands and land reclamation projects relating to geologic resource extraction. The division provides fiscal accountability for all moneys received as a result of lease rentals and royalty payments. The Minerals Division is comprised of two sections: the Oil and Gas Lease Management Section and the Oil, Gas, and Minerals Program Administration Section.

Conservation Science and Ecological Resources Division
The Conservation Science and Ecological Resources Division administers DCNR's native wild plant management program, including status determination (endangered, threatened, etc.) for plant species within the commonwealth, administering the Wild Resource Conservation Program, and providing leadership in the Pennsylvania Natural Heritage Program. The division also administers and coordinates the activities of the Pennsylvania Natural Diversity Inventory (PNDI) with respect to DCNR and inter-departmental use in cooperation with the Western Pennsylvania Conservancy. The division is responsible for fauna and flora habitat efforts on state forest lands and for ecological community classification. The division provides for, or conducts, training for field staff on ecological resources in Pennsylvania. The division is comprised of two sections: the Ecological Services Section and the Natural Heritage Section.

Division of Forest Fire Protection
The Division of Forest Fire Protection is responsible for preventing and suppressing wildfire and reviewing/regulating prescribed fire planning efforts on the 17 million acres of wild land throughout the commonwealth. The division maintains a fire detection system and works with fire wardens and volunteer fire departments to ensure that they are trained in the latest advances in fire prevention and suppression. The division also enters into partnerships with other state and federal agencies to share knowledge and resources. With the passing of the Prescribed Burning Practices Act in 2009, the division also determines necessary qualifications for prescribed burning activities and reviews prescribed fire burn plans submitted by various agencies or landowners. The division is comprised of two sections: the Wildfire Operations and Planning Section and the Logistics and Finance Section.

Division of Operations and Recreation
The Division of Operations and Recreation is responsible for the development and maintenance of all bureau infrastructure, including allocation/management of systems and equipment needs (information technology), state forest recreation, and administration of state forest roads, trails, and structures. The division also is responsible for recreation-related activities, including safety and volunteer programs and the DCNR ranger program. The division plays a key role in supporting and facilitating efficient approaches to infrastructure development and administration on state forest land, including road maintenance, administration right-of-way agreements, managing the camp lease program, and planning and maintaining a suite of recreational opportunities and experiences for state forest users. Major programs also include the volunteer program, snowmobile/ATV safety program, snowmobile/ATV accident reporting, and search and rescue. The division is comprised of two sections: the Recreation Section and the Operations Section.
Division of Forest Health

The Division of Forest Health is tasked with protecting forest resources from damage-causing agents to ensure the long-term health of the commonwealth’s forest ecosystems and state forest land. Created in the early 1970s in response to the gypsy moth, the division has expanded its role over the years to encompass many other forest health programs. This division currently seeks to safely promote healthy forest ecosystems by implementing monitoring programs that survey for damage-causing events and associated pest and disease activities, and provide tree mortality assessments. These activities serve as a basis to implement management actions that reduce, suppress, or regulate a particular damage-causing agent or complex of stressors that pose a significant risk to forest ecosystems. The division is comprised of two sections: the Field Operations Section and the Program Services and Support Section.

Rural & Community Forestry Section

The Rural & Community Forestry Section provides professional forestry leadership and technical assistance promoting forestry and the knowledge of forestry by advising and assisting other government agencies, communities, landowners, forest industry, and the general public in the wise stewardship and utilization of forest resources. The section also provides professional forestry leadership and technical assistance to rural communities and urban areas. Efforts include coordination with Penn State’s regional urban foresters, Arbor Day activities, Tree City USA, Penn ReLeaf, the Harrisburg Greenbelt project, municipal tree restoration program and the Urban & Community Forestry Council.

Ecosystem and Landscape Management Considerations

Introduction

Ecosystem Management

According to the bureau's strategic plan, “Ecosystem management concepts and principles will serve as the fundamental basis for the sustainable management of state forest lands” (Penn's Woods 1995).

Throughout recent history, the approach to forest management in Pennsylvania has shifted from restoration to resource extraction to multiple resource management. A detailed historical account of the bureau’s development as an agency and its dynamic approach to managing Pennsylvania’s changing landscape conditions can be found in The Legacy of Penn's Woods: A History of the Pennsylvania Bureau of Forestry, 1895-1995.

In the early 2000s, the bureau shifted its overall approach to ecosystem management. Ecosystem management can be defined as a holistic approach to resource management where the interdependency of biological and non-biological systems and cycles is the focus. Humans are part of the ecosystem and must be taken into consideration when developing management strategies. Ecosystem management does not preclude resource use, such as timber harvesting,
hunting, or other recreational activities. Forests provide human goods and experiences, ranging from recreation to peace and solitude. Maintaining Pennsylvania’s environmental heritage and values relies on employing a management strategy geared toward sustaining the long-term health and productivity of forested ecosystems.

Ecosystem management is the implementation of practices that promote the long-term health of the forest ecosystem as measured by important ecological indicators. The monitoring of these indicators is the means by which successful management is measured. In general, the objectives of ecosystem management are met when monitoring demonstrates that measurable indicators of ecological health are stable or improving, allowing for natural ecosystem dynamics. The application of ecosystem management should guarantee that the pursuit of resource management objectives (e.g., silviculture, recreation, infrastructure development, etc.) is carried out in a manner that is compatible with the long-term ecological health of the total forest ecosystem.

Because the implementation of ecosystem management principles required a new set of technical and analytical skills and a shift in attitudes and understandings on the part of both managers and the public, key management strategies were developed in order to facilitate this transition. Critical components of these strategies included the development of ecological-based management units on several levels and the plant community classification system, which together continue to provide spatial information and maps necessary to shift to ecological-based management. The forthcoming sections of this plan describe the process by which ecosystem management is applied as the guiding principle for state forest management.

**A Landscape Approach to Forest Ecosystem Management**

Coordinated management at a landscape level, which sometimes considers various ownerships, is essential for implementing ecosystem management. Landscapes can be considered mosaics of interacting communities or ecosystems. Landscape patterns change in time and space, reflecting impact of human activity upon the system, as well as natural changes. Understanding the changes that occur and properly managing for the accommodation of them are challenging efforts that require partnerships between resource agencies and the public. Ecosystem management at a landscape level is the strategy that best ensures that the sustainability of forest systems can be maintained while providing benefits to society. This approach was elucidated in a white paper by Dan Devlin, et al. entitled: *Use of Landtype Associations and Landforms in Managing Pennsylvania’s State Forests*.

The bureau takes a “landscape approach” to ensure ecological health, the sustainability of the full suite of forest values, and the integration and coordination of management activities across the state forest system. Landscape management is both a philosophy and a practice. Effective landscape management can have many components and dimensions. The bureau manages large tracts of forest land and considers how management activities affect land in the larger context. Landscapes, however, can occur at multiple scales, depending on the value or resource being considered. There is also a temporal aspect to landscapes — the dynamics that occur in a forest through time. Landscape management involves a strong spatial component in the relationship, distribution, and patterns of resources, ecological features, and management activities across the landscape.

Perhaps the most important aspects of landscape management are the philosophical underpinnings that inform an approach to forest management which recognizes the greater context of forest resources and accompanying management activities. This philosophy drives forest managers to consider fundamental questions when approaching resource management that go beyond the forest stand level. Some questions and considerations include: What function and role does it play in the greater ecosystem? What resources and values does it contain and
how can they be managed to improve the greater landscape? What management activities and/or resources does this tract lend itself to? How do surrounding management activities and features affect this tract? How can it contribute to ecological or social goals at a larger scale? Considering these questions is essential to effective landscape-level management and ultimately to achieving ecosystem management goals.

This landscape approach also supports and complements DCNR’s agency-wide Conservation Landscape Program, a place-based strategy for natural resource stewardship and advocacy in some key landscapes across the state. It involves a partnership approach to getting work done at a regional level and coordinated resource deployment by DCNR staff. The Conservation Landscape Program has the following shared core principles: natural resource conservation, community revitalization, and civic engagement. Work is currently underway in seven Conservation Landscapes throughout the state: Pennsylvania Wilds, Lehigh Valley Greenways, Susquehanna Riverlands, Laurel Highlands, South Mountain, Schuylkill Highlands and Pocono Forest and Waters.

**Biodiversity Conservation**

A key element in maintaining ecosystem integrity, viability, and resilience is the conservation of biological diversity. Biological diversity, also known as biodiversity, is the variety and abundance of species, their genetic composition, and the communities and ecosystems in which they occur. Biodiversity serves as an indicator for the health of ecosystems on which we depend.

Habitat diversity reflects the health of an ecosystem, as intact habitats with well-functioning ecological processes generally have a higher diversity of native plants and animals. When a habitat is impacted by poor management (e.g., fragmentation, overexploitation, invasive species), the diversity of native species typically declines, as does ecosystem function as nutrient and energy cycling and other processes are disrupted. The maintenance of healthy ecosystems (and native plant and animal diversity) directly supports the bureau’s ecosystem management philosophy.

State forest lands contain a wide variety of habitats, including nearly all of the 127 different plant community types found in Pennsylvania. While the majority of forest products harvested on state forest lands are derived from about 10 forest plant community or stand types, the other 117 plant community types contribute to majority of biodiversity to state forest lands, reflecting species and communities adapted to a diverse range of soils, geology, hydrology, topography, and ecoregion. Many communities are protected and conserved through the designation of wild and natural areas as well as high conservation value forest areas. Biodiversity also is protected and enhanced through the application of management guidelines for activities on state forest lands.

Managing state forest lands for biodiversity requires the cooperation of a broad and diverse group of resource management agencies and the support of the public. In Pennsylvania, management of the various species is divided among the Game Commission, the Fish and Boat Commission, and the Department of Conservation and Natural Resources. Due to the diverse authority and mandates for species management and ownership of ecosystems, cooperation and coordination are critical to success.

The bureau’s commitment to ecosystem management requires that biodiversity considerations be built into all aspects of management on state forest land. Maintenance of biodiversity requires a thorough inventory of species diversity (common as well as rare, threatened, and endangered species) on state forest lands, allowing for the identification of sensitive, unique, and high biodiversity areas. Management activities in these areas should promote and enhance the conservation of biodiversity. Also, information gained through biodiversity inventory efforts can guide the restoration of impaired and degraded habitats (e.g. abandoned mine lands and fire-adapted habitats impacted by prolonged fire suppression).
Biodiversity Goal and Objectives

<table>
<thead>
<tr>
<th>Goal</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To conserve or enhance eco-regional biological diversity through the management of state forest lands.</td>
<td>1.1 Coordinate inventories of endangered, threatened, rare, and unique species and communities on state forest lands, in coordination with the efforts of Pennsylvania Natural Heritage Program (PNHP), PA Game Commission, PA Fish and Boat Commission and the bureau’s inventory and monitoring staff.</td>
</tr>
<tr>
<td></td>
<td>1.2 Consider the conservation of biological diversity on state forest lands during land management decisions.</td>
</tr>
<tr>
<td></td>
<td>1.3 Assess forest management and/or activities resulting in disturbance for impacts to biodiversity. Tools such as the Pennsylvania Natural Diversity Inventory (PNDI) Conservation Planning and Environmental Review tool, PNHP inventories, and state forest land inventories should be consulted prior to the activity.</td>
</tr>
<tr>
<td></td>
<td>1.4 Promote the conservation of biological diversity through land acquisitions and designation of wild and natural areas, high conservation value forests, special management areas, and public plant sanctuaries on state forest land.</td>
</tr>
<tr>
<td></td>
<td>1.5 Encourage natural regeneration and promote the use of suitable native plants and animals for any management activity on state forest lands.</td>
</tr>
<tr>
<td></td>
<td>1.6 Consider the importance of genetics in management on state forest lands.</td>
</tr>
</tbody>
</table>

Fragmentation and Connectivity

The state forest system accounts for 13 percent of Pennsylvania’s forested land, providing a core zone of forest and a critical link in maintaining the connectivity of the commonwealth’s forests in several regions of the state. Looking past the commonwealth’s borders, north-central state forest lands partially comprise the largest continuous block of forest in the northeastern United States. As development pressure in some regions of the state increases, state forest lands maintain consistent forest habitat and ecosystem function on over 2.2 million acres. One important consideration when overseeing such a land base is minimizing and managing the potential effects due to forest loss and forest fragmentation in order to maintain the health, viability, and ecosystem function of forest habitats.

Forest fragmentation can be described as a process by which a continuous forest is converted to non-forest or becomes separated into smaller or more isolated forest patches (Halia, 1999). These disturbances can be natural (e.g. forest fire, windfall, or flooding) or man-made (e.g. land clearing, road construction, or residential development) in origin. Disturbances, whether natural or man-made, can vary in scale and intensity. The consequences of a fragmented forest vary by scale, species, and forest community type, but generally are due to one or more of the following: reduction or change in forest area (forest loss), increased vulnerability of smaller forest patches to further disturbance and degradation (edge effects), or increasing separation between forested areas (loss of connectivity).
When evaluating the ecological consequences of forest fragmentation, a species-specific approach is often necessary to assess habitat implications. Many species of plants and wildlife prefer early successional habitat or edge habitat. Similarly, if a disturbance fragments a late-successional forest, this can reduce connectivity; however, the disturbance could also create a mosaic of early- and late-successional forest across a landscape, leading to an overall gain in species richness.

**Forest Loss**

Fragmentation due to forest loss can significantly alter a landscape and further degrade remaining forests. True forest loss often means human-induced conversion of forested land into a non-forested situation, including but not limited to agricultural fields, residential development, or other human land uses, often leading to arrested succession and the loss of ecological function. Due to the abrupt change in land use, the dramatic loss of nearly all habitat functions often is permanent, disrupting wildlife populations and native plant communities.

**Forest Connectivity**

Alteration of forested areas can merely intersperse mature forest blocks with younger, viable, newly disturbed forest, or can result in isolated forest patches within zones of non-forest land. For some species, the loss of connectivity between forest habitats can result in a reduction of local genetic diversity within a now isolated forest habitat. As isolated forest “patches” and core forests are further fragmented by non-forest, remaining patches become more susceptible to invasion by exotic species and pathogens due to increased forest edge. However, if a species’ population is able to succeed in an isolated habitat, in an evolutionary context, this eventually can result in new adaptations and, in some cases over time, divergence into a new subspecies of plant or animal.

**Forest Edge**

Disturbance and fragmentation, whether human or natural in origin, lead to an increase in forest edge habitat. The portions of remaining forest that form the edges of the undisturbed patch invariably are changed and can differ structurally and ecologically from undisturbed interior portions of the remaining forest. Edge effects due to fragmentation often create conditions that can become unsuitable for species that once utilized the interior forest habitat. At times these edge effects have been shown to increase plant species richness at the forest edge; however, often associated with this gain in early-successional, disturbance-tolerant plants are non-native, invasive plant species such as garlic mustard or honeysuckles. The effects of forest edge on wildlife vary depending on the species and its relative location in the food chain. Some species of songbirds prefer the thick shrub vegetation that often forms along forest edges. However, prey may be easier for some predators to hunt along a forest edge than in interior forest.

**Forest Mosaics**

Mature core forest, early successional forest, forest edge habitat, and areas of non-forest taken together form a complex pattern of forest mosaics at the larger, landscape level. This mosaic can take on a uniform appearance when made up predominantly of mature, undisturbed core forest; can appear dissected or perforated by disturbances; or can be made up of smaller forest patches surrounding disturbed areas. Patches appear on the landscape as a result of disturbance (natural or human) or environmental conditions (e.g., substrate, slope, elevation, aspect) which add variety to composition of forest types across the landscape. Timber harvesting is a man-made disturbance that can impact mature forest habitat; however, managers ensure that harvesting results in early successional habitat by mimicking natural disturbances and plan these young forests to promote a mosaic of habitats across the landscape. Creating and managing for a mosaic of forest habitat sizes and types allows for a larger variety of habitats, which can be utilized by more species and increase biodiversity and
1. Forest fragmentation, connectivity, and patch distribution will be considered in management decisions affecting state forest resources.

<table>
<thead>
<tr>
<th>Goal</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Minimize permanent conversion from forest to non-forest.</td>
<td>1.2 Minimize forest fragmentation.</td>
</tr>
<tr>
<td>1.3 Improve edge habitat to provide benefits for native wildlife species and to mitigate edge effects.</td>
<td>1.4 Use a landscape-level planning approach to encourage a mosaic of diverse forest habitats and patch sizes.</td>
</tr>
<tr>
<td>1.5 Develop guidelines regarding patch management and connectivity.</td>
<td>1.6 Maintain or improve connectivity and fluid corridors of high-canopy forests and other diverse forest habitats.</td>
</tr>
<tr>
<td>1.7 Use wild and natural areas, limited resource and special resource, and buffer management zones to maintain and promote connectivity and corridors of high-canopy forests.</td>
<td>1.8 Use Supra Management Areas to maintain and promote areas of core forest.</td>
</tr>
</tbody>
</table>

available ecosystem services across a larger landscape. The rates and magnitudes of ecological processes, such as the flow of energy and nutrients and the movements of plants and animals, are likely to change at the interface between core forests, patches, edges, and differing forest community types.

**Climate Change**

In Pennsylvania, the average yearly temperature has risen 1 degree Celsius since the 1960s, with a net increase of 1.3 degrees Celsius in the last century, and much of this warming trend has been attributed to greenhouse gas emissions ([2013 Pennsylvania Climate Impacts Assessment Update](#)). Recent research predicts a warming of 3 degrees Celsius between 2000 and 2050 ([2015 Pennsylvania Climate Impacts Assessment Update](#)). Additionally, the U.S. Department of Agriculture has shifted growth zones for the United States; parts of Pennsylvania have moved from Zone 6 to Zone 7, similar to Tennessee and Virginia.

**Impacts to Forests**

Climate change likely will cause many changes to Pennsylvania’s forests. First, the state will become increasingly unsuitable for many of the trees species that are now present, especially those generally associated with northern hardwood ecosystems. Northern species such as paper birch, quaking aspen, bigtooth aspen, and yellow birch are projected to be extirpated in the state under high-emissions scenarios, and greatly reduced, if not eliminated, even under low-emissions scenarios (Iverson et al, 2008). Other species, including American beech, black cherry, striped maple, eastern hemlock, red maple, sugar maple, eastern white pine, sweet birch, white ash, and American basswood, are projected to find increasingly less suitable...
habitat in the state and will likely decline in numbers. In general, the state is projected to become increasingly hospitable for more southern species such as oaks and hickories, although the state’s two most common oaks, northern red oak and chestnut oak, are projected to decline under the high-emissions scenarios. The state also will become increasingly suitable for some species that are currently rare or not present in the state, such as loblolly and shortleaf pines, common persimmon, and red mulberry.

The warming climate will cause susceptible species to become increasingly stressed, and their mortality rates will increase and their regeneration success will decline, resulting in declining populations in the state. The increasing stress due to climate change also will make some species more susceptible to a host of other stressors, including atmospheric deposition and both native and non-native insects and diseases. Tree mortality could rise due to these secondary impacts, and it may be difficult to attribute these changes directly to a changing climate. Tree mortality could also increase if climate change increases the frequency of severe storms, and fires may become more common as temperatures rise. Some studies suggest that the longer growing season, warmer temperatures, possibly higher rainfall, and a phenomenon termed “CO2 fertilization” will increase overall forest growth rates in the state. However, these effects likely will be offset by increased mortality rates, at least until the climate stabilizes and the mix of tree species in the state is once again in a more stable equilibrium with the state’s climate.

The Role of Forests in Mitigating Climate Change

Despite the potential impacts of climate change on forest ecosystems, forests and their soils can play a role in mitigating factors causing climate change. They represent one of the largest terrestrial pools of carbon and actively sequester carbon from the atmosphere. With active management, it is possible to increase the rate at which carbon is sequestered.

The state forest system is an important reservoir for both storing carbon and sequestering it from the atmosphere. In 2015, state forests are estimated to sequester 4.7 million tons of carbon, while storing (above ground) approximately 143 million tons. Managing the state forest sustainably — protecting it from threats and mortality, promoting productivity, ensuring adequate regeneration, and limiting forest conversion — contributes to carbon sequestration and storage and provides society a valuable service in mitigating the impacts of climate change.

Developing Management Strategies

The development of practical conservation measures and adaptation strategies that address stresses and improve forest resilience will likely provide the most effective approach to retaining healthy forest ecosystems while addressing climate change on state forest lands. Climate change is just one of the many influences on the forest the bureau must account for. Likewise, climate change mitigation, primarily through carbon storage and sequestration, is yet another increasingly valuable service to society that the bureau must consider and provide in its management.

While specific guidelines for forest management in response to climate change still need to be investigated and developed, many existing ecosystem management practices contribute to healthy forests that can resist and adapt to the stresses of climate change. Because these practices also promote other goals and benefits, they are relatively “low risk” practices to emphasize. Some of these management practices and strategies include:

- Protecting the forest from severe mortality events, such as insect and disease outbreaks.
- Promoting forest health, growth, and productivity.
- Maintaining and enhancing community, species, and genetic diversity.
- Improving forest connectivity and limiting fragmentation.
- Limiting forest conversion and restoring unproductive sites to tree cover.
- Acquiring key tracts of land to improve forest connectivity and limit forest loss.
• Ensuring diverse and rigorous regeneration following timber harvests and natural mortality events.
• Promoting a vibrant wood products economy to facilitate management activities while providing for long-term carbon storage in durable wood products.

**Pennsylvania’s Climate Change Action Plan**

In response to the developing threat of a changing climate, Pennsylvania passed the Climate Change Act (Title 71 P.S. 1361.1-1361.8) in 2008, which provided for an assessment and action plan regarding potential climate change impacts, and established the Climate Change Advisory Committee. This committee consists of 18 members including the DCNR secretary and is constructed to reflect a diverse set of viewpoints. The Department of Environmental Protection (DEP) composed the first Climate Change Action Plan in 2009 (updated in 2013) and is responsible for compiling an inventory of greenhouse gases.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To consider the current and future impacts of climate change to the state forest system.</td>
<td>1.1 Cooperate with partners and stakeholders in statewide, regional, and national efforts to assess climate change impacts and develop management strategies.</td>
</tr>
<tr>
<td></td>
<td>1.2 Develop best management practices for addressing climate change on state forest lands.</td>
</tr>
<tr>
<td></td>
<td>1.3 Incorporate climate change and forest resiliency characteristics in long-term planning efforts and state forest land acquisition strategies.</td>
</tr>
<tr>
<td></td>
<td>1.4 Monitor the health and productivity of the forest to identify and detect the effects of climate change.</td>
</tr>
<tr>
<td></td>
<td>1.5 Monitor changes in plant community and tree species distributions.</td>
</tr>
<tr>
<td></td>
<td>1.6 Support research to better predict the impacts of climate change to the state’s forests.</td>
</tr>
<tr>
<td>2. Maintain and enhance the carbon storage and sequestration capacity of the state forest system.</td>
<td>2.1 Manage for healthy, resilient forests with a high degree of biodiversity.</td>
</tr>
<tr>
<td></td>
<td>2.2 Protect the forest from severe mortality events.</td>
</tr>
<tr>
<td></td>
<td>2.3 Ensure the economic viability of state forest timber resources.</td>
</tr>
<tr>
<td></td>
<td>2.4 Maintain and enhance forest productivity.</td>
</tr>
<tr>
<td></td>
<td>2.5 Cooperate with efforts to research, assess, quantify, and improve forest carbon storage and sequestration capacities.</td>
</tr>
</tbody>
</table>
Wild Character

Because of their size, location, and rugged terrain, state forests offer some of the best opportunities to experience remote, backcountry recreation and to enjoy the forest in a natural, undisturbed setting. The bureau manages the wild character of the state forest to accomplish part of its mission to conserve forests in Pennsylvania. Wild character can be defined by both physical factors, such as remoteness and primitiveness, and subjective experiences, such as peace and tranquility. Wild character commonly relates to the quality of experience for state forest visitors with regard to scenic beauty, feeling of solitude, sense of remoteness, and the undeveloped and aesthetic nature of the state forest system.

Wild character is a concept that has different meanings to different people. To a backcountry camper, wild character could mean having large expanses of open, undisturbed forest to experience along a narrow hiking trail. To those seeking scenic drives, it could mean experiencing a relatively intact canopy over forest roads through the state forests. Yet to others, it could simply mean that the forest is characterized by little permanent human development.

The bureau recognizes wild character as a value state forest lands provide to visitors and strives to retain wild character while managing the forest. Some components of wild character the bureau considers are scenic viewsheds, aesthetic buffers, and noise impacts. The bureau also carefully considers signage and building colors to minimize impact to the primitive character of state forests. Since the perception of wild character can be subjective, direct measurements are difficult.

Recreation Opportunity Spectrum

The bureau uses the Recreation Opportunity Spectrum (ROS), an inventory system developed by the U.S. Forest Service, to characterize land by types of recreation experiences. The bureau utilizes ROS to make and communicate management decisions that are transparent, credible, and compatible with other state forest management goals.

ROS builds on the premise that people expect certain types of recreational experiences on public land, and that land managers should be able to direct people to appropriate places for those experiences. ROS allows land managers to provide recreational opportunities across a spectrum, or continuum, of five land-use classes so that the user may find satisfying recreational experiences in a variety of recreational activities.

The ROS land-use classes follow a continuum from “primitive” to “developed” and managers can use changes in the acreages associated with each class as a measure of wild character.
Land managers can use ROS as a long-term planning tool to guide management activities to provide a balance of experiences. State forests generally are managed to maintain the conditions that define each ROS land-use class or increase the primitive acreage, but not to increase developed acreage. Temporary activities may affect the condition of the forest, but do not change the ROS land-use class, such as temporary roads used in timber harvesting. Permanent impacts can change ROS classes, such as new roads or buildings. Closing a road or restoring a developed area can change ROS classes back to a more primitive classification.

The primitive classification itself does not define wild character but does tend to provide experiences that are more of a backcountry nature. Visitors also can find wild character in areas classified as semi-primitive and semi-developed, depending on the user’s perception. ROS is primarily a measure of primitiveness or remoteness, which are considerations of wild character. However, an area that is not primitive or remote can still offer wild character. A traditional state forest road is not considered primitive or remote, but the narrow shoulders and closed forest canopy offer more wild character than a wide road with no tree canopy.

**Viewsheds and Vistas**

Scenic driving is one of the most popular uses of state forest lands. Most recreational users participate in this activity coming to and from the state forest, but for many this is the sole purpose of their visit. Viewsheds and vistas are an important consideration when managing scenic driving and all public recreation use.

Viewsheds are the portion of the landscape that can be viewed from a given location. They include the viewable landscape along transportation corridors and areas of visual importance near high-use areas in state forests or state parks where visitors congregate and spend considerable time recreating (e.g., a hill in close view of a high-use picnic or swimming area or along scenic drives). Impact to public use is considered carefully when managing the forest in heavily visited viewsheds.

In 2008 in areas leased for gas development, the bureau identified scenic viewshed “Areas of Special Consideration.” State forest trails, rivers, and major roads were identified to prevent disruption of scenic viewsheds.

Vistas have been established to provide views into or through the forest to unusual or attractive features of the landscape. Current vistas are maintained, while new opportunities to create vistas are considered. Careful consideration must be given to the creation of barriers and parking areas to alleviate safety hazards and maintenance problems. The size of the vista, parking area, and need for signage and naming are also carefully considered.

**Aesthetic buffers**

State forests are actively managed for many uses and values. Buffers are used to avoid, minimize, and mitigate the impacts of one use on another. These forest buffers strive to maintain forest aesthetics and help maintain wild character in actively managed forests. Reasons for zoning areas as buffers include aesthetics, water, or resource protection. The bureau may choose not to utilize aesthetic buffers in favor of other forest values such as fragmentation or forest regeneration. Some buffers are “no management zones,” and others require that at least a partial canopy be maintained. The bureau maintains various guidelines with aesthetic buffers and their management constraints.
Adjoining Land Strategy
The development of an ecosystem management approach to state forest management involves looking beyond the borders of the state forests. The bureau incorporates adjacent land in the formulation of landscape, ecoregion, and state forest goals.

In the bureau’s landscape management approach, every landscape management unit requires consideration of the surrounding lands. Management of the state forest affects the surrounding landscape, and the state forest is affected by the surrounding landscape. Landscape-level decisions must consider the impact to and from surrounding lands. The bureau’s management of wildfire, damaging insects and disease, and invasive species on state forest land are most likely to affect adjacent lands. In addition, the bureau can consider aesthetic impacts and buffers of adjacent land in all management activities. The effects of adjacent lands on forest fragmentation and connectivity should be evaluated as well.

State forests often border lands owned or managed by other agencies such as state parks, state game lands, county or municipal lands, easements, or other private nonprofit organizations. While the mission or priorities of land managers may differ, there often are opportunities for cooperation that provide mutual benefit to each entity and the resource.

The bureau should provide information to interested adjoining landowners regarding landscape-scale resources and opportunities. Coordination with willing adjoining landowners may result in the development of joint landscape plans. Service foresters that work for the bureau can provide adjacent landowners with advice and guidance on how to manage their forested lands in concert with state forest lands.

When possible, the bureau permits access through state forest land to adjacent lands and inholdings. The bureau
Adjoining Lands Goal and Objectives

<table>
<thead>
<tr>
<th>Goal</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To implement strategies to address interactions between state forests and adjacent lands.</td>
<td>1.1 Conduct landscape-level planning that includes consideration of adjacent lands.</td>
</tr>
<tr>
<td></td>
<td>1.2 Consider impacts of adjacent lands on state forest uses and values, such as aesthetics, fragmentation, and invasive species infestations.</td>
</tr>
<tr>
<td></td>
<td>1.3 Consider effects of state forest land management on the surrounding landscape.</td>
</tr>
<tr>
<td></td>
<td>1.4 Provide advice and guidance on forest management to adjacent landowners.</td>
</tr>
<tr>
<td></td>
<td>1.5 Cooperate with adjacent landowners regarding administrative and recreational access.</td>
</tr>
</tbody>
</table>

may also cooperate to site portions of state forest trails on adjacent lands. A letter of mutual understanding may be issued to document a formal long-term agreement and to establish maintenance on private land trails.

Recognizing that state forest lands affect adjacent lands, the bureau strives to be a good neighbor. For easy identification, state forest boundaries are tagged and painted white, with the paint facing the boundary.

**Acquisitions Strategy**

One of the bureau’s greatest assets is its land base. For more than 100 years, the commonwealth has been acquiring lands to be held and managed as state forests. As called for in Penn’s Woods, the bureau continues to strategically acquire lands to add to the state forest system. New acquisitions meet one or more of the following priorities:

- Interior holdings or deeply indented tracts that will simplify boundaries and thus make land management more efficient
- Properties that strategically link existing state forest lands or other public/conserved lands
- Lands that contain species of special concern or unique habitats or plant communities
- Lands that are threatened by development pressure or that will buffer existing state forest land from nearby development
- Lands that help protect and conserve critical water resources
- Lands that provide new or unique recreational opportunities
- Properties that provide a new or improved point of access to existing state forest lands, which will enhance access for management and recreation
- Expansive properties that create a new core land holding (typically 1,000 acres or more)

The bureau evaluates each acquisition opportunity according to these priorities and in light of present funding availability.
Old Growth

For many, the perception of old growth is the same as that of virgin forest, where large, old trees have existed without any human intervention and where there is an overall feeling of primitive, wild character like that which existed before European settlement. In reality, however, a single suite of characteristics for virgin old growth is difficult to identify because localized ecological factors — such as disturbance regimes, climate, and diversity in species composition — have produced forest communities that appear and function differently.

The perception of old growth in Pennsylvania is further confused because not much virgin forest remains here. Native Americans had been altering the arrangement of the northeastern deciduous forests long before Europeans arrived. Then, by the early 1900s, most of Pennsylvania’s forest lands lay in desolation after wholesale logging and forest fires. The state’s extensive forests at that time were gone, except for a few isolated patches.

Following a century of evolving conservation efforts, today about 60 percent of the state’s land area is covered with 70- to 100-year-old second- and third-growth forest communities. The forests continue to evolve under unprecedented circumstances such as chestnut blight, gypsy moth infestations, invasive plant infestations, fire history, white-tailed deer overbrowsing, air pollutants, and other anthropogenic stresses. As these “new” forest communities mature, they likely will bear traits different from their “virgin” predecessors.

The new-growth forests of Pennsylvania should progress through successional stages and reach a mature steady state, i.e., late successional stage, albeit with a potentially different suite of traits from their pre-European predecessors. One cannot conclusively define the character of potential old-growth systems. They eventually will achieve their own inherent species compositions, age class distributions, canopy structures, decaying ground layers, ecological functions, and overall appearances.

Old-growth forest systems — both “virgin” forests that have never been logged and the second- and third-growth forests that are developing at the present — though difficult to define, have several components or criteria that usually are considered when discussing old-growth forests, including: age (biologically mature, late successional, etc.), structure (species composition, dead and down material, canopy gaps, etc.), disturbance (extent of human influences), and size (self-sustaining, allows natural processes and functions). Perhaps the best way to discuss or describe old-growth forests is in the context of late-successional biological communities or habitats. Although some use the terms “steady state” or “stable communities,” old-growth systems, like all systems, are constantly shifting or changing and thus are unable to be defined.

<table>
<thead>
<tr>
<th>Acquisitions Goal and Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal</strong></td>
</tr>
<tr>
<td>1. To implement a strategic state forest acquisition process to add valuable ecological and recreational resources to the state forest system.</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
The Forest Stewardship Council also has a definition of old growth: 1) the oldest seral stage in which a plant community is capable of existing on a site, given the frequency of natural disturbance events, or 2) a very old example of a stand dominated by long-lived early- or mid-seral species. The onset of old growth varies by forest community and region. For example, in the Pacific Coast region, old growth often begins around 200 to 250 years of age, whereas in the Northeast old growth generally begins at 150 to 200 years after stand-replacing disturbances. Depending on the frequency and intensity of disturbances, and site conditions, old-growth forest will have different structures, species compositions, age distributions, and functional capacities than younger forests. Old-growth and late successional stands and forests include: 1) Type 1 Old Growth: stands that have never been logged and that display late successional/old-growth characteristics, and 2) Type 2 Old Growth: stands that have been logged but which retain significant late-successional/old-growth structure and functions.

Old-growth forests have important values in the forest and in an ecosystem management context. Some of those values include:

- Providing benchmarks of unmanaged forest conditions to which managed forests can be compared.
- Providing special habitats for native wildlife, plants, invertebrates, fungi, and lichens.
- Serving as reservoirs of genetic material and ecological processes.
- Providing visitors with opportunities to enjoy unique recreational and aesthetic experiences.

**Figure 5.** Proposed old growth areas within state forest land.
Old-Growth Conservation and Management

DCNR has long recognized the value and need for protecting old-growth communities. As early as 1908, the department recommended preserving several virgin hemlock communities. These virgin tracts were designated as forest monuments in 1921. During the development of the 1970-85 State Forest Resource Management Plans, all unique or unusual biological areas, including virgin and old-growth tracts, were inventoried for possible natural area designation. All known virgin areas on state forest lands are currently in the state forest natural area system. The natural areas designated for existing old growth are additionally classified as high conservation value forests (HCVF). The bureau maintains 19,454 acres of HCVF designated for old growth.

Old-Growth Goals and Objectives

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Protect existing old-growth systems on state forest lands.</td>
<td>1.1 Protect all existing virgin or old-growth remnant forests by including these areas in the state forest natural area system.</td>
</tr>
<tr>
<td></td>
<td>1.2 Promote research and study on existing virgin and old-growth remnant forests to fully understand the characteristics of these systems.</td>
</tr>
<tr>
<td></td>
<td>1.3 Assess stressors to existing old-growth stands and develop management strategies to address them.</td>
</tr>
<tr>
<td>2. Promote future old-growth systems on state forest land while maintaining at least 20 percent of state forest land as potential or existing old growth.</td>
<td>2.1 Continue to evaluate and refine the bureau’s 556,000 acres of proposed old growth areas.</td>
</tr>
<tr>
<td></td>
<td>2.2 Use the state forest management zoning system to promote successional patterns toward potential old growth. Allow vegetation in designated wild and natural areas, selected special resource management zones, and limited resource management zones to develop into late-successional communities or old-growth system.</td>
</tr>
<tr>
<td></td>
<td>2.3 Connect late-successional and old-growth systems where practical.</td>
</tr>
<tr>
<td></td>
<td>2.4 Investigate and evaluate active management strategies for promoting old-growth characteristics in developing, late-successional forests.</td>
</tr>
</tbody>
</table>

In addition to virgin tracts, the bureau recognizes the need to conserve evolving second- and third growth forests where future old growth will exist. The bureau has designated certain areas for succession to occur and eventually become mature forests. These mapped areas are typically limited resource zones, parts of natural and wild areas, and other areas not part of the commercial land base. Many of these areas are on steep slopes where forest management activities are difficult and stands can be left to develop without direct human impact. The bureau has mapped approximately 556,000 acres for proposed old growth.
Land Inventories, Delineations, Classifications, and Designations

Inventorying, delineating, classifying, and designating the state forest land base is a cornerstone of sustainable management. Appropriately characterizing forest and landscape features facilitates accurate resource inventories, effective analyses, and long-term monitoring, in addition to informing and guiding management decisions. Furthermore, as noted in Penn’s Woods, ecological-based inventories are necessary to discern ecological patterns across the landscapes and are a fundamental part of ecosystem management.

The bureau has a structured, multi-layered land delineation system. The aim of this system is to provide consistency and stability in delineating, classifying, and designating land across the state forest system, while maintaining flexibility to incorporate and absorb new information and analysis from a multiple-resource perspective.

To organize its land delineation system, the bureau stratifies its designations into five subcategories: classification and typing, state forest management zoning, planning and operational, reference and analysis, and supra management areas. These designations are not necessarily hierarchical or “nested,” reflecting the tension between fluid and shifting ecological boundaries and forest landscape characteristics versus the need for consistent structures for operational and planning purposes.

What follows is a brief description of these delineation subcategories and examples of the major systems therein. When analyzing any given area for management activities, the most restrictive practices apply in overlapping designations and management zones.

Classification and Typing
Classification and typing designations refer to basic first-order designations of plant communities, forest stands, lakes, ponds, wetlands, and anthropogenic sites such as parking areas and buildings. These areas are continually inventoried, assessed, updated, or verified by the bureau.

Plant Communities
Of the 2.2 million acres of land managed by the bureau, 95 percent is classified as forest land, which includes woodlands and shrub lands. The remaining 5 percent includes areas such as grasslands; natural and human-made herbaceous openings; lakes, ponds, and wetlands; parking areas; shale pits and mining sites; and state forest facilities such as district offices and maintenance buildings.

<table>
<thead>
<tr>
<th>Land Inventories, Delineations, Classifications, &amp; Designations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Classification &amp; Typing</strong></td>
</tr>
<tr>
<td>• Forest Stands</td>
</tr>
<tr>
<td>• Community Classifications</td>
</tr>
<tr>
<td>• Vegetation Typing</td>
</tr>
<tr>
<td>• Stream Classifications</td>
</tr>
<tr>
<td>• Road/Trail Classifications</td>
</tr>
<tr>
<td><strong>State Forest Management Zoning</strong></td>
</tr>
<tr>
<td>• Management Zoning &amp; Commerciality</td>
</tr>
<tr>
<td>• Wild &amp; Natural Areas</td>
</tr>
<tr>
<td>• Wild Plant Sanctuaries</td>
</tr>
<tr>
<td><strong>Planning &amp; Operational Areas</strong></td>
</tr>
<tr>
<td>• Forest District Boundaries (SFM, Fire, CFM)</td>
</tr>
<tr>
<td>• State Forest Boundary &amp; Ownership</td>
</tr>
<tr>
<td>• Landscape Management Units (LMUs)</td>
</tr>
<tr>
<td>• Compartments</td>
</tr>
<tr>
<td>• Map Sections</td>
</tr>
<tr>
<td>• Gas Tracts &amp; Leased Areas</td>
</tr>
<tr>
<td>• Timbersales &amp; Treatments</td>
</tr>
<tr>
<td>• Navigable Streams</td>
</tr>
<tr>
<td><strong>Supra Management Areas</strong></td>
</tr>
<tr>
<td>• Elk Management Areas</td>
</tr>
<tr>
<td>• Gold Winged Warbler Management Area</td>
</tr>
<tr>
<td>• Important Bird &amp; Mammal Areas (IBAs &amp; IMAs)</td>
</tr>
<tr>
<td>• Vignesheds</td>
</tr>
<tr>
<td>• High Conservation Value Forest (HCVF)</td>
</tr>
<tr>
<td>• Deer Management Assistance Program (DMAP)</td>
</tr>
<tr>
<td><strong>Reference &amp; Analysis Areas</strong></td>
</tr>
<tr>
<td>• Ecoregions</td>
</tr>
<tr>
<td>• Landscape Type Associations (LTAs)</td>
</tr>
<tr>
<td>• Watersheds</td>
</tr>
<tr>
<td>• High Conservation Value Forest (HCVF)</td>
</tr>
<tr>
<td>• Land Use &amp; Soils</td>
</tr>
<tr>
<td>• Insect/Disease Defoliations &amp; Risk Maps</td>
</tr>
<tr>
<td>• Protected Lands</td>
</tr>
<tr>
<td>• Terrain (DEM, slope, aspect, hillshade)</td>
</tr>
<tr>
<td>• Landfire Fuels &amp; Wildland Urban Interface (WUI)</td>
</tr>
<tr>
<td>• Natural Heritage Areas (NHAs)</td>
</tr>
<tr>
<td>• TNC Forest Patches &amp; Landscape Blocks</td>
</tr>
<tr>
<td>• Geology</td>
</tr>
<tr>
<td>• Tree Canopy Heights</td>
</tr>
</tbody>
</table>

Figure 6. Land inventories, delineations, classifications, and designations of state forest land
Plant communities are groups of plants sharing a common environment that interact with each other, animal populations, and the physical environment. As plant communities tend to co-occur on the landscape due to shared environmental requirements, they provide a valuable framework for organizing biological information, creating mappable units for land management, and conservation planning. Communities often are defined by dominant plant species, and these plant associations provide useful habitat information for many animal species and provide an efficient starting point for forest inventory and analysis. Plant communities may be described at many different scales, from the small vernal pond community to the northeastern deciduous forest community. The scale of a classification system is driven by its intended use.

The Terrestrial and Palustrine Plant Communities of Pennsylvania 2nd Edition represents the best approximation of the upland and wetland plant community types of Pennsylvania. It is used by the bureau to categorize and describe terrestrial and palustrine plant communities at the stand level for landscape planning and analysis. Additional applications include mapping, environmental impact assessment, development planning, site selection for long-term monitoring, and a variety of other activities related to conservation. This classification system is being modified to reflect a better understanding of the patterns that constitute plant communities and will be adapted into the bureau’s stand typing inventory. Additionally, it will be the most detailed land classification unit to be delineated on state forest land and will be the basic building block for management of the state forest system.

**Forest Stand Typing**

Every acre of state forest is delineated into forest stands based on the primary features of the dominant vegetation. This process is known as typing. Typing allows for forest condition data to be captured and analyzed spatially through geographic information system (GIS). Stand delineations provide information on:

- Forest land area and acreage
- Management zone
- Plant community Type
- Site class
- Size and stocking class
- Commercial availability

This broad inventory provides a general “snapshot” of forest conditions and allows managers to analyze these conditions at desired scales, whether across the state forest system, at the district level, or within a particular landscape of interest. As management occurs on the ground, this inventory is revised to account for changes that may have resulted from timber sales, mortality events, and new management designations.
The bureau manages this data in the Forest Information Management System (FIMS), a custom GIS used to manage spatial and tabular data, monitor forest conditions, produce maps, and conduct spatial analyses of the forest.

**Site, Size, Stocking**
Site classes denote the potential quality of the growing site from a statewide perspective, from good to medium to poor. Size denotes the diameters of trees. Stocking is used to determine if the forest community is fully stocked with trees. The appropriate site, size, and stocking codes should follow the forest community type for all forest communities.

**Site Class**
Site classes are numbered 1 (the best), 2, and 3 (the poorest). Bureau of Forestry site classes are designated as follows:

**Site 1:** Characterized by moist, well-drained, fairly deep soils that usually occur in protected coves, along streams, or in bottomlands that remain moist throughout the year. Dominant and codominant total tree heights have the potential to average more than 85 feet at maturity.

**Site 2:** Characterized by soil intermediate in moisture, depth, drainage, and fertility that may dry out for short periods during the year. Dominant and codominant total tree heights have the potential to average more than 65 feet but less than 85 feet at maturity.

**Site 3:** Characterized by shallow, rather dry, stony, or compact soils which usually occur on ridges or broad flat plateaus. Dominant and codominant total tree heights average less than 65 feet at maturity.

**Size/Stocking**
Size/stocking classes are numbered 1 through 4 to represent stands ranging from large sawtimber (1), medium sawtimber (2), and poletimber (3) to sapling stages or smaller (4) that are fully stocked. Size/stocking classes 5 through 8 are used for areas that have experienced a disturbance and as a result, are understocked. Bureau of Forestry size/stocking classes are designated as follows:

- **Stand is > 50 percent stocked**
  1. Majority of the dominant and codominant trees are > 18” dbh.
  2. Majority of the dominant and codominant trees are 12-18” dbh.
  3. Majority of the dominant and codominant trees are 6-12” dbh.
  4. Majority of the dominant and codominant trees are < 6” dbh.

- **Stand is < 50 percent stocked with a manageable overstory**
  5. Majority of the dominant and codominant trees are > 18” dbh.
  6. Majority of the dominant and codominant trees are 12-18” dbh.
Introduction

Majority of the dominant and codominant trees are 6-12” dbh.

Majority of dominant and codominant trees are < 6” dbh.

**Commercial/Non-Commercial Availability**

Commercial/non-commercial designation should follow the forest community type for all forest communities. This determination is based on current and future commercial availability. It includes all sites and/or size/stocking classes.

C  Designated land classification unit for stands that possess, or have the potential to produce, enough value and wood volume to be operable for a timber sale operation.

N  Designated land classification unit that does not, and does not have the potential to ever, have enough value and wood volume to be operable for a timber sale operation, or the stand is located in areas restricted to sale operations (areas such as natural areas, wild areas, some trail buffers, special resources, or areas where aesthetics are highly regarded).

Each forest community land classification unit consists of a fixed-length, six-character code. For example, MAR11C denotes: M (multiple resource management zone), AR (red oak/mixed hardwood forest), 1 (site1), 1 (size/stocking class 1), C (Commercial Availability). All other land classification units consist of a fixed-length, three-character code. For example, HO2 denotes; H (anthropogenic site management zone), O2 (cultivated herbaceous area).

**State Forest Management Zoning**

Primary land use and land use capability dictate the management zoning designations for state forest land. The bureau zones all state forest land according to its primary land use and to apply management practices that will protect and enhance the values for which the land was zoned. This zoning system is one of the primary forest planning tools for state forest management.

The following is a brief description of the management zones and the values that determine land use:

The **MULTIPLE RESOURCE MANAGEMENT ZONE** is the least restrictive management zone and applies to areas managed for many resources, such as timber, water, recreation, fauna, flora, and minerals. Appropriate forest community types within this zone may be considered part of the commercial forest land base.

The **AESTHETICS / BUFFER MANAGEMENT ZONE** applies to areas where connectivity, aesthetics, and water quality conservation are the primary values. These areas are associated with linear features such as roads, trails, and streams, or encompass a significant feature of state forest land. Appropriate forest community types within this zone may be considered part of the commercial forest land base, with certain exceptions, such as along national trails, wilderness trout streams, and national scenic trails.

The **LIMITED RESOURCE MANAGEMENT ZONE** was applied to areas where management alternatives are limited due to site quality or topographic constraints. Recreation, aesthetics, water, and soil protection are the primary values. This zone typically is not part of the commercial forest land base, since timber harvesting usually is not practical.

The **NATURAL AREA MANAGEMENT ZONE** applies to areas that have been designated or are pending designation as state forest natural areas. Natural areas are defined as areas of unique scenic, historic, geologic, or ecological value which will be maintained in a natural condition by allowing physical and biological processes to operate, usually without direct human intervention. These areas are set aside to provide locations for scientific observation of natural systems, to protect examples of typical and unique plant and animal communities, and to protect outstanding examples of natural interest and beauty.
The **WILD AREA MANAGEMENT ZONE** applies to areas that have been designated or are pending designation as state forest wild areas. A wild area is defined as an extensive area which the general public will be permitted to see, use, and enjoy for such activities as hiking, hunting, fishing, and the pursuit of peace and solitude. No development of a permanent nature will be permitted so as to retain the undeveloped character of the area and conserve ecological resources.

The **SPECIAL RESOURCE MANAGEMENT ZONE** applies to areas that will be managed for specific values such as public wild plant sanctuaries, special wildlife management areas, certain recreation sites, vistas, and reservoirs. These zones will have specific management recommendations or plans focusing on the values that are being recognized. Forest community types within this zone typically are not part of the commercial forest land base; however, timber harvesting will be allowed if specific management recommendations recognize timber harvesting as an appropriate management tool.

The **ANTHROPOGENIC SITE MANAGEMENT ZONE** applies to human-made structures or facilities such as roads, rights-of-way, mineral sites, tower sites, leases, buildings, and so forth. The primary value for this zone is human amenities.

### Table 2. Acres of state forest management zones.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Acreage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Resource</td>
<td>1,098,153.72</td>
</tr>
<tr>
<td>Limited Resource</td>
<td>511,897.21</td>
</tr>
<tr>
<td>Aesthetic/ Buffer</td>
<td>244,401.95</td>
</tr>
<tr>
<td>Wild Area</td>
<td>158,797.02</td>
</tr>
<tr>
<td>Natural Area</td>
<td>80,537.05</td>
</tr>
<tr>
<td>Other</td>
<td>77,781.17</td>
</tr>
<tr>
<td>Special Resource</td>
<td>14,454.70</td>
</tr>
<tr>
<td>Anthropogenic Site</td>
<td>13,841.51</td>
</tr>
</tbody>
</table>

**Wild and Natural Areas**

The Conservation and Natural Resources Act, Act 18 of 1995, states that “The department is authorized and directed to set aside, within the state forests, unusual or historical groves of trees, or natural features, especially worthy of permanent preservation, to make the same accessible and convenient for public use and to dedicate them in perpetuity to the people of the state for their recreation and enjoyment,” and “To set aside when in the judgment of the department it is deemed necessary, for exclusive use for parks, parkways, and other places of scientific, scenic, or wildlife interest, any state-owned lands which are now or which may hereafter be under the jurisdiction of the department.”

DCNR has long recognized the value and need for setting aside unusual or interesting areas of state forest land. As early as 1908, the department recommended preserving several virgin hemlock stands that had been left by lumbermen because of inaccessibility. These virgin stands were given legal status in May 1921, when the legislature “…authorized the department to set aside unusual or historic groves of trees.” The State Forest Commission passed a resolution in September 1921 describing these areas as forest monuments. The commission designated 13 monuments.

The term monument was proper for the type of area that was set aside under this early effort; however, in the 1960s, it became apparent that in addition to the virgin forests and rare bogs, there was a need for, and considerable public
interest in, setting aside additional areas where natural succession could be observed with little or no influence by man. This new concept included preserving typical examples of second-growth forests and common plant communities. Coincidental with an expanding interest in preserving representative natural ecosystems was a public interest in large forest areas that would be retained in a wild or undeveloped condition.

In December 1970, the State Forest Commission passed a resolution changing the name of state forest monuments to state forest natural areas. The resolution placed the 13 areas under a new definition that more aptly described the broadened concept. The resolution also created a new class of state forest land called “wild areas” and designated Quehanna as the state’s first wild area.

To date, with the finalization of this plan, the Bureau of Forestry will have designated 60 state forest natural areas on more than 78,620 acres and 20 state forest wild areas representing more than 161,981 acres. Wild and natural areas are visible on the bureau’s online interactive map. Wild and Natural Areas remain in proposed status while oil and gas right ownership is confirmed and acceptance of these designations is

<table>
<thead>
<tr>
<th>Area Type</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Areas</td>
<td>60</td>
</tr>
<tr>
<td>Proposed Natural Areas</td>
<td>0</td>
</tr>
<tr>
<td>Proposed Wild Areas</td>
<td>5</td>
</tr>
<tr>
<td>Wild Areas</td>
<td>15</td>
</tr>
<tr>
<td>Grand Total</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 3. Total number of Natural and Wild Areas on state forest lands.

<table>
<thead>
<tr>
<th>District</th>
<th>Wild Area Acres</th>
<th>Proposed W.A. Acres</th>
<th>Natural Area Acres</th>
<th>Proposed N.A. Acres</th>
<th>Total WNA Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest District 1, Michaux</td>
<td>0</td>
<td>0</td>
<td>1,647</td>
<td>0</td>
<td>1,647</td>
</tr>
<tr>
<td>Forest District 2, Buchanan</td>
<td>11,676</td>
<td>0</td>
<td>2,109</td>
<td>0</td>
<td>13,785</td>
</tr>
<tr>
<td>Forest District 3, Tuscarora</td>
<td>5,345</td>
<td>0</td>
<td>1,369</td>
<td>0</td>
<td>6,714</td>
</tr>
<tr>
<td>Forest District 4, Forbes</td>
<td>0</td>
<td>6,094</td>
<td>4,130</td>
<td>0</td>
<td>10,224</td>
</tr>
<tr>
<td>Forest District 5, Rothrock</td>
<td>5,881</td>
<td>0</td>
<td>2,714</td>
<td>0</td>
<td>8,596</td>
</tr>
<tr>
<td>Forest District 6, Gallitzin</td>
<td>2,764</td>
<td>0</td>
<td>392</td>
<td>0</td>
<td>3,155</td>
</tr>
<tr>
<td>Forest District 7, Bald Eagle</td>
<td>3,811</td>
<td>2,474</td>
<td>7,442</td>
<td>0</td>
<td>13,726</td>
</tr>
<tr>
<td>Forest District 8, Kittanning</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Forest District 9, Moshannon</td>
<td>24,240</td>
<td>4,378</td>
<td>900</td>
<td>0</td>
<td>29,517</td>
</tr>
<tr>
<td>Forest District 10, Sproul</td>
<td>7,509</td>
<td>0</td>
<td>14,727</td>
<td>1,464</td>
<td>23,555</td>
</tr>
<tr>
<td>Forest District 11, Pinchot</td>
<td>0</td>
<td>0</td>
<td>70</td>
<td>0</td>
<td>70</td>
</tr>
<tr>
<td>Forest District 12, Tiadaghton</td>
<td>11,700</td>
<td>0</td>
<td>5,321</td>
<td>0</td>
<td>17,021</td>
</tr>
<tr>
<td>Forest District 13, Elk</td>
<td>21,317</td>
<td>10,306</td>
<td>11,300</td>
<td>522</td>
<td>43,445</td>
</tr>
<tr>
<td>Forest District 14, Cornplanter</td>
<td>0</td>
<td>0</td>
<td>99</td>
<td>0</td>
<td>99</td>
</tr>
<tr>
<td>Forest District 15, Susquehannock</td>
<td>0</td>
<td>29,836</td>
<td>1,654</td>
<td>0</td>
<td>31,490</td>
</tr>
<tr>
<td>Forest District 16, Tioga</td>
<td>2,783</td>
<td>0</td>
<td>14,518</td>
<td>0</td>
<td>17,301</td>
</tr>
<tr>
<td>Forest District 17, William Penn</td>
<td>0</td>
<td>0</td>
<td>185</td>
<td>0</td>
<td>185</td>
</tr>
<tr>
<td>Forest District 18, Weiser</td>
<td>0</td>
<td>0</td>
<td>113</td>
<td>0</td>
<td>113</td>
</tr>
<tr>
<td>Forest District 19, Delaware</td>
<td>0</td>
<td>2,706</td>
<td>6,733</td>
<td>0</td>
<td>9,439</td>
</tr>
<tr>
<td>Forest District 20, Loyalsock</td>
<td>9,161</td>
<td>0</td>
<td>1,357</td>
<td>0</td>
<td>10,518</td>
</tr>
</tbody>
</table>

Table 4. Total acreage of Natural and Wild Areas on state forest lands.
vetted with the public through postings in the PA Bulletin. Proposed Wild and Natural Areas are managed as though they are Wild and Natural Areas, based on the guidelines described below, until they are formally designated.

**Natural Areas**

Recognizing that there is a basic need for the preservation of certain areas of forest land with either limited or no human disturbance, the following definition has been adopted for natural areas that are or will be established on state forest land:

* A natural area is an area of unique scenic, historic, geologic, or ecological value that will be maintained in a natural condition by allowing physical and biological processes to operate, usually without direct human intervention. They are set aside to provide locations for scientific observation of natural systems, to protect examples of typical and unique plant and animal communities, and to protect outstanding examples of natural interest and beauty.

The guidelines governing the administration of natural areas are:

1. No human habitation is permitted, except primitive-type backpack camping in designated areas. Existing forest camp leases will be permitted to remain in natural areas. If a cabin on a forest camp lease is destroyed by fire, storm, flood, or other natural causes, the lease will be relocated to a site outside of the natural area or terminated according to the wishes of the lessee.
2. Access for all but essential administrative activities is restricted to foot trails and non-motorized watercraft, except in designated areas.
3. Buildings and other improvements are restricted to the minimum required for public health, safety, and interpretive aids.
4. Timber harvesting is not permitted except as may be required for maintenance of public safety.
5. Leases and mineral development are prohibited. New rights-of-way are prohibited except for designated utility corridors in the Bucktail Natural Area.

**Natural Area Designation Update**

The bureau is finalizing the following expansions:

- 145-acre expansion of the Tamarack Swamp Natural Area in Sproul State Forest
- 1,841-acre expansion of Bucktail State Park Natural Area due to recent land acquisitions in Elk and Sproul state forests.

**Wild Areas**

* A wild area is defined as an extensive area which the general public will be permitted to see, use, and enjoy for such activities as hiking, hunting, fishing, and the pursuit of peace and solitude. No development of a permanent nature will be permitted so as to retain the undeveloped character of the area. These areas will be administered according to the principles of forest protection and management applied to department-managed lands, with the following restrictions:

1. Existing forest camp leases will be permitted to remain in wild areas. If a cabin on a forest camp lease is destroyed by fire, storm, flood, or other natural causes, the lease will be relocated to a site outside of the wild area or terminated according to the wishes of the lessee. New campsite leases will be prohibited.
2. No new public access roads will be constructed. Existing roads will remain open only where there is a public need. All unauthorized motorized conveyances or vehicles shall be prohibited, with the exception of licensed vehicles, which may be operated only on open public roads.

3. Forest trail use will be restricted to foot travel, horseback riding, and bicycling. Handicapped persons, in hand or electrically powered wheelchairs, or in or on other electrically powered vehicles adapted for this use, may operate such conveyances on designated trails.

4. Buildings and other improvements will be restricted to the minimum required for public health, safety, and interpretive aids.

5. Leases, mineral development, and new rights-of-way will be prohibited.

6. Overnight camping will be limited to the backpack primitive type.

---

**Figure 10.** Natural areas on state forest land.

**Figure 11.** Wild Areas on state forest land.
Wild Area Designation Update
The following wild areas have been finalized and will be published in the Pennsylvania Bulletin:

- **Square Timber/Big Run** (5,617 acres, Elk State Forest)
- **Quebec Run** (6,094 acres, Forbes State Forest). Note: Boundary lines were adjusted from the original proposal to exclude an area that held a vintage oil and gas lease.
- **Hammersley** (29,836 acres, Susquehannock State Forest)
- **Stairway** (2,706 acres, Delaware State Forest)
- **Penns Creek** (2,474 acres, Bald Eagle State Forest) Note: Boundaries have been adjusted from original proposal. Old Mingle Road will be gated. New wild area acreage will be combined with existing White Mountain Wild Area to form one Penns Creek Wild Area complex.

The following proposed expansion is still under review:

- Quehanna (9,066 acres, Elk and Moshannon State Forest)

The following proposed wild areas has been removed from consideration:

- **M.K. Goddard** (4,600 acres, Sproul State Forest). Note: The area does not meet criteria due to severed oil and gas rights and an existing road.

Wild and Natural Area Designation and Management Guidelines
The bureau has developed operating guidelines to further define the designation and management of wild and natural areas.

Wild Plant Sanctuaries
Wild plant sanctuaries on state forest lands are designated specifically for management of plant species of concern “when deemed necessary to protect wild plant species afforded consideration under this act” (Section 10, Wild Resources Conservation Act). Typically, these areas are chosen due to the presence of viable or exemplary populations of plant species of concern, unique plant populations in decline and in need of active management, invertebrate species of concern or their host plants, or habitats with high plant species diversity or values. To date, 51 plant sanctuaries totaling more than 10,000 acres have been proposed on state forest lands. Once identified, plant sanctuaries are surveyed to determine their size, boundaries, and status of or threats to the species of interest. Management plans also are developed to outline management and monitoring needs to conserve the resources for which they were identified. Wild plant sanctuaries are designated special resource management zones.
<table>
<thead>
<tr>
<th>Sanctuary Name</th>
<th>Acres</th>
<th>Reason for Designation</th>
<th>State Forest District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Pine Flats</td>
<td>205</td>
<td>barrens community, PA Endangered plant species</td>
<td>Michaux</td>
</tr>
<tr>
<td>Sage Run</td>
<td>129</td>
<td>seepy woods with 2 PA Endangered plant species, and high diversity</td>
<td>Michaux</td>
</tr>
<tr>
<td>Sand Springs</td>
<td>364</td>
<td>wetland network of hummocks and troughs, PA Endangered plant species</td>
<td>Michaux</td>
</tr>
<tr>
<td>Thompson Hollow</td>
<td>6</td>
<td>vernal pond complex with federal and state listed species</td>
<td>Michaux</td>
</tr>
<tr>
<td>Bear Gap Run</td>
<td>257</td>
<td>bottomland forest with PA Endangered plant species, associated with a Wild Area</td>
<td>Buchanan</td>
</tr>
<tr>
<td>Martin Hill</td>
<td>40</td>
<td>mountain pimpernel</td>
<td>Buchanan</td>
</tr>
<tr>
<td>Fifteen Mile Creek</td>
<td>70</td>
<td>5 listed plant species, diversity</td>
<td>Buchanan</td>
</tr>
<tr>
<td>Tuscarora</td>
<td>10</td>
<td>PA Threatened plant species that is rare globally, associated with a Natural Area</td>
<td>Tuscarora</td>
</tr>
<tr>
<td>Juniata River Hollow</td>
<td>14</td>
<td>proposed PA Threatened plant, associated with a Wild Area</td>
<td>Tuscarora</td>
</tr>
<tr>
<td>Licking Creek</td>
<td>58</td>
<td>two plants of concern</td>
<td>Tuscarora</td>
</tr>
<tr>
<td>Three Square Hollow</td>
<td>156</td>
<td>complex of vernal ponds, Federally-listed species present</td>
<td>Tuscarora</td>
</tr>
<tr>
<td>Christner bog</td>
<td>18</td>
<td>large high quality wetland supporting the rare sphagnnum-beaked rush peatland plant community, 3 plant species of concern</td>
<td>Forbes</td>
</tr>
<tr>
<td>Jones Mill Run</td>
<td>119</td>
<td>three plant species of concern</td>
<td>Forbes</td>
</tr>
<tr>
<td>Linn Run</td>
<td>277</td>
<td>steep mesic gorge with a diversity of spring ephemerals and a PA Threatened plant species</td>
<td>Forbes</td>
</tr>
<tr>
<td>Laurel Run</td>
<td>35</td>
<td>associated with the Quebec Run Wild Area, supports a PA Endangered plant species</td>
<td>Forbes</td>
</tr>
<tr>
<td>Spruce Flats</td>
<td>202</td>
<td>successional, high-altitude non-glacial bog with a PA Threatened plant species population</td>
<td>Forbes</td>
</tr>
<tr>
<td>Ben Jacobs</td>
<td>49</td>
<td>complex of vernal ponds, Federally-listed species present</td>
<td>Rothrock</td>
</tr>
<tr>
<td>Detweiler</td>
<td>43</td>
<td>population of a proposed PA Threatened plant species</td>
<td>Rothrock</td>
</tr>
<tr>
<td>Martin Gap</td>
<td>68</td>
<td>PA Rare plant species, wet woods, associated with Rocky Ridge Natural Area</td>
<td>Rothrock</td>
</tr>
<tr>
<td>Bog Path</td>
<td>76</td>
<td>nice wetlands and bog assemblage</td>
<td>Gallitzin</td>
</tr>
<tr>
<td>Havice Mountain</td>
<td>65</td>
<td>proposed plant species</td>
<td>Bald Eagle</td>
</tr>
<tr>
<td>Mohn Mill Ponds</td>
<td>376</td>
<td>complex of vernal ponds, Federally-listed species present</td>
<td>Bald Eagle</td>
</tr>
<tr>
<td>Pine Swamp</td>
<td>259</td>
<td>many wetland species</td>
<td>Bald Eagle</td>
</tr>
<tr>
<td>Allegheny</td>
<td>1083</td>
<td>rare habitat of river floodplain scour, plant species of concern</td>
<td>Clear Creek</td>
</tr>
</tbody>
</table>

Table 5. Proposed Plant Sanctuaries on state forest land with their respective acreage and reason for designation.
<table>
<thead>
<tr>
<th>Sanctuary Name</th>
<th>Acres</th>
<th>Reason for Designation</th>
<th>State Forest District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crystal Springs Bog</td>
<td>56</td>
<td>large bog with PA Threatened and PA Rare plant species</td>
<td>Moshannon</td>
</tr>
<tr>
<td>Little Beaver Swamp</td>
<td>68</td>
<td>nice mix of communities associated with East Branch Swamp Natural Area</td>
<td>Sproul</td>
</tr>
<tr>
<td>Tamarack Swamp</td>
<td>307</td>
<td>Comm, S. decora, P. hookeri, C.disperma</td>
<td>Sproul</td>
</tr>
<tr>
<td>Crystal Lake</td>
<td>2663</td>
<td>swamp and barrens that harbors diversity of butterfly and moth</td>
<td>Pinchot</td>
</tr>
<tr>
<td>Cowgate</td>
<td>32</td>
<td>unique population of a fern species</td>
<td>Pinchot</td>
</tr>
<tr>
<td>Harvey’s Creek</td>
<td>47</td>
<td>botanically diverse site with rock ledges and streamlets, several plant species of concern.</td>
<td>Pinchot</td>
</tr>
<tr>
<td>Painter Creek Bog</td>
<td>98</td>
<td>high diversity of bog and wetland plant species, many PA listed species.</td>
<td>Pinchot</td>
</tr>
<tr>
<td>Clay Mine Swamp</td>
<td>24</td>
<td>nice bog with high diversity of wetland plants</td>
<td>Tiadaghton</td>
</tr>
<tr>
<td>Red Run Swamp</td>
<td>193</td>
<td>pitch pine-leatherleaf palustrine woodland with at least one listed plant species, and several both and butterfly species, associate with the Algerine Swamp Natural Area</td>
<td>Tiadaghton</td>
</tr>
<tr>
<td>Slate Run</td>
<td>40</td>
<td>steep cliffs along creek with high diversity of liverworts and mosses, PA Endangered plant species, part of Algerine Wild Area</td>
<td>Tiadaghton</td>
</tr>
<tr>
<td>Wykoff</td>
<td>169</td>
<td>many species across wetland complex, part of Wykoff Run Natural Area</td>
<td>Elk</td>
</tr>
<tr>
<td>Jacob Hollow</td>
<td>48</td>
<td>cool, moist northern woods with proposed PA Rare plant species</td>
<td>Susquehannock</td>
</tr>
<tr>
<td>Kettle Creek Swamp</td>
<td>29</td>
<td>wetland with PA Threatened plant</td>
<td>Susquehannock</td>
</tr>
<tr>
<td>Sand Run Headwaters</td>
<td>26</td>
<td>nice wetland</td>
<td>Tioga</td>
</tr>
<tr>
<td>Scotch Pine Hollow</td>
<td>47</td>
<td>wetland with PA Threatened plant</td>
<td>Tioga</td>
</tr>
<tr>
<td>Goat Hill</td>
<td>603</td>
<td>serpentine barrens, high diversity of moth and butterfly species and several rare plants</td>
<td>William Penn</td>
</tr>
<tr>
<td>Little Tunicum Island</td>
<td>96</td>
<td>many species of concern on an island with the rare plant community type riverbank freshwater tidal marsh; Wild Area</td>
<td>William Penn</td>
</tr>
<tr>
<td>Yellow Run Barrens</td>
<td>393</td>
<td>barrens habitat with many rare species</td>
<td>Weiser</td>
</tr>
<tr>
<td>Little Mud Pond</td>
<td>86</td>
<td>unique assemblage of bog species</td>
<td>Delaware</td>
</tr>
<tr>
<td>Long Bruce</td>
<td>195</td>
<td>unique assemblage of bog species; associated with Bruce Lake Natural Area</td>
<td>Delaware</td>
</tr>
<tr>
<td>Pecks Pond</td>
<td>272</td>
<td>unique assemblage of bog species</td>
<td>Delaware</td>
</tr>
<tr>
<td>Sones Pond</td>
<td>89</td>
<td>rare aquatic plants and nice wetland feeding pond</td>
<td>Loyalsock</td>
</tr>
<tr>
<td>Sprout</td>
<td>284</td>
<td>several species of concern, nice cool woods habitat</td>
<td>Loyalsock</td>
</tr>
</tbody>
</table>

Table 5 Continued. Proposed Plant Sanctuaries on state forest land with their respective acreage and reason for designation.
Planning and Operational Areas
The bureau uses many designated areas to facilitate planning, administration, and operations across the state forest system. Examples include forest district boundaries, oil and gas lease tracts, stand compartments and landscape management units.

Forest Districts
Pennsylvania and the state forest system are divided into 20 forest districts to facilitate bureau operations and state forest management. District boundaries were drawn for efficient operations and consider county lines and other political subdivisions, population centers, ecological features, and the state forest land base. Forest districts help organize state forest, fire, forest health, and private forest management.

Forest Stand Compartments
Compartments are an operation unit that range in size from 500 to 3,000 acres. Compartments generally follow easily recognizable boundaries, such as streams, roads, ownership boundaries, forest district boundaries, and other landscape features. Compartment boundaries have stayed relatively consistent through time. Their purpose is to facilitate administrative operations, serve as a unit for grouping forest stands and typing information, and serve as a unit to assist in data collection and storage.

Landscape Management Units
With this revision of the SFRMP, the bureau is introducing the landscape management unit (LMU) concept to facilitate consistent, structured, and integrated resource management and planning across large landscape units on state forest and adjoining lands. The LMU, which will complement other ecological delineations, represents an effort to operationalize landscape-level planning and management.

While landscape-level planning can and should occur at multiple scales and contexts, the LMU will serve as the primary unit for landscape-level planning and management on state forest lands. LMUs will facilitate planning on a landscape scale that has ecological context, incorporate multiple forest uses and values, include all state forest land, and facilitate ecological analysis. LMUs can serve as a way to structure individual state forest district plans, integrate multi-resource management, and improve communication to the public about resource management goals and activities. The units also can serve as a tool to facilitate cooperative management with adjoining forest districts, landowners, and agencies.
LMU delineations will follow these general guidelines and considerations:

- Landtype associations (LTAs) will be the building blocks of LMUs. LTAs will be grouped considering LTA characteristics, landform, plant communities, soils/parent material, natural disturbance regimes, land use history, and watershed or eco-regional position.
- While ecological considerations should be primary, secondary considerations in LMU delineations can include management goals, human use of the landscape, or operational constraints.
- LMUs will center around state forest land; however, to maintain ecological connectivity and context, adjoining land, including adjacent state forests, also should be included and considered.
- LMUs may vary in size and juxtaposition on the landscape determined appropriate for the landscape and management considerations. Sizes generally should be between 5,000 and 40,000 acres.
- While LMUs can be adjusted through time, their intent is to serve as a consistent delineation for landscape level planning, inventory, and monitoring.

**Reference and Analysis Areas**

Advances in natural resources inventories and analysis techniques have improved access to spatial datasets that aid forest managers in understanding ecological patterns; species, community, and resource distributions; habitat availability; landscape features; etc. These spatial delineations and datasets inform landscape management efforts and overall management context. Additionally, many stakeholders and partner groups develop spatial datasets that can contribute to sustainable forest management.

Reference and analysis areas advance the overall understanding of ecological or landscape context. They may help inform management goals or decisions, but they are not used operationally, nor do they require specific management plans. Some examples may include important bird areas, priority forest patches; ecological regions, landtype associations, watersheds, ROS zoning, and certain high conservation value forests.

**Ecological Regions**

The bureau has adopted the U.S. Forest Service ECOMAP hierarchy of ecological designations and led efforts to delineate ecological boundaries within Pennsylvania. ECOMAP represents a national effort to classify ecological units on a national scale using a consistent hierarchy. This effort incorporates a standardized classification and mapping system to stratify land into progressively smaller areas of increasingly uniform ecological potential. The result is an eight-level system that can be applied at a national scale.

*Figure 13. Pennsylvania Bureau of Forestry Ecological Regions with state forest land.*
The broader levels of this framework were determined by the U.S. Forest Service. At the state level, the bureau created eco-regions based on Pennsylvania’s physiographic provinces. Eco-regions represent large, multi-landscape areas as the broadest landscape unit for management planning and are defined primarily on landform patterns and geology. The bureau mapped 19 eco-regions in Pennsylvania which guide ecosystem management in broad terms (Figure 13). The bureau is continuing to develop eco-regional priorities that can be applied or considered during landscape planning.

In coordination with Penn State University, the bureau coordinated the delineation of lower levels within ECOMAP at the landtype association (LTA) and ecological land type (ELT) levels. These units were mapped at the local level and considered fluctuations in topography and drainage patterns on the landscape. In most cases, ELTs were delineated first and combined to create LTAs.

Landtype Associations

As part of its efforts to implement ecosystem management and delineate the landscape based on ecological features and patterns, the bureau, in the 2003 SFRMP, adopted LTAs as its basic large-scale land management unit. LTAs are delineated primarily by landform characteristics, including soils and underlying geology. For more information about LTA delineations, refer to Use of Landtype Associations and Landforms in Managing Pennsylvania’s State Forests. The bureau currently has approximately 2,500 LTAs ranging in size up to 8,200 acres.

With this version of the SFRMP, the bureau is shifting to larger LMUs to facilitate and operationalize landscape level planning and management. LTAs will be used to guide the delineations of larger LMUs. Once LMUs are designated by each forest district, LTAs will become reference and analysis areas and will not be used formally for landscape planning and management.

Supra Management Areas

By definition, supra means “above” or “over” or “beyond the limits of.” Some extensive areas of state forest should be managed to promote certain resources or values. These areas have discrete boundaries that may cross management zones, LMUs, and forest districts. Some examples include elk management areas, golden winged warbler management areas, deer management assistance program areas, and some high conservation value forests. Supra management area designation is best suited for areas that are large in size, require a specific management plan, or have certain management restrictions. Management of supra management areas sometimes deviates slightly from normal operating procedures, but management within these areas does not supersede management zone restrictions.

Supra management areas can focus management on single or broad resource values, depending on the management context. Designated supra management areas will be stored in FIMS. The bureau will implement a formal process for reviewing and designating supra management areas in the state forest system.
High Conservation Value Forests

Pennsylvania state forests are certified under the Forest Stewardship Council (FSC) standards. FSC certification prioritizes the protection of particularly valuable forest ecosystems and introduced the concept of high conservation value forests (HCVFs) to ensure identification and proper management of forest areas with exceptional conservation value. FSC recognizes six types of HCVFs:

- **HCV 1**: HCV forest areas that contain globally, regionally, or nationally significant concentrations of biodiversity values (protected areas, rare or threatened species, endemic species, and seasonal concentrations of species)
- **HCV 2**: Globally, regionally, or nationally significant large landscape-level forests
- **HCV 3**: Forest areas that are in or contain rare, threatened, or endangered ecosystems
- **HCV 4**: Forest areas that provide basic services of nature in critical situations (protection of watersheds and protection against erosion and destructive fire)
- **HCV 5**: Forest areas fundamental to meeting basic needs of local communities
- **HCV 6**: Forest areas critical to local communities’ traditional cultural identity

In 2011, the bureau followed FSC’s HCVF guidance to identify, designate, and manage for areas of high conservation value. For state forest management, these areas represent opportunities to consider specific values during management planning and implementation. HCVF designation does not preclude timber harvesting or other management activities, but special considerations are taken to promote the values for which these areas were designated, and conversion of forest land to a “non-forested use” is prohibited.

Almost 400,000 acres of Pennsylvania state forests have been designated as HCVFs in the six identified types (Table 6). However, this does not represent a cumulative total, as some areas in different types overlap. More information on HCVFs can be found in the [2011 High Conservation Value Forests Analysis and Identification](#).

The bureau is still in the process of integrating HCVFs into its zoning and management systems. For some HCVFs, existing management guidelines, such as those for natural areas, will suffice in promoting the HCVF value. These areas will be considered reference and analysis areas. HCVFs that require specific management plans will be incorporated into special resource management zones (such as wild plant sanctuaries) or designated supra management areas. In all cases, HCFVs and their promoted values will be considered during district management activities and will be part of district management plans and landscape-level planning.

<table>
<thead>
<tr>
<th>HCVF Category</th>
<th>Acres</th>
<th>Values Considered for Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCV 1</td>
<td>44,185</td>
<td>Wild Plant Sanctuaries, concentrations of species of concern</td>
</tr>
<tr>
<td>HCV 2</td>
<td>295,739</td>
<td>Natural Areas &gt;2,000 acres, Wild Areas, primitive recreation classifications</td>
</tr>
<tr>
<td>HCV 3</td>
<td>42,053</td>
<td>Natural Areas containing old growth forests, primitive recreation classifications, plant communities with S1 or S2 state rank</td>
</tr>
<tr>
<td>HCV 4</td>
<td>14,108</td>
<td>DEP Wellhead Protection Areas, DEP Surface Water Protection Areas, coastal floodplains (Little Tincum Island)</td>
</tr>
<tr>
<td>HCV 5</td>
<td>0</td>
<td>No areas included</td>
</tr>
<tr>
<td>HCV 6</td>
<td>268</td>
<td>Significant archeological or cultural sites</td>
</tr>
</tbody>
</table>

Table 6. Acres of High Conservation Value Forests by type.
# Land Inventories, Delineations, Classifications, and Designations Goals and Objectives

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To use landscape-level units built on ecological parameters to inventory, analyze, and plan management activities.</td>
<td>1.1 Use existing ecological units to develop a new forest management strategy that includes larger landscape management units (LMUs).</td>
</tr>
<tr>
<td></td>
<td>1.2 Develop eco-regional profiles and priorities that consider factors unique to each eco-region and incorporate into management planning.</td>
</tr>
<tr>
<td></td>
<td>1.3 Participate in efforts to reclassify terrestrial and palustrine plant communities and incorporate revisions into stand-level inventory and management.</td>
</tr>
<tr>
<td>2. To identify, designate, and manage special management areas to conserve unique ecological, geological, cultural, or social values.</td>
<td>2.1 Protect areas of scenic, historic, geologic or ecological significance through the establishment of natural areas that will remain in an undisturbed state, with development and maintenance being limited to that required for public health safety.</td>
</tr>
<tr>
<td></td>
<td>2.2 Set aside areas known as wild areas where development or disturbance of a permanent nature will be prohibited, thereby preserving the wild character of the area.</td>
</tr>
<tr>
<td></td>
<td>2.3 Manage and monitor areas designated for high conservation values or special management values.</td>
</tr>
<tr>
<td></td>
<td>2.4 Classify land with unique management opportunities and develop and implement strategies to promote these values, such as potential old-growth and primitive recreation classifications.</td>
</tr>
</tbody>
</table>
Monitoring and Adaptive Management

Monitoring is an important aspect of fully implementing ecosystem management principles on state forest lands. Through monitoring, one can identify changes in ecosystem characteristics that may be important for forest management or demonstrate whether current management practices are effectively meeting goals and objectives. Alternatively, one can also identify when current management is not effective by detecting undesirable changes. Monitoring is critical for providing the evidence for supporting the continuation of current practices or changes to planning and on-the-ground management practices in an adaptive context. The bureau conducts various types of monitoring activities in its management of state forest land.

**Inventory**

This type of monitoring is designed to establish reference conditions that can be used to quantify change. The BOF conducts several inventory activities on a periodic basis that are intended to gather critical information, useful both for assessing natural trends and detecting the effects of management regimes. Inventory programs continue to grow as technology advances. These inventories provide information on various levels, including statewide, eco-regional, individual state forest, landscape, and finally, plant community type, or forest stand level.

**Continuous Forest Inventory**

The purpose of the continuous forest inventory (CFI) is to provide basic biological data on herbaceous plants, shrubs, trees, tree growth and mortality, forest stand structure, volume, and change on state forest lands. The Resource Inventory and Monitoring Section conducts this inventory, which is a continuous process to provide data for developing periodic updates to resource management plans, as well as for long-range planning and monitoring. The basic design of the CFI is to proportionally allocate sample field plots among the major forest community types of state forests. This methodology has resulted in a system of more than 1,700 CFI plots located on 18 of the 20 forest districts. Data from these plots are used to generate descriptive statistics for state forest land.

The bureau began implementing a periodic timber inventory in 1955, focusing mainly on timber-oriented metrics of the overstory trees. The inventory was expanded in 1997 to include metrics pertaining to mid-canopy, ground flora, and coarse woody debris to make up the current CFI. Since formalizing the inventory in 1997, there have been three cycles of CFI data collection. A breakdown of plots measured by cycle is found below:

- **Cycle 1** – 1997 to 2000: 630 re-measured and 160 new plots
- **Cycle 2** – 2003 to 2006: 718 re-measured and 983 new plots
- **Cycle 3** – 2009 to 2013: 1,664 re-measured plots
The Resource Inventory and Monitoring Section has analyzed and summarized CFI data on statewide and eco-regional levels. These data are used for planning and implementation strategies on various levels, to establish baseline information, and to monitor change on state forest land.

**Landscape Exams**

The landscape examination is the primary planning tool for verifying management zoning and vegetation typing, identifying critical landscape features and opportunities, and identifying candidate areas for management activities in implementing the SFRMP. The landscape examination is designed to collect basic silvicultural, ecological, recreational, and cultural information to facilitate long-term planning for each of these opportunities and to monitor changes occurring at the landscape level. The data collected in landscape examinations also updates and adds to inventory data, but serves as a basis for developing project plans based on landscape-level conditions.

**Annual Forest Certification Surveillance and Recertification Audits**

Shortly after the development of the strategic plan, the management of the state forest underwent an independent third-party review based on the forest management principles established by the Forest Stewardship Council. The emergence of third-party certification grew out of a joint effort by environmental groups, forest industries, and other nonprofit economic development organizations to arrive at a consensus on numerous criteria for sustainable forest practices and to develop a process by which organizations, landowners, foresters, or industries could have their forest products certified as sustainably produced, through a third-party auditory process.

In 1998, state forest lands in Pennsylvania became certified as “well managed” based on the management principles established by the FSC toward long-term ecological, social, and economic sustainability. Since that time, state forest lands have undergone annual certification and five-year recertification audits to maintain certification. During the audit process, various facets of state forest management are evaluated to determine if these practices conform with the FSC U.S. Forest Management Standard. If non-conformances are witnessed, the bureau adjusts practices or develops new ones to remain in compliance.

The audits performed for FSC certification actually represent a form of implementation and effectiveness monitoring and assist the bureau in identifying gaps or improvement needs in management. In general, meeting the requirements of the certification process provides the bureau additional opportunities for institutional developments to support implementation of ecosystem management. Non-conformances generally result in improved efficiency and effectiveness in meeting desired goals on state forest lands. Audit reports are provided to the public on the bureau website.

The FSC is an independent organization supporting environmentally appropriate, socially beneficial, and economically viable management of the world’s forests. Timber harvested from Pennsylvania’s state forests is FSC certified, and certification ensures that products coming from state forest land are managed in an environmentally responsible manner.
Shale-Gas Monitoring Program

As part of its overarching goal of ensuring the sustainability of the commonwealth’s forests, the bureau established a Shale-Gas Monitoring Program to monitor, evaluate, and report on the impacts of shale-gas development to the state forest system and its stakeholders. The program aims to provide objective and credible information to the public and inform and improve shale-gas management efforts. The goal is to determine whether the bureau’s management of shale-gas development is effectively avoiding, minimizing, and mitigating impacts.

In 2014, the first Shale Gas Monitoring Report was released. The report represents the first iteration of measurements conducted from the start of shale-gas development on state forest lands through 2012. Future reports are anticipated as more data are collected and analyzed and more trends are observed. Because the report is intended to be objective and allow readers to make their own judgments based on their values, the bureau also provides raw monitoring data to the public for their own analysis. The Shale-Gas Monitoring Program is a long-term effort and one that the bureau is committed to continue. Additional information on shale-gas development can be found in the Geologic Resources chapter on page 130.

Implementation Monitoring

This type of monitoring is designed to assess whether activities were carried out as specified. The main challenge to this type of monitoring is in how one measures or evaluates the implementation. The objectives in the SFRMP are designed to be subject to implementation monitoring, such that the bureau can assess its progress in implementing the SFRMP.

Districts develop annual activity plans to describe activities taking place within the district, such as timber harvests, trail maintenance, and habitat modifications. Activity plans can be linked to the objectives of the SFRMP. Completion of an activity demonstrates progress toward SFRMP objectives. These activity plans can serve as a basis for future implementation monitoring.

Research

Research is utilized to verify assumptions, establish causal pathways, or identify a cause and effect relationship. This is the most rigorous type of monitoring and requires the highest level of specific expertise. The most current scientific findings, informed forestry trends, and relevant data provide the input for the bureau’s planning and operations. The bureau considers research findings and philosophies from various academic and professional institutions. These sources are used in the formulation of the bureau’s management approach and in training bureau personnel to use the most up-to-date methods and materials in their respective fields. External content is received from multiple sources.

The bureau’s goal is to review and participate in the sciences related to forestry and incorporate findings into guidelines and management techniques when possible. Additionally, the bureau aims to use current knowledge to provide training to staff in order to enhance overall forestry expertise.

Research conducted on state forest lands increases knowledge and provides benefits to society. The bureau
has a long history of cooperating with researchers, and the application of research results has kept the bureau among the leaders in public forest land management.

State forest lands and bureau personnel are subject to increasing demands and pressures from a wide range of users and user groups. Careful planning and coordination are essential to protect forest resources from overuse, avoid overburdening personnel, and minimize the potential for conflicts. To address these concerns, all requests to conduct research or other scientific studies on state forest land or other projects involving significant commitment of bureau resources, including personnel time, must undergo a project review and be approved by the state forester. This policy is intended to facilitate communication between the bureau and researchers through the use of formal agreements.

**Adaptive Management**

Through inventory, planning, and monitoring efforts, state forest managers can identify where management activities may have failed to produce desired results or where changes in forest conditions may have implications on the management strategies they employ. The process of “learning by doing” and integrating experiences and scientific information to improve practices is the basis of adaptive management. Adaptive management should not represent a “trial and error” or reactive approach to accounting for change, but should be an integral process in the implementation of ecosystem management. As activities and monitoring of results continue on state forest lands, the bureau employs adaptive management strategies to periodically update plans, guidance documents, or project specifications.

During management activities, the bureau assesses and reports on monitoring data in a variety of ways and adjusts management strategies to reflect the information realized through monitoring, improve efficiency, and achieve desired results. Often, monitoring and reporting is built into our day-to-day work, such as visually assessing the progress of a regenerating stand or evaluating invasive plant impacts. In other cases, resources are monitored in a more formal format and are reported on as information becomes available, such as with the Shale-Gas Monitoring Program.
Project Planning and Review

The bureau has implemented several practices to ensure that specific projects and management activities conform with its ecosystem management approach.

State Forest Environmental Reviews

State forest environmental reviews (SFERs) are a mechanism to propose projects and consider potential impacts for many operations on state forest lands that may or will disrupt, alter, or otherwise change the environment. These projects may include new recreation infrastructure or disturbance activities in wild and natural areas. SFERs are prepared by state forest districts with assistance from Central Office program areas to consider project impacts on environmental, social, or economic resources and are submitted for internal review. Comments are gathered and any necessary modifications may be made to the project specifications. All SFERs must be approved by the state forester with possible recommendations or conditions before the projects can begin.

Pennsylvania Natural Diversity Inventory

The Pennsylvania Natural Diversity Inventory (PNDI) is used to inventory, document, and monitor state and federally listed animal species, plant species, and other protected resources (threatened, endangered, or species of special concern). Data collection and management is performed largely by the Pennsylvania Natural Heritage Program, of which DCNR is a partner. The bureau has legal authority over state-listed plants, terrestrial invertebrates, natural communities, and unique geologic formations, and performs PNDI reviews for these resources across the state. The PNDI data is linked to an online tool that allows users to draw in the location of projects statewide, identify project type, and generate a receipt showing whether there are potential conflicts with species of special concern.

The bureau uses PNDI to screen projects for potential impacts to species of concern and develop mitigation or protection strategies for these resources. Although PNDIs are typically run for any projects that require a permit from the Department of Environmental Protection, the bureau expanded use of PNDI to include smaller, less disturbing activities that could still impact species of concern. As part of the timber sale proposal and SFER processes, a PNDI screening must be performed, and coordination with the Ecological Services Section and jurisdictional agencies is required to ensure that potential impacts have been reviewed by a wildlife biologist or botanist and that mitigation strategies are incorporated into project specifications.
Timber Sale Planning

Before a sale is submitted for proposal, several steps have to be met both in the field and procedurally. Several guidelines covering policies, haul roads, sale analysis, water resources, and regeneration need to be understood before working on sale proposals.

Scouting is the first and a necessary step in establishing a timber sale. Proper scouting will enable a forester to avoid costly mistakes and save valuable time in the marking and administration of a sale. Wet areas, trails, roads, streams, camps, and deer populations should be noted and planned for. The purpose of scouting is to determine if the sale is economically feasible and accessible, and to identify potential areas of concern for future evaluation (wetlands, endangered species habitat, etc.) Scouting provides valuable reconnaissance, which helps the forester determine where it might be most beneficial for silvicultural treatment of a forest, which silvicultural approach might be most appropriate, and if any additional treatments such as herbicide, fencing, and planting might be needed.

Once it has been determined that the sale area is operable, silvicultural treatment is prescribed for the involved stands, based on a sufficient number of SILVAH analysis plots. The sale area is then surveyed with a GPS unit. Areas of different treatments and paths for access roads, haul roads, and skid trails are flagged. A series of project maps are created, including:

- Map of all haul roads, landings, treatment blocks, trails, roads, and water resources
- Overlay of the typing layer on the proposed sale
- Topographic map showing physical terrain and drainages
- Soils map

A PNDI review is then conducted for the proposal, including correspondence regarding any conflicts with the appropriate jurisdictional agency. Conflicts may be resolved by seasonal restrictions, buffers, and in some cases, no-cut zones around sensitive areas and critical habitats.

The next step is to request any permits necessary for the sale, such as highway occupancy permits or stream crossing permits. If the sale includes more than 25 acres of haul roads and landings, then an NDPES permit will be required as well.

Other agencies or persons that may be affected by the proposed sale are consulted. This may include municipal water supply managers, state parks, oil and gas lessees, owners of rights-of way, leased-campsite owners, trail clubs, and/or adjacent landowners.

Once this preliminary work is completed, a formal timber sale proposal is submitted to the Silviculture Section for review and approval. This proposal includes the following:

- Description of the treatment goal and the reason for initiating the treatment
- Description of the area involved, including species composition, condition, history, and timber stand analysis using SILVAH
- Request and justification for any waivers to deviate from established policies on acreage limits, buffer impacts, or whole-tree harvesting
- The maps described above
- A copy of the PNDI search and any resulting agency correspondence
- Correspondence with any affected agencies or persons described above
Following approval of the timber sale proposal, the area will be marked and tallied. Marking must follow the guidelines in the Silviculture Manual, including the reservation guidelines.

Once the sale has been marked and tallied, bid documents will be prepared and advertised publicly to prospective bidders. A successful bidder will have to accept various contracts and bonding requirements set by the bureau.

The timber sale contract is a legal binding document. The bureau then takes an active role in sale administration and monitoring. The most important objective of sale administration is carrying out silvicultural treatments in a way that is environmentally sensitive. Maximum protection must be given to soil, water, and the residual stand to ensure their viability for the future. This must be done in a way that is practical under existing operating conditions, equipment limitations, policies, and procedures. The bureau expects and must have compliance with in the scope of the contract. The requirements of the contract must be fulfilled and duly executed by the operator. Foresters will inspect a sale at irregular intervals, but no more than one week apart. Inspection results are recorded, and any problems are dealt with directly until the matter is corrected.

Once logging operations have been completed, clean-up and road retirement has been conducted by the operator, and the operator has met all of the contract requirements, the sale can be closed.

**Prescribed Fire Planning**

The need to use prescribed fire for natural resource management on state forest land is based on the evaluation of the current and desired conditions for a number of factors such as fuel loading, species composition, and horizontal and vertical vegetative structure. These factors are then compared with a range of management options.
to determine if prescribed fire is the appropriate management tool to accomplish the resource management goals for the particular project area. Bureau of Forestry policy requires that prescribed fire shall be used only when it is deemed to be the most effective tool in meeting the desired resource need.

After the decision has been made to implement a prescribed fire for natural resource management, the planning process begins. A prescribed fire plan, also known as a burn plan, is prepared in accordance with the Pennsylvania Prescribed Fire Standards and the Pennsylvania Prescribed Fire Practices Act. Prescribed fire plans specify who will conduct the fire, the conditions and equipment needed to conduct the fire, the fire objectives, and other pertinent information needed to implement a successful burn. These plans are then reviewed for completeness and technical accuracy by the district forester, who serves as the agency administrator, and by the bureau’s prescribed fire specialist. The Silviculture Section also performs a review for all prescribed fires that are being used for silvicultural purposes, and the Ecological Services Section reviews the plan in conjunction with a PNDI review. Before the fire is implemented, pre-burn conditions are assessed by collecting vegetative data on overstory and understory vegetation. A specific prescribed fire monitoring protocol has been established to conduct this assessment. The same data is also collected after the prescribed fire has been completed in order to determine if the objectives specified in the prescribed fire plan have been met.

Upon completion of these reviews, the burn plan is considered to be final, and the project moves forward to implementation. Implementing a prescribed fire requires that staff monitor the fuel and weather conditions on and around the site where the fire will be conducted. When conditions are within the range of fuel and weather parameters specified in the plan, then the staff assigned to implement the project gathers the necessary tools and equipment needed for conducting the fire. All of these resources assemble on site, where a briefing provides the information needed to complete the project successfully. A final check is conducted to ensure that all preparations and notifications have been made before the fire is actually started. The fire is then ignited and progresses following the steps outlined in the plan. Weather and fuel conditions are monitored constantly throughout ignition of the fire. Following ignition, work continues until the fire is extinguished and no longer poses a threat of escape. Information and observations from the burn are compiled, and a report is submitted at the conclusion of the fire.
Since the inception of the Bureau of Forestry in the late 1800s, communications has been a cornerstone of the success and continued growth of the organization. Joseph Rothrock, the “Father of Pennsylvania Forestry,” lectured and wrote extensively to “incite the interest of people throughout the state — to preserve, protect, and propagate forests.” He understood the role communications played in meeting the needs of communities and improving their relationships with their natural resources.
Gifford Pinchot adopted the utilitarian philosophy for guiding forest management to provide “the greatest good for the greatest number.” Internally and externally, the bureau communicates with a diversity of people that have a variety of values, agendas, cultures, languages, and perceptions, and so the “greatest good” varies with demographics. Depending on what stakeholder group is surveyed, the public’s view of the bureau’s primary responsibility varies among different perspectives, such as: strict preservation, development of economic resources, serving as a sanctuary for wildlife, or providing recreational opportunities.

The Bureau of Forestry disseminates information to various destinations through various channels. Recipients of bureau content include researchers, government agencies, the public, and various stakeholders. The bureau contributes articles for publications as requested; it reports to government agencies and shares data with interested parties; and it develops educational content for broad use by the public. The bureau is also a source of unbiased, credible information on Pennsylvania forests and native wild plants, and it shares its data regularly.

Public education and outreach is an essential component of the bureau’s mission. DCNR’s enabling legislation mandates it to “promote forestry and the knowledge of forestry” throughout the commonwealth. The bureau’s mission further states that it will accomplish this by “advising and assisting other government agencies, communities, landowners, forest industry, and the general public in the wise stewardship and utilization of forest resources.” The bureau also has a responsibility in its mission for conservation of native wild plants, and part of this function involves educating the public on the importance of plant conservation. Fulfilling this role is vital in advancing forest and plant conservation throughout the commonwealth.

Effective public communication is especially vital to natural resource agencies, where conservation efforts are tied closely to promoting “stewardship,” or care of the resource, on the parts of individuals and communities. For example, the bureau promotes best land management practices by private forest land owners; it cautions people to be careful with fire; and it encourages people to plant trees along their streets and the streams that run through their communities. Furthermore, broader conservation strategies that go beyond the scope of individual action require a citizenry that appreciates and understands the benefits that forest resources provide to the community. Conservation funding, forest land acquisitions, community forestry programs, and forest-friendly land use planning efforts all require a constituency that actively promotes and supports forest conservation. The bureau employs effective communication, education, and public outreach in an effort to foster stewardship and convey a message of environmental sustainability.

The future success of many forest conservation efforts and programs, both on and off state forest land, in many ways hinges on the bureau’s ability to engage the public, especially youth, with forest resources and inspire the public to action. There is considerable concern and mounting evidence that people are increasingly disconnected and insulated from the natural world. This subject has been the source of books, newspaper articles, and conferences. Resource professionals point to a public that does not necessarily draw direct links between certain values and benefits and the forest’s role in providing them. For example, kayakers may appreciate and enjoy clean rivers and streams but may not be aware of the forest’s role in keeping watersheds healthy.

In the bureau, each forest district and each section of the central office is engaged in communicating. Additionally, the Communications Section consolidates communication activities to provide greater focus and streamlined coordination for the bureau’s outreach efforts.
Media

Newsletters and Publications
Print media are efficient ways to present information in various styles and contexts to many people. They are advantageous in many situations because the information content is recorded and can be copied and distributed widely over long time intervals. The bureau receives and sends printed content on a regular basis. Especially notable are the maps, brochures, and newsletters that the bureau produces (Table 1), and the forest districts and central office produce many informational pamphlets and brochures to inform interested patrons about the features of Pennsylvania state forests. Many bureau publications are also available electronically.

<table>
<thead>
<tr>
<th>Publication</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statewide welcome kit</td>
<td>A Pennsylvania map, jointly published with the Bureau of State Parks, that contains information on the state forests and parks and the various recreational activities available at each</td>
</tr>
<tr>
<td>Common Trees of Pennsylvania</td>
<td>A field identification guide published by the bureau on some of the most prevalent trees in the state. This is the bureau’s most popular publication.</td>
</tr>
<tr>
<td>State forest map and recreation guides</td>
<td>Individual maps for each forest district that contain physical information, roads and trails, and other landmark data. Each map also contains historical, ecological, and recreational information for its respective district.</td>
</tr>
<tr>
<td>District newsletters</td>
<td>Several forest districts publish the details of their happenings, including some statistics and photos. These are updated periodically.</td>
</tr>
<tr>
<td>Press releases</td>
<td>Statements to the public prepared by the DCNR press office in conjunction with the Communications Section</td>
</tr>
</tbody>
</table>

Table 1. Some notable Bureau of Forestry publications

Web and Electronic Media
In keeping with using current technology to communicate with user groups, the bureau maintains websites and other internet resources. The Bureau of Forestry website contains a variety of resources, including bureau-wide and district-specific information, current topics, educational resources about community forestry, and ecological material. Web users also can come here to learn about recreational opportunities, state forest policies, permits to engage the bureau in a business capacity, and contact information. Additionally, the bureau maintains a YouTube channel, where users can view informational videos relating to forestry. YouTube is a powerful audiovisual website that boasts more than 1 billion monthly users. According to Nielsen, YouTube reaches more U.S. adults ages 18 to 34 than any cable network, with the number of daily subscriptions having increased fourfold from 2013 to 2014 (Source: YouTube).

The bureau also manages an “Ask a PA Forester” email account where users can ask forestry related questions and receive professional feedback from the bureau. There also is a mobile app that people can use to obtain information on state forests and parks.
Social Media

Social media are public, web-based forums that allow people to share information informally in virtual communities and networks. Facebook is the largest online social medium, with 864 million daily active users and 1.35 billion monthly active users as of September 2014 (Source: Facebook). The bureau acknowledges the communication potential of these media. At the time of writing, the bureau and 12 state forest districts maintained public Facebook accounts (Table 2) to engage the public and provide educational information. Additionally, the Division of Forest Fire Protection maintains an informational account with Twitter, a social media site somewhat similar to Facebook. The bureau maintains a social media policy and set of guidelines.

<table>
<thead>
<tr>
<th>State Forest District</th>
<th>Facebook Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA Bureau of Forestry</td>
<td>Rothrock State Forest</td>
</tr>
<tr>
<td>Delaware State Forest</td>
<td>Susquehannock State Forest</td>
</tr>
<tr>
<td>Elk State Forest</td>
<td>Tiadaghton State Forest</td>
</tr>
<tr>
<td>Forbes State Forest</td>
<td>Tioga State Forest</td>
</tr>
<tr>
<td>Loyalsock State Forest</td>
<td>Tuscarora State Forest</td>
</tr>
<tr>
<td>Michaux State Forest</td>
<td>Weiser State Forest</td>
</tr>
</tbody>
</table>

Table 2. Bureau Facebook pages

Education, Interpretation, and Outreach

The communication of new knowledge plays a vital role in the management of forest resources in Pennsylvania. In addition to providing forest products and recreational opportunities, Pennsylvania state forests serve as an outdoor classroom and forest research laboratory. Currently, the bureau employs two environmental education specialists to facilitate interpretive programming with state forest users and conduct outreach activities, and state-of-the-art resource management centers house educational displays and stimulate interest in forest conservation. Bureau personnel also develop educational materials like lesson plans for use by other educators. In the field, the bureau posts interpretive panels to display information for the public about forest features, including ecology, history, and recreation. Demonstration areas are set aside to showcase examples of sustainable forestry practices for the sake of other landowners or interested persons.

Activities on state forest land generate significant interest from a variety of stakeholders, organizations, educational institutions, government agencies, and other groups. Periodically, tours are organized for these groups. These tours, conducted by both the bureau and its partners, offer valuable opportunities to demonstrate how management is conducted on state forests. The bureau strives to coordinate and manage outreach tours in a way that represents the full suite of uses and values of the state forest system. The bureau takes the opportunity to convey stewardship messages, impressing upon attendees that ecosystem management is the core principle by which state forest lands are managed.
**Key Messages**

DCNR has developed a set of “key messages” to use in the development of publications, outreach, and interpretive material. The bureau also has developed a set of forest-related key messages that complements the department’s communications efforts. The bureau considers and uses these key messages when developing communications products.

**Natural resources are critical to our health, economy, and quality of life.**

- Forests are Pennsylvania’s principal land use.
- Forests provide vital services to society. They clean our air, purify our water, provide habitat for plants and animals, and support key ecological processes.
- Forests provide a renewable source of wood products to society.

**Everyone uses and has the opportunity to enjoy Pennsylvania’s vast natural resources.**

- Healthy forests benefit all citizens, no matter where they live.
- Forests provide nearly boundless opportunities for healthful recreation.
- Forests serve as a source of inspiration and wonder.
- There is a forest to explore near you.

**DCNR leads everyday efforts to conserve Pennsylvania’s natural resources and connect people to the outdoors.**

- DCNR Bureau of Forestry leads Pennsylvania in forest and native wild plant conservation and stewardship.
- DCNR Bureau of Forestry seeks to foster an awareness of the forests’ many uses and values and inspire people to conserve them.

**The future of Pennsylvania’s natural resources depends on you.**

- People and communities every day shape the future of Pennsylvania’s forests.
- Sustaining our forests and associated values depends on wise stewardship.
- We have a responsibility to manage our forests for current and future generations.

**Service Foresters**

Service foresters work for the bureau and promote the conservation of private forest lands. One of their functions is to provide landowners with advice and guidance on how to manage their forested lands. Service foresters work in forest districts on the county level to encourage sustainable forest management. The bureau maintains a list of service foresters by county. Service foresters may provide the following:

- Sustainable forest management technical assistance
- Cost-share assistance
- Information on hiring a professional forester
- Help with writing and reviewing forest stewardship plans
- Regional planning advice
- Forestry and water best management practices advice
• Educational programs
• Urban and community forestry management assistance
• Tree planting for riparian forest buffer restoration

**Envirothon**

Hundreds of teachers and professionals throughout Pennsylvania guide high school students through Envirothon, a natural resource environmental education program that combines classroom learning and outdoor activities. This exposure to nature and the impact of humans on the natural world provides invaluable lessons for understanding ecosystems and our environment.

At Envirothon, teams of high school students compete in field testing using their knowledge in five topic areas, including forestry. The bureau, particularly service foresters, teaches basic forestry principles from tree identification to forest structure and dynamics and assists in administering the test.

**Forest Fire Prevention**

DCNR is legally mandated to provide for the protection of all wild lands in the commonwealth from damage by wildfire (71 P.S.§ 1340.302d). This mandate is accomplished by a combination of wildfire prevention, suppression, investigation, and preparedness. Public safety and awareness in wildfire prevention is enhanced through education. The Smokey Bear program is administered by the U.S. Forest Service, and the bureau’s fire wardens may offer local Smokey Bear prevention programs.

**Public Safety**

The bureau promotes safe experiences through administration of the ranger program and through state forest officers. The role of state forest rangers is to provide visitor services, educational programs, and information and to enforce forestry rules and regulations and commonwealth laws. Rangers have full state police powers and address violations occurring on DCNR lands.

The bureau employs 37 rangers across the state forest system. In addition, state forest officers have authority to enforce various state forest rules and regulations, but only have jurisdiction on state forest lands. The bureau has 288 personnel with state forest officer duties.

DCNR is the primary coordinator for search-and-rescue efforts on state forest and state park lands within the commonwealth. The DCNR search-and-rescue website provides search-and-rescue information and promotes outdoor safety to help ensure that visitors have safe and enjoyable experiences.

**Project Learning Tree**

*Project Learning Tree* (PLT) is an award-winning, environmental education program designed for educators working with youth from preschool through 12th grade. It uses hands-on, interdisciplinary activities to help students learn how to think, not what to think, about complex environmental issues. PLT is the environmental education program of the American Forest Foundation, (AFF).

DCNR is the state sponsor and coordinator of Project Learning Tree in Pennsylvania. As the department’s forest content expert, the Bureau of Forestry has taken a key role in moving this program forward. Since the bureau began sponsoring PLT in Pennsylvania, 150 DCNR staff members have been trained as PLT facilitators. In 2014, support, materials, and additional training were provided for these facilitators to complete 24 workshops for 554 educators across Pennsylvania. The bureau works cooperatively with the Bureau of State Parks and the state’s other co-sponsor, the Pennsylvania Alliance of Environmental Educators.
Forest Demonstration Sites
The bureau has co-developed timber harvesting demonstration areas to exemplify harvesting techniques and introduce private landowners and other citizens to the benefits and consequences of different timber harvesting methods. At the demonstration areas, different area blocks have received different timber treatments, including: a control area, clearcut, improvement thinning, thinning from above, and thinning from below. Some areas also include shelter wood, crop tree, and group selection treatments and some deer exclusion areas. For each treatment block, researchers have been recording data on species diversity, forest conditions, mortality rates, and economic value over time.

Numbered interpretive signs identify the treatments, and self-guided tour brochures are usually available in a box near the start of the demonstration trail or at the corresponding state forest office. Forest landowners, especially those planning a timber harvest, should visit one of these demonstration areas to investigate the results from different methods of logging.

Figure 1. Locations of forest demonstration sites.

Public Engagement
The bureau is committed to providing opportunities for the public to be engaged in its activities. Penn’s Woods and the SFRMP outline the policies and processes for public participation in state forest resource management planning. Central to state forest management is an understanding of the concerns and needs of Pennsylvania’s citizens, who ultimately own the state forest. Within the bureau’s overall approach to public engagement, there are many avenues for various stakeholders to express their views and perspectives, including public meetings and tours, surveys and comment cards, and advisory committees. Additionally, DCNR rangers provide visitor services and public contact while enforcing resource protection and public safety on state forest lands.

The bureau has cooperated with Penn State University to adapt a visitor use monitoring (VUM) program for state forests and parks. VUM produces estimates of the volume of recreation visitation and produces descriptive information about visitation including activity participation, demographics, visit duration, measures of satisfaction, and spending connected to the visit. To understand needs and concerns in the short term, the bureau duplicated a portion of the VUM survey on postage-paid index cards. The cards are placed in boxes in high-use recreation areas. Through these comment cards, the bureau receives ongoing feedback from visitors.
Advisory Committees

Collaboration, facilitation, information sharing, and informal dialogue are key principles that guide the management and work of bureau advisory committees (Table 3). This is rooted in the bureau’s approach to promoting stakeholder feedback and methods for managing public meetings. The bureau provides specific mechanisms and encourages stakeholders with divergent interests to express their viewpoints and recommendations in an atmosphere that promotes common understandings and acknowledges differing opinions. Gathering diverse opinions allows the bureau to make better, more-informed decisions. This informal approach results in greater dialogue and transparency and produces recommendations and other products supported and understood by all committee members. If a committee identifies differing recommendations, then those differences are noted and provided. The committee typically does not vote on recommendations. The recommendations are provided to DCNR for consideration.

<table>
<thead>
<tr>
<th>Committee Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation and Natural Resources Advisory Committee</td>
</tr>
<tr>
<td>Ecosystem Management Advisory Committee</td>
</tr>
<tr>
<td>Natural Gas Advisory Committee</td>
</tr>
<tr>
<td>PA Appalachian Trail Committee</td>
</tr>
<tr>
<td>PA Biological Survey and Vascular Plant Technical Committee</td>
</tr>
<tr>
<td>PA Forest Stewardship Steering Committee</td>
</tr>
<tr>
<td>PA Greenways Partnership Commission</td>
</tr>
<tr>
<td>PA Rare Plant Committee</td>
</tr>
<tr>
<td>PA Urban and Community Forestry Council</td>
</tr>
<tr>
<td>Pine Creek Rail Trail Advisory Committee</td>
</tr>
<tr>
<td>Recreation Advisory Committee</td>
</tr>
<tr>
<td>Silviculture/Timer Advisory Committee</td>
</tr>
<tr>
<td>Snowmobile and ATV Advisory Committee</td>
</tr>
</tbody>
</table>

Table 3. BOF advisory committees
Communications Management Principle
The citizens of Pennsylvania appreciate the forests of Pennsylvania and their resources and values and are engaged in the issues that affect them.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To provide education and interpretive opportunities regarding the values, services, and benefits of sustainable forest management.</td>
<td>1.1 Promote Project Learning Tree with Pennsylvania educators and youth leaders through workshops and material support.</td>
</tr>
<tr>
<td></td>
<td>1.2 Promote forestry and conservation through public education and outreach such as the statewide Envirothon, natural gas tours, ECO Camp, and other public programming partnerships.</td>
</tr>
<tr>
<td></td>
<td>1.3 Provide forest demonstration areas throughout the state forest system that show forest management practices.</td>
</tr>
<tr>
<td></td>
<td>1.4 Create statewide and district interpretive plans and increase the use of interpretive resources.</td>
</tr>
<tr>
<td></td>
<td>1.5 Promote a public stewardship ethic regarding the commonwealth’s forests and wild plant resources.</td>
</tr>
<tr>
<td></td>
<td>1.6 Develop state-of-the-art resource management centers to house educational displays and stimulate interest in forest conservation.</td>
</tr>
<tr>
<td>2. To provide customer service and information that promote the use and enjoyment of the state forest system.</td>
<td>2.1 Maintain a steady and available supply of our public use maps, guides, and printed materials.</td>
</tr>
<tr>
<td></td>
<td>2.2 Continually update and utilize electronic media, providing information in an engaging format on the bureau and its work.</td>
</tr>
<tr>
<td>3. To engage the public and consider input in state forest management decisions.</td>
<td>3.1 Utilize advisory committees to engage stakeholders.</td>
</tr>
<tr>
<td></td>
<td>3.2 Provide information on forests, forest issues, and native wild plants.</td>
</tr>
<tr>
<td></td>
<td>3.3 Plan and coordinate public meetings on specific bureau topics including the SFRMP process and shale-gas management as well as issues of local interest at the district level.</td>
</tr>
<tr>
<td></td>
<td>3.4 Monitor and respond to social media questions and comments.</td>
</tr>
<tr>
<td></td>
<td>3.5 Coordinate responses to public inquiries on state forest management topics.</td>
</tr>
</tbody>
</table>
**Guidelines, Tools, and Resources**

**Template Guidelines**
There are guidelines that should be used by state park and state forest staff to guide the look and feel of promotional materials such as program- and event-specific brochures, like forestry trail guides and bird watching guides, in addition to fliers, fact sheets, newsletters, and so on.

**Map and Recreation Guide Process**
This process document informs staff of what to expect when preparing a new version of a state forest map and recreation guide for print.

**Procedures for Wayside Exhibits**
This document details the process for constructing a wayside exhibit on state forest lands and includes the approval points for the Communications Section.

**Transition Document, January 2015**
This document is intended to inform an incoming executive administration of the activities of the bureau. The document depicts a broad picture and provides a summary of all the major bureau program activities at a section-by-section level.

**UCM Contributor Instructions & Website**
**Style Guidelines Manual**
The guidelines and step-by-step instructions for creating and managing DCNR web content are found in this manual. Style guidelines, editing instructions, and best practices and standards for writing are included.

**PA DCNR Social Media Guidelines**
This document contains DCNR’s social media goal, “to increase interaction and two-way communication with various audiences to encourage involvement with Pennsylvania’s state parks, forests, and natural resources,” as well as overall social media guidelines. Additionally, goals and directions specific to Twitter and Facebook are provided.

**Monitoring**
- Social media activity
- Public input opportunities
  - Online surveys
  - Visitor use monitoring
  - Comment cards
  - Advisory committee meetings
According to the Conservation and Natural Resources Act, one of the purposes for the creation of a state forest system was “…to provide a continuous supply of timber, lumber, wood, and other forest products…” and thus an important economic resource in Pennsylvania. In addition, managing timber and non-timber forest products (NTFPs) is central to the bureau’s mission “to ensure the long-term health, viability, and productivity of the commonwealth’s forests and to conserve native wild plants.” Forest products, whether timber or NTFPs, are managed on state forest lands as a component of ecosystem management and to provide a wide variety of environmental, social, and economic values.

Pennsylvania’s state forests contain an abundance of high-quality forest products, an integral part of the materials base of the commonwealth’s $19 billion per year forest products industry, which employs nearly 58,000 people. Both Pennsylvania’s consumers and the general economy benefit from this regionally important supply of forest products, including timber.
To retain forest productivity, it is essential that forest products be harvested in an environmentally sensitive manner that ensures forest renewal. The bureau accomplishes this by harvesting timber using best management practices that are derived from silvicultural and ecological research. Silviculture is defined as “the art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values of landowners on a sustainable basis” (SAF 1998). Silviculture is a tool for altering the forest condition to attain predefined needs or values, such as regenerating the forest, securing a sustainable flow of timber products, conserving and perpetuating underrepresented forest community types, and creating or enhancing specific types of wildlife habitat.

For the purposes of this plan, NTFPs are plants, plant parts, fuelwood, or other products not associated with timber sales that have perceived economic or consumption value. Such products may be all or part of living or dead plants, lichens, fungi, or other forest organisms. NTFPs may include herbaceous understory plants known or believed to have medicinal or tonic properties, including American ginseng, goldenseal, wild sarsaparilla, and black cohosh. Other NTFP species are valued for their decorative or ornamental value, such as princess pine, teaberry, mosses, fungi and lichens, pine knots, driftwood, and pine cones. Some NTFPs are used for food, such as wild leeks and various species of mushrooms, berries, and nuts. NTFPs also include fuelwood, specific trees for posts and sawdust, and stone or gravel removals for individual use. NTFPs, therefore, represent a diversity of potential products sought by a wide variety of people at varying scales and intensities. Because of the potential impacts of NTFP harvesting on biodiversity, the bureau tries to understand the issues surrounding NTFPs and develop effective strategies for managing these resources.

**History of Timber in Pennsylvania**

At the turn of the 19th century, Pennsylvania’s native forests lay barren, exploited by industrial logging operations and the ravenous forest fires that often followed. Large treeless landscapes were common in Pennsylvania. In 1896, before fire wardens were appointed, Pennsylvania lost 280 square miles (179,000 acres) of forests to wildfires. Without any leaf litter and roots to hold soils in place, rain storms caused huge floods in downstream cities and eroded the landscape. Heavy erosion and wildfires slowed the reestablishment of new trees on these barren lands. High real estate taxes and low land values caused many landowners to abandon their land.

In 1895, nearly all forest land in Pennsylvania was held by private interests, but the newly established Forestry Commission began purchasing large parcels of land using county tax sales. Stringent new fire laws were passed, and the new Division of Forestry was tasked with enforcing them and suppressing fires to allow new forest to develop. An excellent historical account of this period is more fully described in the *The Legacy of Penn’s Woods: A History of the Pennsylvania Bureau of Forestry*.

In 1899, the Forestry Commission began planting trees in areas where fires had so completely destroyed the landscape that no natural seed sources were available. By 1909, silvicultural operations to aid in establishment of the new forest had grown into a large program. By 1923, 34.9 million tree seedlings were being grown in state nurseries and then planted, mostly on state forest land. With the Great Depression and the start of Franklin Roosevelt’s Civilian Conservation Corps (CCC), forestry projects saw a great influx of labor and funding. By 1936, the Department of Forestry had four large nurseries and was producing 179 million tree seedlings per year. The CCC conducted forest improvement treatments on countless acres of young forest stands and developed most of the state forest road system that is still used today.
The start of World War II marked the first significant timber removals from state forest land. Many of the trees targeted for harvesting were those which had been established in reserves 50 years prior. The Pennsylvania Timber Production War Project was initiated to coordinate the harvesting, carried out via diameter-limit cutting; these harvests resulted in all trees over a target diameter being harvested. These harvests were carried out by 1,750 prisoners of war, placed in old CCC camps by the U.S. Army.

As Pennsylvania’s forests developed, it became clear that a plan for their management would be necessary. The first plan was developed in 1955, followed by additional planning efforts in 1970, 1985, and 2003. The 1955 plan was based on single-tree selection silviculture and the establishment of an uneven-age management system. Following poor regeneration results that followed selection harvesting, management plans were amended in 1965 to include even-age management systems. The 1970 plan recognized both even-age and uneven-age silvicultural treatments and established natural and wild areas. The 1985 resource plan was developed based on the multiple resource management of water, recreation, fauna and flora, timber, and minerals. With each of these plans, forest inventories were completed and new management maps were drafted. The 2003 plan marked the shift to an ecosystem management approach.

In 1998, state forest lands in Pennsylvania became “certified” based on the management principles established by the Forest Stewardship Council (FSC) toward long-term ecological, social, and economic sustainability. The results of the FSC’s evaluation established the bureau as one of the first and largest governmental entities to be certified. Since that time, state forest lands have undergone annual certification and five-year recertification audits to maintain certification. FSC certification is especially important to the timber industry due to the premium price that can be charged for certified timber, and this has allowed the bureau to manage and sell timber in areas with otherwise lower economic potential.

Today, the United States is the largest consumer of round wood and pulp wood in the world. Pennsylvania leads the nation in hardwood log production, and these forest products from state forest lands are essential to our state and regional economies. On a global level, log exports to Asia have increased significantly in the last five years to
feed a growing housing market. In addition, the demand for certified pulp and chip products also greatly increased. When traditional timber prices stumbled in 2007, pulp prices continued to increase and supplement the logging industry. Today, state forests represent the largest single forest ownership in Pennsylvania and continue to provide forest products and benefits to the citizens of Pennsylvania.

### Timber Condition on State Forest Lands

#### Forest Types

The Continuous Forest Inventory (CFI) provides basic biological data on herbaceous plants, shrubs, trees, tree growth and mortality, forest stand structure, volume, and change on state forest lands. On state forest land, more than 50 typed plant communities have been identified in accordance with the bureau’s typing manual. The bureau recognizes seven aggregated forest types on state forest land, and each forest type includes one or several dominant plant communities (Table 1).

In the most recent CFI cycle (2009 to 2014), red maple is the most prevalent species on state forest lands, based on number of stems and plot occurrence (Figure 2). Oaks, as a group (northern red oak, scarlet oak, black oak, chestnut oak, and white oak), are ranked second in number of stems. Other important species, such as American beech and conifers, also are common on state forest lands.

![Table 1. Aggregated forest types and prevalent communities](image1)

<table>
<thead>
<tr>
<th>Aggregated Forest Type</th>
<th>Prevalent Community Type(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allegheny hardwoods</td>
<td>Black cherry</td>
</tr>
<tr>
<td>Northern hardwoods</td>
<td>Northern hardwoods, Sugar maple</td>
</tr>
<tr>
<td>Red oak</td>
<td>Red oak</td>
</tr>
<tr>
<td>Other oak</td>
<td>Dry oak — mixed hardwood</td>
</tr>
<tr>
<td></td>
<td>Dry oak — heath</td>
</tr>
<tr>
<td>Red maple</td>
<td>Red maple</td>
</tr>
<tr>
<td>Conifers</td>
<td>Hemlock (white pine)</td>
</tr>
<tr>
<td></td>
<td>Dry white pine (hemlock) — oak</td>
</tr>
<tr>
<td></td>
<td>Hemlock (white pine) — northern hardwood</td>
</tr>
<tr>
<td></td>
<td>Hemlock (white pine) — red oak — mixed hardwood</td>
</tr>
<tr>
<td></td>
<td>Hemlock — tuliptree — birch</td>
</tr>
<tr>
<td></td>
<td>Hemlock — rich mesic</td>
</tr>
<tr>
<td></td>
<td>Red pine — mixed hardwood</td>
</tr>
<tr>
<td></td>
<td>Spruce plantation</td>
</tr>
<tr>
<td>Other hardwoods</td>
<td>Aspen, Pitch pine, Virginia pine, Black gum, Etc.</td>
</tr>
</tbody>
</table>

![Figure 2. Presence of different species and species groups on state forest lands, based on their occurrences at sample plots and their total number of stems counted during sampling](image2)
**Timber Volume**
The three completed CFI cycles show that the diameter class distribution has changed in the last 15 years (Figure 3). State forest lands now have more volume in higher diameter classes. Although plots are not measured following a timber harvest, remeasured plots show increase in biomass over time. This suggests that the implementation of the bureau’s timber harvesting plan, as well as individual tree growth, is shifting the diameter distribution.

**Age Class Distribution**
The current age class distribution of the forest is unsustainable in the long term. There is an overabundance of acreage in mature age classes, and early successional forest habitat is lacking. One of the bureau’s primary silvicultural goals is to balance the age distribution of the forest in the multiple resource/commercial land base so that each year, a relatively consistent number of mature acres can be harvested, regenerated, regrown, and reharvested in perpetuity. Additionally, achieving a balanced age class distribution establishes adequate levels of wildlife habitat across all successional stages of the forest, which is needed to sustain ecosystem functions and promote forest health. The harvest model also creates harvest schedules that distribute acreage more evenly across all age classes, forest types, and site classes over time. Balanced age classes also lead to more even, predictable flows of timber to the economy.

**Regeneration**
Regenerating the forest has been a continuing challenge on state forest lands. Many stands have inhibiting factors working against the establishment of desirable regeneration. These factors may include deer, inhibiting vegetation, exotic invasive vegetation, lack of seed source, mortality, thick duff, site limitations, and potential climatic variables. All silviculture and timber management plans are written to mitigate against these factors.

*Figure 3.* Average volume per acre of state forest lands by diameter class. The majority of the 1,664 CFI plots were located in the multiple resource, limited resource, and buffer management zones, with 58 plots located within wild and natural areas.
In 1996, to aid in the bureau’s regeneration efforts, the Forest Regeneration Restricted Revenue Account was established, commonly referred to as the “regeneration fund.” This funding allows 10 percent of revenues generated through state forest timber sales to be reinvested in projects to establish new forests. The bureau spends more than $3 million annually from the regeneration fund, which makes up a large part of the silvicultural projects in many districts. The regeneration fund provides funding to employ a wide range of tools to promote regeneration through projects such as fencing to exclude deer, herbicide application and prescribed fire to combat inhibiting or invasive vegetation, and tree planting in areas with poor seed source, as well as equipment to complete these projects, such as back-pack sprayers, herbicides, royer attachments for skid steers, and drip torches.
Forest managers and researchers generally agree that overabundant white-tailed deer populations have the greatest impact on forest ecosystems in some areas. Following decades of high deer populations, the forest understory became dominated by shrubs, ferns, and other herbaceous vegetation, thus preventing the establishment of young tree seedlings. In areas where young trees have managed to become established, regeneration of the forest is successful on state forest lands. To address deer management and regeneration issues, the bureau continues to fund regeneration programs, support and engage in regeneration-related research, and partner with other agencies, such as the Pennsylvania Game Commission and U.S. Forest Service, to work toward solutions, including the Deer Management Assistance Program.

Competing vegetation is defined as any vegetation that interferes with the establishment of acceptable tree regeneration as part of a prescribed silvicultural treatment. Regeneration treatments targeting competing vegetation species such as beech brush, striped maple, and ferns, which have been identified by research to be a problem. All potential treatment methods that would control the target species should be considered. Precisely targeted treatments are generally preferred over broad spectrum applications if they are cost effective. In choosing a control method, foresters try to achieve the best balance of effectiveness, cost efficiency, and environmental acceptability.

### Table 2. Acres of regeneration treatments by treatment type and year

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fence installation</td>
<td>3,034</td>
<td>2,571</td>
<td>1,846</td>
<td>1,936</td>
<td>2,158</td>
<td>1,594</td>
<td>2,677</td>
</tr>
<tr>
<td>Herbicide contract</td>
<td>6,260</td>
<td>6,450</td>
<td>5,262</td>
<td>4,834</td>
<td>5,073</td>
<td>5,776</td>
<td>3,992</td>
</tr>
<tr>
<td>Mowing</td>
<td>553</td>
<td>369</td>
<td>380</td>
<td>537</td>
<td>768</td>
<td>701</td>
<td>505</td>
</tr>
<tr>
<td>Planting</td>
<td>1,374</td>
<td>1,879</td>
<td>4,314</td>
<td>3,995</td>
<td>3,961</td>
<td>4,576</td>
<td>3,795</td>
</tr>
<tr>
<td>District herbicide</td>
<td>2,859</td>
<td>1,373</td>
<td>953</td>
<td>1,776</td>
<td>1,715</td>
<td>918</td>
<td>1,136</td>
</tr>
<tr>
<td>Fence dismantling</td>
<td>2,688</td>
<td>1,662</td>
<td>2,111</td>
<td>2,802</td>
<td>2,094</td>
<td>1,447</td>
<td>3,099</td>
</tr>
</tbody>
</table>

### Timber Management on State Forest Lands

Managing timber under sound ecosystem management principles requires considering the complexities of forest ecosystems and maintenance of all vital parts of the ecosystem. The bureau uses many tools to manage forest ecosystems and their products on state forest lands in accordance with these principles.

### Timber Management Systems

Nearly all of Pennsylvania’s state forest land base consists of second-growth forests established as a result of widespread timber and charcoaling industries of the late 1800s and early 1900s. As a result, most of the forest types are even-aged. In addition many of the desirable tree species found in our forests, both from a timber and a wildlife perspective, regenerate best in full sunlight. Perpetuation of our current timber types is most effectively accomplished through the use of even-aged management strategies. Most of the goals set forth in the harvest allocation model will be achieved through the practice of even-aged management.

### Regeneration Harvests

Regeneration harvests are designed to replace an older age class stand with a younger one. These include overstory removals, clearcuts, and seed tree cuts. Ideally, these harvests should fall within the constraints of the harvest allocation model and occur within targeted acreages.
for types and site classes to be harvested. Widespread deviations from the harvest allocation model should be avoided unless districtwide salvage events, significant changes in typing, land acquisitions, or natural disturbance require a flexible course of action. The bureau focuses on regenerating harvests, but it may be necessary to conduct shelterwood or some other preparatory timber harvest to achieve regeneration acreage goals. A shelterwood is the attempted establishment of a new cohort of natural regeneration through the partial removal of the overstory. The purposes for shelterwoods include fostering potential seed producers and controlling light levels within the stand to allow specific species of new seedlings to become established.

**Size and Shape of Regeneration Harvests**

The size limit of reproduction cuts mitigates potential social and ecological impacts of timber harvests. In addition, reservation guidelines and buffers (discussed below) are, in part, necessary to ameliorate the visual impacts of regeneration harvests. Regeneration harvests should be irregular in shape, greater than 10 acres in size, and should not isolate small pockets of standing timber that will be too small to manage in the future. To mitigate the social and aesthetic impacts of timber harvests, the bureau limits regeneration harvests to 125 acres (75 acres for districts 19, 4, and 1). Permission from the state forester is required to exceed these sizes. Waivers to regeneration harvest size are often necessary to advance certain ecological and landscape goals, make low-value harvests economically feasible, prevent the isolation of small pockets of standing timber, take advantage of exceptional regeneration, and facilitate timber salvage and forest restoration operations after significant mortality events. When regeneration harvests exceed the normal size restriction, the bureau will, when possible, implement practices to limit the social, aesthetic, and ecological impacts of the timber sale. In some instances, a single larger timber harvest may better achieve landscape-level goals while having less social impact than multiple smaller harvests. Therefore, regeneration harvests that exceed the maximum size are considered on a case-by-case basis.

**Reservation Guidelines**

In every final regeneration treatment, various trees should be reserved for the future stand. Reserved trees potentially can serve multiple ecological functions. They can provide structural habitat factors for wildlife; they can serve as seed sources both for stand regeneration and for wildlife forage; and they can help to retain forest aesthetics in the area.

Residual selections may be a mix between single-tree and clump reservations, with most of the sale area being occupied by clump reservations whenever possible, as this preserves greater structural diversity than single-tree reservations. The trees should be reserved for superior genetic, species, and structural diversity. For overstory removals and clearcuts, 10 to 20 square feet per acre should be maintained across the entire stand area. For all two-aged stands, 20 to 40 BA to the acre should be reserved. Harvest openings with no retention are limited to 10 acres.

Foresters should seize opportunities to expand and improve wildlife habitats as part of the reservation guidelines. Snags and den trees should be reserved, and additional snags can be created where they are lacking by girdling additional trees. The assortment of clump reservations and single trees should be selected to promote the desired structural diversity. The Wildlife Habitat Guidelines describe management of habitat types and factors. Reserve trees also should be selected with consideration for social and recreational impacts.

**Intermediate Treatments in Even-aged Stands**

An intermediate treatment is a marginal cutting that occurs after establishment of regeneration and prior to final harvest. The purpose of intermediate treatments in even-aged stands is to improve species composition, release desirable trees, control spacing, and shorten the overall
stand rotation. Thinnings and improvement cuts work best in younger stands where trees will show response to more available nutrients and light through improved growth and vigor.

Increased growth rate may shorten the rotation length as opposed to if the stand was left otherwise untended. Older, more mature trees are slower to respond. Due to the older condition of many of the stands on state forest lands, the instances to practice improvement cutting will be limited. However, the opportunity to apply improvement cuttings to some of the earliest clearcuts will be coming in the next few years. Some of these stands were cut in the mid-1960s and soon will be approaching the 50- to 60-year range. Crop-tree thinnings are a pre-commercial option for younger stands where timber has not yet reached a commercial size.

**Buffer Management**

Buffers are managed differently than even-aged stands. The reasons for having buffers on state forest lands include aesthetics, water resource protection, and recreational resource protection. Some buffers are no-management zones, and others require at least a partial canopy to be maintained. Aesthetics should be considered along forest roads and near leased forest camp sites. Typing maps, landscape exams, and district resource plans should be consulted to determine the nature of a buffer, and if it is commercial or non-commercial (no cut). The ultimate goal of a mature buffer stand should be regeneration of the stand while maintaining aesthetics or ecological benefits. Herbicide treatments and fencing may be necessary to achieve this. When uneven-aged silvicultural techniques are used (e.g., individual tree selection or group selection), canopy openings are less than 2.5 acres.

**Two-aged Management in Buffers**

Two-aged management is a relatively new practice to the bureau. Research has shown that uneven-aged management for oak species and many northern hardwood species does not work well in the uneven-aged stand condition prevalent on state forest land. Uneven-aged management in many of these stands results in decreased yields and the loss of shade intolerant species that define and are beneficial for those forest types from timber, ecological, and wildlife perspectives.

Two-aged management is an overstory removal with higher residual basal areas reserved throughout the stand. Usually 20 to 30 square feet of basal area should remain in the overstory in oak stands, and 10 to 20 square feet in
northern hardwood stands. The higher light intensities in these stands are conducive to regenerating shade intolerant and moderately shade tolerant species. The careful planning that goes into establishing even-aged stands is necessary in two-aged buffers.

**Salvage Operations**

When known mortality events take place in a district, every effort should be made to determine the value of the affected stand or group of stands and whether a salvage operation is the appropriate course of action. When evaluating a possible salvage operation, careful considerations should be made, such as a cost-benefit analysis and the regeneration potential of the stand. Salvage operations, when possible, should coincide with silvicultural practices and should promote desired landscape conditions and other resource management goals.

**Timber Harvest Scheduling**

The bureau formed a partnership with Pennsylvania State University to develop a timber harvest allocation model. Through the partnership, the bureau created timber harvest schedules that accomplish goals in efficient ways, evaluate tradeoffs among competing interests, and anticipate and avoid problems in the future. The model uses the bureau’s forest inventory data, economic information, bureau policies, and desired ending target forest conditions to develop timber harvest schedules that best meet the bureau’s silvicultural and timber management goals. The model, which relies on linear programming, is intended for large-scale planning (10,000s to 100,000s of acres of forest land) and for long-range planning horizons (100+ years). The parameters, inventories, constraints, and modelling approach help the bureau create feasible timber harvest schedules that achieve silvicultural goals.

The estimated commercial land base for the timber model is determined from the forest stands zoned multiple resource and typed for commercial availability (M&C). A timber harvest schedule derived from the model specifies the number of acres to harvest from each aggregated forest type, site class, stocking level, and 10-year age class combination by treatment (shelterwood or overstory removal) in each 10-year planning period over the entire planning horizon (~140 years). These timber harvest schedules do not assign individual forest stands for harvest, so the boundaries of treatments are determined by field staff and may contain combinations of portions of multiple forest stands.

The timber harvest schedules are intended to be used as a guide for district staff, along with their field expertise and professional judgment, to plan harvests. The harvest schedule’s 10-year acreage targets are divided by 10 to determine annual targets for operational purposes. However, current accessibility (haul road infrastructure), the general need to disperse harvests across the district, spatial orientation of stands, natural disturbance events, insect and disease outbreaks, and other factors may determine where and when timber sales are implemented.

It may not be feasible for field managers to strictly meet annual harvest targets every year. Therefore, field managers must understand the hierarchy among the different harvest targets in the timber harvest schedules and continuously monitor and adapt to stay on course. The bullets below list some examples of how managers must adapt and understand the hierarchies among the harvest schedule’s targets:

- Cumulative 10-year harvest targets are higher ranking than annual harvest targets. If less acreage is harvested in a given year for a specified annual harvest target, then the following year should compensate so that the cumulative acres harvested stays on track to meet the 10-year target.
- Overstory removal treatments are the most important treatment because they regenerate the forest and balance the age class distribution, while shelterwood treatments do not. However, shelterwood treatments play an important role because they are preparatory cuts used to establish the needed regeneration in order to proceed with an overstory removal at a later time. Buffer and intermediate treatments are the lowest priority
treatments. Salvage-only treatments are not encouraged and not counted toward harvest schedule targets, but treatments implemented related to salvage (e.g., salvage-shelterwood, salvage-overstory removal, etc) do contribute to the harvest schedule’s targets.

- Following the timber harvest schedule targets by forest type, site class, and age are important because they contribute to the goals associated with stable volumes, stable revenues, extended rotation acres (older forest), dispersed age classes within forest types/sites, and future commercial value of unharvested (remnant) cutting units. Poor growing sites should not be avoided if they have been determined to be part of the commercial land base because, if avoided now, there will be an overabundance of these sites to treat in a few decades.

Since 2004, the bureau has been implementing these timber harvest schedules. In 2006, new schedules were created for districts 12, 18, and 20 due to the realignment of these forest districts’ boundaries, which resulted in a drastic change in their M&C land bases. As of 2015, all forest districts are implementing the second-decade harvest targets from their original timber harvest schedules.

Maintaining some areas of older forest beyond typical rotation ages is important to address ecological, aesthetic, recreational, and high-quality sawlog production concerns. The extended rotation constraints ensure that some areas of the M&C land base will be managed longer than the minimum rotation lengths. Extended rotations can be specified by forest type and/or site class.

**Harvest Scheduling Parameters**

The following is a brief list of parameters specified in the harvest scheduling model:

- Planning time horizon length (typically ~140 years) and planning period length (10 years)
- Number of possible removal harvests allowed over the planning horizon (typically allows two harvests)
- Minimum ages (by aggregated forest type and site class) at which acres are eligible for harvests (see also the bureau’s desirable rotation ages)
- Proportion of M&C acres (by aggregated forest type and site class) that will require a shelterwood treatment before an overstory removal can be done
- Proportion of a stand’s volume removed in a typical shelterwood treatment
- Proportion of a stand’s volume reserved (unharvested) after an overstory removal harvest
- Defined list of products and product groups
- Economic data (including wood prices by product, discount rates, regeneration costs, timber sale costs, etc.)
- Area reduction factor (typically 10 percent) to prevent over-harvesting and which reduces the model’s M&C land base acreage to account for errors in the inventory data, such as areas that are too rocky, too wet, too steep, and too small to delineate as stands
- Proportion of fully stocked stands that regenerate to fully stocked stands following an overstory removal (typically 95 percent), and the proportion of under-stocked stands that regenerate to fully stocked stands following an overstory removal (typically 80 percent)

**Harvest Scheduling Inventories**

The following is a brief description of the inventories input into the software to develop a new timber harvest scheduling model:

- Acres of M&C land, broken down by aggregated forest type, site class, stocking level, and 10-year age class.
- Other acres outside of the M&C land base by 10-year age class (these acres are not considered eligible for harvest in the model)
- Acres (by aggregated forest type, site class, and 10-year age class) which previously have undergone a shelterwood treatment and are awaiting an overstory removal
• Growth and yield tables (equations derived from the bureau’s CFI plots) for determining species composition and estimated volume per acre for all aggregated forest type and site class combinations and all 10-year age classes.

Harvest Scheduling Constraints
Natural resource limitations and bureau policy decisions are represented in the harvest scheduling model by “constraints.” The following is an abbreviated list of constraints typically used in bureau harvest scheduling models:

• Volume control fluctuation, all treatments - Total board foot volume scheduled for harvest may not increase by 10 percent or decrease by 1 percent between adjacent 10-year planning periods.

• Volume control fluctuation, specific product - Total board foot volume scheduled for harvest of black cherry product may not increase or decrease by 5 percent between adjacent 10-year planning periods.

• Area control fluctuation, all treatments - Total area (all treatments) scheduled for harvest may not increase or decrease by 10 percent between adjacent 10-year planning periods.

• Area control fluctuation, specific treatment - Total area scheduled for shelterwood treatment may not increase or decrease by 5 percent between adjacent 10-year planning periods.

• Area control fluctuation, specific site class - Total area scheduled for harvest from a Class 1 site may not increase or decrease by 5 percent between adjacent 10-year planning periods.

• Area control fluctuation, specific forest type - Total area scheduled for harvest from red oak forest type may not increase or decrease by 10 percent between adjacent 10-year planning periods.

• Extended rotations, specific forest type - For the conifers forest type, a minimum of 25 percent, 12 percent, and 5 percent of the acreage must be greater than 80, 100, and 120 years old respectively (see also the bureau’s desirable rotation ages).

• Ending forest age constraint - The average ending age of the forest must be greater than half of the average of the minimum rotation age lengths.

The model’s volume control fluctuation constraints are used to ensure a sustainable, consistent, and even flow of volume and forest products to the wood products industry from state forest land in perpetuity.

Figure 5. Statewide total regeneration and shelterwood acres by period

Figure 6. Statewide volume projections for regeneration and shelterwood treatments by period
**Growth and Harvest Volume**

Another way to estimate sustainability of a timber harvest schedule is by comparing volume harvested to the growth of the forest. In theory, sustainability is achieved when the volume harvested from the forest equals the forest’s growth. Figure 7 depicts the growth of the M&C land base over the projected sawtimber harvest volumes for one forest district. Because most acreage is in older age classes, total growth of the forest is currently decreasing. After about the third decade of harvesting, enough acreage has been regenerated into faster-growing, younger age classes to turn the growth trend upwards. Beginning around the eighth decade, the total harvest volume of the M&C land base converges with total growth of that land base, thereby reaching a perpetual state of sustainability.

**Intermediate and Buffer Treatments**

Intermediate treatments are scheduled manually and are defined as a percentage of specific forest type and site classes within defined age ranges. Most forest districts only specify intermediate treatments for site classes 1 and 2. An estimate of volume per acre removed in an intermediate treatment is also specified to determine additional volume harvested.

Buffer treatments are also scheduled manually. Within each forest district, the acreage of commercial buffer is determined from the vegetation typing. Two-aged management with a 160-year rotation age is assumed, and therefore, 1/80th of the commercial buffer acreage is scheduled for harvest annually. An estimate of volume per acre removed in a buffer treatment is also specified to determine additional volume harvested.

**Biomass**

Biomass is generally defined as any organic material that can be converted into energy. On state forest lands, biomass can be harvested from woody biomass found in forests — wood or bark, sawdust, timber slash, and mill scrap. Demand for biomass is being driven by a desire to strengthen national security through energy independence and by state-mandated alternative energy portfolio standards, partially in response to climate change.
At the state level, interest in biomass harvest is fueled in large part by passage of Pennsylvania’s Alternative Energy Portfolio Standards Act (Act 213 of 2004), which “requires all load-serving energy companies in the state to provide 18 percent of their electricity using alternative sources by the year 2020.”

There has been interest in Pennsylvania’s forests as raw material for the emerging bioenergy market. DCNR created Guidance on Harvesting Woody Biomass for Energy in Pennsylvania to help frame the issues surrounding the emerging biofuel industry, including existing markets, inventory, supply, demand, best practices, sustainable forest management, potential impacts, and opportunities.

Harvesting woody biomass from state forest lands could help meet the demand for alternative sources of energy and reduce greenhouse gas emissions, but should not compromise other important forest functions and values, including protecting water quality, critical natural areas and communities, biodiversity, recreational opportunities, and wildlife habitat.
### SUMMARY OF ANNUAL ACRES TREATED GOALS (2014 TO PRESENT)

<table>
<thead>
<tr>
<th>District</th>
<th>Land-base multiple use &amp; commercial (acres)</th>
<th>Even-aged</th>
<th>Two-aged/uneven</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overstory removal (acres)</td>
<td>Shelterwood (acres)</td>
<td>Total volume (bdft. equiv.)</td>
</tr>
<tr>
<td>1</td>
<td>56,599</td>
<td>439</td>
<td>123</td>
</tr>
<tr>
<td>2</td>
<td>36,855</td>
<td>232</td>
<td>189</td>
</tr>
<tr>
<td>3</td>
<td>42,567</td>
<td>264</td>
<td>212</td>
</tr>
<tr>
<td>4</td>
<td>27,037</td>
<td>285</td>
<td>200</td>
</tr>
<tr>
<td>5</td>
<td>38,874</td>
<td>258</td>
<td>172</td>
</tr>
<tr>
<td>6</td>
<td>9,316</td>
<td>80</td>
<td>74</td>
</tr>
<tr>
<td>7</td>
<td>64,122</td>
<td>415</td>
<td>13</td>
</tr>
<tr>
<td>8</td>
<td>9,123</td>
<td>81</td>
<td>80</td>
</tr>
<tr>
<td>9</td>
<td>107,092</td>
<td>990</td>
<td>535</td>
</tr>
<tr>
<td>10</td>
<td>109,478</td>
<td>874</td>
<td>409</td>
</tr>
<tr>
<td>11</td>
<td>3,886</td>
<td>38</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>54,762</td>
<td>520</td>
<td>153</td>
</tr>
<tr>
<td>13</td>
<td>65,384</td>
<td>552</td>
<td>460</td>
</tr>
<tr>
<td>14</td>
<td>964</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>160,692</td>
<td>1,100</td>
<td>681</td>
</tr>
<tr>
<td>16</td>
<td>86,531</td>
<td>483</td>
<td>383</td>
</tr>
<tr>
<td>17</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>18</td>
<td>19,743</td>
<td>183</td>
<td>0</td>
</tr>
<tr>
<td>19</td>
<td>25,777</td>
<td>226</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>60,161</td>
<td>621</td>
<td>33</td>
</tr>
<tr>
<td>Totals</td>
<td>978,963</td>
<td>7,651</td>
<td>3,717</td>
</tr>
</tbody>
</table>

Table 4. Timber harvest acre goals from the harvest allocation model by district and management system including estimated volume

The forest floor, including roots, stumps, and below-ground biomass, should always be off-limits to biomass harvesting. This material provides too many irreplaceable functions to sustaining a healthy forest, including nutrients essential for tree growth and maintaining biodiversity. Natural regeneration is promoted on state forest lands, and for biomass to be considered a renewable resource, the proportion of growing wood volume needs to be greater than the amount harvested in any given year. Vigorous regeneration is essential to maintain a sustainable supply.
of biomass, and on state forest lands there are numerous factors that affect regeneration, including competing vegetation, deer browse, and sunlight reaching the forest floor. These factors will continue to have a great impact on biomass opportunities on state forest lands.

**Whole Tree and Mechanized Harvesting**

One method to harvest biomass is through whole-tree harvesting. Whole-tree harvesting is the act of cutting and removing an entire tree consisting of trunk, branches, and leaves. In some cases, whole-tree harvesting may offer the potential to improve forest regeneration and aesthetics and reduce fire hazards, but should be done with extreme care to avoid damage to the remaining forest during harvesting. Whole-tree harvesting can present ecological and practical problems for forest management. Much of the nutrients in a tree are stored in the small twigs and leaves. Removal of the whole tree removes these important resources and may negatively affect nutrient cycling. Whole-tree harvesting is often mechanized using large equipment and can cause significant damage to young seedlings. In partial harvests, shelterwoods, and thinnings, regeneration is not as important, but harvesting and skidding whole trees with broad tops is difficult without damaging residual trees. However, whole-tree harvesting is not always detrimental. If there is dense brush competing with establishment of new seedlings, mechanized whole tree logging operations can be used to efficiently crush and control this layer. Whole-tree harvesting also leaves a very clean forest floor, which helps when planting additional trees.

Because of potential impacts of whole-tree harvesting, the practice is currently prohibited on state forest land. However, waivers are granted by the state forester under certain conditions to advance certain goals, and when mitigation practices are implemented.

While whole-tree harvesting may be used on state forest land in some cases, the bureau does not normally sell timber explicitly for biomass uses. There is great demand for certified pulpwood to make paper, which has been the primary use of materials harvested through whole tree harvesting. These harvests should always include practices that lead to healthy forest regeneration. Currently, less than 10 percent of all harvests receive a whole-tree harvesting waiver.

**Seed Collection and Penn Nursery**

Named after William Penn and founded in 1908, Penn Nursery and Wood Shop is located in the Seven Mountains region of central Pennsylvania. After the nursery’s creation, it produced the seedlings needed to replant land denuded by timbering and forest fires in the late 19th and early 20th centuries. Today, the nursery continues to provide high-quality tree and shrub seedlings for regeneration and wildlife enhancement projects on state forest lands. Nursery and district staff coordinate the selection, harvesting, and collection of millions of tree and shrub seeds from trees and orchards on state forest lands. One goal in the seed collection procedure is to preserve and maintain genetic diversity. To select and breed forest trees that resist disease and pest attacks, Penn Nursery cooperates with U.S. Forest Service Forest Health Monitoring and Protection programs and universities across the northern United States, in addition to selectively propagating the stock from state forest lands.

<table>
<thead>
<tr>
<th>Year</th>
<th>Seedlings distributed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>789,505</td>
</tr>
<tr>
<td>2009</td>
<td>389,743</td>
</tr>
<tr>
<td>2010</td>
<td>472,761</td>
</tr>
<tr>
<td>2011</td>
<td>896,425</td>
</tr>
<tr>
<td>2012</td>
<td>754,240</td>
</tr>
<tr>
<td>2013</td>
<td>472,415</td>
</tr>
<tr>
<td>2014</td>
<td>636,757</td>
</tr>
</tbody>
</table>

*Table 5. Seedlings distributed by Penn Nursery to state forest lands*
**Timber Revenues**

Supplying a consistent yield of forest products to the market from state forest land helps promote stability in this sector of Pennsylvania’s economy and keeps sawmills and other wood product industries operational, even during poor economic times when timber stumpage prices are low. Harvesting consistent yields of timber from state forest land also helps stabilize revenues for the bureau over time.

Timber sales generate significant revenue for the commonwealth. From 2008 to 2013, Pennsylvania received income from timber sales averaging over $20 million (Table 6). The age of the forest is requiring more regeneration harvests, and these harvests yield greater volumes of sawtimber than other silvicultural treatments, resulting in higher revenue from timber harvesting. In addition, FSC certification has bolstered the market for pulpwood and lower quality timber, supplementing revenue when sawtimber prices slumped in 2007.

<table>
<thead>
<tr>
<th>Year</th>
<th>Sawtimber MBF</th>
<th>Pulpwood HCF</th>
<th>Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>48,258</td>
<td>31,090</td>
<td>$28.9 million</td>
</tr>
<tr>
<td>2009</td>
<td>59,382</td>
<td>48,076</td>
<td>$21.1 million</td>
</tr>
<tr>
<td>2010</td>
<td>45,304</td>
<td>38,333</td>
<td>$23.3 million</td>
</tr>
<tr>
<td>2011</td>
<td>43,351</td>
<td>35,987</td>
<td>$20.9 million</td>
</tr>
<tr>
<td>2012</td>
<td>47,000</td>
<td>27,855</td>
<td>$21.3 million</td>
</tr>
<tr>
<td>2013</td>
<td>46,166</td>
<td>64,744</td>
<td>$20.0 million</td>
</tr>
<tr>
<td>2014</td>
<td>42,665</td>
<td>48,848</td>
<td>$22.1 million</td>
</tr>
</tbody>
</table>

Table 6. Sawtimber volume, pulpwood volume, and revenue from timber sales on state forest lands from 2008 to 2014.

**Non-Timber Forest Products**

NTFPs have perceived economic or consumption value for humans and represent forms of biodiversity that are critical to maintain on the landscape from an ecosystem management perspective. Thus, NTFPs are a conservation concern on state forest lands when their sustainability as species or populations or the health of other components of the forest ecosystem is threatened by overconsumption.

Collection of NTFPs is regulated by the [State Forest Rules and Regulations](#) and the Wild Resource Conservation Act of 1982. The State Forest Rules and Regulations indicate that individuals must receive written permission to remove any living or dead plant or plant part from state forests unless for personal consumption. Historical records show that the bureau started issuing permits for NTFP collection in the early 1950s, and recent permit receipts can be seen in Tables 7a and 7b. Collection of rare, threatened, and endangered plant species is controlled by DCNR through the provisions of the Wild Resource Conservation Act, P.L. 597, No. 170.

The native plant American ginseng was historically abundant on state forest lands. Because of its value and importance as a national commodity, the export of ginseng is regulated by the U.S. Fish & Wildlife Service. Ginseng has been listed as a vulnerable species in Pennsylvania due to the demand and suspected overharvesting. Since 1985, the bureau has been the regulatory agency for the trade and export of ginseng harvested in Pennsylvania and issues vulnerable-plant licenses to authorized ginseng dealers. However, American ginseng may not be collected on state forest lands for personal or commercial consumption.

Generations of state forest users have gone to state forests on seasonal outings to pick berries, mushrooms, leeks, etc. for personal use. Harvesting, consuming, and enjoying the...
resources of state forests is a long-established tradition in Pennsylvania. Within limits and with proper management, future generations of users will be able to continue these long-established and cherished traditions of gathering NTFPs from state forest land.

However, the bureau is becoming increasingly concerned with the sustainability of these resources. Unfortunately, little is known about the removal rates of NTFPs from state forest lands for personal use, and even less is known about the population status of plant species used as NTFPs. Further, much remains to be learned about the maintenance needs, life history characteristics, and natural distribution and abundance of many NTFP species before sustainable management guidelines can even be developed.

<table>
<thead>
<tr>
<th>Year</th>
<th>Sawtimber</th>
<th>Pulpwood</th>
<th>Fuelwood</th>
<th>Posts</th>
<th>Sawdust</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Permits</td>
<td>MBF</td>
<td>Receipts</td>
<td>HCF</td>
<td>Receipts</td>
</tr>
<tr>
<td>2008</td>
<td>6,905</td>
<td>2,689</td>
<td>$39,176</td>
<td>258</td>
<td>$4,080</td>
</tr>
<tr>
<td>2009</td>
<td>6,925</td>
<td>677</td>
<td>$65,757</td>
<td>1270</td>
<td>$8,728</td>
</tr>
<tr>
<td>2010</td>
<td>6,637</td>
<td>528</td>
<td>$51,696</td>
<td>106</td>
<td>$1,369</td>
</tr>
<tr>
<td>2011</td>
<td>6,804</td>
<td>291</td>
<td>$39,724</td>
<td>342</td>
<td>$4,655</td>
</tr>
<tr>
<td>2012</td>
<td>5,729</td>
<td>244</td>
<td>$39,362</td>
<td>886</td>
<td>$6,552</td>
</tr>
<tr>
<td>2013</td>
<td>6,470</td>
<td>276</td>
<td>$59,197</td>
<td>124</td>
<td>$2,456</td>
</tr>
<tr>
<td>2014</td>
<td>6,718</td>
<td>170</td>
<td>$41,058</td>
<td>396</td>
<td>$4,331</td>
</tr>
</tbody>
</table>

Table 7a. Receipts for sale of permits to collect or harvest non-timber forest products on state forest lands from 2008 to 2014

<table>
<thead>
<tr>
<th>Year</th>
<th>Ground pine</th>
<th>Moss</th>
<th>Stone</th>
<th>Miscellaneous</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Permits</td>
<td>Permits</td>
<td>Receipts</td>
<td>Bushels</td>
<td>Receipts</td>
</tr>
<tr>
<td>2008</td>
<td>6,905</td>
<td>0</td>
<td>$0.00</td>
<td>0</td>
<td>$0.00</td>
</tr>
<tr>
<td>2009</td>
<td>6,925</td>
<td>0</td>
<td>$0.00</td>
<td>0</td>
<td>$0.00</td>
</tr>
<tr>
<td>2010</td>
<td>6,637</td>
<td>0</td>
<td>$0.00</td>
<td>0</td>
<td>$0.00</td>
</tr>
<tr>
<td>2011</td>
<td>6,804</td>
<td>0</td>
<td>$0.00</td>
<td>0</td>
<td>$0.00</td>
</tr>
<tr>
<td>2012</td>
<td>5,729</td>
<td>0</td>
<td>$0.00</td>
<td>0</td>
<td>$0.00</td>
</tr>
<tr>
<td>2013</td>
<td>6,470</td>
<td>0</td>
<td>$0.00</td>
<td>0</td>
<td>$0.00</td>
</tr>
<tr>
<td>2014</td>
<td>6,718</td>
<td>0</td>
<td>$0.00</td>
<td>0</td>
<td>$0.00</td>
</tr>
</tbody>
</table>

Table 7b. Receipts for sale of permits to collect or harvest non-timber forest products on state forest lands from 2008 to 2014 (continued)
**Timber and Forest Products Management Principle**

Timber and other forest products on state forest lands are managed to promote and maintain desired landscape conditions and provide sustainable social and economic benefits to the commonwealth.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To promote and maintain desired landscape conditions through planning and implementing appropriate, sustainable timber harvest levels.</td>
<td>1.1 Plan individual harvests that promote natural regeneration and consider landscape goals, desired stand conditions, rotation ages, spatial patterns, dispersed successional stages, and other impacts to ecological and social resources.</td>
</tr>
<tr>
<td></td>
<td>1.2 Develop and use best management practices that protect forest resources and meet or exceed legal requirements.</td>
</tr>
<tr>
<td></td>
<td>1.3 Meet harvest allocation goals to promote balanced age class and tree diameter distributions, diverse native forest communities, and a mix of patch sizes and successional stages, including old growth, and provide sustained yields of forest products.</td>
</tr>
<tr>
<td></td>
<td>1.4 Periodically adjust harvest allocation goals when there are significant changes to landscape-level forest conditions, such as major changes to timber policies or goals, large natural disturbance events, and new acquisitions.</td>
</tr>
<tr>
<td></td>
<td>1.5 Maintain or improve overall forest resilience by managing for forest connectivity, native species diversity, genetic diversity, and structural diversity, including desirable commercial species.</td>
</tr>
<tr>
<td>2. To promote natural regeneration of forest communities through sustainable silvicultural practices.</td>
<td>2.1 Conduct regeneration harvests when natural regeneration is present or likely to follow.</td>
</tr>
<tr>
<td></td>
<td>2.2 Establish forest cover in areas that failed to regenerate following disturbance.</td>
</tr>
<tr>
<td></td>
<td>2.3 Use dedicated forest regeneration funds to ensure forest regeneration in areas affected by inhibiting factors.</td>
</tr>
<tr>
<td></td>
<td>2.4 Support research to understand factors impacting natural forest regeneration.</td>
</tr>
<tr>
<td></td>
<td>2.5 Evaluate forest regeneration success following silvicultural treatments.</td>
</tr>
<tr>
<td></td>
<td>2.6 Use artificial regeneration that is consistent with genetic seed zones when natural regeneration is not feasible or when necessary to maintain or restore desired forest composition.</td>
</tr>
<tr>
<td>Goals</td>
<td>Objectives</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3. To provide economic and social benefits through a sustained yield of forest products.</td>
<td>3.1 Provide a consistent flow of quality forest products to aid local, regional, and state economies.</td>
</tr>
<tr>
<td></td>
<td>3.2 Promote the growth of high quality and desirable trees.</td>
</tr>
<tr>
<td></td>
<td>3.3 Ensure that silvicultural operations are compatible with the protection, use, and development of other forest resources.</td>
</tr>
<tr>
<td></td>
<td>3.4 Consider revenues from stumpage sales, road building costs, and cost to regenerate the site to make timber harvests financially advantageous to the commonwealth, within the constraints of ecosystem management.</td>
</tr>
<tr>
<td></td>
<td>3.5 Salvage dead commercial timber only when economically and ecologically appropriate.</td>
</tr>
<tr>
<td></td>
<td>3.6 Promote the sale of Forest Sustainable Council certified timber and ensure silvicultural operations comply with the FSC standard.</td>
</tr>
<tr>
<td>4. To meet landscape goals by expanding silvicultural practices into areas previously considered economically or operationally unfeasible.</td>
<td>4.1 Conduct timber harvests to benefit wildlife habitat, reduce fuels, and create desired landscape conditions including low value timber, and poor growing sites.</td>
</tr>
<tr>
<td></td>
<td>4.2 Develop recommendations for sustainably managing sites with limiting operational conditions or low economic value to meet landscape and ecosystem management goals.</td>
</tr>
<tr>
<td></td>
<td>4.3 Consider managing a balance of high and low quality sites.</td>
</tr>
<tr>
<td>5. To conserve and manage non-timber forest products and consider the sustainability of these resources in allowing public consumption.</td>
<td>5.1 Manage harvest of NTFPs through permits.</td>
</tr>
<tr>
<td></td>
<td>5.2 Develop mechanisms to determine the sustainability of non-timber forest product consumption at the district level.</td>
</tr>
<tr>
<td></td>
<td>5.3 Develop and implement guidelines for harvest restrictions and remedial activities of non-timber forest products.</td>
</tr>
<tr>
<td></td>
<td>5.4 Build and strengthen relationships with partners interested in the conservation of ginseng and other non-timber forest products.</td>
</tr>
</tbody>
</table>
Guidelines, Tools, and Resources

Silviculture Manual

The bureau developed this manual to guide silviculture efforts on state forest land. The management objectives are: 1) to promote, establish, and maintain desired landscape conditions, 2) to maintain and develop naturally reproducing forest communities, 3) to provide economic and social benefits through a sustained yield of forest products, and 4) to determine appropriate sustainable timber harvest levels.

Non-Timber Forest Product (NTFP) Reporting Form

This form is to be used to report the location of, or provide an observation dealing with, any non-timber forest product occurring on Pennsylvania state forest lands.

Inventory Manual of Procedure for the Fourth State Forest Management Plan (Typing Manual)

This manual has been prepared to serve as a working guide for the inventory and subsequent management of state forest lands. The results of zoning classifications have implications for timber management.

SILVAH (Silviculture of Allegheny Hardwoods)
http://www.nrs.fs.fed.us/tools/silvah/

SILVAH is a computer tool that supports silvicultural decision-making by using objectives as well as overstory, understory, and site data in order to recommend treatments. Information about the tool and the software can be found here.

Penn State Oak Regeneration Guidelines

These guidelines are designed to aid forest managers in securing adequate oak regeneration before harvesting oak-dominated stands by providing a method for measuring an oak stand’s regeneration potential in advance of harvest.

Ginseng Information
http://dcnrwebcenter.pa.gov:16200/DCNR/forestry/plants/vulnerableplants/ginseng/index.htm

This informational web resource contains news and a FAQ sheet as well as detailed guidance on regulation, licensing, and the sustainable collection of ginseng.

Planting and Seeding Guidelines on State Forest Lands

Supplemental planting on state forest lands is a common practice for activities such as re-vegetating a log landing after timber harvest. These guidelines were developed to assist in deciding the appropriate use of non-native plantings on state forest lands.

Genetics Guidelines
The bureau acknowledges the importance of genetic diversity in the overall conservation of populations. In keeping with the tenet of biodiversity, the bureau has developed these guidelines and actions to maintain genetic variety on state forest lands.

Chain of Custody Procedures
The purpose of these guidelines is to detail how the bureau assures buyers and maintains records regarding the Forest Stewardship Council (FSC) certification status of the wood it sells. The procedures are required by FSC to maintain the integrity of the supply chain and the bureau’s chain-of-custody certificate.

Ash Management in State Forest Lands Under Pressure from the Emerald Ash Borer

Pennsylvania recognizes the benefits of trees to the long-term health of the state forest system. While ash is an integral species in Pennsylvania’s forests, the emerald ash borer (EAB) significantly threatens the health and survival of ash trees. To address the immediate and long-term impact of EAB on state forest lands in Pennsylvania, the Division of Forest Health developed this comprehensive ash
management plan with the following objectives:
1. Maintaining ash as a component in the forest
2. Protecting rare and endangered ash species
3. Mitigating potential negative impacts
4. Conserving economic value through silviculture
5. Managing seed orchards and collecting seeds
6. Conducting training and public outreach

**Eastern Hemlock Conservation Plan**

The purpose of this plan is to provide a sustainable conservation strategy for eastern hemlock, integrating all available information regarding the species and its associated threats into a comprehensive and science based approach. There are five main sections:
1. Biology, life history, and ecological, economic, and cultural significance
2. Stressors, threats, and control tools
3. Conservation strategy
4. Strategy implementation
5. Critical research needs

**Indiana Bat Habitat Conservation Plan**

The bureau and the Pennsylvania Game Commission are developing this plan in order to: 1) avoid and minimize incidental taking of Indiana bats resulting from forestry management and other related activities to the maximum extent practicable on state lands, 2) accommodate current and future forestry management activities on state lands, 3) support state conservation goals, and 4) identify targeted conservation efforts that can improve the value of state lands for Indiana bats and help stabilize and aid in the recovery of the species.

**PA Code Title 17: Conservation and Natural Resources**
http://www.pacode.com/secure/data/017/017toc.html

This contains state forest rules and regulations, found in subpart C. Sections of Chapter 21 contain regulations pertaining to forest products. Chapter 45 covers the conservation of Pennsylvania Native Wild Plants, including ginseng and other vulnerable plants.

**Erosion and Sedimentation Guidance for State Forest Management**
The bureau seeks to minimize the impacts of timber management on soil and water resources. Best management practices and general guidelines for erosion and sedimentation control during state forest operations are described in a series of documents, the links to which are provided for staff in this guidance document.

**Monitoring**
- Landscape exams
- Regeneration surveys
- Post-sale inspections
- Continuous Forest Inventory
- Forest Inventory and Analysis Program (U.S. Forest Service)
- Penn State University regeneration study

**Critical Research Needs**
- Systematic analysis of the effectiveness of SILVAH prescription results
- Evaluation of the effectiveness of herbicide treatments
- Oak seedling survivability
- Prescribed fire meta-analysis of current prescribed fire monitoring plots
- Evaluation of mechanized harvesting impacts
- Oak regeneration study
- The potential of soil types to support desirable or undesirable vegetation communities
- Determination of sustainable population harvest levels for NTFPs
Plants play a major role in every ecosystem by providing food and influencing habitat factors, such as temperature, water quality, cover, light, physical structure, and air quality. Pennsylvania boasts a great diversity of native wildlife species, many of which rely on native plant communities represented within state forest lands. In addition, native plant species serve as hosts for many invertebrates, an important element in ecosystem food-web dynamics. Plants also provide valuable economic resources, such as timber and medicinal products, and influence many state forest recreational experiences.

The Bureau of Forestry’s mission includes the conservation of the commonwealth’s native wild plants. On state forest lands and other lands across the commonwealth, the bureau is committed to conserving native plant species; protecting rare, threatened, or endangered plants; managing or enhancing vegetation communities; classifying plants; and addressing non-native, invasive species issues in all ecosystems.
The term “wild plants” comes from the Wild Resource Conservation Act (WRCA) of 1993 (P.L. 597, No. 170): “Any and all naturally occurring native flora, except those commonly considered an agricultural commodity, including green and non-green species or subspecies or any part, product, seed, or offspring thereof.” The bureau uses the federal government’s definition of a “native” species from Executive Order 13112: “[with respect to a particular ecosystem, a [native] species [is one] that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem.”

Of the approximately 3,400 plant species found in Pennsylvania, roughly two-thirds are considered native, and the rest have been introduced (Rhoads and Block, 2007). In addition, the Pennsylvania Biological Survey recognizes 443 moss (bryophytes), 135 liverwort, and 552 lichen species as existing in the state. Many of these plant species have been further classified into 136 unique plant community types, 87 palustrine and 49 terrestrial (Zimmerman et al., 2012).

**Jurisdictional Responsibility**

Originally, the Wild Resource Conservation Act (WRCA) of June 23, 1982 (P.L. 597, No. 170) established a procedure for the conservation, classification, and protection of wild flora, and grants that power to the then-Department of Environmental Resources. Later, Section 305(a) (9) of Act 18 of 1995 created the Department of Conservation and Natural Resources and delegated the WRCA responsibilities to the new department. Pennsylvania Code Title 17, Chapter 45, the Conservation of Pennsylvania Native Wild Plants, is DCNR’s regulatory effort to carry out the responsibility of the WRCA. Since the DCNR Bureau of Forestry’s mission includes the conservation of native wild plants, the responsibility of implementing Chapter 45 and the WRCA has been the Bureau of Forestry’s. Through this authority, the bureau cooperates with biologists and collects scientific information about plant species that may be of conservation concern and classifies them based on their rarity throughout the state (Table 4). The WRCA also permits the bureau to designate wild plant sanctuaries on state and private lands and issue plant collection permits for threatened, endangered, or vulnerable species.

**Plant Diversity and Communities**

Plant species are integral components of overall ecosystem function. Common and rare alike, they have evolved diverse physical and behavioral characteristics to compete for vital roles in the cycling of energy and nutrients. They also have differing interactions with wildlife and invertebrate communities. These variables contribute to the overall species richness within the commonwealth and on state forest lands.

<table>
<thead>
<tr>
<th>Plant group</th>
<th>n species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees</td>
<td>83</td>
</tr>
<tr>
<td>Shrubs</td>
<td>75</td>
</tr>
<tr>
<td>Vines</td>
<td>26</td>
</tr>
<tr>
<td>Ferns</td>
<td>30</td>
</tr>
<tr>
<td>Grasses</td>
<td>70</td>
</tr>
<tr>
<td>Forbs</td>
<td>291</td>
</tr>
</tbody>
</table>

*Table 1. Plant species richness on state forest lands. Species occurrences were counted as part of the bureau’s Continuous Forest Inventory (CFI), which samples plots on multiple resources management zones, limited resource management zones, and buffers only (approximately 84 percent of total state forest land).*

Some plant species are moderately abundant, including dominant forest trees and widespread wildflowers, but diversity is greatly increased by the occurrences of many rare species represented by a small number of individuals in a few populations. These uncommon species can sometimes be found in specialized geologic substrates, including serpentine, diabase, limestone, glacial till, and peat.
Plant communities are groupings of plants that share a common environment and interact with each other, animal populations, and the physical environment. Species in a community are generally related via interactions, which can include competition for space and resources. The increase or decline of any species potentially can alter structure in a community, but communities often are defined by a few dominant species. These plant associations provide useful habitat information regarding animal species and an efficient starting point for forest inventory and analysis. There are 136 classified plant communities found in Pennsylvania, including palustrine and terrestrial types.

The North American deciduous hardwood forest that historically covers most of the northeastern United States, including an estimated 95 percent of Pennsylvania, can be divided into several subtypes, characterized by different proportions of dominant and subdominant trees. Geographically, Pennsylvania is situated where several forest types co-occur at the edge of their ranges. Geologic features such as the Appalachian Plateau, the Allegheny Front, and the Susquehanna Valley contribute to the diversity by offering a variety of environmental conditions.

<table>
<thead>
<tr>
<th>Aggregated Forest Type</th>
<th>Prevalent Community Type(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allegheny hardwoods</td>
<td>Black cherry</td>
</tr>
<tr>
<td>Northern hardwoods</td>
<td>Northern hardwoods, Sugar maple</td>
</tr>
<tr>
<td>Red oak</td>
<td>Red oak</td>
</tr>
<tr>
<td>Other oak</td>
<td>Dry oak — mixed hardwood</td>
</tr>
<tr>
<td></td>
<td>Dry oak — heath</td>
</tr>
<tr>
<td>Red maple</td>
<td>Red maple</td>
</tr>
<tr>
<td>Conifers</td>
<td>Hemlock (white pine)</td>
</tr>
<tr>
<td></td>
<td>Dry white pine (hemlock) — oak</td>
</tr>
<tr>
<td></td>
<td>Hemlock (white pine) — northern hardwood</td>
</tr>
<tr>
<td></td>
<td>Hemlock (white pine) — red oak — mixed hardwood</td>
</tr>
<tr>
<td></td>
<td>Hemlock — tuliptree — birch</td>
</tr>
<tr>
<td></td>
<td>Hemlock — rich mesic</td>
</tr>
<tr>
<td></td>
<td>Red pine — mixed hardwood</td>
</tr>
<tr>
<td></td>
<td>Spruce plantation</td>
</tr>
<tr>
<td>Other hardwoods</td>
<td>Aspen, Pitch pine, Virginia pine, Black gum, Etc.</td>
</tr>
</tbody>
</table>

Table 2. Aggregated forest types and prevalent communities

The bureau recognizes seven aggregated forest types on state forest land, and each forest type includes one or several dominant plant communities. These dominant communities are interspersed with many marginal terrestrial and palustrine communities that occupy relatively small areas — some only an acre in size — yet contribute much to overall species richness; however, the majority of state forest land area is comprised of the relatively few dominant plant communities listed here (Table 2 and Figure 1).

The dry oak heath forest community is the most prevalent on state forest land, comprising approximately 35 percent of inventoried state forest lands, totaling 751,411 acres, and may serve as an
example of species composition in a typical forested plant community. The most characteristic tree species for this forest type is chestnut oak, which co-occurs with a mix of other species found in Table 3.

The conifer component generally does not exceed 25 percent, and American chestnut sprouts are not uncommon. Due to typically thick leaf litter, the herbaceous layer is often sparse.

The state forest system provides a wide range of vegetation types, from open areas to mature forests. In its approach to landscape management, the bureau manages land for overall species diversity. Mature forest stands provide habitat for species that adapted to thrive in areas of more closed canopy, lower light, and less competition on the forest floor. These species generally do not respond favorably to disturbance. Other vegetation types, such as early successional shrub land, provide a much different set of habitat parameters and different species that utilize it and require periodic disturbance to maintain its structure. Since openings in the canopy caused by natural tree mortality are a normal occurrence of a healthy forest, many plant communities and species are adapted to disturbance in forested ecosystems.

Adaptation to disturbance allows management activities on state forest lands that may enhance plant diversity while also meeting other resource objectives. For example, timber harvesting results in more sunlight reaching the forest floor, allowing many native plant species to become established in harvested sites where they previously were absent or found in low abundance, such as raspberry species (*Rubus spp.*) and pokeweed (*Phytolacca americana*).

Activities that create a temporary disturbance may allow early and later successional species to occupy sites jointly, providing higher plant diversity and richness (Bormann and Likens 1979). This enhanced plant diversity may in turn increase insect diversity and the diversity of available food for a variety of wildlife species. However, some disturbance activities may also cause the introduction of non-native invasive plants or have damaging impacts on plant habitat, such as soil compaction or erosion. Ecosystem management on state forest lands should provide for a matrix of early to late successional forest ecosystems and consider the diversity of plant species and communities across the landscape.

Through its inventories and landscape examinations, the bureau identifies various plant communities and aggregated forest types across state forest lands. Maintaining common and rare plant communities through various successional stages can serve as a way to establish ecological reference conditions as a baseline in order to track changes in community composition and ecosystem function over time.

By providing areas where limited management can occur, such as Natural and Wild Areas, buffers, limited resource management zones, and HCVFs the bureau is able to provide places where plant communities and aggregated forest types can exist with minimal human-caused

<table>
<thead>
<tr>
<th>Plant group</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic tree species</td>
<td>Chestnut oak, Black oak, Scarlet oak, White oak</td>
</tr>
<tr>
<td>Other tree species</td>
<td>Sassafras, Black gum, Sweet birch, Red maple, Pignut hickory, Pitch pine, Virginia pine, Eastern white pine</td>
</tr>
<tr>
<td>Shrub layer</td>
<td>Mountain laurel, Black huckleberry, Lowbush blueberry, Low sweet blueberry, Maple-leaved viburnum, Sweet fern</td>
</tr>
<tr>
<td>Herbaceous layer</td>
<td>Canada mayflower, Pennsylvania sedge, <em>Carex communis</em> (a sedge), Pipissewa, Trailing arbutus, Teaberry, Wild sarsaparilla, Bracken fern, Pink lady’s slipper</td>
</tr>
</tbody>
</table>

Table 3. General species composition of the dry oak heath community
disturbance and community structure can be tracked. Presently, 46 terrestrial and palustrine communities and all aggregated forest types occur within Natural and Wild Areas, buffers, limited resource management zones, and/or HCVFs (Table 4). Additionally, other areas where regular management occurs, such as multiple resource zones, encourage a mosaic of communities in various successional stages where successional progress in the second- and third growth forests can be tracked.

**Terrestrial Invertebrates**

Bees and other pollinating insects are critical to the ecology of some flowering plants in the eastern deciduous forest, such as willows and maples. Without specific pollinators, some flowering plants would be unable to reproduce. Terrestrial invertebrate species, such as moths and butterflies, are important considerations in biodiversity conservation because they play a vital part in food webs. Surveys for terrestrial invertebrate species of concern have found a higher abundance on state forest lands than elsewhere in the state. This may be due in part to the mosaic patterns of forestry management on state forest systems as well as the idea of refugia. Many species of moths and butterflies require specific host plants and habitats for their larval stage, such as the giant swallowtail (associated with prickly ash), the spiny oakworm moth (associated with oak species), and the fly-poison borer moth (associated with fly-poison plant). Considerations regarding host plants for invertebrates can be developed into management planning to promote these species and biodiversity in natural communities.

**Rare, Threatened, and Endangered Species and Communities**

Sensitive plant communities in the commonwealth are threatened by factors including habitat loss due to conversion to a human-made environment. Fragmentation and edge habitat have grown in many areas across Pennsylvania, which increases the threat of invasive plant species. Invasive plants can displace native plants, while providing fewer benefits to native wildlife. Selective browsing by white-tailed deer populations may also threaten native flora. Showy, edible, or medicinal plants are sometimes over-collected, which can lead to a decline in populations. For these reasons, conservation of native plant resources is especially important on state forest lands because the lands provide some protection from development, fragmentation, invasive species encroachment, and over-collection.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pennsylvania extirpated</td>
<td>A species thought to be extinct in Pennsylvania</td>
</tr>
<tr>
<td>Pennsylvania endangered</td>
<td>A species in danger of extinction in Pennsylvania</td>
</tr>
<tr>
<td>Pennsylvania threatened</td>
<td>A species that may become endangered in Pennsylvania</td>
</tr>
<tr>
<td>Pennsylvania rare</td>
<td>A species which is uncommon due to restricted range and/or low numbers in Pennsylvania</td>
</tr>
<tr>
<td>Pennsylvania vulnerable</td>
<td>A species that may be in decline in Pennsylvania due to a perceived economic value</td>
</tr>
<tr>
<td>Special concern population</td>
<td>A colony or population found in Pennsylvania that is unique and deserving of protection</td>
</tr>
<tr>
<td>Tentatively undetermined</td>
<td>A species for which not enough information is available to make a determination at this time</td>
</tr>
</tbody>
</table>

Table 4. Pennsylvania plant status classifications and their definitions (from Chapter 45 Conservation of PA Native Wild Plants)
The process for classifying native wild plants, in terms of conservation status, begins with questions surrounding a species, taxa, or region of Pennsylvania which is in need of focused scientific study. The bureau then requests data collection from experts and botanists as well as bureau staff to help determine correct classifications of species. Examples of collected information include field, taxonomic, genetic, and/or nomenclatural data. The bureau assimilates, evaluates, and interprets the information obtained by the botanists and other experts and makes the final decision for classification of native wild plants.

The bureau presents these needs through the Pennsylvania Biological Survey (PABS), the public Rare Plant Forum (RPF), and the Vascular Plant Technical Committee (VPTC). These groups provide the bureau with discussion and recommendations on classification and use standardized data collection methods. These recommendations are considered "proposed" statuses until the regulations are updated.

The bureau carries out the duties of the WRCA by providing information on the management or conservation needs of classified plants. This is done by performing environmental reviews for projects potentially impacting classified plants across the commonwealth. In addition, the bureau reviews for plant communities, invertebrate species, and unique geologic features identified by the Pennsylvania Biological Survey as being of conservation concern. Projects throughout the state that require certain regulatory permits are required to screen for potential impacts to state-classified species and resources through the Pennsylvania Natural Diversity Inventory (PNDI) tool.

Within the state forest system, there are 26 plant communities of conservation concern that are not well-represented within the commonwealth or are otherwise rare. As of spring 2015, 228 plant species are classified as endangered, 78 as threatened, 41 as rare, and three as vulnerable. Wild plant management permits are required when a botanist must collect a voucher specimen of a rare species during a survey.

State forest lands are scattered throughout the commonwealth and, as such, are representative of Pennsylvania’s overall landscape and serve as habitat for a high proportion of classified plant species, terrestrial invertebrates, and plant communities (Table 5).

Some areas, such as mature forests and wetlands, have been historically disturbed on private lands, and many species that utilize these areas are provided a refuge on state forest lands. Through conservation measures, species’ sensitive habitats can be protected and conserved. A good example is the federally endangered northeastern bulrush (Scirpus ancistrochaetus). This species is only found in eight states, and the majority of the global population is in Pennsylvania.

<table>
<thead>
<tr>
<th>Species Description</th>
<th>Populations on state forest</th>
<th>Populations across Pennsylvania</th>
<th>Percentage found on state forest lands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeastern bulrush</td>
<td>46</td>
<td>86</td>
<td>53.5</td>
</tr>
<tr>
<td>Classified or proposed classified plant species (rare, threatened, endangered, tentatively undetermined)</td>
<td>155</td>
<td>513</td>
<td>30.2</td>
</tr>
<tr>
<td>Natural communities of conservation concern</td>
<td>25</td>
<td>58</td>
<td>43</td>
</tr>
<tr>
<td>Terrestrial invertebrate species (moths, butterflies, and ground beetles)</td>
<td>37</td>
<td>52</td>
<td>71.2</td>
</tr>
</tbody>
</table>

Table 5. Numbers of populations of rare plants, natural communities, and terrestrial invertebrates found on state forest lands and all of Pennsylvania.
This illustrates the importance of the state forest for this species and how it is afforded a refuge within the state forest system. Similar trends can be seen for other plant species and natural communities as well as terrestrial invertebrates.

State forest lands also provide habitat for at least seven plant species that have not been observed elsewhere in the state (Table 6). These species are associated with rare habitat types that largely exist on state forest lands. For example, Goat Hill chickweed is endemic to the rare serpentine barrens of the Goat Hill Wild Plant Sanctuary on the William Penn State Forest. Habitat for these and other extremely rare plant species are often types that have largely been eliminated on private lands, but strategies can be implemented on state forest lands to ensure their survival through ecosystem management principles. All of these plants are state-ranked S1 (critically imperiled, using NatureServe methodology), and listed or proposed to be listed as Pennsylvania endangered.

Management of Native Plants on State Forest Land
As part of adaptive management strategies, the bureau inventories and monitors plant communities and populations on state forest land before and after management activities to adapt strategies to further conserve native plant communities. Parts of these strategies include special designation and management of natural areas, wild areas, wild plant sanctuaries, high conservation value forests, and other areas of plant conservation interest. The bureau manages these sites using appropriate techniques and practices to promote and improve growing conditions for plant species of concern or may limit certain management activities in other areas to conserve sensitive plant resources. The bureau also promotes natural forest regeneration of native tree species following timber management and reclamation activities that use native species.

Invasive plant species are a major concern for the Bureau of Forestry, as they can out-compete native species, alter habitats, and disrupt life cycles of native invertebrates. Invasive management on state forest lands is important to limit the impact of invasive species on native plant communities. The bureau has a comprehensive plan to address invasive plant species as well as other forest health issues.

### Plant Inventory
The bureau serves as a partner member in the Pennsylvania Natural Heritage Program and, through this partnership, has access to current, reliable, objective information to help inform management decisions regarding plant conservation throughout the commonwealth and on state forest lands. In addition, the bureau supports inventory efforts to further identify plant species and community types found on state forest lands. Targeted botanical surveys and broad inventory work provide valuable information on populations of species of concern, general forest composition, and opportunities to conserve plant diversity through active management.

### Public Wild Plant Sanctuaries
Public wild plant sanctuaries are located on public lands and are designations specifically for management of plant species of concern “when deemed necessary to protect wild plant species afforded consideration under

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goat hill chickweed</td>
<td>Cerastium velutinum</td>
</tr>
<tr>
<td>Bog aster</td>
<td>Oclemena nemoralis</td>
</tr>
<tr>
<td>Mountain alder</td>
<td>Alnus viridis</td>
</tr>
<tr>
<td>Fogg’s goosefoot*</td>
<td>Chenopodium foggi</td>
</tr>
<tr>
<td>Blue ash+</td>
<td>Fraxinus quadrangulata</td>
</tr>
<tr>
<td>Wintergreen</td>
<td>Pyrola chlorantha</td>
</tr>
<tr>
<td>Heart-leaved twayblade</td>
<td>Listera cordata</td>
</tr>
</tbody>
</table>

Table 6. Pennsylvania plants which have only been documented on state forest lands
* denotes a globally rare species
+ denotes a population which may be extirpated
this act” (Section 10, Wild Resource Conservation Act). Typically, these areas are chosen due to the presence of viable or exemplary populations of plant species of concern, unique plant populations in decline and in need of active management, invertebrate species of concern or their host plants, or habitats with high plant species diversity or values. To date, 51 plant sanctuaries totaling more than 10,000 acres have been designated on state forest lands.

Once identified, plant sanctuaries are surveyed to determine their size, boundaries, and status of or threats to the species of interest. Management plans are also developed to outline management and monitoring needs to conserve the resources for which they were designated. All but five public wild plant sanctuaries are also considered high conservation value forest areas.

**High Conservation Value Forests**

High conservation value forests (HCVFs) on state forest lands prioritize the protection of particularly valuable forest ecosystems. HCVFs have been set aside for one or more specific management reasons, including conserving native vegetation and plant communities. High conservation value forests can be managed to promote these values. The HCVF concept can be attributed to the Forest Stewardship Council (FSC), which coined the term and has provided guidance for how to differentiate between the types of HCVFs. Using the Forest Stewardship Council definitions, three types of HCVFs directly relate to the conservation of native vegetation and plant communities. These flora-focused sites are chosen based on the presence of a public wild plant sanctuary or natural area (also called category 1.1 under FSC definitions, and in the HCVF section), a concentration of endangered or threatened species (category 1.2), and at-risk natural plant communities (category 3.3). The designation of these sites allows the bureau to further highlight the importance of these plant resources and prepare site- and species-specific management and monitoring techniques to improve the viability of these unique populations and habitats on state forest lands.

**Plant Genetics**

In conserving the natural diversity of plants and animals on state forest lands, the bureau also aims to consider the natural patterns of genetic variation of native species in its management practices. Genetic conservation is essential to avoid loss of unique populations that may have unexpected economic or ecological value. Genetically unique populations may be encountered at the edges of species’ natural ranges or in small, isolated populations. Many plant species reach their northernmost or southernmost limits in Pennsylvania, and the genetic diversity in these populations may allow for adaptation to climate change and other environmental stressors.

**Plantings Using Native Species**

Natural forest regeneration is the norm on state forest lands, but supplemental planting is sometimes necessary to enrich the species composition of a regenerating stand, restore a species to an area from which it has been lost, correct natural regeneration failures, or improve local genetics of a given species. There is also increasing use of native herbaceous species on state forest lands to create wildlife habitat openings or reclaim disturbed sites such as haul roads or rights-of-way. For these reasons, efforts by Penn Nursery to establish seed orchards, collect seed in appropriate zones, and supply state forests with native tree seedlings are of increasing importance.
**Native Wild Plants Management Principle**
Native wild plants on state forest lands are managed to conserve and support a diversity of resilient plant species and communities.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. To conserve and enhance habitats for a diversity of plant species and communities.</strong></td>
<td>1.1 Conduct inventories of plant species and communities.</td>
</tr>
<tr>
<td></td>
<td>1.2 Identify native plant communities to serve as examples for effective management of similar communities.</td>
</tr>
<tr>
<td></td>
<td>1.3 Identify at-risk native plant communities and prioritize management of these areas.</td>
</tr>
<tr>
<td></td>
<td>1.4 Develop landscape-scale management strategies to balance the needs of native plant communities and wildlife habitat.</td>
</tr>
<tr>
<td></td>
<td>1.5 Build and strengthen relationships with partners interested in botanical research or conservation efforts.</td>
</tr>
<tr>
<td></td>
<td>1.6 Develop a strategy for reintroduction of American chestnut.</td>
</tr>
<tr>
<td><strong>2. To identify, protect and manage plant species of concern or other imperiled floral resources and habitats critical to their survival.</strong></td>
<td>2.1 Conduct inventories for new or existing populations of plant species and communities of concern.</td>
</tr>
<tr>
<td></td>
<td>2.2 Develop and implement management and species recovery plans to ensure protection and viability of plant species or communities of concern.</td>
</tr>
<tr>
<td></td>
<td>2.3 Ensure management activities consider impacts to plant species and communities of concern.</td>
</tr>
<tr>
<td></td>
<td>2.4 Manage and implement the public Wild Plant Sanctuary Program.</td>
</tr>
<tr>
<td></td>
<td>2.5 Evaluate opportunities to conserve or enhance habitat for host plants of invertebrate species of concern.</td>
</tr>
<tr>
<td><strong>3. To promote the use of native wild plants in management activities.</strong></td>
<td>3.1 Use guidelines to ensure re-vegetation efforts comply with regulations while providing additional benefits to forest ecosystems.</td>
</tr>
<tr>
<td></td>
<td>3.2 Use Penn Nursery to conserve genetic material and increase the availability of native plants during management activities.</td>
</tr>
</tbody>
</table>
**Guidelines, Tools and Resources**

**PNDI Environmental Review Tool**
http://www.gis.dcnr.state.pa.us/hgis-er/default.aspx

The Pennsylvania Natural Diversity Inventory (PNDI) is a tool that allows the public to search for potential impacts of proposed projects to species of concern. A PNDI search is required for all projects requiring a state forest environmental review (SFER). The tool is maintained by the Pennsylvania Natural Heritage Program (PNHP), whose databases represent the most current and accurate information available on species of concern in Pennsylvania.

**Planting and Seeding Guidelines on State Forest Lands**

Supplemental planting on state forest land is a common practice for activities such as re-vegetation of disturbed areas, control for erosion and sedimentation, and forage and cover habitat in wildlife openings. The bureau encourages the use of native species in supplemental plantings whenever possible; however, in some cases, non-native species may be preferred. These guidelines were developed to assist in deciding the appropriate use of non-native plantings on state forest lands.

**Invasive Plant Species Fact Sheets**
http://www.dcnr.state.pa.us/forestry/plants/invasiveplants/index.htm

The bureau maintains species-specific fact sheets on invasive trees, shrubs, vines, grasses, herbs, and aquatic plants. Each sheet contains concise information on background, description and look-alikes, habitat and range, dispersion, potential threats, and methods for control.

**Terrestrial and Palustrine Plant Communities of Pennsylvania, 2nd Edition**
http://www.naturalheritage.state.pa.us/Communities.aspx

This work represents PNHP’s best approximation of the upland and wetland plant community types of Pennsylvania and can be used to classify and describe patterns in vegetation seen across the landscape.

**Genetics Guidelines**

The bureau acknowledges the importance of genetic diversity in the overall conservation of populations. In keeping with the tenet of biodiversity, the bureau has developed these guidelines and actions to maintain genetic variety on state forest lands.

**Wild Resource Conservation Act**
(June 23, 1982, P.L. 597, No. 170)

This act grants DCNR the authority to establish a procedure for the protection of wild flora in Pennsylvania. Particularly relevant are the following sections that specifically address the conservation of wild flora:

Section 7. Wild Plant Management
Section 10. Public Wild Plant Sanctuaries

**2011 High Conservation Value Forests Analysis and Identification**
http://www.dcnr.state.pa.us/forestry/stateforestmanagement/Certification/index.htm

This document contains the analysis and establishment of HCVFs and state forest lands in accordance with the FSC certification standard. HCVFs related to the conservation of native wild plants, i.e. Table 2, include the designations:

HCVF 1.1: Wild plant sanctuaries
HCVF 1.2: Significant concentrations of rare, threatened, or endangered species
HCVF 3.3: Rare, threatened, or endangered ecosystem

**HCVF 1.1 Wild plant sanctuaries management and monitoring framework**
The bureau prepares management and monitoring plans for wild plant sanctuaries using the framework outlined in this document to ensure that the values for which the sites were chosen are maintained or enhanced. Typically, these plans are prepared by Ecological Services with input from the forest districts and botanical experts familiar with the species and sites.

**HCVF 1.2 Significant concentrations of RTE species management and monitoring framework**

These HCVF areas represent more than 75 plant species of concern. The bureau prepares management and monitoring plans for these sites using the framework described in this document. The structure and content of management plans for HCVF 1.2 are somewhat dependent on the specific species resources for which the area was designated.

**HCVF 3.3 Rare, threatened, or endangered ecosystem management and monitoring framework**

Areas of this designation include rare, threatened, or endangered ecosystems consisting of plant communities ranked as critically imperiled (S1) or imperiled (S2) in Pennsylvania. This document outlines the framework for developing management plans and drafting monitoring protocols for HCVF 3.3 areas on state forest lands.

**Northeastern Bulrush (Scirpus ancistrochaetus) Recovery Plan**

Northeastern bulrush is a federally endangered species that is known to occur on state forest lands. The bureau uses information from this USFWS recovery plan to guide efforts towards conserving this species.
Pennsylvania Natural Heritage Program (PNHP)
http://www.naturalheritage.state.pa.us/

PNHP gathers and provides information on the locations and statuses of important ecological resources. Its purpose is to provide current, reliable, objective information to help inform environmental decisions.

County Natural Heritage Inventories
http://www.naturalheritage.state.pa.us/cnhi.aspx

These reports provide snapshots from county-level biological inventories that are used as tools for planning through detailed mapping, discussions, and recommendations for management and protection.

Monitoring

- Continuous forest inventory
- Landscape exams
- Surveys for species of special concern

Critical Research Needs

- Continuing research on reclaiming disturbed forested sites, using native grasses, herbaceous species, trees, and shrubs to promote native plant communities and habitat diversity
- Careful study of the ecology and threats posed to plant species of concern at the edge of their native U.S. range in Pennsylvania
- Further development of a category of priority species that could be affected — positively or negatively — by climate change. This classification would allow better use of resources to protect those species negatively affected, while promoting some of the species which could benefit from climate change.
- Research that investigates the effects of inadvertent herbicide applications on native plants and their associated pollinators
- Investigation on the allelopathic effects that some non-native, invasive plant species have on native plants and tree regeneration in forest soils
Wildlife species represent valuable resources in Pennsylvania’s forested ecosystems and carry with them a long cultural history. The term “wildlife” refers to any non-domesticated vertebrate or invertebrate animal species. State forest lands provide habitat for a wide variety of wildlife species that play key roles in essential ecosystem functions such as seed dispersal, pollination, insect and disease control, and support for an ecosystem’s food-web dynamics.

Wildlife also play an important role for people by providing opportunities for hunting, fishing, and bird and wildlife viewing, or the intrinsic value of simply knowing wildlife species exist on state forest land. These human values of wildlife contribute greatly to the local economies of our state, and forest visitors expect that state forests will supply abundant wildlife populations to support these values. The bureau manages state forests to provide habitats that support diverse, healthy populations of wildlife that contribute to these important roles and ecological functions of forest ecosystems.
Managing habitat for wildlife species on state forest lands is emphasized in the bureau’s mission and strategic plan. The state forest management goal in Sustaining Penn’s Woods is “…to manage state forests under sound ecosystem management… and maintain biological diversity while providing… habitats for forest plants and animals.” This strategy directs forest management to support animal communities with emphasis on diversity. The bureau’s mission builds on this foundation to ensure the long-term health, viability, and productivity of the commonwealth’s forests and to conserve native wild plants, including habitat considerations for wildlife species.

**Wildlife Diversity on State Forest Lands**

Wildlife species are integral components of communities and ecosystems. Species diversity is generally defined as the combination of the number of species (i.e., species richness) and their relative abundance (i.e., species evenness). Common and rare alike, wildlife species have evolved diverse physical and behavioral characteristics to compete for vital roles in the cycling of energy and nutrients. Since resources on a landscape are limited and unevenly distributed, animals are said to be in competition for available resources. The non-uniform availability of resources and the competition for them have helped shape each species’ approach to survival and reproduction and have helped produce the diversity of animal species we see in the forest today.

Most species are moderately abundant; few are very abundant or extremely rare. Since the presence of animals is dependent upon the availability of resources they need to survive, the amount of wildlife species diversity in a community or ecosystem is often a reflection of the variety and quality of resources across the landscape. The different types of land cover found on state forest land, including plant communities, have helped shape the animal species diversity found there. State forest lands host a multitude of wildlife species from different groups. Jurisdiction over wildlife species falls under other agencies (Table 1). Thus, the bureau works cooperatively with these agencies by managing land and vegetation to benefit an array of species.

**Wildlife Inventory and Planning**

To account for wildlife diversity on state forest lands and inform management, wildlife biologists and ecologists from the bureau or agency partners conduct inventories of wildlife species and their habitats. During these inventories, data is collected on the conditions of wildlife populations, identification of essential habitat elements, and observations of any perceived threats or unnatural disturbances to wildlife species. The bureau uses this information to develop strategies to protect, maintain, or enhance wildlife habitat features during management activities.

In 2005, the Game Commission and Fish & Boat Commission joined to form an interagency partnership in developing the commonwealth’s first comprehensive State Wildlife Action Plan. The State Wildlife Action Plan was an outcome of the federal State Wildlife Grants Program and developed strategies to proactively manage and protect

<table>
<thead>
<tr>
<th>Jurisdictional agency</th>
<th>Animal group</th>
<th>n species (statewide)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA Game Commission</td>
<td>Birds</td>
<td>414</td>
</tr>
<tr>
<td></td>
<td>Mammals</td>
<td>66</td>
</tr>
<tr>
<td>PA Fish &amp; Boat Commission</td>
<td>Reptiles</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Amphibians</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Fish</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td>Mussels</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>Non-mussel aquatic invertebrates</td>
<td>&gt;10,000</td>
</tr>
<tr>
<td>U.S. Fish &amp; Wildlife Service</td>
<td>Federally listed species (all guilds)</td>
<td>19</td>
</tr>
</tbody>
</table>

*Table 1. Catalog of recognized PA animal species and relevant jurisdictional agency*
declining fish and wildlife species. The plan not only targets those species listed for protection in state or federal legislation, but also examines more common species that may be experiencing recent declines and outlines strategies to ensure that these species do not become endangered. The bureau provides input for revisions to the plan and supports implementation of the various strategies on state forest lands.

The bureau also carries out various levels of habitat- and species-specific management plans on state forest lands, as detailed in the sections below.

**Wildlife Habitat on State Forest Lands**

Habitat is the totality of biotic and abiotic resources that produce occupancy by an organism in a space. Biotic resources could include food, associated plant communities, the presence or absence of other organisms, or availability of mates. Abiotic resources could include temperature, humidity, or geology.

Habitat is species-specific; it relates the presence of a species to an area’s ecological characteristics. A mature oak-heath forest is a major habitat component for some wildlife species, but not necessarily for others. Likewise, an open herbaceous opening near a forest edge may produce occupancy by some species but restrict occupancy by others. Furthermore, the habitat concept can be discussed at different scales with respect to space and time. For example, the large-scale habitat for a migratory bird species might include its entire migration corridor along many degrees of geographic latitude over the course of a year; conversely, the small-scale habitat for that same species might include a particular perch site during a particular season. Habitat should always be discussed in terms of the species or species groups that occupy it and the scale at which it is being considered.

**Habitat Diversity**

The diversity of lands and vegetation types on state forest lands includes mostly forested spaces. More than 92 percent of state forest land is terrestrial forest, most of which is second growth. Although many plant communities have been noted on state forest lands, the majority of the total area consists of relatively few community types. Plant communities are important for shaping habitats for animals for many reasons, including that they provide food sources for herbivores and some available structure in the space that animals occupy.

While vegetational composition is certainly a habitat factor for a given forest animal species, it would be misleading to suggest that the species depends solely on the presence of a few trees and understory plants for its survival. On a bigger scale, the large swaths of forested spaces that comprise state forest land produce occupancy by many forest-dwelling animal species; however, within those spaces, on a more intimate scale, other factors such as temperature, slope, aspect, proximity to other types of land cover, and the presence or absence of other biotic and abiotic factors also contribute to a species’ ability to occupy and utilize a space.

Intermediate levels of disturbance produce higher species diversity on a landscape. Forests experience sporadic disturbance events such as fires, windthrow, pest and disease outbreaks, and timber harvesting. In the wake of these events, disturbed areas proceed through a gradient of successional plant community changes that foster respective changes in the animal communities. Common yellowthroats, eastern cottontails, and white-tailed deer become prevalent in early- and mid-successional areas, becoming replaced by scarlet tanagers, southern flying squirrels, and black bears as the forested areas mature. While old forests typically harbor greater animal species diversity than younger ones, maximum diversity may be achieved by providing a mosaic of forest stands at different ages.

In addition to the trees associated with a forested landscape, state forest lands host additional land structures such as cliffs, talus, ridgetops, ravines, forest edges, open herbaceous areas, serpentine barrens, streams, wetlands, vernal pools, and even tidal mud flats, all of which
potentially accommodate different communities of wildlife species, increasing overall animal diversity.

**Habitat Selection Factors**

Most animals are neither evenly nor randomly distributed across their geographical range, but rather they usually occur in patches in response to the presence or absence of environmental factors. Landscape-level conditions often influence habitat quality at the stand level. Animals typically select habitats disproportionately, favoring some spaces over others (i.e., habitat preference). Some animals are capable of exploiting a variety of habitats (i.e., generalist) while others have specific habitat requirements (i.e., specialist).

The type, number, quality, and arrangement of resources in a space change over time, such as can be seen in seasonal variations at temperate latitudes or throughout forest succession. For example, one might consider timber rattlesnakes a resident of state forest land; however, one should not expect to find the snakes distributed uniformly throughout the forest at all times of year. Likewise, another forest dweller, the ruffed grouse, utilizes forested stands in various successional stages for its seasonal food and cover requirements.

Mostly by virtue of wild processes but also through active forest management, state forest lands host a broad diversity of structural features, climates, and food sources that produce occupancy by an assortment of animals. Although habitats rarely fit into clearly defined categories with set parameters, it is often the best forestry approach to manage for the presence or absence of quality structural factors, such as the following:

**Deciduous Leaf Litter**

A layer of moist leaf litter on the forest floor provides habitat for an assortment of insects and other invertebrates, amphibians, and reptiles. Nest selection for ovenbirds is strongly associated with this variable.

**Understory Vegetation and Early-Successional Forest**

This is the lowest vegetation stratum in the forest and includes tree seedlings and saplings, shrubs, and herbaceous vegetation. High stem densities provide potential nest sites, foraging substrates, and protective cover for many species of mammals and birds. Many species such as eastern towhee, American woodcock, ruffed grouse, turkeys, raccoons, and white-tailed deer utilize these forest spaces. In the case of the eastern towhee, regeneration heights over 20 feet become unsuitable for nesting. Predators such as foxes, bobcats, hawks, and owls also prey on the small mammal and birds populations that occupy these places.
Midstory Vegetation
The layer of vegetation between the understory and overstory includes mostly trees and shrubs. The majority of forest birds, such as American redstart and blue-headed vireo, nest and forage within the 1- to 30-foot forest layer.

Large Overstory Trees and Old Growth
Large trees dominate the forest canopy and are usually excellent mast producers for wildlife forage. The numerous limbs provide a variety of roosting sites for birds, and the trees may have cavities that animals can use for dens. Many animal species, such as barred owls, porcupines, and pileated woodpeckers, use these trees.

Coarse and Fine Woody Material, Brush Piles
Coarse woody material is downed logs and branches at least 4 inches in diameter. Fine woody material is limbs and branches less than 4 inches in diameter. These structural factors can provide protective cover and nesting substrates for many species, especially if aggregated in brush piles. Ruffed grouse often use coarse woody debris greater than 8 inches in diameter for drumming perches. For some mammals, including deer mice, chipmunks, and squirrels, log tops are highways over the forest floor, and at least 19 kinds of salamanders and 26 species of reptiles utilize logs, stumps, bark, and slash piles in Pennsylvania’s forests. Insects, salamanders, snakes, and some small mammals utilize rotting logs.

Snags and Cavity Trees
Snags are standing trees that are dead or partially dead and are good feeding and perching sites for birds. Cavity trees are alive or dead trees that have a hollow or partially hollow section and often result from heartwood decay fungus and sapwood decay fungus. At least 21 mammal species, including grey squirrels, bats, and raccoons, and 33 bird species, including wood ducks, screech owls, and pileated woodpeckers, use tree cavities for nest sites, dens, and cover.

Canopy Height
The height of the forest canopy is especially important for nesting birds that select mature forest. For wood thrush and scarlet tanager, nest selection is strongly associated with increasing canopy height.

Canopy Closure
Canopy closure typically is inversely proportional to understory development. An open canopy of less than 30 percent fosters early successional vegetation. An intermediate canopy of 30 to 80 percent often promotes advance regeneration and shrub development suitable for understory and mid-story nesting birds.

Edge
An edge is a transitional zone between different adjacent areas. In the case of forest and non-forest, the first 300 feet of forested area tends to experience edge effects that are characterized by increased temperature, increased light penetration, lower humidity, and plant and animal species compositions that can be markedly different from those in the forest interior. A hard edge is an area where land cover types end and begin abruptly. A soft edge refers to a more gradual transition from one area to the next. The edge concept also can include the boundary between two different successional stages or the interface between a pond and a stand of trees. While edge can limit the presence of forest interior species, it can favor the presence of others, especially some generalists.

Upland Herbaceous Openings
In these forest openings, woody vegetation is absent or sparse, and vegetation typically includes herbaceous plants such as grasses and forbs. These areas are important for many insects and the grouse chicks and turkey poults that prey upon them. Other species, such as rabbits and deer, graze on the forage, while foxes and raptors prey upon the small mammals there.
Cliffs, Talus, and Rocky Areas

Rocky areas where boulders and stones are abundant and where trees are less than 30 percent stocked provide unique habitat components for many wildlife species. Although management potential in these areas is limited, their ecological value on the landscape level is recognizable. Rattlesnakes use these areas for basking and as gestation areas, and Allegheny woodrats utilize the areas for cover when mast trees are nearby.

Caves and Karsts

Caves provide shelter and nesting and roosting sites for bats, woodrats, and bobcats. These areas are particularly important in conservation considerations for threatened and endangered bats.

Rocky Bottom Streams and Riparian Areas

State forest lands include more than 4,800 miles of streams, many of which are classified as exceptional value (EV) or high quality (HQ) and provide a cold water resource for aquatic ecosystems. Many streams on state forest lands provide habitat for native brook trout, darters, and thousands of aquatic macroinvertebrates.

Riparian areas or streamside forests play a critical role in protecting water quality, reducing soil erosion, and enhancing fish and wildlife resources. Also, because of the dendritic pattern exhibited by most streams on state forest lands, riparian zones provide travel lanes or corridors for many wildlife species. Riparian areas form a natural buffer between an aquatic ecosystem and the drier upland terrestrial systems.

Forest Wetlands and Vernal Pools

Wetlands are defined under Section 404 of the Federal Clean Water Act and Chapter 105 regulations pursuant to the Pennsylvania Dam Safety and Encroachment Act. These areas typically are characterized by hydrophytic vegetation, hydric soils, and the presence of water at or near the surface for a portion of the year. Forested wetlands usually support greater species richness than nearby upland forests do. These places provide habitat for wood turtles, water shrews, muskrats, beavers, and water fowl. Bears are also known to spend ample time in spring and summer in forested wetlands.

A vernal pool is a temporary body of water in a depression fed by surface water that lacks surface outflow. The rich food supply of microscopic algae and small invertebrates and the lack of predatory fish provide a habitat significant and sometimes critical to the continued survival of some amphibians, insects, and crustaceans.
Managing for Wildlife Habitat Diversity

**Silviculture**
In keeping with its ecosystem management approach, the bureau uses silviculture as a way to harvest timber sustainably and manage for wildlife habitats, watershed health, and the overall conservation of regional biodiversity. By controlling stand structure and forest structure through combinations of uneven-age management, regeneration harvests, tree reservations, intermediate treatments, and salvage operations, various local and landscape effects can be produced for wildlife benefit.

Landscape goals should be considered when determining silviculture prescriptions. For wildlife implications, it is important to determine desired animal species composition with necessary habitat factors. Silviculture methods can be used to create forest disturbance and initiate succession. Long-term landscape planning involving multiple silvicultural treatments can be used to create a pattern of areas in various successional stages across a large area that may be utilized by different wildlife species. Additionally, reserve trees may be left, including mast trees for forage and cavity trees and snags for nesting, roosting, or denning. Residual selections can be mixed between single-tree and clump reservations to maintain structural diversity in the stand. Furthermore, log landings can be seeded upon retirement to produce grasses and flowers for forage, and the limbs and crown cutoffs can be used as cover by a variety of animal species.

The bureau’s silviculture guidelines, including reservation guidelines, and wildlife habitat guidelines contain directional assistance for the managing of lands for the benefit of wildlife.

**Prescribed Fire**
Fires had been a relatively frequent disturbance event on the forested Pennsylvania landscape prior to European settlement, and they remain beneficial to the germination and establishment of some tree species. Prescribed fire can be used as a tool to engineer plant community dynamics to favor the occurrence of desirable plant species that can benefit wildlife. Depending on landscape goals, prescribed fire can be used to initiate forest succession and foster a mosaic of plant communities for wildlife habitats across the landscape.

**Restoration**
Upon the retirement of a land use activity, such as gas development where the land has been converted to non-forest, an area may be managed for the return of its preexisting ecological function, approximate appearance, and/or species composition. Alternatively, although inconsistent with a strict restoration definition, a retired area may be managed for the creation of a new ecological function, such as habitat for grassland bird species.

Interim reclamation may be carried out on sites where operational activity has temporarily halted but may resume. Interim reclamation consists of minimizing the footprint of disturbance by reclaiming all portions of the site not needed for immediate operations. Interim reclamation may include spreading topsoil evenly and re-vegetating using a predominately native seed mix for the creation of open herbaceous areas, reducing the amount of edge, or enhancing wildlife habitat, e.g., creating brush piles and rock piling around edges to encourage basking areas for rattlesnakes and other reptiles.

Final restoration begins when the area is inactive and will not be accessed again. There are several choices when it comes to restoration on state forest lands. Restoration may focus on reverting to original condition, creating underrepresented habitat factors for marginalized species, providing additional food sources for wildlife, or enhancing special habitat factors.
High Conservation Value Forests

In 2011, the bureau evaluated and selected sites to designate as high conservation value forests (HCVFs) on state forest lands as part of the FSC certification process. One of the considerations for HCVF selection is the presence of “globally, regionally, or nationally significant concentrations of biodiversity values.” On state forest lands, HCVF category 1.2 consists of “ecological focus areas” that have significant concentrations of species of concern. These areas have been delineated to identify “hotspots” that include more than 75 plant species and 22 wildlife species (Table 2). Managing and monitoring these areas is usually done on a case-by-case basis, dependent on site-specific resources, and efforts are under way to develop specific management plans. Currently, more than 34,000 acres are designated as ecological focus areas for HCVF.

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
<th>Guild</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scaphiopus holbrookii</td>
<td>eastern spadefoot</td>
<td>amphibian</td>
</tr>
<tr>
<td>Aneides aeneus</td>
<td>green salamander</td>
<td>amphibian</td>
</tr>
<tr>
<td>Lithobates sphenocephalus</td>
<td>southern leopard frog</td>
<td>amphibian</td>
</tr>
<tr>
<td>Pseudemys rubriventris</td>
<td>northern red-bellied cooter</td>
<td>reptile</td>
</tr>
<tr>
<td>Opheodrys aestivus</td>
<td>rough green snake</td>
<td>reptile</td>
</tr>
<tr>
<td>Crotalus horridus</td>
<td>timber rattlesnake</td>
<td>reptile</td>
</tr>
<tr>
<td>Stygobromus allegheniensis</td>
<td>Allegheny cave amphipod</td>
<td>crustacean</td>
</tr>
<tr>
<td>Villosa fabalis</td>
<td>rayed bean</td>
<td>mussel</td>
</tr>
<tr>
<td>Pleurobema clava</td>
<td>clubshell</td>
<td>mussel</td>
</tr>
<tr>
<td>Epioblasma torulosa rangiana</td>
<td>northern riffleshell</td>
<td>mussel</td>
</tr>
<tr>
<td>Quadrula cylindrica</td>
<td>rabbitsfoot</td>
<td>mussel</td>
</tr>
<tr>
<td>Alasmidonta marginata</td>
<td>elktoe</td>
<td>mussel</td>
</tr>
<tr>
<td>Alasmidonta undulata</td>
<td>triangle floater</td>
<td>mussel</td>
</tr>
<tr>
<td>Alasmidonta varicosa</td>
<td>brook floater</td>
<td>mussel</td>
</tr>
<tr>
<td>Lasmigona subviridis</td>
<td>green floater</td>
<td>mussel</td>
</tr>
<tr>
<td>Neotoma magister</td>
<td>Allegheny woodrat</td>
<td>mammal</td>
</tr>
<tr>
<td>Myotis septentrionalis</td>
<td>northern long-eared bat</td>
<td>mammal</td>
</tr>
<tr>
<td>Myotis leibii</td>
<td>eastern small-footed bat</td>
<td>mammal</td>
</tr>
<tr>
<td>Sorex palustris albibarbis</td>
<td>northern water shrew</td>
<td>mammal</td>
</tr>
<tr>
<td>Ardea herodias</td>
<td>great blue heron</td>
<td>bird</td>
</tr>
<tr>
<td>Asio flammeus</td>
<td>short-eared owl</td>
<td>bird</td>
</tr>
<tr>
<td>Haliaeetus leucocephalus</td>
<td>bald eagle</td>
<td>bird</td>
</tr>
<tr>
<td>Ammodramus henslowii</td>
<td>Henslow’s sparrow</td>
<td>bird</td>
</tr>
<tr>
<td>Circus cyaneus</td>
<td>northern harrier</td>
<td>bird</td>
</tr>
<tr>
<td>Bartramia longicauda</td>
<td>upland sandpiper</td>
<td>bird</td>
</tr>
<tr>
<td>Porzana carolina</td>
<td>sora rail</td>
<td>bird</td>
</tr>
</tbody>
</table>

Table 2. Wildlife species of concern in ecological focus areas covered by HCVF 1.2 designation
Special Resource Management Zones for Wildlife Species

Habitat guidelines for terrestrial, wetland, aquatic/riparian, and cave habitats represent the bureau’s “normal” operating plan on state forest lands. In conjunction with these guidelines, certain areas have been designated as special management areas to highlight the importance of a particular species, species group, or unique habitat type in management planning. Because of the nature of these species and/or areas, the bureau’s management strategies employed on them generally deviate from “normal” operating guidelines. Specific plans may have been established for these species and/or areas.

Site-specific habitat management plans can direct management in a particular area to create or enhance particular habitats. Early successional habitats are the least represented successional stage in Pennsylvania due to decreased forest harvesting and increased development or conversion of old agricultural lands. These habitats benefit a suite of species, including golden-winged warbler, American woodcock, ruffed grouse, and white-tailed deer. In addition, large expanses of wetland habitats provide important habitat elements not common across the landscape. In parts of northern Pennsylvania, special management consideration may also be given to areas occupied by elk, a species reintroduced to Pennsylvania during 1913-1926.

Golden-winged warblers use multiple successional areas during their lifecycle and have suffered steep population declines in recent decades. These birds breed in thick, shrubby habitats, such as early successional forest regeneration following a clearcut, and move into mature forest after fledging. The bureau fosters conservation for this species by creating habitat through routine management operations, such as timber harvesting. In addition, Indiana University of Pennsylvania hosts workshops to identify forest conditions created by timber harvests that support golden-winged warblers, and the Delaware State Forest has designated a special management area to enhance connectivity of early successional habitats across the landscape.

Reptile & Amphibian Protection Areas

In 1979, the bureau and the PFBC designated 18 natural areas as special regulation areas for the protection of all amphibians and reptiles. Section 77.1(b) of the Fishing and Boating Regulations states: “The taking, catching, killing, and possession of individuals of any species of Pennsylvania amphibians and reptiles occurring naturally within the boundaries of designated natural areas by persons other than those possessing a valid scientific collectors’ permit is prohibited.” In 1982 and 1985, 10 additional areas were added to the list, bringing the total to 28 natural areas where amphibians and reptiles are protected. Additionally, the bureau participates in the statewide Pennsylvania Amphibian and Reptile Survey in an effort to inventory and gather locality data on these species.

Important Bird and Mammal Areas

The Important Bird and Biodiversity Areas Program was first initiated on a global scale in the late 1980s by Birdlife International in an effort to minimize or reverse through science, advocacy, and outreach the effects of human-caused impacts on bird habitat. In 1996, the Important Bird Areas (IBA) Program began administration in Pennsylvania by the PA Audubon Society, marking the initiation of the first statewide IBA program in the United States. Pennsylvania forests provide crucial nesting habitat for forest interior birds, including 17 percent of the world’s scarlet tanagers and 9 percent of wood thrushes. Generally, IBAs are targeted for threatened and endangered birds, birds with small ranges, birds with specific habitat types, and large groups of birds. By focusing attention on the most important habitat types, the IBA program provides proactive habitat conservation, benefiting birds and biodiversity. Audubon Pennsylvania works with numerous partners across the state to promote avian conservation, and many IBA areas overlap with state forest land (Table 4).
Patterned after the IBA project, the Important Mammal Areas Project was launched in Pennsylvania in 2001 to conserve habitats critical to mammal survival in important mammal areas (IMAs) and to educate the public about mammals. The project is the first of its kind in the United States and possibly the world, and it complements the State’s Wildlife Action Plan. IMAs are sites that support diverse or unique mammal communities, high-density mammal populations, threatened or endangered species, declining or vulnerable species, or wildlife viewing and public education opportunities. IMAs in Pennsylvania share significant overlap with state forest lands (Table 4), where much of the space is conducive to mammal occupancy and a diversity of some unique habitat types can be found.

<table>
<thead>
<tr>
<th>Forest</th>
<th>Acres</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michaux</td>
<td>780</td>
<td>Carbaugh Run</td>
</tr>
<tr>
<td>Buchanan</td>
<td>1,403</td>
<td>Sweet Root</td>
</tr>
<tr>
<td>Tuscarora</td>
<td>1,270</td>
<td>Frank E. Masland, Jr.</td>
</tr>
<tr>
<td>Forbes</td>
<td>3,090</td>
<td>Roaring Run</td>
</tr>
<tr>
<td>Rothrock</td>
<td>890</td>
<td>Bear Meadows</td>
</tr>
<tr>
<td>Rothrock</td>
<td>184</td>
<td>Big Flat Laurel</td>
</tr>
<tr>
<td>Rothrock</td>
<td>463</td>
<td>Detweiler Run</td>
</tr>
<tr>
<td>Rothrock</td>
<td>624</td>
<td>Little Juniata</td>
</tr>
<tr>
<td>Gallitzin</td>
<td>384</td>
<td>Charles F. Lewis</td>
</tr>
<tr>
<td>Bald Eagle</td>
<td>5,119</td>
<td>The Hook</td>
</tr>
<tr>
<td>Bald Eagle</td>
<td>512</td>
<td>Mt. Logan</td>
</tr>
<tr>
<td>Bald Eagle</td>
<td>152</td>
<td>Rosecrans Bog</td>
</tr>
<tr>
<td>Bald Eagle</td>
<td>660</td>
<td>Tall Timbers</td>
</tr>
<tr>
<td>Moshannon</td>
<td>917</td>
<td>Marion Brooks</td>
</tr>
</tbody>
</table>

Table 3. Reptile and amphibian protection areas on state forest lands and associated natural areas.

<table>
<thead>
<tr>
<th>Forest</th>
<th>Acres</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sproul</td>
<td>144</td>
<td>Cranberry Swamp</td>
</tr>
<tr>
<td>Sproul</td>
<td>186</td>
<td>East Branch Swamp</td>
</tr>
<tr>
<td>Sproul</td>
<td>86</td>
<td>Tamarack Swamp</td>
</tr>
<tr>
<td>Tiadaghton</td>
<td>84</td>
<td>Algerine Swamp</td>
</tr>
<tr>
<td>Tiadaghton</td>
<td>73</td>
<td>Bark Cabin</td>
</tr>
<tr>
<td>Tiadaghton</td>
<td>4,987</td>
<td>Miller Run</td>
</tr>
<tr>
<td>Elk</td>
<td>892</td>
<td>Lower Jerry Run</td>
</tr>
<tr>
<td>Elk</td>
<td>1,215</td>
<td>Wykoff Run</td>
</tr>
<tr>
<td>Susquehannock</td>
<td>1,521</td>
<td>Forrest H. Dutlinger</td>
</tr>
<tr>
<td>Tioga</td>
<td>308</td>
<td>Black Ash Swamp</td>
</tr>
<tr>
<td>Tioga</td>
<td>1,302</td>
<td>Reynolds Spring</td>
</tr>
<tr>
<td>Delaware</td>
<td>471</td>
<td>Buckhorn</td>
</tr>
<tr>
<td>Delaware</td>
<td>936</td>
<td>Pennel Run</td>
</tr>
<tr>
<td>Loyalsock</td>
<td>774</td>
<td>Kettle Creek Gorge</td>
</tr>
</tbody>
</table>

Table 4. Important bird areas and important mammal areas in Pennsylvania and on state forest lands.

<table>
<thead>
<tr>
<th># of areas</th>
<th>Total acres</th>
<th>Acres on state forest lands (% of IBA/IMA total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBA</td>
<td>91</td>
<td>2,944,280</td>
</tr>
<tr>
<td>IMA</td>
<td>43</td>
<td>5,398,085</td>
</tr>
</tbody>
</table>

State Forest Environmental Review

The state forest environmental review (SFER) is the process used by the bureau to assess impacts to a variety of forest resources for projects that may or will disrupt, alter, or otherwise change the environment. Some common activities, such as timber sales, have developed checklists.
to facilitate environmental reviews. SFERs are a way to determine if the benefits gained from the proposal outweigh potential impacts to other forest resources or if any negative impacts may result. Within an SFER, wildlife species and habitats are considered in a variety of ways, including presence of species of concern, general impacts to common animals, habitat diversity and interspersion, and biological productivity. For all SFERs, it is standard practice to include the results of a PNDI review for potential impacts on species of conservation concern.

**Wildlife Species Management on State Forest Lands**

**White-Tailed Deer and Deer Management Assistance Program**

The bureau recognizes that the white-tailed deer is perhaps the most influential wildlife species in the forest ecosystem. Deer influence the vegetation and health of the forest through selective browsing of native plants, shrubs, and trees. Deer also influence other wildlife species and other forest values and can impact their own habitat.

To accomplish its mission of conserving Pennsylvania’s forests, the bureau monitors and manages deer impacts on state forest land and promotes sustainable deer management in all commonwealth forests.

The vegetation impact protocol (VIP) is used to measure the impact of deer on state forest habitats. This monitoring effort measures the abundance of herbaceous plant species (particularly indicator species), regeneration, competing vegetation, and site limitations to determine if local deer populations are in balance with vegetation composition. If the data suggest an imbalance, the bureau employs the Deer Management Assistance Program (DMAP) to allocate additional antlerless deer tags in an effort to reduce deer populations in specific areas of state forest lands. This program was established by the PA Game Commission and allows the bureau to promote forest regeneration by targeting the most vulnerable and severely impacted tracts of land for additional antlerless deer harvests. The amount of DMAP area and the number of coupons fluctuates over time due to operational and management needs (Table 5).
Table 5. The number of DMAP coupons awarded and individual DMAP units designated on state forests and total acres by year

<table>
<thead>
<tr>
<th>Year</th>
<th># of coupons</th>
<th># of units</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>14,859</td>
<td>64</td>
<td>910,462</td>
</tr>
<tr>
<td>2010</td>
<td>12,089</td>
<td>58</td>
<td>830,621</td>
</tr>
<tr>
<td>2011</td>
<td>12,081</td>
<td>72</td>
<td>936,802</td>
</tr>
<tr>
<td>2012</td>
<td>12,296</td>
<td>61</td>
<td>798,261</td>
</tr>
<tr>
<td>2013</td>
<td>16,259</td>
<td>67</td>
<td>980,115</td>
</tr>
<tr>
<td>2014</td>
<td>15,775</td>
<td>67</td>
<td>928,329</td>
</tr>
</tbody>
</table>

**Bats**

Nine species of bats are known to inhabit Pennsylvania’s forests and play an important role in the ecology of a forest system. Bats are integral in managing insect pests and contribute to forest health. As our understanding of the relationship between bats and forests increases, we have been able to identify adaptive management strategies to ensure ecosystem sustainability. As a result of their small size and energetic requirements, bats are especially vulnerable to stressors and habitat alteration. Species whose vulnerability has been documented often need specific strategies and management practices to ensure long-term survival. North American bats fall into this category. Because bat species in Pennsylvania and across North America have suffered significant population declines in recent years, due primarily to white-nose syndrome and habitat loss/fragmentation, the development of a conservation and management plan for bat species is important.

The federally endangered Indiana bat and the federally threatened northern long-eared bat both occur on public lands, including state forest lands. Forest management activities, including timber harvesting, fuelwood collection, and prescribed burning, can impact the habitats and activities of these species. To avoid negative impacts and mitigate when possible, the bureau, Bureau of State Parks, and PA Game Commission, in conjunction with U.S. Fish and Wildlife Service, are developing a habitat conservation plan (HCP) that will help avoid incidental harm to Indiana and northern long-eared bats, accommodate forestry activities, support conservation goals, and aid in the recovery of the population. To achieve these ends, the HCP will include best management practices (BMPs) and mitigation measures, including seasonal restrictions near bat hibernacula, retention of high-value roost tree species and snags, protection of hibernacula, monitoring strategies to ensure BMPs are implemented, staff education, and installation of artificial roosts.

**Brook Trout**

Brook trout are indicators of superior water quality, provide recreational angling opportunities, and are a symbol of the state’s outdoor traditions. The thousands of stream miles on state forest lands provide quality habitat for brook trout, a species that has already been extirpated from 70 percent of its historic range. Species whose fragility has been documented often need specific strategies to ensure long-term survival; therefore, the bureau has a unique responsibility to conserve this keystone species on state forest lands. This plan establishes goals and objectives for brook trout conservation, provides an assessment of the most important threats, and recommends management actions for goal achievement.

**Timber Rattlesnakes**

Timber rattlesnakes are important predators that have experienced past population declines due to unrestricted hunting, den poaching, and land development. The bureau shares a large part of timber rattlesnake conservation responsibility because the largest populations of rattlesnakes occur in the heavily forested regions of the state. The bureau follows PFBC recommendations for establishing buffers around den and gestation sites and participates in an effort to assess historic den and gestation site records, acquire new records, identify new sites, and improve basking areas. The bureau participates in efforts to augment rattlesnake habitats using guidelines from PFBC.
The bureau also supports research to understand the impacts of state forest activities on timber rattlesnakes. For example, the bureau funded a study examining the response of rattlesnakes to commercial logging operations. Two additional studies are currently under way, one in the Moshannon State Forest studying the impacts of Marcellus shale-gas development on timber rattlesnakes and the other looking at the potential impacts of prescribed burns.

Special protection for these animals exists by way of specific designations for areas with important populations, including natural areas or high conservation value forest.

**Allegheny Woodrat**

The Allegheny woodrat is listed as PA threatened and is protected under the Game and Wildlife Code. The decline of the woodrat has been attributed to forest fragmentation, the spread of the raccoon roundworm (Baylisascaris), and the decline of mast-producing trees such as the American chestnut. Because New York woodrat populations are extirpated, Pennsylvania is at the northeastern edge of the range for the Allegheny woodrat. Preferred habitat for this species includes tightly spaced rocky areas for dens and surrounding unfragmented forests that supply mast for forage. With these requirements in mind, state forest lands provide ample potential habitat and support viable populations of Allegheny woodrat. To foster conservation of this species, the bureau utilizes PGC’s guidelines to actively improve woodrat habitat and cooperates with other agencies to establish core conservation areas on state forest lands.

**Threats to Wildlife Species on State Forest Lands**

Although state forest lands provide habitats for a rich diversity of animals, many species have already been lost and many more are in jeopardy. There are many reasons for the declines, and the reasons vary among species, but habitat loss or degradation and disease are the two main threats that wildlife species face in Pennsylvania.

Habitat loss occurs when space becomes unsuitable for occupancy by an animal. This is due largely to conversion of lands for human development. Habitat degradation is a decrease in the quality, number, arrangement, or availability of resources for species and may be an indirect effect of habitat loss. As natural habitats and ecosystems are converted or degraded, forest fragmentation presents another serious threat to diversity and wildlife populations. Because these threats are common across Pennsylvania, state forest lands act as vital refugia for many wildlife species and provide habitat that continues to be managed intentionally under sound ecosystem management principles.

Within the 2.2 million acres of state forest lands, sporadic declines in forest health can present threats or disturbances to the desired balance and diversity of wildlife habitats. The lack of desirable regeneration on some state forest lands could threaten the future of the forest when young trees are not being produced to replace old, dying, or harvested trees. The species of trees are important as well, as oaks and other mast producing trees are key food sources for many native wildlife species.

Diseases, many of them non-native, are a significant threat to wildlife in Pennsylvania: Bat species have experienced steep population declines as a result of white-nose syndrome; amphibian populations are affected by potentially fatal fungal and viral infections; and chronic wasting disease has been documented in white-tailed deer and is likely to spread. By providing healthy forest ecosystems and habitats, the bureau can help minimize the effect of these and other wildlife diseases.
Wildlife Species of Concern on State Forest Lands

The Pennsylvania Natural Heritage Program (PNHP) inventories and maintains a list of all plant and animal species as well as plant communities and geologic features in the state for which there is conservation concern. The information maintained by PNHP represents the most up-to-date and accurate scientific information available on species of concern in Pennsylvania. Many wildlife tracked by PNHP can be found on state forest lands (Table 6), and PNHP maintains records for two species that only occur on public lands (including state forest lands): the rock vole and the yellow-bellied flycatcher.

<table>
<thead>
<tr>
<th></th>
<th>Total # of species</th>
<th># of species on state forest lands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birds</td>
<td>30</td>
<td>9</td>
</tr>
<tr>
<td>Mammals</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Reptiles</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Amphibians</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Fish</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>Mussels</td>
<td>40</td>
<td>6*</td>
</tr>
</tbody>
</table>

Table 6. Wildlife species tracked by PNHP in Pennsylvania and on state forest lands

*Data may be inconsistent with HCVF 1.2 data (Table 2) due to different methods of GIS analysis.

The Pennsylvania Natural Diversity Inventory (PNDI) is a database that contains known records of species of special concern in the commonwealth. It is also a spatial tool maintained by PNHP that allows the public to search for potential impacts to these species. The bureau uses PNDI to screen projects for potential impacts to species of concern and develop mitigation or protection strategies for these resources. Although PNDIs typically are run for any projects that require a permit from the Department of Environmental Protection, the bureau expanded use of PNDI to include smaller, less disturbing activities that still could impact species of concern. As part of the timber sale proposal and state forest environmental review processes, coordination with the Ecological Services Section and jurisdictional agencies is required to ensure that potential impacts have been reviewed by a wildlife biologist or botanist and mitigation strategies are incorporated into project specifications. Because new information is constantly added to the PNDI, reviews are valid only for a two-year period.
Wildlife Management Principle
Habitats for native wildlife species on state forest lands are managed and enhanced to provide diversity in successional stages and forest cover types that support balanced wildlife populations.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
</table>
| 1. To conserve and enhance a diversity of wildlife habitat types across the landscape. | 1.1 Identify fundamental wildlife habitat types to serve as examples for effective management.  
1.2 Inventory and monitor fundamental wildlife habitats that are at risk of degradation and develop strategies for prioritizing management of these areas.  
1.3 Consider landscape-level habitat conditions during management activities.  
1.4 Build and strengthen relationships with partners interested in wildlife research or conservation efforts. |
| 2. To identify, protect, and manage habitats critical to the survival of wildlife species of concern. | 2.1 Conduct inventories for new or existing populations of state or federally listed wildlife species and their habitats.  
2.2 Develop and implement plans for the protection and viability of wildlife species of concern and their habitats.  
2.3 Ensure that management activities avoid impacts to wildlife species of concern and their habitats.  
2.4 Provide training to district staff on species of concern natural history and identification. Contact Ecological Resources to report new locations for species of concern. |
| 3. To conserve and manage wildlife populations and their habitats that provide specific benefits or impacts to the public and forest ecosystems. | 3.1 Designate and manage special management areas that focus on conserving particular wildlife species and their habitats (DMAP, elk, golden-winged warbler, keystone, etc.).  
3.2 Develop and implement management plans for species of high interest in the commonwealth (white-tailed deer, brook trout, etc.).  
3.3 Provide habitat for wildlife species that may be enjoyed sustainably by the public through viewing, hunting, trapping, and other opportunities.  
3.4 Support research regarding the impacts of white-tailed deer on native forest communities and maintain deer population levels that are proportionate with healthy forest ecosystems. |
Guidelines, Tools, and Resources

PNDI Guidelines
http://www.gis.dcnr.state.pa.us/hgis-er/default.aspx

The Pennsylvania Natural Diversity Inventory (PNDI) is a tool that allows the public to search for potential impacts of proposed projects to species of concern. A PNDI search is required for all projects requiring a state forest environmental review (SFER) as well as all timber sales. The tool is maintained by the Pennsylvania Natural Heritage Program (PNHP), whose databases represent the most current and accurate information available on species of concern in Pennsylvania.

Planting and Seeding Guidelines on State Forest Lands

Supplemental planting on state forest land is a common practice for activities such as re-vegetating disturbed areas, control for erosion and sedimentation, and forage and cover habitat in wildlife openings. The bureau encourages the use of native species in supplemental plantings whenever possible; however, in some cases, non-native species may be preferred. These guidelines were developed to assist in deciding the appropriate use of non-native plantings on state forest lands.

HCVF 1.2 Significant Concentrations of RTE Species Management and Monitoring Framework

These HCVF areas represent more than 20 animal species of concern. The bureau will prepare management and monitoring plans for these sites using the framework described in this document. The structure and content of management plans for HCVF 1.2 will be somewhat dependent on the specific species resources for which the area was designated.

White-Tailed Deer Plan

This plan provides the framework for the bureau’s goals and responsibilities regarding white-tailed deer on state forest land, specifically: 1) identification of the goals targeted by the plan, 2) the history of deer on state forest land, 3) assessment of forest health conditions and theories on recovery, and 4) a review of deer population management on Pennsylvania, DCNR’s role in deer management, and DCNR’s deer initiatives to meet its goals.

Brook Trout (Salvelinus fontinalis) Conservation Plan

This conservation plan gives the framework for conserving brook trout on Pennsylvania’s state forestland. The plan presents: 1) an identification of the conservation goal and objective targeted by the plan, 2) an assessment of the threats believed to be the most current and important to the status of brook trout on state forest land, and 3) the recommended conservation and management actions whose implementation would help attain that goal and objective.

Bat Habitat Conservation Plan

The Bureau of Forestry, Bureau of State Parks, and PA Game Commission are developing this plan in order to: 1) avoid and minimize incidental take of Indiana bats resulting from forestry management and other related activities to the maximum extent practicable on state lands, 2) accommodate current and future forestry management activities on state lands, 3) support state conservation goals, and 4) identify targeted conservation efforts that can improve the value of state lands for Indiana bats and help stabilize and aid in the recovery of the species.
**Rattlesnakes in Pennsylvania State Forests**
http://www.dcnr.state.pa.us/forestry/wildlife/rattlesnakes/index.htm

This web resource provides general information on timber rattlesnakes in state forests as well as facts on life history, nuisance snakes, safety precautions, and avoiding and treating snakebites.

**Important Bird Area Program**
http://netapp.audubon.org/IBA/State/US-PA

Significant portions of important bird areas (IBAs) in Pennsylvania overlap with state forest lands. **Important**

**Mammal Areas Project**
http://www.portal.state.pa.us/portal/server.pt?open=514&objID=948195&mode=2

This is the informational web resource for the Important Mammal Areas (IMA) Project. Much of the project area overlaps with state forest lands.

**Pennsylvania Natural Heritage Program (PNHP)**
http://www.naturalheritage.state.pa.us/

This web resource contains authoritative information on the location and status of important ecological resources in the state. PNHP information can be used to guide conservation work and land-use planning, ensuring the maximum conservation benefit with the minimum cost. PNHP manages the PNDI tool that is used in bureau review processes.

**Pennsylvania’s Wildlife Action Plan**
http://www.portal.state.pa.us/portal/server.pt?open=514&objID=622722&mode=2

This plan lays out the goals and objectives necessary to carry out the state’s vision for wildlife conservation. The purpose of the plan is to conserve Pennsylvania’s diverse wildlife to maintain its role in ecological processes and to protect and enhance species of conservation concern.
Deer Management Assistance Program (DMAP)
http://www.dcnr.state.pa.us/forestry/deer/dmap/index.htm
This web resource is a hub of information on how to obtain DMAP tags, permit updates, harvest data, an interactive map, and a FAQ sheet.

Silviculture Manual (select sections)
Chapters I.XV and I.XVI give mention to wildlife in the context of using timber management in the creation of habitats.

County Natural Heritage Inventories
http://www.naturalheritage.state.pa.us/CNHI.aspx
These reports provide snapshots from county-level biological inventories that are used as tools for planning through detailed mapping, discussions, and recommendations for management and protection.

Aquatic Habitat Buffer Guidelines
Management guidelines for aquatic buffers are provided here. Aquatic areas and adjacent terrestrial areas are important habitats for numerous animal species.

Monitoring
- Surveys for species of special concern
- Deer Management Assistance Program areas and acreage

Critical Research Needs
- Increase understanding of how deer density and other wildlife factors affect tree regeneration and plant species composition.
- Define a target percentage of forest plots that should contain an indicator species.
- Differentiate between elk and deer damage in order to better understand how to manage these species on state forest lands.
- Study the effects of small mammal presence on oak regeneration.
- Study the effects of habitat improvement projects on ruffed grouse populations.
- Study effects of prescribed fire on wildlife.
Water resources include watersheds, riparian ecosystems, aquatic ecosystems (surface waters), and groundwater systems, as well as social values and uses of water resources for drinking, recreation, aesthetic enjoyment, research, and industrial use. This scope and complexity demonstrates the need for managing water resources within the broader context of ecosystem management on state forest lands.

The commonwealth began protecting watersheds in 1897 when the Legislature passed an act authorizing the purchase of unseated lands for forest reservations in the headwaters of each of the main rivers. The original purpose of the legislation was to enable land preservation to minimize flooding, assure suitable levels of water for navigation and power generation, and protect public water sources. This foresight, along with subsequent legislation, helped to acquire and establish the present state forest system, which today encompasses 2.2 million acres of public land. One of the original purposes for establishing the state forest system was to protect forested watersheds, which remains a major part of the Bureau of Forestry’s current mission.
The Value of Water on State Forest Lands

Today, state forest lands serve as a reserve of clean water for the entire commonwealth and specifically for those municipalities which have entered into agreements with the bureau to provide public water supply from surface water or groundwater on state forest lands. In addition to providing drinking water for communities from surface sources, state forest lands also serve as groundwater recharge areas. Public ownership, scientific management, and the vast geographic extent of state forest lands make them uniquely suited to provide clean water for Pennsylvania’s citizens. The bureau cooperates with agencies such as the Pennsylvania Department of Environmental Protection, U.S. Geologic Survey, Susquehanna River Basin Commission, and DCNR’s Bureau of Topographic and Geologic Survey to monitor and protect surface and groundwater resources.

There are many different kinds of aquatic ecosystems on state forest lands, including rivers, streams, lakes, ponds, wetlands, and vernal pools. The nature and quality of these systems are critical to the survival of thousands of plant and wildlife species. Riparian areas are vital for the protection of these aquatic ecosystems. Riparian habitats form a natural buffer between an aquatic ecosystem and the drier upland terrestrial systems. Riparian areas protect water quality, reduce soil erosion, and enhance fish and wildlife resources in the aquatic-terrestrial interface. Up to 97 percent of the energy processed in forested headwater streams originates from outside the stream, in the riparian areas. Riparian zones, particularly stream channels, also provide travel corridors for many wildlife species. Aquatic and riparian food webs are highly interconnected. Most aquatic insects that feed on the leaf litter falling into the stream are themselves (as winged adults) prey for terrestrial creatures from the riparian zone.

Recreational use of state forest water resources vary widely among users. State forest water resources are used for environmental education, conservation, and recreational uses like fishing, boating, hunting, and trapping. Water-related recreational interests are extensive and often conflict, which means not every water resource can simultaneously support all activities. Therefore, in areas of high recreation use, the bureau will base recreation management decisions on uses of each water body to minimize conflict among recreation users while also protecting the ecological values of the resource.

The bureau recognizes that with projected increases in water use and environmental pressures, there is a need to develop sustainable land management policies that support the missions of various commonwealth, interstate, and federal agencies in managing Pennsylvania’s water resources. The bureau understands the important roles that such sister agencies play in assessing and regulating water quantity and quality. In 2009, shale-gas development began on state forest lands, bringing associated concerns over potential impacts to surface and groundwater. To address these concerns, the bureau strengthened partnerships with other agencies like the Pennsylvania Department of Environmental Protection, Susquehanna River Basin Commission, and U.S. Geological Survey to monitor and assess and minimize impacts of natural gas development on water resources. In 2011, the bureau initiated its own water quality monitoring program to assess potential impacts from shale-gas development activities. The results of this program through the end of 2012 were released in the 2014 Shale-Gas Monitoring Report.

The bureau will continue monitoring for impacts of oil, gas, and mineral extraction activities on state forest lands to improve our land management practices, specifically for mitigating impacts to water resources. The bureau will manage state forest land to preserve water quality and quantity, aquatic life, and recreation and aesthetic enjoyment, while providing clean and abundant potable water, scientific research opportunities, and responsible industrial uses.
Rivers and Streams
The water quality of densely forested watersheds is determined largely by the underlying geology, which influences the character of groundwater discharge into streams, especially at base flow, when nearly all the surface water is from groundwater infiltration into the stream bed or from springs. Forested land uses typically yield the highest surface water quality. Land uses other than forest can introduce a myriad of inputs into ecosystems that change the character of the water cycling through it, and the manner with which it cycles.

Special Protection Waters
In Pennsylvania, the Department of Environmental Protection is the primary agency responsible for enforcing and regulating the special protection for rivers and streams determined by Chapter 93 Water Quality Standards of Title 25 in the Pennsylvania Code. Chapter 93 codifies water quality standards for surface waters of the commonwealth, including wetlands. The DEP developed these water quality standards based upon water “uses” which are to be protected and which will be considered by the DEP in implementing its authority to protect surface water quality. The protected uses are identified in Chapter 93, paragraph 93.3 (Table 1). They include special protection uses such as high quality (HQ) and exceptional value (EV) waters. Approximately 87 percent of all streams on state forest lands carry the HQ or EV designation (Table 1).

According to the Chapter 93 standards, watersheds can be formally designated as HQ or EV if they meet certain qualifying characteristics under DEP regulatory considerations and authority. HQ and EV waters shall be maintained and protected at the level that is more restrictive, with rare exceptions for HQ streams under officially designated social or economic justification (SEJ) waivers. Under the SEJ process, the DEP may allow a reduction of water quality in HQ waters when “after full satisfaction of the intergovernmental coordination and public participation provisions of the commonwealth’s continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located.” SEJ waivers are not often granted.

In addition, under Chapter 105 regulations ($105.17), wetlands are designated as exceptional value when a wetland:

- Serves as habitat for federally listed threatened or endangered plants or animals or is hydrologically connected to or is within half a mile of such a wetland
- Is in or along the floodplain of the reach of a wild trout stream or EV waters listed under Chapter 93 or surface waters formally designated as wild or scenic rivers
- Supplies drinking water or is located along an existing drinking water supply
- Is located in designated natural or wild areas in state forests or parks, or in areas designated as national natural landmarks

<table>
<thead>
<tr>
<th>Total</th>
<th>EV</th>
<th>HQ</th>
<th>CWF</th>
<th>HQ-TSF</th>
<th>TSF</th>
<th>WWF</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,996</td>
<td>1,528 (30.6%)</td>
<td>2,699 (54%)</td>
<td>639 (12.8%)</td>
<td>3 (0.1%)</td>
<td>90 (1.8%)</td>
<td>36 (0.7%)</td>
</tr>
</tbody>
</table>

Table 1. Miles of rivers and streams on state forest land by Chapter 93 designations*

* This 2014 total includes all streams in the bureau’s GIS database, not all of which were designated into one of the categories listed.

EV = Exceptional value waters; HQ = High quality waters; CWF = Cold water fishes
HQ-TSF = High quality trout-stocked fishery; TSF = Trout-stocked fishery; WWF = Warm water fishery
Pennsylvania Fish and Boat Commission Trout Water Designations

The Pennsylvania Fish and Boat Commission (PFBC) is the agency responsible for surveying, inventorying, and managing fish fauna in commonwealth waters. It may also apply special fisheries management designations to waters that contain stocked or naturally producing trout populations for conservation and recreation purposes.

There are 724 miles of Class A wild trout stream which may also qualify for HQ designation. Additionally there are 316 miles classified as wilderness trout streams which may qualify for EV designation. In addition, PFBC is conducting a statewide assessment of previously unassessed waters — including extremely small headwaters — to document the presence of naturally reproducing native brook trout populations, so the miles of trout-protected waterways on state forest lands will likely rise.

The bureau recognizes these PFBC designations as important and incorporates restrictions and guidelines during land management activities. In 2010, the bureau developed a Brook Trout Conservation Plan to identify threats and recommendations for native brook trout conservation on state forest lands.

Scenic Rivers Program

The Pennsylvania Scenic Rivers Act of 1982 authorized the statutory designation of outstanding aesthetic or recreational rivers, affording them additional environmental protection. For purposes of designating and managing rivers for recreation and aesthetic enjoyment, the DCNR developed the Pennsylvania Scenic Rivers Program. Additionally, in 1968, President Johnson signed the federal Wild and Scenic Rivers Act, which designated under this Act portions of the Allegheny, Clarion, and Delaware Rivers as well as White Clay Creek, for a total of 409 miles of river in Pennsylvania. There are 36 miles of federally designated scenic rivers flowing through or along state forest lands.

Lakes and Ponds

State forest lands contain numerous natural and human-made lakes and ponds. These bodies of water are valuable for both aquatic and terrestrial wildlife, provide habitat for aquatic plants, and are utilized for various recreational activities.

<table>
<thead>
<tr>
<th></th>
<th>Natural lakes and ponds</th>
<th>Human-made impoundments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>38</td>
<td>61</td>
</tr>
<tr>
<td>Acres</td>
<td>374</td>
<td>1,317</td>
</tr>
</tbody>
</table>

Table 2. Number and acres of natural and human-made impoundments, lakes, and ponds on state forest lands

As described in the goals and objectives section, the bureau plans to take a more active role in its management of lakes and ponds.

River Islands

The bureau has management responsibilities for all unwarranted and unpatented river islands in the commonwealth. For private citizens to hold ownership of Pennsylvania river islands, the citizens must possess a patent documenting release from the commonwealth to any rights or interests in the land, which acts essentially as a deed. However, many river islands have not been patented since the early 1900s. In 1990, an Interagency River Island Task Force was formed to determine the ownership status of river islands and divide management responsibilities of unpatented islands between the bureau and the Pennsylvania Game Commission. As a result, many major river islands in the commonwealth were photographed, mapped and researched for ownership rights. However, island geography has been ever-changing, making confidence in public or private ownership of river islands challenging.

River islands offer excellent recreational opportunities and provide important habitat for wildlife and plants along rivers and streams. The bureau partners with several
volunteer groups to develop, promote, and maintain river island trails through the state. These volunteers also serve as trail stewards for maintenance, monitoring resource impacts, and tracking public use. Many of these river island groups produce maps and brochures describing the trail, recreation opportunities, and conservation practices to protect these valuable resources. Trail maps show access sites and river islands designated for day use and primitive camping.

River islands are a unique resource managed by the bureau and connected to water resources. The bureau maintains a database of river islands to document knowledge of ownership or other issues. With increased interest in recreation opportunities on river islands, as well as the sensitivity of ecological values associated with these lands, the bureau is working toward developing a standard strategy for managing river islands across state forest boundaries. Weiser State Forest claims management of the most islands in the commonwealth, including over 500 islands in the Susquehanna River covering approximately 1,300 acres.

**Water Supply**

**Drinking Water**

State forest lands provide protection and recharge areas for numerous public water supplies, sourced from both surface water intakes and groundwater wells. The bureau regards with importance the conservation of watersheds that supply wells off state forest land. The DEP’s [Bureau of Safe Drinking Water](https://www.dep.state.pa.us/DEP/MainThemes/WaterSupply/DrinkingWater/default.aspx) and [Bureau of Point and Non-Point Source Management](https://www.dep.state.pa.us/DEP/MainThemes/WaterSupply/PointNonPoint/default.aspx) provide guidelines for protecting groundwater resources as well as information regarding water well regulations and permits. As part of a 2011 analysis, the bureau designated approximately 14,000 acres of state forest lands as high conservation value forests for the protection of drinking water wells, water emergency supply wells, drinking water withdrawal points, and associated buffers.

**Industrial Use**

Accompanying the recent increase in shale-gas development on state forest lands has been an increase in industrial use of water resources for hydraulic fracturing. Approximately 5 million gallons of water are used for the hydraulic fracturing of each shale-gas well. To meet this need, gas operators have installed surface water intakes and groundwater wells. To date, four surface water intakes and one groundwater well have been installed on state forest lands to meet this growing need. The bureau encourages local sourcing of freshwater to limit the impacts of truck traffic on state forest infrastructure for water transportation. The bureau prefers extraction from surface water sources, as opposed to groundwater wells, due to the complexity in predicting the effect of groundwater extractions on nearby streams, springs, and other habitats.

In addition to the water intakes, the bureau encourages the construction of surface water impoundments for use in hydraulic fracturing. Centralized surface water impoundments and the associated water pipeline systems also reduce the need for truck transport. Presently, there are 30 surface water impoundments on state forest land for shale-gas development, covering 148 acres.

**Impaired Water Bodies**

Erosion and sedimentation, acid mine drainage, legacy acid deposition, and chemical and thermal pollution are notable examples of human-caused factors adversely affecting water resources on state forest lands. Land management can influence pollutant input into aquatic systems and is essential for maintaining and improving the quality of Pennsylvania’s water resources. Modern technologies and
lessons learned provide opportunities to remediate legacy pollution issues and help prevent the continuation of past land-use mistakes though the implementation of effective best management practices and monitoring.

The bureau develops and implements best management practices to minimize and prevent water pollution, as well as to support and engage in research and programs to restore degraded water resources and conserve high quality water resources on state forest lands. It is the bureau’s goal, when remediating an identified pollution problem, to invest in eliminating the root cause or source of the pollution, rather than applying remediation measures to the symptoms or effects. For instance, the bureau would prefer to remediate the mine source of acid-mine drainage, rather than to treat the acid-polluted receiving waters. The bureau typically partners with DEP or local watershed conservation organizations for water remediation projects.

The DEP has an ongoing program (in-stream comprehensive evaluations) to assess the quality of waters in Pennsylvania according to Section 303(d) of the Federal Clean Water Act. Water quality standards include uses that the waters can support and goals established to protect those uses. Uses may include recreation, trout stocking, and drinking water, while the goals include water quality criteria to support the uses. Periodic reports on the quality of waters in the commonwealth are required under section 305(b) of the Clean Water Act. On state forest lands, waterways currently listed for impairment on the 303(d) integrated report total almost 500 acres and represent a variety of impairment causes (Table 3).

<table>
<thead>
<tr>
<th>Total</th>
<th>AMD</th>
<th>AD</th>
<th>Ag</th>
<th>PCB &amp; Hg</th>
<th>Misc</th>
</tr>
</thead>
<tbody>
<tr>
<td>491</td>
<td>226</td>
<td>215</td>
<td>21</td>
<td>19</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 3. Miles of rivers and streams on state forest lands by impairment cause from PA DEP 2014 303(d) Integrated List.
AMD = Acid mine drainage; AD = Acidic atmospheric deposition; Ag = Agriculture related; PCB & Hg = Polychlorininated biphenyl or mercury; Misc = Unknown and “road runoff”

**Aquatic Invasive Species**

Aquatic invasive species are plants and animals that have been introduced into waterways in which they do not naturally occur. These invasive species have the potential to cause considerable ecological harm to our aquatic ecosystems by competing with native species for food and space, and by altering the trophic structure of the ecosystem. Some examples of invertebrate invasives include the rusty crayfish, zebra mussel, and quagga mussel. Invasive fishes include but are not limited to the Asian carp, northern snakehead, and round goby. The red-eared slider is an invasive turtle that can compete with our native turtles, some of which are rare. Some examples of aquatic plant invasive species are didymo (an algae), Phragmites, purple loosestrife, fanwort, yellow floating heart, water chestnut, Eurasian watermilfoil, curly-leaf pondweed, parrotfeather, and hydrilla.

Simple precautions can be taken to prevent spreading of aquatic invasive species. Fish and live crayfish should not be transported between bodies of water on state forest land. Bait fish should not be released in waters other than where they were collected. Finally, boats and fishing gear should be cleaned between trips and bodies of water.

**Aquatic Community Classification**

An aquatic community classification project was recently completed by the Pennsylvania Natural Heritage Program, which developed and applied standardized aquatic ecosystem classifications and which references conditions. This classification system is part of the larger effort to refine all plant community classifications for Pennsylvania. Furthermore, the system helps identify areas of high priority for aquatic resources protection and supports planning, protection, and restoration efforts for watersheds and water resources.
On state forest lands, aquatic communities are classified as palustrine, wetland, spring seeps, or vernal pools, depending on the dominant vegetation composition and flow patterns of the influencing waters. These sites are typically inventoried and buffered during management activities, and state forest environmental reviews are required for any alterations to these systems.

Palustrine and wetland communities are mapped according to the bureau’s typing manual and the Natural Heritage Program publication, Zimmerman et al. (2012). There are over 31,000 acres of palustrine or wetland communities mapped on state forest lands (Table 4).

Spring seeps and vernal ponds are inventoried through the landscape examination process and other surveys conducted by the bureau.

Spring seeps are areas where groundwater is expressed at the surface as surface water flow or overland flow. They are important water sources for wildlife and often contain unique plant communities. There are 295 inventoried spring seeps on state forest lands.

Vernal ponds are water bodies that form due to impervious layers in the soil that pond water. They fill with water during the wetter parts of the year but dry out during drier times. They provide important water sources for terrestrial wildlife and provide critical habitat for amphibians. There are 795 inventoried vernal pools on state forest lands.

<table>
<thead>
<tr>
<th>Palustrine forest types</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black spruce - tamarack peatland forest</td>
<td>100</td>
</tr>
<tr>
<td>Bottomland oak - hardwood palustrine forest</td>
<td>399</td>
</tr>
<tr>
<td>Hemlock - mixed hardwood palustrine forest</td>
<td>7,829</td>
</tr>
<tr>
<td>Hemlock palustrine forest</td>
<td>3,396</td>
</tr>
<tr>
<td>Miscellaneous palustrine/floodplain forest</td>
<td>1,374</td>
</tr>
<tr>
<td>Red maple - black ash palustrine forest</td>
<td>8</td>
</tr>
<tr>
<td>Red maple - black gum palustrine forest</td>
<td>1,581</td>
</tr>
<tr>
<td>Red maple - elm - willow floodplain swamp</td>
<td>7</td>
</tr>
<tr>
<td>Red spruce - mixed hardwood palustrine forest</td>
<td>228</td>
</tr>
<tr>
<td>Red spruce palustrine forest</td>
<td>1,397</td>
</tr>
<tr>
<td>Silver maple floodplain forest</td>
<td>1,276</td>
</tr>
<tr>
<td>Sycamore - river birch - box elder floodplain forest</td>
<td>575</td>
</tr>
<tr>
<td><strong>Subtotal – palustrine forest</strong></td>
<td><strong>18,170</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Palustrine woodland, shrubland, and opening types</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bog/fen</td>
<td>641</td>
</tr>
<tr>
<td>Emergent wetland</td>
<td>2,888</td>
</tr>
<tr>
<td>Palustrine scrub/shrub</td>
<td>3,869</td>
</tr>
<tr>
<td>Palustrine woodland</td>
<td>5,713</td>
</tr>
<tr>
<td><strong>Subtotal – palustrine woodland, shrubland, and openings</strong></td>
<td><strong>13,111</strong></td>
</tr>
</tbody>
</table>

**Total – palustrine and wetland communities** | **31,281** |

Table 4. Acres of palustrine and wetland communities on state forest lands
**Water Management Principle**

Water resources on state forest lands are managed to conserve or enhance water quality, water quantity, ecological function, and social values.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
</table>
| **1. To conserve water resources for sustainable utilization for public benefit.** | 1.1 Employ best management practices for consuming water resources.  
1.2 Manage state forest lands to ensure protection of public water supplies.  
1.3 Provide recreational opportunities and sustain aesthetic values of water resources. |
| **2. To conserve and enhance riparian, wetland, and aquatic ecosystems and their ecological function.** | 2.1 Minimize impacts to riparian, wetland, and aquatic ecosystems during management activities.  
2.2 Identify, evaluate, and enhance streams with degraded forest riparian buffers.  
2.3 Identify and address negative ecological impacts on riparian, wetland, and aquatic ecosystems.  
2.4 Remove unneeded dams to restore natural stream flow and connectivity.  
2.5 Improve or replace bridges and culverts with designs that improve water flow, reduce scouring, and allow aquatic organism passage.  
2.6 Continue to develop and adopt best management practices that limit sedimentation effects from dirt and gravel roads on these ecosystems. |
| **3. To manage lakes for their ecological and recreational values.** | 3.1 Develop and implement a strategy for inventorying, assessing, prioritizing, and managing lakes.  
3.2 Develop and implement lake management plans for priority lakes, emphasizing desired resources, uses, and values.  
3.3 Build and strengthen relationships with partner organizations interested in addressing lake management on state forest lands. |
| **4. To manage river islands throughout the state for their ecological and recreational values.** | 4.1 Develop and implement a strategy for inventorying, assessing, prioritizing, and managing river islands.  
4.2 Develop and implement river island management plans for priority areas or districts, emphasizing desired resources, uses, and values.  
4.3 Build and strengthen relationships with partner organizations interested in addressing river island management. |
| **5. To remediate impaired water resources due to point- and non-point source pollution.** | 5.1 Assess and prioritize impaired waters requiring remediation and existing remediation infrastructure requiring maintenance.  
5.2 Build and strengthen relationships with watershed groups interested in addressing impaired waters.  
5.3 Attempt to secure funding for remediation and monitoring of prioritized projects. |
Guidelines, Tools, and Resources

Erosion and Sedimentation Guidance for State Forest Management
The bureau follows established guidance in an effort to prevent and remedy the effects that operational activities have on soil and water. These BMPs and guidelines are described in a series of documents, the links to which are provided for staff in this guidance document.

Aquatic Habitat Buffer Guidelines
These guidelines provide a standard set of operating procedures for conducting management activities in or near aquatic habitats and establish quantitative guidelines for the creation of vegetated buffers to define environmentally safe working distances between areas of operation and bodies of water.

Chapter 93 of PA Code – Water Quality Standards
http://www.pacode.com/secure/data/025/chapter93/chap93toc.html
General provisions, antidegradation requirements, water quality criteria, and designated uses and water quality criteria are set forth in these regulations. The specifications for HQ and EV waters are given in section 93.4b.

PA DEP Division of Water Quality Standards
http://www.portal.state.pa.us/portal/server.pt/community/water_quality_standards/10556
This web resource provides information on DEP’s assessments, monitoring, and quality standards for commonwealth waters, including those found on state forest lands.

Trout Water Classifications
http://fishandboat.com/waters_trout.htm
The PFBC classifies streams as Class A wild trout streams and wilderness trout streams based on their trout populations and wild characteristics. These designations by PFBC make the streams candidates for receiving classification by DEP as EV and HQ waters. Information on PFBC trout water designations can be found at this web resource.
Monitoring

- Shale-gas monitoring
- Partnership with Susquehanna River Basin Commission and DEP for monitoring and research

Critical Research Needs

- Monitoring Marcellus and other shale-gas development impacts on surface and groundwater resources
  - Real time, near-real time, and long-term monitoring of water quality
  - Stream, spring, and seep baseline sampling to detect methane migration
  - Sediment sampling for long-term deposition of signature fracking metals like barium and strontium
- Inventories of groundwater resources
- Impacts of groundwater development on forest ecosystems, including surface water systems
- Baseline data for monitoring changes to biological diversity, pH, dissolved oxygen, chemical levels, sedimentation, and temperature change
- Baseline chemical analysis data for lakes, ponds, and streams
- Aquatic life use inventories
Forest soils are composed of an assortment of materials and organisms that, when viewed in whole, function as a living ecosystem. This “soil ecosystem” performs several key functions that are essential to a healthy forest:

- Sustaining biological activity, diversity, and productivity by providing habitat for plants, animals, and other organisms
- Regulating water storage and flow
- Filtering, buffering, immobilizing, and detoxifying potential pollutants
- Storing and cycling nutrients

Healthy soils perform these various functions by having diverse soil organism communities, containing a mixture of organic and mineral material, and maintaining suitable soil structure and density. Soils are important considerations while implementing ecosystem management on state forest lands. The Enhance Penn’s Woods program states that soils should be maintained at the highest possible quality. Therefore, the bureau aims for soil quality to be increased or maintained at current levels; soil quality should not be allowed to decrease as a result of management activities.
Soils and Forest Management

Soil type has a strong influence on the trees and other plants that grow in a given area and, in turn, on the wildlife that rely on the forest soils. The texture of soil is determined by how much sand, silt, and clay particles are present, and soil texture affects a soil’s ability to hold moisture and be available for plant use. Sandy soils tend to be drier, and loamy soils (with more silt and clay) tend to be wetter. Different plant communities are adapted to different levels of soil wetness. Soil nutrient levels also affect the plant communities that establish on a given soil type. For instance, conifers are generally more capable than deciduous trees of thriving on nutrient-poor soils. The amount of organic material in a soil is also important. For example, wetland soils typically have a high accumulation of organic material due to the slow decomposition process in wet, anaerobic soils. For these reasons, it is important to understand the soil type when managing forests and other plant communities.

Forest management activities have the potential to negatively or positively impact soils. When trees are harvested from an area, nutrients and organic material stored in the trees are partially removed from the ecosystem. This loss can affect water and nutrient cycles. During timber harvests on state forest land, tops of harvested trees typically are left on site, along with standing snags and reserve trees. This minimizes losses and reincorporates tree tops into the soil ecosystem, providing organic material and nutrients as they decompose. Whole-tree harvesting can have negative effects on soil nutrient- and water-cycling. Prior to approval, any whole-tree harvest on state forest lands requires additional review and waivers. Timber harvesting can lead to soil erosion or compaction if not conducted properly. Compaction issues are of particular concern during mechanized harvesting, and such work should not be conducted in overly wet conditions. Erosion and sedimentation plans are always on site for timber harvests on state forest lands, and the bureau maintains Erosion and Sedimentation Guidance for State Forest Management.

Road construction and maintenance also can lead to soil erosion issues or change water flow during large storm events. Bureau staff work closely with the Penn State Dirt and Gravel Road Center to ensure that forest roads are constructed using well-researched best management practices. Careful evaluation and monitoring of herbicides and pesticides used on state forest lands minimizes the potential for these chemicals to have any long-term impacts on forest soil quality. Lastly, certain recreational uses can impact soils, particularly horse riding, mountain biking, and motorized activities. The bureau monitors such activities to evaluate their effects on forest soils and conducts mitigation measures when impacts are observed.

Acid deposition is a long-term and complex concern that has potential negative impacts on Pennsylvania’s water quality and forest ecosystems, although the extent and significance of its effects are not fully defined. Pennsylvania receives some of the most acidic precipitation in the country, originating from industrial centers in Chicago and the Ohio Valley regions. Although many forest soils in Pennsylvania are naturally acidic, the added effects of acid deposition are changing soil chemical properties and affecting the health of forest ecosystems. As soils become more acidic, nutrients important for plant health become less available, and aluminum, which is toxic to most plants,
becomes more available. Scientists and natural resource professionals continue to research the effects of acid deposition on forest plant communities and tree regeneration.

**Soils on State Forest Lands**

Physical, chemical, and biological properties of Pennsylvania’s forest soils have changed over time as a result of long-term climate change, glaciation, acid deposition, and erosion and burning that occurred during the period of heavy harvesting from the late 1800s to the early 1900s. Because of these changes, establishing a historical baseline for evaluating soil ecosystem health and productivity in a conventional sense may not be possible for the forest soils of Pennsylvania. Instead, the bureau can use a relative measure, such as current conditions, for establishing baseline soil conditions.

Current information on soil types and properties is available from the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). Soil maps are also available through an online tool called the Web Soil Survey. The bureau uses soil data as an integral management tool in planning timber harvests and other land management projects.

Table 1 and Figure 1 show the soil orders that are present on state forest land. Soil order is the highest level of soil taxonomy; it is based largely on soil-forming processes and can be used to generally categorize soils. However, management decisions regarding soils are based on lower levels of classification, such as the soil map unit, that provide more detailed information about soil characteristics and limitations.

The majority of soils on state forest land are either Inceptisols or Ultisols. Inceptisols are relatively undeveloped soils, with very weak development of subsurface layers (also called horizons). The weak development is often due to a lack of time for stronger development, a parent material that is resistant to weathering, or erosion occurring fast enough to remove soil before layer development can occur. Inceptisols are common on steeply sloped forest land. Conversely, Ultisols are highly weathered soils that are typically acidic and contain a clayey subsurface layer. Chemically, the Ultisols have a low base saturation, which means the soils have more aluminum and hydrogen than magnesium and calcium. This increases their acidity and decreases their fertility.
Table 1. Soil orders occurring on state forest land, based on NRCS data

<table>
<thead>
<tr>
<th>Soil order</th>
<th>Dominant characteristics</th>
<th>Acreage of state forest lands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inceptisols</td>
<td>Soils with weak to moderate layer/horizon development; common on steep slopes</td>
<td>1,213,169</td>
</tr>
<tr>
<td>Ultisols</td>
<td>Acidic, highly weathered soils, typically with clayey subsurface layers</td>
<td>836,653</td>
</tr>
<tr>
<td>Alfisols</td>
<td>Similar to Ultisols, but more fertile and only slightly to moderately acidic</td>
<td>37,866</td>
</tr>
<tr>
<td>Spodosols</td>
<td>Sandy, acidic, leached soils; typical of coniferous forests</td>
<td>29,308</td>
</tr>
<tr>
<td>Entisols</td>
<td>Little to no layer/horizon development; commonly found in flood plains or unconsolidated deposits</td>
<td>23,794</td>
</tr>
<tr>
<td>Mollisols</td>
<td>Very deep and dark surface layer; common in grasslands</td>
<td>182</td>
</tr>
<tr>
<td>Not Defined</td>
<td>Soil order not defined in NRCS data</td>
<td>17,593</td>
</tr>
</tbody>
</table>

Figure 1. Map of soil orders on state forest land, based on NRCS data. Soils on state forest land are predominantly Inceptisols and Ultisols, with Michaux District having a significant proportion of more fertile Alfisols. Spodosols and Entisols tend to be scattered throughout state forest land in lower proportions.
**Soils Management Principle**

Soil quality and soil ecosystem integrity on state forest lands are protected or enhanced to provide for healthy and productive forests.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To manage state forest lands in a manner that soil quality and</td>
<td>1.1 Manage road system and other infrastructure to minimize risk for erosion,</td>
</tr>
<tr>
<td>ecosystem integrity is maintained or improved.</td>
<td>sedimentation, compaction, or drainage problems.</td>
</tr>
<tr>
<td></td>
<td>1.2 Implement and improve best management practices and guidelines relating</td>
</tr>
<tr>
<td></td>
<td>to soil impacts during management activities.</td>
</tr>
<tr>
<td></td>
<td>1.3 Identify and address soil limitations, such as poorly drained soils,</td>
</tr>
<tr>
<td></td>
<td>compactable soils, rocky soils, and highly erodible soils, when planning</td>
</tr>
<tr>
<td></td>
<td>management activities.</td>
</tr>
<tr>
<td>2. To address existing soil quality problems on state forest lands.</td>
<td>2.1 Identify, characterize, and inventory existing soil problems on state</td>
</tr>
<tr>
<td></td>
<td>forest lands.</td>
</tr>
<tr>
<td></td>
<td>2.2 Develop remediation strategies and best management practices for dealing</td>
</tr>
<tr>
<td></td>
<td>with problems relating to soils.</td>
</tr>
<tr>
<td>3. To use information on soil properties, quality, and limitations</td>
<td>3.1 Continue to fund research to understand biotic and abiotic soil</td>
</tr>
<tr>
<td>when determining appropriate management activities for desired</td>
<td>dynamics, particularly effects on tree regeneration and other plant</td>
</tr>
<tr>
<td>vegetation communities.</td>
<td>community establishment.</td>
</tr>
<tr>
<td></td>
<td>3.2 Determine the potential of soils to support desirable and undesirable</td>
</tr>
<tr>
<td></td>
<td>vegetation communities and work this understanding into management</td>
</tr>
<tr>
<td></td>
<td>planning.</td>
</tr>
<tr>
<td></td>
<td>3.3 Assess and improve data resources regarding soils.</td>
</tr>
</tbody>
</table>
Guidelines, Tools, and Resources

Erosion and Sedimentation Guidance for State Forest Management
Best management practices and general guidelines for erosion and sedimentation control during state forest operations are described in a series of documents, the links to which are provided for staff in this guidance document.

Silviculture Manual
Chapter I.XVIII describes soil factors and protection in terms of considerations for timber operations. Special mention is given to wet areas and poorly drained soils, rocky areas, haul road construction, and soils surveys for species suitability.

Guidelines for Administering Oil and Gas Activity on State Forest Lands
Several sections of this guiding document contain recommendations or BMPs for soil management during oil and gas operations on state forest lands.

State Forest Road Maintenance Manual
The purpose of this manual is to present road construction and maintenance methods that reduce the erosion, sediment, and dust that pollute commonwealth streams. Soil is discussed at length in several chapters.

Monitoring
- Process to track number and acreage of areas with soil quality problems
- Timber sale inspections to watch for erosion and sedimentation or compaction issues

Critical Research Needs
- Methods for improving soils that have experienced long-term impacts (e.g., mining and gas development)
- The potential of soil types to support desirable or undesirable vegetation communities
- Appropriate soil evaluation/sampling protocols for foresters to use in field assessments (e.g., CFI or landscape exams)
- Long-term impacts of silvicultural activities such as timber harvesting, herbicides, fertilizing, and liming
- Extent and effects of acid precipitation on soil chemistry and tree growth.
- Accuracy of soil maps in expansive forested areas
- Appropriate post-construction storm-water management practices in forested settings
- Rutting during timber harvests and potential erosion and sedimentation controls related to rutting
Geologic resources are the basis for soil and forest development and affect landforms and topography. Heritage geologic features are recognized special places of intertwined geology and landscape, and they may include unique or exemplary outcrops, scenic vistas, or other geologically significant features that together represent the geologic diversity of the commonwealth. Extraction of geologic resources such as coal, oil, and natural gas also has long been a keystone to Pennsylvania’s economy. These resources provide benefits to society including: domestic energy for heating, fuel, and electrical generation; material for plastic polymers and manufacturing and industrial processes; material for infrastructure construction; and job creation in areas throughout the commonwealth. Geologic resources on state forest lands offer a variety of environmental, social, and economic values that the bureau considers in ecosystem management.
Geology and Landscapes

The present-day landscape of Pennsylvania reflects billions of years of geologic events. The events that took place in various parts of the state were different, and the landscape reflects those differences. Because of this, the state is divided into six physiographic provinces, each of which has a particular type of landscape and geology. The following descriptions and Figure 1 were prepared by the Bureau of Topographic and Geologic Survey.

The state’s southeasternmost physiographic province, the Atlantic Coastal Plain, includes all except the northwestern part of Philadelphia County. It also includes the southeastern parts of Bucks and Delaware counties. Beyond Pennsylvania, this province encompasses areas near the Atlantic Ocean from Massachusetts to Florida, including all of southern New Jersey and most of Delaware. It is marked by rather flat land and sandy soil. It contains sediments of Cenozoic age that are the result of erosion and deposition by rivers.

Moving inland, the first province that covers a large area within Pennsylvania is the Piedmont. From northwest Philadelphia, it extends north past Quakertown and west past Gettysburg. Metamorphic rocks that are at least 443 million years old underlie much of the Piedmont and have been greatly distorted by the forces of plate collisions.

The next province moving inland, the Ridge and Valley, contains one of Pennsylvania’s most distinctive landscapes. Geology students all over the nation study its unusually long, narrow, nearly parallel ridges and valleys, and they puzzle over the formation of water gaps that allow rivers to pass through the ridges. The province makes a broad sweep through the center of the state, extending northeastward into New Jersey and southwestward into Maryland and beyond. Most of the ridges and valleys consist of Paleozoic sedimentary rock. Some metamorphosed Proterozoic volcanic rock that is about 575 million years old forms minor ridges in the South Mountain Section of the province, which extends approximately 30 miles into Pennsylvania from Maryland.

The tremendous pressures that operated on the rocks of the Ridge and Valley province during the Alleghanian orogeny have left them folded and standing at angles far from the horizontal position in which the sediments were originally deposited. Erosion since that time has formed valleys in areas of soft rock, such as shale and limestone, that alternate with ridges of harder rock, such as sandstone.

The province that covers the largest area of Pennsylvania is the Appalachian Plateaus province. It extends from Greene,
Fayette, and Somerset counties in the southwest part of the state to Erie County in the northwest and Wayne and Pike counties in the northeast. As in the Ridge and Valley province, the rocks are of Paleozoic age, but they were not affected as much by mountain-building processes. This province is a highland that has been eroded by streams, creating deep valleys and hilly topography. Northern sections that were overridden by the glaciers of the Pleistocene Epoch also have lakes, swamps, peat bogs, and extensive deposits of loose sediments.

The northwesternmost province in Pennsylvania is the Central Lowlands along the shore of Lake Erie in Erie County. Like the Atlantic Coastal Plain, only a small part of this large province is found in our state. From northwestern Pennsylvania and western New York, the province extends northwestward to Minnesota and southwestward to central Texas. The portion in Pennsylvania, which includes Erie, North East, and Girard, consists of gently rolling land. It contains low ridges of sand and gravel, which are old beaches that were formed by Lake Erie at the end of the Pleistocene glaciation. At that time, the water level in the lake was much higher than it is now because the lake’s outlet, the Niagara River, was blocked by receding glaciers.

### Unique Geologic Features

Currently, 32 sites on state forest land are classified as heritage geologic features through the Pennsylvania Natural Heritage Program (PNHP). On state forest land, the environmental review process of PNHP employs the PNDI tool to identify activities that could impact these sites. A matrix of specific activities that occur within a buffer area of a PNDI geologic feature will trigger an environmental review by the Bureau of Topographic and Geologic Survey.

In addition, the Bureau of Topographic and Geologic Survey has identified outstanding scenic geological features in Environmental Geology Report 7, Parts 1 and 2 (Geyer and Bolles, 1979 and 1987), and more recently, outstanding geologic features (OGF) that are included in the bureau’s online geologic map (PaGEODE). These sites carry with them recognition of exceptional geologic value and are not necessarily included in PNHP. Sites determined to have a conservation concern can be added to the PNHP list or OGF list through input by the Bureau of Topographic and Geologic Survey.

The table below shows the PNDI categories for the geologic sites. An erosional remnant is a landform or outcrop produced by an erosion process, such free-standing rock columns, boulders, bedrock pinnacles, peaks, or cliffs. A kettlehole is a depression, typically formed from melting blocks of glacial ice.

<table>
<thead>
<tr>
<th>PNDI classification</th>
<th>PNDI sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosional remnant</td>
<td>21</td>
</tr>
<tr>
<td>Kettlehole</td>
<td>3</td>
</tr>
<tr>
<td>Springs</td>
<td>5</td>
</tr>
<tr>
<td>Waterfalls and rapids</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>32</strong></td>
</tr>
</tbody>
</table>

Table 1. Geologic natural heritage features on state forest land.

### Geologic Resource Extraction

State forest lands are working forests, belonging to the citizens of the commonwealth, and are managed for multiple resources and values consistent with the principles of ecosystem management. The economic use and sound extraction and utilization of geologic resources is part of the bureau’s mission in managing these lands. Managing geologic resources requires thorough analysis, strategic planning, and attentive oversight to ensure that the value of geologic resources is balanced with other forest uses and values. Development of geologic resources should occur when it is compatible with landscape goals and functions, avoids sensitive ecological and socially important areas, and minimizes adverse impacts.

The department was granted authority to lease lands of the commonwealth for oil and natural gas extraction, natural gas storage, and hard mineral development whenever it is in
the best interest of the commonwealth. The Conservation and Natural Resources Act grants the department the authority to lease lands managed by the department including state forests, state parks, navigable waters, and subsurface oil and gas rights. Of the commonwealth’s 2.2 million-acre state forest system, approximately 1.5 million acres are located within areas historically developed for oil and gas.

In addition to managing gas development through leasing of state forest lands where the commonwealth has complete ownership of the subsurface, a key role of the bureau is to actively manage gas development on state forest lands where the commonwealth has no ownership of the subsurface. In general, the bureau is unable to prohibit development where it does not own the subsurface rights as it is infringes upon the subsurface owners’ rights to access their property. Because subsurface development could impact various forest resources, the bureau works closely with operators developing the subsurface to promote best management practices and attempts to manage operations consistently.

The bureau administers oil and gas leases, gas storage leases, and other agreements related to oil, natural gas, and gas storage operations. The bureau coordinates with lessees to manage on-the-ground development of the resource. This includes evaluating the siting of infrastructure and working with other programs in the bureau to avoid, minimize, mitigate, and monitor any potential impacts.

In addition to oil and gas, the management of coal and hard minerals is also an integral program to the bureau. The program restricts new development of coal and other hard minerals to state forest lands that were disturbed previously by mining practices and improperly reclaimed. Any new mining project is conditioned to ensure that any new or previously impacted land within the project area is properly reclaimed to present-day standards. The coal and hard minerals program is responsible for issuing new mining agreements, oversight of mining operations, and the monitoring of coal and hard mineral resources.

Incoming revenue from leasing of geologic resources is managed through the bureau’s accounting and audits program. The bureau tracks and evaluates all incoming revenue to ensure payments are made in compliance with the terms of the various leases. The bureau also ensures payment compliance through the periodic auditing of revenue.

**Oil and Gas Development**

Pennsylvania’s state forests have been leased for valuable oil and gas reserves since 1947. Operators initially targeted the Lower Devonian-aged Oriskany Sandstone or a stratigraphic equivalent. This deep formation is located 6,000 to 10,000 feet below the surface under moderate pressures. The Oriskany formation was successful largely due to the formation’s high porosity and permeability. These characteristics led to many Oriskany gas fields being converted to gas storage fields once production had ceased, and many storage fields remain in use today.

In the mid to late 1970s, operators sought natural gas reservoirs that were shallower and easier to reach than potential Oriskany targets. As a direct result, Upper Devonian-aged strata became the preferred target. These shallow formations typically are located several thousand feet above the Oriskany Sandstone and exhibit much lower pressures. Development of Upper Devonian formations continued through the mid 1980s, when the bureau held its largest lease sale. Approximately 1 million acres were under lease in 1984 through the early 2000s.

In the early 2000s, there was renewed interest in potential deep gas reservoirs, specifically the Ordovician-aged Trenton-Black River Formation. This deep formation is located 11,000 to 16,000 feet below the surface under high pressures. Successful development of the formation in New York and West Virginia spurred interest in the Pennsylvania play. In 2002, the bureau offered 218,000 acres for lease, targeting the Trenton-Black River Formation. Approximately 51,000 acres were leased for $1.5 million in bonus bid payments. Preliminary testing of the Trenton-
Black River in Pennsylvania proved unsuccessful. The leased acreage remained undeveloped, eventually expired, and was returned to the commonwealth.

The bureau received considerable public input following the 2002 Trenton-Black River lease. In the 2003 SFRMP, the bureau proposed a moratorium on shallow gas leasing due to the potential negative impacts of forest fragmentation associated with the density of well sites and access roads necessary for shallow gas development. This proposal was met with opposition from the Legislature and the oil and gas industry. The bureau re-evaluated the proposed moratorium based on recommendations from the Legislature, key advisory committees, and the oil and gas industry. The bureau's standard oil and gas lease agreement was revised to provide opportunity for shallow gas development on a limited, case-by-case basis if economically and geologically justified through a formal state forest environmental review. Many of the provisions established in this revised lease are still used today and provide opportunities for exploration at all target depths, establish minimum well spacing requirements, improve business processes, and afford greater protection of state forest resources, uses, and values. Since that time, the bureau's standard oil and gas lease has been continually reviewed, adapted and updated to reflect changes to the bureau's best management practices and the industry's development practices.

The exploration and development of organically rich shales became prevalent in many western states in the early 2000s. Within a few years, the interest moved east to Pennsylvania and focused on the Devonian-aged Marcellus Shale. The Marcellus Shale is a deep horizon located typically 4,000 to 8,000 feet below the surface under high pressure. The shale varies from 100 to 250 feet in thickness. Development of organically rich shales is considered an "unconventional" drilling process. Developing the reservoir requires a cemented and cased vertical well bore that transitions to a horizontal leg upon reaching the Marcellus. The horizontal legs may extend from 5,000 to 8,000 feet in length. Due to the low permeability of shales, hydraulic fracturing is required to release the natural gas locked within the formation. Development of shale wells differs from development historically seen on state forests in that horizontal well bores and large-scale hydraulic fracturing have not been necessary to develop "conventional" oil and gas reservoirs, which only require a vertical well bore. However, completions utilizing less intensive hydraulic fracturing have been commonplace in the industry since the mid-20th century.

The bureau held its first lease sale targeting the Marcellus Shale in 2008. Approximately 74,000 acres were leased for a record bonus payment of $163 million. The bureau's second lease sale targeting the Marcellus Shale was held in 2010, with 31,947 acres leased for $130 million. In 2010, 32,896 acres were leased, which generated $120 million in bonus payment. The bonus payments for unconventional leases have generated more revenue than the cumulative total received by the program since its inception in 1947. No lease sales have been held by the bureau since 2010.

Following the 2010 lease sales, the bureau developed a monitoring team to ensure that development of geologic resources was accomplished in a manner that maintained other state forest uses and values. Forest resource monitoring plays an essential role in ecosystem management by aiding in measuring ecological health as well as other social and economic considerations. The bureau monitors a variety of activities and resources on state forest land including plants, wildlife, water, soil, and recreation. The bureau released its first shale-gas monitoring report in 2014 assessing the condition of state forests where oil and gas development is occurring. The bureau continues to monitor for potential impacts to state forest lands during resource development, and it is expected that subsequent monitoring reports will follow.

On January 29, 2015, an executive order was enacted that states: "As of the date of this Executive Order, to protect
Figure 2. Historical oil and gas lease sales by acreage

the lands of the commonwealth that are held in trust for its citizens and for future generations, and subject to future advice and recommendations made by DCNR, no State Park and State Forest lands owned and/or managed by DCNR shall be leased for oil and gas development.”

Coal and Hard Minerals Development

Pennsylvania’s state forests have been explored and developed for valuable coal and other hard mineral resources since before 1947, and much of the exploration occurred before the commonwealth gained ownership of most of the coal prone lands in its system. The extracted products include, coal, stone, aggregate, sand, and various commercial hard minerals. As coal has been a known resource commodity in the United States over the past 200 years, it is not unusual that lands impacted by past coal mining have been accumulated in the state forest system. Coal operators initially targeted deep, thick coal seams that were near population centers, but over time, as rail systems expanded to harvest timber in remote areas of the state, the coal operators followed. They located and mined large expanses of coal lands in central Pennsylvania, where the majority of state forest land holdings now reside.

The bureau, then the Department of Forests and Waters, recognized that accumulation of lands with known coal reserves meant possibly hosting mining, and at that point in time the activity was encouraged through an active leasing program on the part of the department. Initially, mining was focused on deep coal seams that required deep mining techniques such as room and pillar mining. This type of mining was thought to be somewhat benign in surface impacts because traditional deep mining involves little to no surface subsidence effects.

However, just prior to and with the advent of World War II and the development of large economical mining machines and means of moving large amounts of earth inexpensively, strip mining became economic. Prior to this time, strip mining was generally considered uneconomic because the act of removing the overburden to expose the coal seam was cost prohibitive. The need for large amounts of coal for the war effort, and the new heavy machine technologies all combined to result in large-scale surface strip mining in Pennsylvania. Unfortunately, the result was widespread water quality degradation, loss of critical forest habitat, and no funding for land reclamation in the old mine pits and high walls. These consequences caused the bureau in the early 1990s to conclude that further mining of coal on state...
forest lands that was not being done as part of reclamation was not worth pursuing. The bureau then crafted an internal policy stating that it would no longer consider new proposals for surface mining for coal or stone, and it would only consider mining projects where reclamation of past mining impacts was to be addressed.

**Subsurface Ownership**
The Pennsylvania state forest system is comprised of approximately 2.2 million acres of state forest land. The commonwealth owns approximately 85 percent of the subsurface underlying these lands. Where the commonwealth owns both the surface and subsurface rights, it is known as fee simple ownership. The remaining 15 percent of state forest is comprised of areas in which the commonwealth has either partial ownership of the subsurface or the subsurface is owned completely by a private entity. These areas are referred to as severed ownership.

**Status of Unconventional Oil and Gas Development**
The bureau currently has 123 oil and gas leases on state forest lands. These leases encompass approximately 385,940 acres, primarily in northcentral Pennsylvania. The bureau’s active oil and gas leases are of varying vintages dating back to the early 20th century. The bureau strives to update any historical leases still in effect to modern terms and conditions whenever possible. The bureau’s standard oil and gas lease is evolving continually to utilize the most current best management practices and to coincide with modern development practices. In addition, on severed lands, the bureau endeavors to have operators sign surface-use agreements that stipulate some of the same protections and best management practices called for in the current-day lease.

The most active development of geologic resources occurring on state forest lands is the extraction of natural gas from organically rich shales. Act 13 of 2012 defines this development as unconventional due to the shale lacking natural permeability conducive to oil and gas development. Therefore, the permeability of the formation needs to be enhanced through hydraulic fracturing in order to allow efficient drainage of the formation. The majority of this development has occurred in the Devonian-aged Marcellus Shale. Approximately 1.5 million acres of state forest lands lie within the prospective...
limits of the Marcellus Shale. Assuming a drainage area of 120 acres per well, the bureau expects that approximately 3,000 wells may be drilled to fully develop the lands it currently has leased.

However, advancements in drilling technology and practices are allowing each new well to develop a greater area due to longer well bores and better completion techniques. The bureau estimates that the Marcellus Shale is approximately 16 percent developed on lands currently leased.

To a lesser extent than in the Marcellus, the bureau also is seeing active development in the organically rich shales of the Upper Devonian. Upper Devonian Shales lie on average approximately 2,000 feet shallower than the Marcellus. Given that Upper Devonian Shales are significantly shallower than the Marcellus, wells drilled within this unit are less costly to construct,
and therefore they can be economically viable even with lower levels of gas production. While the extent of the Upper Devonian Shales are coincident with that of the Marcellus, it is difficult to determine the actual limits of the prospective area for this unit because reservoir characteristics are much more heterogeneous than in the Marcellus. Currently, the majority of Upper Devonian wells drilled on state forest lands have been confined to Lycoming County. At this time, it is difficult to determine the number of wells that may be drilled to fully develop Upper Devonian Shales on state forest lands given the uncertainty of the prospective area for this unit.

In recent years, there has been a marked increase in the development of the Ordovician-aged Utica Shale in western Pennsylvania and eastern Ohio. The Utica is on average several thousand feet deeper and under much higher pressure than the Marcellus Shale. This leads to substantially increased development costs and difficulty of drilling and completions in the Utica. Therefore, development of the Utica is greatly dependent upon the natural gas market and production results. However, generous production from many Utica wells continues to make this a viable target in certain areas. As development moves eastward from the Pennsylvania-Ohio border, the bureau has seen an increased interest in the Utica Shale on state forest lands. Development of the Utica has become increasingly prevalent adjacent to state forest lands, primarily in Tioga County and the northwestern section of the state forest system. Currently, oil and gas operators are drilling and completing the first exploratory Utica wells on state forest lands in these areas. Given cost and geological constraints, it is unlikely that widespread development of the Utica Shale will take place on state forest lands in the near future.

Unconventional shale-gas development can cause short-term or long-term conversion of existing natural habitats to gas infrastructure. The footprint of shale-gas infrastructure is a byproduct of shale-gas development. The use of existing transportation infrastructure on state forest lands, such as roads and bridges, increase considerably due to gas development. The bureau strives to design and maintain existing and proposed gas infrastructure to efficiently serve its intended purpose, reduce impacts to other state forest uses and values, and ensure the safety of staff and state forest users.

Figure 6. Overlay of unconventional oil and gas wells with state forest land
The bureau conducts an extensive review of proposed gas activities and infrastructure. To facilitate these reviews, the bureau typically is provided with the operator’s conceptual site plan as early in the development process as possible. The bureau evaluates the plan for known areas of concern or potential conflicts and coordinates with the operators to develop an infrastructure plan that minimizes impacts to state forest land while facilitating efficient extraction of gas. Commencement of construction and installation of proposed infrastructure is authorized upon receipt of final approval from the bureau.

The lease terms and also the Guidelines for Administering Oil and Gas Activity on State Forest Lands contain provisions intended to prevent gas development operations from interfering with other state forest uses and values. Examples of such provisions prohibit well drilling and site clearing within the following distances from certain features:

- 200 feet from any building
- 200 feet from any stream or body of water
- 300 feet from any stream or body of water designated as exceptional value by DEP
- 300 feet from any trail or road
- 300 feet from the boundary line of leased premises
- 600 feet from the boundary line of a state park or a state forest wild or natural area

These restrictions minimize the impact of development when it occurs near valued resources. Deviations from conditions specified in leases or surface-use agreements require an approved waiver. The bureau grants waivers when the proposed deviation is the most effective way to resolve conflicts between competing resource uses and values, minimizes overall impact to the forest, and is in the best interest of the commonwealth.

Infrastructure for Unconventional Oil and Gas Development

Development of unconventional oil and gas resources requires the construction of various types of infrastructure on state forest lands. A well pad is the area where shale-gas well drilling and hydraulic fracturing occurs. A typical shale-gas well pad is approximately 3.5 to 7 acres. A typical well drains approximately 120 acres, but that figure can vary depending on a number of factors. Well pads are typically constructed of crushed limestone or other rock, compacted to form a stable operating surface. The bureau works with operators to balance their need to place pads according to geologic factors with the potential impacts such placement will have on other resources, such as plant communities, trail systems, streams, and wetlands.

New roads often are required to access private subsurface estates or leased lands. However, the bureau promotes the use of the existing road system whenever feasible, reducing the need for additional clearing and new road construction. The minimum road standards required to facilitate shale-gas development exceed the minimum requirements necessary to accommodate the traditional uses of state forest roads. Shale-gas development requires extensive truck traffic by large vehicles, which may require upgrades to existing roads to support this use. These upgrades may affect the wild character of roads, a value that is enjoyed by state forest visitors and is considered during gas development activities. In addition, heavy truck traffic during peak development periods increases social and environmental concerns related to noise, dust, access limitations, public safety, and user experience, as well as operational concerns associated with road conditions, maintenance, and rehabilitation.

The bureau has adapted to this non-traditional forest road use by developing standards for road construction and improvements during shale-gas development. Heavy-hauling restrictions are provided yearly to avoid conflict with traditional forest users. On days with heavy-hauling restrictions, operators are asked not to operate heavy-hauling trucks on state forest roads.
Compressor stations commonly are used in association with gas production and pipelines. Compressor stations increase the gas pressure at the well bore or within pipelines to overcome friction or production volume decreases. Noise from compressors can dramatically affect a state forest user’s recreational experience and generate conflict. Unlike compressors, most sources of potential noise on state forest land are temporary in nature. To lessen the impacts of compressor noise on recreation experiences, the bureau uses guidelines for maximum noise levels caused by compressors and actively monitors compliance with these guidelines. In cases where the guidelines are exceeded, the bureau works with the operator on noise mitigation measures.

The development of a single shale-gas well requires an average of 5 million gallons of water for the completion process (i.e., hydraulic fracturing). This water must be readily available to the well site throughout the process. The water-intensive nature of shale-gas development requires extensive advance planning. Typically, water needed for shale-gas development can be acquired through surface water withdrawals, groundwater well withdrawals, or a third-party supplier who trucks the water on site. When reviewing requests for water acquisition, the bureau takes into consideration potential impacts to watersheds, headwater streams, wetlands, and adjacent ecological resources. Centralized freshwater storage facilities and temporary water pipelines are preferred because they reduce truck traffic and in some cases can decrease total acreage disturbed because an impoundment is not needed at each pad.

The development of oil and gas resources requires pipelines for delivering the product to market. When compared to other aspects of gas development, pipeline construction has the greatest potential to cause forest conversion and fragmentation due to the length and quantity of pipelines required. Therefore, careful pipeline planning occurs early in the development process to address production needs while minimizing impacts and implementing ecosystem management.

**Status of Conventional Oil and Gas Development**

Development of conventional oil and gas fields, although historically prevalent on state forest lands, has subsided substantially in recent years due to a marked decrease in natural gas prices and the increased focus on organically rich shale formations. No wells targeting conventional natural gas producing reservoirs have been drilled on state forest lands since 2010. However, development of conventional oil-producing reservoirs still continues in the northwestern section of the state forest system in portions of Clear Creek and Cornplanter state forests. Approximately 1,800 wells have been drilled into conventional formations on lands leased by the bureau since 1947. The majority of these wells have become uneconomic or ceased production altogether and have been plugged and abandoned.

Nearly all discovered conventional oil and gas fields located on state forest lands have long been fully developed. Most of the active wells within these fields are producing the last of the reserves, and are on their last years of production. The immense productivity of organically rich shales has overshadowed the moderate production of conventional formations in Pennsylvania. It is unlikely that moderate to widespread development of conventional oil and gas fields will occur on state forest lands in the foreseeable future.

**Status of Coal and Hard Mineral Development**

As detailed above, development of coal and other hard minerals is restricted to state forest lands that were previously disturbed by mining practices and improperly reclaimed or where the new mining proposal would allow for significant reclamation on other nearby mine lands. Also, if a mining proposal involves deep mining with no surface disturbance, the proposal may be considered if there is a possible land exchange wherein the commonwealth
would deed its title to the coal or stone to the deep mining company in return for new lands of the bureau’s choice that would be of equal or greater value of the ground exchanged. This method became a common land management tool from the late 1990s to present, and it is still used sparingly today.

The current state of the coal and stone resource on state forest lands remains largely as it was in the past five decades. Residual coal reserves are found across several forest districts, and in some cases blocks of coal remain that can be recovered economically if the bureau could structure a lease agreement such that the bureau receives its compensation in additional land reclamation.

The bureau has an extensive inventory of coal reserve estimates by forest district, with maps and tonnage estimates in most cases. These assessments were performed in the 1970s. The bureau has taken the position that it will entertain private proposals and DEP Bureau of Abandoned Mine Reclamation (BAMR) reclamation proposals on a case-by-case basis and judge each proposal on its own merits as opposed to proactively searching for partners for remining and reclamation interest in the coal industry. In this manner, private industry decides what has value and the bureau can decide where it wants its royalty value to be expended for new reclamation.

An estimated 30,000 acres of mine scarred lands in the state forest system would benefit from reclamation. This would not only improve the productivity of the land, but would greatly enhance water quality and aquatic habitats as well. Knowing that the funds do not exist within the state system to begin reclaiming all these lands, it has largely fallen to BAMR and private industry to nominate and contract for mining and reclamation projects that involve state forest lands.

A condition imposed on any additional mineral development will be the proper reclamation of all affected lands to present-day standards. Knowing that the coal mining industry has a limited capacity to remine and reclaim these old mine areas and that the companies have to have a reasonable expectation of making a profit at the completion of the project in the current low-price environment, it is expected that new proposals will be few. However, BAMR does have federal money it allocates to the worst areas for reclamation that involve safety issues first and water quality second.

Figure 7. Overlay of conventional oil and gas fields and state forest lands
Figure 8. Abandoned mine lands on state forest lands
<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. To conserve state forest resources, uses, and values in conjunction with coal and hard minerals development.</strong></td>
<td>1.1 Allow surface extraction of coal resources only when the activity is part of land reclamation and mitigation efforts.</td>
</tr>
<tr>
<td></td>
<td>1.2 Permit hard mineral extraction when operations can be conducted entirely underground and the circumstances benefit the commonwealth.</td>
</tr>
<tr>
<td><strong>2. To allow no new leasing for oil and gas development on state forest land subject to future advice and recommendations by DCNR.</strong></td>
<td>2.1 Manage the ongoing extraction of oil and natural gas, from existing leases and severed lands, by implementing best management practices and careful oversight.</td>
</tr>
<tr>
<td></td>
<td>2.2 Continue the shale-gas monitoring program to assess potential effects of shale-gas development on state forest resources, uses, and values.</td>
</tr>
<tr>
<td></td>
<td>2.3 Gather and evaluate public input regarding past and ongoing effects of oil and gas development as well as public sentiment toward potential future leasing for oil and gas development.</td>
</tr>
<tr>
<td><strong>3. To pursue opportunities for the bureau to manage geologic resource development where the commonwealth is not the fee-simple land owner.</strong></td>
<td>3.1 Endeavor to obtain a bonded surface-use agreement from the operator to conserve state forest resources in severed-rights situations.</td>
</tr>
<tr>
<td></td>
<td>3.2 Pursue the strategic acquisition of privately owned oil, gas, coal, or hard mineral rights coincident with state forest surface ownership when funding is available.</td>
</tr>
<tr>
<td></td>
<td>3.3 Give preference to fee-simple land purchases for new acquisitions, whenever possible.</td>
</tr>
<tr>
<td><strong>4. To provide technical guidance and oversight when geologic resources are developed on state forest lands.</strong></td>
<td>4.1 Communicate and promote the use of current best management practices consistent with bureau guidelines.</td>
</tr>
<tr>
<td></td>
<td>4.2 Monitor the effects of shale-gas development on state forest resources, uses, and values.</td>
</tr>
<tr>
<td></td>
<td>4.3 Enforce current lease terms and conditions.</td>
</tr>
<tr>
<td></td>
<td>4.4 Continuously adapt guidelines based on monitoring results and other experiences.</td>
</tr>
<tr>
<td></td>
<td>4.5 Collaborate with the DEP and other organizations on compliance monitoring and researching the effects of shale-gas development.</td>
</tr>
</tbody>
</table>
### Geologic Resources Management Principle Cont.

<table>
<thead>
<tr>
<th>5. To mitigate adverse impacts resulting from historical development of geologic resources when funding is available.</th>
<th>5.1 Mitigate public nuisances and safety hazards resulting from historical development.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.2 Mitigate environmental hazards and repair environmental damage resulting from historical development.</td>
</tr>
<tr>
<td></td>
<td>5.3 Identify orphaned wells on state forest land and coordinate efforts with the jurisdictional authority to prioritize, plug, and properly abandon them.</td>
</tr>
<tr>
<td></td>
<td>5.4 Coordinate with watershed groups and similar organizations to identify external funding sources for these activities.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6. To identify and conserve unusual or exemplary geologic features and assist in the advancement of geologic knowledge in Pennsylvania.</th>
<th>6.1 Work with the Bureau of Topographic and Geologic Survey to identify and catalog unusual and exemplary geologic features.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6.2 Develop and implement best management practices to protect unusual or exemplary geologic features during management activities.</td>
</tr>
<tr>
<td></td>
<td>6.3 Attempt to secure funding for remediation and monitoring of prioritized projects.</td>
</tr>
</tbody>
</table>

## Guidelines, Tools, and Resources

**Guidelines for Administering Oil and Gas Activity on State Forest Lands**


The objective of this document is to establish and communicate a set of guidelines and best management practices that provide consistent, reasonable, and appropriate direction for managing oil and gas activity on state forest lands in accordance with the bureau’s mission.

**Stone and Shale Policy and Program Guidelines**


This policy document sets forth allowable collection methods and other requirements for stone and geologic material on state forest lands.

### Pennsylvania Natural Heritage Program (PNHP)

http://www.naturalheritage.state.pa.us/Species.aspx

PNHP inventories and maintains a list of geologic features in the state for which there is conservation concern. This list of features is considered in the PNDI phase of state forest environmental reviews (SFERs).

### Monitoring

- Oil and gas infrastructure tracking
  - Number and acreage/extent:
    - Pads
    - Pipelines
    - Roads
  - Leased and severed acreage
- Track and audit volume and revenue from gas production
- Shale-gas monitoring
- Gas foresters monitoring gas activity
Critical Research Needs

- Locate and inventory orphaned and abandoned wells.
- Further develop and refine accounting and auditing methodologies and practices.
- Identify, abstract, and prioritize for acquisition outstanding oil, gas, and minerals rights severed from state forest lands.
- Consolidate reports and data on past coal mining and possible coal reserves located on state forest lands into a single repository.
- Assess accuracy and continually update spatial ownership and lease data.
- Identify future oil and gas trends in Pennsylvania that may impact state forest lands.
- Identify and evaluate oil and gas producing formations on state forest lands.
- Identify and assess the spatial extent of abandoned underground mines beneath state forest lands.
Human perception of fire and its role in the forest ecosystem has changed over time. Fire once was viewed only as a destructive threat to be wholly eliminated. Today, modern forest managers recognize fire’s role in forest ecosystems. However, challenges still exist in balancing our mandate to protect life, property, and natural resources and our desire to use fire as a tool in the landscape.
DCNR is legally mandated to provide for the reasonable protection of all wild lands in the commonwealth from damage by wildfire (71 P.S.§ 1340.302d). This mandate is accomplished through a combination of wildfire prevention, suppression, investigation, and preparedness. Part of the bureau’s mission is to protect lives, property, and natural resources from damage by wildfire. Protecting wild lands from damage by wildfire is part of the bureau’s mission of “protecting forestlands, public and private, from damage and/or destruction by fires, insects, diseases and other agents.”

Other legal references for wildfire and prevention include:
- PA Statute Title 16, regarding the county burn ban
- Title 17, regarding state forest rules and regulations
- Title 32, regarding forest fire hazards, liability, bills, cost recovery, out-of-state fire, Mid-Atlantic Compact, and prescribed fire
- Title 35, regarding fire prevention: statewide burn ban
- Act 18, Chapter 1, section 302, regarding forests

**History of Wildland Fire in Pennsylvania**

Fire played an important role in shaping Pennsylvania’s forests and is an option for managing for desired ecological or silvicultural objectives. Prior to European settlement, Native Americans used fire to modify the forest, encourage food production, prepare sites for agriculture, control undesirable pests, clear forests for villages, move preferred game species during hunting, and during intertribal conflicts (Brose et al. 2001). These burning activities likely were more common in the ridge and valley province, where there was a higher concentration of Native American settlements, but less common on the Allegheny Plateau, which acted as a buffer between the Iroquois and Susquehannock tribes.

During European settlement in the mid-18th and early 19th centuries, settlers also adopted Native American burning practices to promote desired conditions on the landscape. Logging, railroad use, charcoal, and iron production by the settlers also created a rise in wildfires in Pennsylvania, especially from 1880 to about 1930 (Figure 1). In most cases across the state, fire frequency and severity dramatically increased during this time period, creating many of the even-aged, oak-dominated forests the bureau now manages. There has been a dramatic decrease in the acres and size of wildfires since that time period due to full suppression activities. The public perception around these large, intense fires contributed to a national effort of fire suppression.

![Figure 1. Conceptual model of the changes in fire regimes for the mixed-oak forests of the Appalachian Mountains since 1500 (Brose 2001).](image-url)
In the 18th and 19th centuries, several Pennsylvania laws prohibited forest burning, making it illegal for anyone to purposefully start wildfires (DeCoster 1995). In 1901, the Pennsylvania State Department of Forestry (now the Bureau of Forestry) was given responsibility to address wildfires through detection, suppression and prevention. More than 250 fire towers were built and used throughout the state by the 1920s; the towers were linked to local fire wardens through telephone lines. In 1915, law established the fire warden program to create a network of chief, district, and local fire wardens. This program is still used today and was a model for fire suppression in other eastern states. Today, about 50 fire towers remain, many of which are slated to be rebuilt to address safety concerns and to provide for continued use. Wildfires are actively suppressed in Pennsylvania, a priority for the bureau in addressing safety and property damage risks associated with wildfire. This is especially important in Pennsylvania because portions of the state have a large amount of wildland/urban interface.

Prescribed fire, however, when carefully planned and properly executed, may be considered a management tool that can benefit forests and reduce the risk of wildfires due to fuel reduction. In 2009, the Pennsylvania Prescribed Burning Practices Act was enacted to provide requirements for the regulation and implementation of prescribed burning in Pennsylvania. This law established the bureau as the agency responsible for developing standards and ensuring the proper and safe use of prescribed fire throughout the commonwealth. Since the law was enacted, the use of prescribed fire increased on state forest land and continues to rise as more individuals become trained on employing prescribed fire and the long-term benefits are realized.

Wildfire Risk

Over the last few decades, expansion of the wildland/urban interface — areas where homes and other human development meet or overlap with undeveloped land — has significantly impacted all emergency response and disaster management activities. In many areas, community expansion has outpaced local infrastructure, stretching capabilities of fire, police, and other local emergency services. The wildland/urban interface creates an environment where fire can move readily between structural and vegetative fuels, increasing the likelihood that wildfires will threaten homes and people. The University of Wisconsin and the U.S. Forest Service report that more than 17 percent of Pennsylvania residents live in the wildland/urban interface. An informal wildfire risk assessment conducted in 2002 identified more than 250 municipalities at risk. A more thorough and detailed review of these issues should be conducted by analyzing spatial data. Increasingly, the bureau is tasked with protecting lives and property from damage by wildfires. As these demands continue to increase, the bureau’s capacity to provide these services is being tested in terms of work hours and funding.

Future efforts should focus on targeting communities at the county or township level in order to standardize implementation across political units and better manage the effects of increased wildland/urban interface.

The Effects of Fire in Pennsylvania

Wildfires in Pennsylvania often are caused by people and can represent a threat to forest resources and human property. Understanding the ecology of wildfire can lessen these threats by understanding what factors contribute to fire frequency, behavior, and intensity. Guidelines on fighting wildfire also can lessen impacts to forest resources or human property. Because of wildland/urban interface and the risk to human property or safety, there are potentially very few areas on state forest land where the bureau would not actively suppress wildfires. However, in some management situations, prescribed fire may be used as a surrogate for wildfire in controlled situations to assist in managing forest ecosystems.

Following widespread logging and railroad use in Pennsylvania, wildfires were an important disturbance in encouraging and maintaining oak-dominated forests. Oaks are well adapted to frequent, low-intensity surface fires.
In the absence of fire, less fire-tolerant species have increased in the understory of oak-dominated forests and directly compete for growing space. Many of these species are less desirable for economic and ecological reasons. Although fire is not the only factor for successful oak regeneration in Pennsylvania’s forests, it can be used in conjunction with other silvicultural practices to promote regeneration and decrease undesirable species in mixed oak stands. Prescribed fires can damage or kill thin-barked species and open up the mid- and understories to encourage oak establishment.

Forest conditions often influence the success of prescribed fire for promoting oak regeneration. Soil conditions, invasive species presence, herbivory pressure, amount of competing vegetation, quality of competitive oak seedlings, and even the fire behavior can influence how a forest may respond to prescribed fire. Forest managers should also consider the cost of burning and only use prescribed fire where it is likely to achieve desired ecological and silvicultural objectives.

Pennsylvania’s Wildlife Action Plan cites fire as an important disturbance in maintaining particular forest, barrens, and grassland habitats for species of greatest conservation need, while also promoting game species, native flora, and host species for rare invertebrates. Barrens habitats are often influenced by frequent disturbance, especially fire, and soil/climate conditions to maintain an early successional habitat that is important for game species, Appalachian cottontails, rare invertebrates, and golden-winged warblers and other songbirds (PGC Wildlife Action Plan, section on Barrens Habitat). Warm season grass habitats — important for game species, grassland birds, and rare invertebrates — also can be maintained through regular disturbances, such as fire. Without disturbance, these communities may shift to forested communities over time, and maintaining them could include a prescribed fire program along with other management activities such as mowing.

A habitat conservation plan for bats is being developed for state lands in Pennsylvania in cooperation with the Pennsylvania Game Commission and U.S. Fish and Wildlife Service. This plan aims to create, enhance, and protect habitat for bat species that are imperiled from the effects of white-nose syndrome on state forest and state game lands. As part of the plan, prescribed fire is encouraged to improve habitat conditions for bats, particularly the federally endangered Indiana bat, although some seasonal restrictions may apply.
Wildfire Management
Minimizing damage by safely and efficiently suppressing wildfires is the top priority of the bureau’s wildland fire activities. Wildfires tend to occur relatively infrequently on state forest land compared to the occurrence on private land; however, some of these fires have grown large and/or severe because of mountainous terrain, remote locations, lack of access, and fuel conditions. On state forest land, appropriate strategies and tactics are used in managing wildfires or fuels to minimize damage to forest ecosystems.

The bureau has increased investments in training and equipment for suppression, prevention, and prescribed fire activities over the past several years. More work needs to be done to standardize equipment, policies, procedures, training, and qualifications. There is a need to analyze and understand the factors that influence wildfire occurrence, hazard, and risk on and adjacent to state forest land.

Wildfire Detection
Wildfires are detected by a number of means, including ground patrol, fire towers, and aerial observation. The Bureau of Forestry has a network of approximately 40 fire towers that can be used for detection of wildfires. A large effort to rehabilitate and replace some of the high-priority fire towers is currently under way. Contracts for aerial reconnaissance aircraft also are used to provide access to aircraft for use in detection and observation of wildfires.

Forest Fire Wardens
All forest districts have a network of volunteer forest fire wardens who can be utilized to augment bureau personnel for wildfire patrol, prevention, and suppression. The system of fire wardens was created in 1915 through legislation granting authority and responsibility through a chief forest fire warden to a network of local wardens statewide. These wardens are authorized to develop local crews of trained wild-land firefighters and to respond to wildfires in the commonwealth regardless of land ownership. Nearly 2,000 fire wardens are on call across the commonwealth.

Fire Prevention, Firewise, and Smokey Bear
Firewise is a nationally based program to assist communities and townships in high fire risk areas where wild land and urban land interface. The program gives federal grant money to assist with mechanized fuel reduction to prevent fire from reaching buildings, install dry hydrants for fire departments, and carry out many more fire suppression preparations. The program also advises homeowners on how to build with fire resistant materials and use landscaping techniques to keep fire from reaching their structures.

The Pennsylvania Firewise Communities Program was first introduced in the Pocono region and targeted gated communities. In 2003,

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of fires</th>
<th>Acres burned</th>
<th>Number of fires</th>
<th>Acres burned</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>689</td>
<td>7,670</td>
<td>22</td>
<td>4394</td>
</tr>
<tr>
<td>2009</td>
<td>619</td>
<td>6,065</td>
<td>34</td>
<td>290</td>
</tr>
<tr>
<td>2010</td>
<td>569</td>
<td>3,398</td>
<td>43</td>
<td>303</td>
</tr>
<tr>
<td>2011</td>
<td>202</td>
<td>579</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>2012</td>
<td>719</td>
<td>3,186</td>
<td>33</td>
<td>252</td>
</tr>
<tr>
<td>2013</td>
<td>632</td>
<td>1,785</td>
<td>27</td>
<td>606</td>
</tr>
<tr>
<td>2014</td>
<td>871</td>
<td>4511</td>
<td>19</td>
<td>43</td>
</tr>
</tbody>
</table>

Average, 2008-2014 614 3885 27 844

Table 1. Wildfires Reported by the Bureau of Forestry, 2008-2014
the Firewise Task Force initiated an effort to develop one Firewise Community in each of the 20 bureau forest districts. Sixteen districts have successfully developed Firewise Communities. Today, 36 communities have community wildfire protection plans.

Public safety and awareness in wildfire prevention is enhanced through education. Smokey Bear is administered by the U.S. Forest Service, and the bureau’s fire wardens may offer local Smokey Bear prevention programs.

**Incident Management Teams**

In 2006, the bureau began the development of interagency incident management teams to increase its capacity to deal with large or complex wildfires. This program has focused on building and maintaining partnerships with other state emergency management agencies, dealing with all-hazard situations, credentialing, training, and responding to wildfire incidents. At the time of writing, the teams had been used 17 times since 2006.

**Prescribed Fire**

Prescribed fire activities are governed by the Pennsylvania Prescribed Burning Practices Act, Act 17 of 2009, 32 P.S. § 425. The Pennsylvania prescribed fire standards were developed by the bureau in consultation with the Pennsylvania Prescribed Fire Council. These standards specify qualifications, training requirements, safety issues, and burn plan content required for all prescribed fires conducted in the commonwealth. The bureau also has developed an internal prescribed fire policy and a vegetation monitoring program to further promote and manage this activity on state forest land. In late 2013, district prescribed fire coordinators were assigned to facilitate coordination and information sharing on prescribed fire in the bureau. The prescribed fire program continues to grow as more bureau staff become trained to carry out the activity and more information is learned on its applicability as a tool for state forest management.

The number of acres burned through prescribed fire has increased in recent years on state forest land. In addition to increasing acreage, the average size of prescribed fires also has increased (Table 2). Most prescribed burning on state forest land has been used as part of silviculture systems to promote oak regeneration and reduce undesirable tree species competition in combination with shelter wood or clear-cut harvests. Because of the success of these prescribed fires and research supporting their use in oak ecosystems, there is increasing interest in expanding the prescribed fire program on state forest land as a part of ecosystem management. Prescribed fire is an emergent tool that has potential for use in a variety of plant communities to promote desirable species compositions and structure.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of prescribed fires</th>
<th>Acres treated</th>
<th>Average size (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>12</td>
<td>186</td>
<td>14</td>
</tr>
<tr>
<td>2011</td>
<td>11</td>
<td>189</td>
<td>17</td>
</tr>
<tr>
<td>2012</td>
<td>10</td>
<td>208</td>
<td>21</td>
</tr>
<tr>
<td>2013</td>
<td>33</td>
<td>844</td>
<td>26</td>
</tr>
<tr>
<td>2014</td>
<td>22</td>
<td>357</td>
<td>16</td>
</tr>
<tr>
<td>2015 YTD</td>
<td>36</td>
<td>1013</td>
<td>28</td>
</tr>
</tbody>
</table>

*Table 2. Prescribed fires conducted on DCNR lands, 2010-2015*

The bureau also has developed and implemented a vegetation monitoring protocol for prescribed fire on state forest land to help determine if objectives of prescribed fire are met and to adjust techniques from the information learned on resulting conditions. The protocol involves measuring vegetation composition and structure before and after a prescribed fire, as well as weather conditions and behavior during the fire. As more information is gathered about the use of prescribed fire, managers may be able to indicate conditions that were more successful in attaining management objectives or where other techniques may be more successful.
Expanding the use of prescribed fire should be explored beyond stand-level silviculture for oak regeneration and could be incorporated into landscape level management. Increasing the use of prescribed fire on state forest land will require additional attention to standardizing operations, building capacity of bureau staff to safely conduct prescribed burns, partnering with a variety of stakeholders, monitoring the effectiveness of the program, and researching potential impacts of prescribed fire on forest resources.

<table>
<thead>
<tr>
<th>Wildland Fire Management Principle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildland fire on state forest lands is prevented and suppressed to control threats to natural resources, infrastructure, and human life, but it is also used as an ecological and silvicultural tool as a component of ecosystem management.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To consider forest conditions impacted by wildland fire.</td>
<td>1.1 Develop and implement a strategy to analyze and manage vegetation communities and fuel conditions based on natural fire regimes.</td>
</tr>
<tr>
<td></td>
<td>1.2 Document and analyze wildfire occurrences and conditions to better understand wildfire activity.</td>
</tr>
<tr>
<td></td>
<td>1.3 Promote and support prevention activities that may influence wildfire occurrence or intensity on state forest land.</td>
</tr>
<tr>
<td>2. To conduct wildfire suppression activities in a safe and effective manner that minimizes damage to forest ecosystems.</td>
<td>2.1 Respond to, suppress, and investigate wildfires on state forest land.</td>
</tr>
<tr>
<td></td>
<td>2.2 Maintain and follow standards and guidelines for wildland fire suppression activities that minimize damage to forest resources and provide for the safety of personnel.</td>
</tr>
<tr>
<td></td>
<td>2.3 Maintain an appropriate suppression capacity through fire staffing, training, and equipment availability.</td>
</tr>
<tr>
<td>3. To implement a safe and effective prescribed fire program as a management tool.</td>
<td>3.1 Increase the use of prescribed fire on state forest land to meet ecological and silvicultural objectives.</td>
</tr>
<tr>
<td></td>
<td>3.2 Build the capacity of staff to conduct prescribed fires through training.</td>
</tr>
<tr>
<td></td>
<td>3.3 Develop and implement guidance for the use of prescribed fire to meet ecological and silvicultural objectives.</td>
</tr>
</tbody>
</table>
Guidelines, Tools, and Resources

Pennsylvania Prescribed Fire Standards

The purpose of this guide is to provide standards, establish common terminology and definitions, and identify planning and implementation procedures for the use of prescribed fire in Pennsylvania. Goals for the prescribed fire program are also provided.

District Fire Resource Plans

These plans provide each respective district with a constantly revised and standardized action and resource study assembled in one place to facilitate the dispersion of fire information.

Pennsylvania Wildfire Support Crew Standard Operating Guidelines

The requirements and general operating framework for additional personnel to assist in wildfire suppression and other emergency incidents are described here.

Prescribed Fire Policy

This provides the general principles of action that pertain to the bureau’s prescribed fire practices.


This reference manual is provided as guidance for the utilization of aircraft to protect Pennsylvania’s forested areas and natural resources against wildfire and destructive insects. It is the basic document for planning, programming, obtaining, and operating aircraft in a safe, timely, and effective manner.

Pennsylvania Wildland Fire Crew (Manual)

This resource provides information on the requirements, standards, and some procedures of the Pennsylvania wildland fire crew.

Wildfire Investigation Guidelines

The criteria that warrant a wildfire investigation and the qualifications for a wildfire investigator are given here.

Monitoring

- Track occurrence of wildfires
  - Number
  - Acres damaged
  - Causes
  - Cost of damage and suppression
- Track prescribed fires
  - Purpose
  - Number
  - Acres
  - Cost
  - Success/result

Critical Research Needs

- Effect of prescribed fire on species of special concern
- Effect of prescribed fire on invasives
- Location of wildland/urban interface and intermix in Pennsylvania, especially in relation to state forest land.
- Fire behavior in ericaceous fuels and development of accurate fuel models in these fuels
A healthy forest is an association of species interacting in various ways with biotic and abiotic factors over time to create a mix of components that coexists and reacts to changing conditions in order to support forest cover, a functional equilibrium between supply and demand of essential resources, and diversity of seral stages and stand structures. A healthy forest is one that can sustain itself ecologically. Processes leading to forest and tree decline are countered through processes of resilience, recovery, and rejuvenation. Retention of ecosystem integrity and function enables a healthy forest to respond to destructive agents through repair, replenishment, and regeneration of affected areas within a forest community.
A variety of native and natural agents, occurring at various intervals and intensity, can threaten or cause significant damage to forest ecosystems. If healthy, ecosystems are resilient to these stress events and tend to recover quickly. In some cases, natural stresses can become unusually high and have detrimental impacts, such as the lack of regeneration causing overabundant white-tailed deer populations and a shift to recalcitrant vegetative cover. Non-natural or exotic pests, diseases, and threats pose a greater risk to forest ecosystems and may lead to significant damage and mortality of forest species, potentially resulting in decline of ecosystem integrity and function.

Protecting the health of forest ecosystems is critical to implementing ecosystem management on state forest lands. In Pennsylvania, forest damage-causing agents may include forest insects and disease, invasive plants, climate change, inadequate forest regeneration, acid mine drainage, acid deposition, waste and littering, air pollution, habitat fragmentation, overabundant deer populations, and wildfire. These damaging agents are actively managed on state forest lands to lessen their overall impact to forest ecosystems.

**Forest Insects and Disease**

Non-native invasive insects and diseases are very serious threats and can have devastating impacts on the long-term health and sustainability of state forest ecosystems. Diseases, such as chestnut blight and Dutch elm disease, and insect pests, such as gypsy moth and hemlock woolly adelgid, already have significantly changed forest landscapes. Many of the invasive insects and pathogens threatening forest ecosystems first became established in urban forests.

Oaks continue to be at risk from gypsy moth defoliation, while beech bark disease continues to expand and threaten beech populations. Threats to oaks and beech are especially important because they are the largest remaining sources of hard mast for wildlife. Additionally, hemlock woolly adelgid, introduced into Pennsylvania in 1967, continues to spread westward and is affecting the hemlock resource. Similarly, the emerald ash borer was detected in Pennsylvania in 2007 and is now found in most of Pennsylvania and several state forest districts. A European woodwasp, Sirex noctilio, was detected in Pennsylvania in 2006 and has the potential to be a

![Figure 1. Tree mortality risk map for Pennsylvania in terms of predicted basal area loss due to insects and diseases](http://www.fs.fed.us/foresthealth/technology/pdfs/2012_RiskMap_Report_web.pdf)
serious pest of pines, while the Asian longhorned beetle, though not yet detected in Pennsylvania, has been found in the U.S. and could cause considerable harm to the maple resource already under stress due to sugar maple decline. Finally, other tree species, such as walnut and butternut, are threatened by other invasive insects and diseases that are established in North America. With tools developed by the U.S. Forest Service, tree mortality risk maps can help predict where forests are at risk for mortality due to various damage causing agents (Figures 1 and 2).

In addition to exotic insects and diseases, intense outbreaks of native insect pests and disease, such as forest tent caterpillar and anthracnose disease, can cause severe defoliation and mortality in localized areas. The risk of mortality increases when these outbreaks occur in conjunction with other stressors, such as drought or acid deposition. Climate change adds an additional level of uncertainty to future impacts of both native and exotic forest pests. Secondary pests that attack stressed trees may become more prevalent if their tree hosts are exposed to pressures associated with climate change.

The Bureau of Forestry monitors and manages insect and disease threats on state forest lands and throughout the commonwealth. With aerial detection programs, specialists map defoliation and mortality events across the state to understand where impacts may be the highest and to develop integrated pest management strategies to manage impacts in forest ecosystems (Figures 3 and 4). Prioritizing management based on susceptibility to damage and vulnerability to mortality is important in effectively addressing insect and disease issues across the landscape.

Of the pests that affect state forest resources, hemlock woolly adelgid, forest tent caterpillar, and gypsy moth have caused the most damage in terms of tree defoliation and mortality in recent years (Figures 3 and 4). Additional deforestation and mortality events have occurred due to increased winter and frost severity (“Others” category in Figures 3(b) and 4(b)).

The bureau has a variety of active surveys and projects in place to monitor pests and manage against forest insects and disease on state forest lands. Included is an effort to protect old growth hemlock trees in state forest natural areas from decline or mortality due to hemlock woolly adelgid infestations. Continued monitoring of hemlock woolly adelgid will be critical to research and

---

**Figure 2.** Tree mortality risk map in terms of areas at risk to lose more than 25% basal area due to insects and diseases only [http://www.fs.fed.us/foresthealth/technology/pdfs/2012_RiskMap_Report_web.pdf](http://www.fs.fed.us/foresthealth/technology/pdfs/2012_RiskMap_Report_web.pdf)
management efforts aimed at understanding and projecting the impact on hemlock ecosystems. Additionally, the emerald ash borer is spreading rapidly across the state (Figure 5), and a program is being implemented to protect valued ash resources and to slow the spread and impact of emerald ash borer in state forests, state parks, and private forest lands. Emerald ash borer is a serious threat to the 323 million ash trees throughout the commonwealth, including pumpkin ash, a state species of concern, and ash seed orchards managed by the bureau. Without active management, it is predicted that emerald ash borer will decimate nearly all populations of ash trees in the state.

Perhaps the longest-standing effort to manage forest pests on state forest lands has been through the bureau’s gypsy moth program. The gypsy moth has been causing significant forest damage in Pennsylvania since the 1970s. The most recent outbreak occurred between 2005 and 2010, and this pest has been the principal agent of tree mortality on state forest land since 2008 (Figure 6). As with other pest populations, gypsy moth outbreaks have been cyclic over time, and the bureau uses an integrated pest management approach to monitor and treat gypsy moth populations to lessen tree mortality and slow the spread of this pest.
**Invasive Plants**

Plant species are considered invasive when they are not native to an ecosystem and their establishment causes or is likely to cause economic, environmental, or human harm (Federal Executive Order 13112). Aggressive native species such as hay-scented fern, beech “brush,” birch, and striped maple may also adversely impact forest management operations and are considered “competing vegetation,” but they will not be considered here (see the Timber and Forest Products chapters for more information on competing vegetation). Exotic invasive plants are one of the most serious threats to native plant communities and biodiversity, second only to habitat loss (DCNR, Invasive Plant Management Tutorial). An overarching Invasive Species Management Plan exists for lands managed by DCNR. The bureau recognizes invasive plants as a serious problem to state forest lands and is developing strategies to more effectively manage them.
In a forested landscape, the effects of invasive plants on native plant communities are numerous and may include alterations to nutrient cycling, hydrology, natural fire regimes, light levels, regeneration of native tree species and understory species, and physical habitat structure. Especially critical is the direct competition with native plants for available resources, such as space and sunlight. Invasive plants, by definition, outcompete native vegetation for these resources, ultimately leading to minimization of native species on the landscape. The long-term effects of all these changes are largely unknown, but the increasing occurrence of invasive plants on state forest land raises concern about the ability of native plant communities to adapt or remain resilient to additional threats.

Invasive plants also impact a range of human activities and values. Some invasive plant species, such as kudzu, mile-a-minute and Japanese knotweed, can grow into tangled thickets that impede human use of an area. One may also encounter diminished access to waterways for recreation or increased costs of right-of-way maintenance due to invasive plants. Extensive infestations of invasive plants can decrease habitat quality for important wildlife species, and others, such as giant hogweed and poison hemlock, can cause skin inflammations on people who come into contact with them. Japanese barberry thickets enhance cover and habitat for mice, which could bolster tick populations and the instances of Lyme disease in an area.

The bureau actively manages against invasive plant populations on state forest lands at various levels. Strategies may include directly attacking an invasive plant population for eradication, using preventive measures for invasive plant introduction and spread, or mapping and evaluating invasive plant risks across the landscape. Additional invasive plant management activities are carried out by each forest district at a local level. As new invasive plant species continue to migrate into Pennsylvania and existing species spread further, the impact of invasive plants, coupled with the expense of controlling them, is a continuing challenge and requires a coordinated effort within the bureau and with other agencies or landowners.

The department recognizes 92 plant species as invasive on DCNR lands and has placed an additional 22 plant species on a “watch list” to monitor their impact on natural communities. Of the 92 recognized species, 56 are known to occur on state forest lands. Different plant species pose varying degrees of threats to ecosystems and forest management operations. These species are prioritized for management at the district level, and impacts are often already widespread. The invasive plant species with the greatest negative impacts on timber and regeneration operations include Japanese barberry, Japanese stiltgrass, and mile-a-minute.

For the complete list of invasive plants, find the reference to “DCNR Invasive Plants” in the “Guidelines, Tools, and Resources” section below.

The bureau can evaluate the long-term trend of invasive plant presence and spread through data collected during the landscape examination process and the continuous forest inventory (CFI). Now in its fourth cycle, the CFI provides data from established plots throughout the state forest system in 18 forest districts. Although conclusions from these data regarding the presence of invasive species are somewhat limited because the scope of the inventory is not aimed strictly at inventorying invasives, some interesting trends can be observed. From cycle 2 (2003-2006) to cycle 3 (2009-2013), the number of plots with occurrences of any invasive plant species increased from 221 to 301, and from 210 to 294 for only the species listed in Table 1. Most notably, plots with Japanese stiltgrass increased from 15 in cycle 2 to 124 in cycle 3. Also notable was that invasive honeysuckle species were found in four additional state forests during the third cycle.
Through landscape examinations, invasive plant species are also recorded at the stand level at varying densities. The bureau is currently obtaining more complete sample data on the occurrences, distributions, and densities of invasive plants on state forest lands. Although not all landscapes have been inventoried, general trends on invasive plants have been documented.

As with most organisms, plants species exist where there is an introduction source and favorable environmental conditions for establishment. One procedure the bureau uses for the immediate mitigation of novel invasive species is early detection and rapid response (EDRR). This protocol provides a brief reporting protocol that can be carried out by all bureau personnel. The focus is on high priority species (Table 2) that are either new or uncommon to a district or are currently found outside a district but have the potential to move in. Tracking these novel populations and treating them promptly is essential for slowing the spread of invasive plants and allows the bureau to understand if the species are colonizing new areas or becoming more widespread due to development. Also, keeping careful record of how new invasive plant populations are treated and the success or failure of treatments is essential to better managing these species on state forest lands.

The number of invasive species and their population sizes continue to grow over time on state forest lands. The bureau is developing better strategies to map and track the location and behavior of invasive plants for management planning and prioritization. Through careful planning of invasive plant treatments, prevention measures, and prioritization of management activities, the bureau can lessen the impacts of invasive plants to forest resources on state forest lands.

<table>
<thead>
<tr>
<th>Species</th>
<th>Plots (#)</th>
<th>Cycle 2</th>
<th>Cycle 3</th>
<th>% increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree-of-heaven Ailanthus altissima</td>
<td>22</td>
<td>26</td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Garlic mustard Alliaria petiolata</td>
<td>16</td>
<td>24</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Japanese barberry Berberis vulgara</td>
<td>123</td>
<td>140</td>
<td></td>
<td>14</td>
</tr>
<tr>
<td>Honeysuckle Lonicera mackii</td>
<td>14</td>
<td>23</td>
<td></td>
<td>64</td>
</tr>
<tr>
<td>Japanese stiltgrass Microstegium vimineum</td>
<td>15</td>
<td>124</td>
<td></td>
<td>727</td>
</tr>
<tr>
<td>Multiflora rose Rosa multiflora</td>
<td>94</td>
<td>102</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Wineberry Rubus phoenicosius</td>
<td>12</td>
<td>15</td>
<td></td>
<td>25</td>
</tr>
</tbody>
</table>

Table 1. Invasive species with substantial instances of occurrence and/or increase on CFI sample plots that were measured in both cycles 2 and 3

<table>
<thead>
<tr>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree-of-heaven Ailanthus altissima</td>
</tr>
<tr>
<td>Japanese angelica tree Aralia elata</td>
</tr>
<tr>
<td>Poison hemlock Conium maculatum</td>
</tr>
<tr>
<td>Glossy buckthorn Frangula alnus</td>
</tr>
<tr>
<td>Goatsue Galega officinalis</td>
</tr>
<tr>
<td>Mile-a-minute Persicaria perfoliata</td>
</tr>
<tr>
<td>Common reed Phragmites australis australis</td>
</tr>
<tr>
<td>Japanese knotweed Polygonum cuspidatum</td>
</tr>
<tr>
<td>Black swallow-wort Vincetoxicum nigrum</td>
</tr>
<tr>
<td>Pale swallow-wort V. rossicum</td>
</tr>
</tbody>
</table>

Table 2. Target species for early detection and rapid response
Other Forest Health Threats
Acid deposition, pollution, lack of adequate forest regeneration, forest fire, and overabundant white-tailed deer populations also impact forest ecosystems on state forest lands. A few of these issues are highlighted here, but also addressed in other chapters of the SFRMP.

Climate Change
According to the 2013 Pennsylvania Climate Impacts Assessment Update, climate change could impact state forests directly through increases in average, maximum, and minimum temperatures; longer growing seasons; increased average rainfall; decreased winter snow cover; more intense weather events; and longer periods of drought. While some impacts could result in increased forest and tree growth due to longer growing seasons and increased carbon availability, the suitability of areas to support certain species may also change. These forest composition changes could cause increased stress and mortality of trees, affect forest regeneration rates, and ultimately alter forest composition and wildlife habitat. These impacts also could affect forests indirectly by altering soil chemistry, growth rate and spread of invasive species, species interactions, and ultimately the function of forest ecosystems.

Acid Deposition
Acid deposition occurs when acid-forming substances are transferred from the atmosphere to the surface of the earth, often through precipitation. The deposited materials include ions, gases, and particles typically resulting from power generation and heavy manufacturing. Research has shown that acid deposition can cause slower growth, injury, or death of trees, particularly sugar maple and red spruce. Acid deposition generally causes stress to trees by interfering with calcium and magnesium nutrition and the physiological processes that depend on these elements. Acid deposition does not usually kill trees directly. Instead, it is more likely to weaken trees by damaging their leaves, limiting the nutrients available to them, or exposing them to toxic substances slowly released from the soil. Quite often, injury or death of trees is a result of these effects of acid rain in combination with one or more additional threats.
**Pollution**

The illegal dumping of waste on state forest lands can potentially pose detrimental environmental effects and also threatens the wild character of the forests. Even the littering of small cigarette butts can threaten wildlife and the environment and can detract from visitor recreation experience. Hazardous waste dumping presents even more serious potential threats to the environment, such as if toxic materials are involved. Stopping illegal dumping requires effective surveillance, enforcement, and education.

**Lack of Forest Regeneration**

The capacity of the forest to renew itself through natural regeneration is a key indicator of forest health and a necessary component of a sustainably managed forest. Ensuring desirable regeneration throughout Pennsylvania’s forest is a significant management challenge. Across the state, only 49 percent of sampled stands have adequate regeneration to develop into high-canopy forests (FIA, 2014). When only considering commercially desirable species, the number drops to 36 percent. The extent and quality of forest regeneration has far-reaching impacts on forest health and the suite of values the forest provides to society. The natural replacement of forests helps maintain and enhance Pennsylvania’s forest land base of nearly 60 percent that recharges water within watersheds, stores carbon, and provides incalculable ecological services. The habitat structure that young forests also provide is essential to many wildlife species and species mix in regenerating forests affect the future availability of wood products. For more information on regeneration issues on state forest lands, please refer to the Timber and Forest Products chapter.

**Deer Browse**

One of the most significant threats to forest health, particularly concerning regeneration, is over-browsing by overly abundant white-tailed deer populations. In severe cases, deer can completely limit the capacity for forest renewal, and in some areas of the state, deer have completely removed the forest understory. The bureau has long advocated balancing white-tailed deer populations with forest habitat conditions. Recent efforts to manage the state’s deer herd in this manner, as well as new tools for landowners such as the Deer Management Assistance Program, have yielded significant improvements in habitat conditions in some areas of the state. Other areas, however, continue to suffer from a lack of new forest growth, and habitat conditions and overall forest health remains poor.

**Fragmentation**

Forest fragmentation is the process by which an otherwise continuous forest is converted to non-forest or becomes separated into smaller, more isolated forest patches. Whether natural or man-made, the consequences of a fragmented forest are usually due to the reduction in forest area, the increased vulnerability of smaller forest patches to further disturbance, or the increasing separation between forested areas. When evaluating the ecological consequences of forest fragmentation, a species-specific approach is often necessary because of differing patterns of habitat preference, habitat selection, and resource requirements across species. While fragmentation could benefit species that select non-forested space, a loss of connectivity is generally detrimental for species dependent upon large tracts of contiguous forest and to the forest ecosystem as a whole. A fragmented forest is generally less resilient and is impacted more severely by damaging agents.

A bureau goal is to consider elements of connectivity and fragmentation in its forest management to foster overall resilience. Generally, the bureau encourages a mosaic of diverse forest habitats across landscapes, aims to retain large patches of intact forest, minimizes permanent land conversion to non-forest, and seeks to acquire key tracts of land in order to retain connectivity and limit fragmentation.
## Forest Health Management Principle
The long-term health of state forest lands is maintained and enhanced through management, monitoring, prevention, and suppression of forest damage causing agents.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To utilize integrated management techniques to study, survey, monitor, assess, and manage damage causing agents.</td>
<td>1.1 Develop and implement a plan for early detection and rapid response for non-native invasive species in Pennsylvania.</td>
</tr>
<tr>
<td></td>
<td>1.2 Identify and compile relevant data on forest damage causing agents and adopt new inventory and monitoring protocols as appropriate to fill gaps in existing information.</td>
</tr>
<tr>
<td></td>
<td>1.3 Develop and enforce preventative measures to reduce introduction of new forest damage causing agents.</td>
</tr>
<tr>
<td></td>
<td>1.4 Develop and implement integrated management plans and practices to address significant forest damage causing agents.</td>
</tr>
<tr>
<td></td>
<td>1.5 Prioritize restoration projects on areas impacted by forest damage causing agents.</td>
</tr>
<tr>
<td></td>
<td>1.6 Identify high risk areas subject to environmental stressors to prioritize adaptive management needs.</td>
</tr>
<tr>
<td>2. To address abiotic issues that impact forest health.</td>
<td>2.1 Develop and implement climate change adaptation strategies.</td>
</tr>
<tr>
<td></td>
<td>2.2 Develop and implement programs to address illegally deposited waste, including remediation, recycling, and education.</td>
</tr>
<tr>
<td></td>
<td>2.3 Assess acid mine drainage and other hazardous or environmental problems causing ecosystem degradation and develop strategies for remedial action.</td>
</tr>
<tr>
<td>3. To use Penn Nursery to collect and maintain seeds and genetic material for species that could be impacted by forest damage causing agents or used to improve forest resilience.</td>
<td>3.1 Incorporate the selection and integration of host resistance genotypes to significant diseases or insect pests through seed orchards and pedigree certification.</td>
</tr>
<tr>
<td></td>
<td>3.2 Consider species translocation opportunities in response to climate change.</td>
</tr>
</tbody>
</table>
Guidelines, Tools, and Resources

Division of Forest Health Strategic Plan 2014-2016
This strategic plan provides guidance to this division’s mission to protect forest resources from forest pests and other adverse factors to ensure the long-term health of the commonwealth’s forest ecosystems. Specific objectives are outlined in furtherance of the following strategic goals:

- Integrated Pest Management: Utilize ecologically sound integrated pest management techniques to study, survey, monitor, assess, and protect forest ecosystems.
- Information and Education: Provide employees, cooperators, forest land owners, and forest users with readily available, easily understood, and usable forest health information and training.
- Technology and Innovation: Use innovative and technological solutions to improve forest health programs.
- Organizational Performance: Operate a professional organization that efficiently and effectively meets the needs of employees, cooperators, forest land owners, and forest users.

Ash Management in State Forest Lands Under Pressure from the Emerald Ash Borer

Pennsylvania recognizes the benefits of trees to the long-term health of the state forest system. While ash is an integral species in Pennsylvania’s forests, the emerald ash borer (EAB) significantly threatens the health and survival of ash trees. To address the immediate and long-term impact of EAB on state forest lands in Pennsylvania, the bureau developed this comprehensive ash management plan to:

- Maintain ash as a component in the forest
- Protect rare and endangered ash species
- Mitigate potential negative impacts of EAB or loss of ash from the forest
- Conserve the economic value of dying ash trees through silviculture
- Manage ash seed orchards and collect seeds for genetic preservation
- Conduct training and public outreach on ash resources and the impacts of EAB
Cooperative Forest Insect Pest Suppression Program Operating Procedure and Deadlines Manual

This operating manual is used to ensure compliance with federal, state, and departmental regulations and implement a consistent forest pest suppression program statewide. It is aimed primarily at gypsy moth suppression, but the procedures can be used for a variety of forest insect pests. The manual details guidelines for proposal submission at the federal, state, and local levels and also provides specifications for approved insecticides, information on formulating spray blocks, and parameters for prespray, spraying, and postspray activities.

FSC Pesticides Policy: Guidance on Implementation

This document provides guidance on implementing the FSC Pesticides Policy through:

- Identification and avoidance of “highly hazardous” pesticides
- Promotion of “non-chemical” methods of pest management as an element of an integrated pest and vegetation management strategy
- Appropriate use of the pesticides that may be applied

DCNR Invasive Plants

Find the list of PA invasive plants and “watch list” plants here.

Invaders of the Commonwealth, Pennsylvania Invasive Species Management Plan

Developed in 2009 by the Pennsylvania Invasive Species Council, this plan provides the framework for guiding efforts to minimize the harmful impacts of non-native invasive plant and animal species in the State. The document outlines goals and actions identified by the Pennsylvania Invasive Species Council to provide guidance to protecting commonwealth resources.

Planting and Seeding Guidelines on State Forest Lands

Supplemental planting on state forest lands is a common practice for activities such as revegetating a disturbed area, erosion and sedimentation control, forage and cover habitat in wildlife openings, and restoration in gas development areas. A carefully selected seed mix can reduce the spread of invasive plants and enhance habitat elements. These guidelines detail best practices for planting, including species recommendations and considerations for different circumstances and purposes. Special caveats are given for noxious weeds and invasive species.

Invasive Plant Species Fact Sheets
http://www.dcnr.state.pa.us/forestry/plants/invasiveplants/index.htm

The bureau maintains species-specific fact sheets on invasive trees, shrubs, vines, grasses, herbs, and aquatic plants. Each sheet contains concise information on background, description and look-alikes, habitat and range, dispersion, potential threats, and methods for control.

Invasive Plant Tutorial
http://www.dcnr.state.pa.us/forestry/plants/invasiveplants/invasiveplanttutorial/index.htm

The bureau manages a series of web-based resources on invasive species that serve both as a tool for management and as a public reference. The contents include: invasive species definitions and impacts, prevention and detection, laws and regulations, management tools and planning, and restoration.
Pennsylvania Final Climate Change Action Plan

Published in 2009 by DEP, this document establishes the foundation for Pennsylvania’s first climate action plan with detailed recommendations that were vetted through a stakeholder process and that include detailed economic analyses of the recommendations for reducing greenhouse gases.

Invasive Plant Species Early Detection and Rapid Response (EDRR)

This protocol, currently in use by gas districts, provides a reporting procedure that allows for opportunistic sampling and timely treatment of invasive plants. The focus of the protocol is on species that are new or uncommon to a forest district or outside species that pose a threat of invasion to a district.

Landscape Prioritization and Treatment of Invasive Plants in Development Areas

This document describes the process for establishing priorities in landscape-level management of invasive plants and is currently mostly applicable to gas-related infrastructure. Factors to consider include:

- Threats to forest ecosystem
- Density and scale of infestation
- Novelty of species on the landscape
- Areas targeted for forest management
- Resources available for treatment

Guidelines for Administering Oil and Gas Activity on State Forest Lands

The objective of this document is to establish a set of guidelines and best management practices that provide appropriate direction for managing oil and gas activity on state forest land in accordance with the bureau’s mission. Section J (p. 44) and Appendix D (p. 89) provide information and guidelines on management for invasive plants on state forest lands developed for gas infrastructure.

Eastern Hemlock Conservation Plan

The purpose of this plan is to provide a sustainable conservation strategy for eastern hemlock, integrating all available information regarding the species and its associated threats into a comprehensive and science based approach.

Monitoring

- Insect and disease monitoring
  - District forest insect and disease reports
  - Aerial and remote surveys of damage
- Invasive plant species monitoring
  - Early detection and rapid response for invasive plants of high concern
  - Mapping extent of known invasive plant infestations
  - Monitoring timber sales for introduction of invasive plants
  - Monitoring use of non-native plants in seeding and planting
- Pesticide use tracking
Critical Research Needs

- Host resistance/tolerance for tree species threatened by non-native invasive species: eastern hemlock, ash species, butternut
- Aerial application of biopesticides for managing hemlock woolly adelgid and the emerald ash borer.
- Hemlock woolly adelgid predator release strategies to establish permanent predator populations that can be “farmed” and dispersed to other HWA infested hemlock stands
- Assist research efforts on invasive plant biocontrols
- Research invasive plant distribution patterns
- Research novel chemical and mechanical control techniques for invasive plants
- Research restoration efforts to prevent and control infestations of invasive plants
State forests provide unique opportunities for dispersed, low-density outdoor recreation that can be obtained only through large blocks of forest. Forest recreation is one of the most common ways that people connect with and enjoy the state forest. The state forest system provides bountiful opportunities for citizens to recreate and enjoy the forest. However, state forests cannot sustainably provide unlimited recreational opportunities. Recreational opportunities on state forest land are aimed at those forms of dispersed forest recreation that are not being provided by other land uses or ownerships and that are compatible with ecosystem management.

The Conservation and Natural Resource Act of 1995, P.L. 89, No.18 authorizes the establishment of and provides for the use and control of state forest lands. The act states, in part, that one of the purposes for which state forests are created is “... to furnish opportunities for healthful recreation to the public.”
Outdoor recreational pursuits are continually changing. Our social structure, affluence, mobility, leisure time, and a multitude of new recreation equipment influence these changes. As opposed to basic human needs for forest products, recreation deals more with attitudes and emotions. Recreation users may not understand their impacts on other resources or the limitations of some forest ecosystems to provide various levels of recreation opportunities. Recreationists feel a sense of ownership over their activity and the places they enjoy this activity, and thus may not agree with constraints on recreation in some places for the sake of sustainability. The bureau strives to be aware of attitudes toward recreation to provide a healthful outdoor recreation experience.

Visitor use monitoring (VUM) surveys are a systematic approach to answering questions about Pennsylvania state forest and state park visitors. In recent VUM surveys, most respondents indicated favorable ratings for access to state forests and for all of the recreational experience items rated. The majority of visitors spent some money within 50 miles of the state forest they were visiting, and average expenditures ranged from $80 to $200.

Increasing recreational use and the diversity of uses are having a growing impact on other resources and forest ecosystems. With the influx of more individuals and groups in pursuit of recreational activities, it becomes increasingly important for the bureau to develop strategies to provide a quality outdoor experience, minimize conflicts between user groups, and maintain ecological processes.

**History of Recreation on State Forests**

The first state forest reservations were created to preserve water supplies and protect the forests from uncontrolled wildfires and the devastating floods that followed them. Dr. Joseph T. Rothrock encouraged public recreational use of these reservations, particularly through hunting, fishing, and camping. Some of the reservations included parks with developed infrastructure for picnicking, swimming, hiking, and even bowling.

At the turn of the 20th century, thousands of Pennsylvanians were infected with tuberculosis. Anecdotal evidence suggested the infection was associated primarily with those living in urban areas. People who lived or worked outdoors were less susceptible to the malady. As a medical doctor, Rothrock embraced and encouraged the “fresh air cure.” In 1903, he established a tuberculosis camp within the 50,000-acre Mont Alto State Forestry Reservation to treat the afflicted with clean air that was “filtered through many miles of foliage” and water supply that was “pure and ample.” This is reflected today in the reference to healthful recreation in the bureau’s recreation policy.

Beginning in 1913, small plots of state forest were leased to the public as campsites. The program was well received and grew rapidly. Longer-term leases were offered, and people began to build cabins on the sites. The leases allowed public lands to be converted to private use for long periods of time. This program grew rapidly, but further leasing was halted in 1970 because of concerns about sustainability. The bureau currently administers approximately 4,000 legacy state forest camp leases.

The United States witnessed tremendous prosperity after the First World War. Families were reunited, the economy was thriving, and recreational leisure time was growing. The advent of automobiles and improved roads provided more opportunities for the public to access the state forest system. In 1927, the newly organized Department of Forests and Waters created a Bureau of Parks to administer high-use recreational areas, including state forest parks and public campgrounds. This event effectively differentiated the management of state parks, which focuses on high-density recreation, and the management of state forests, which focuses on natural resource management with a low-density recreation component. Because of their origin, state parks are often within or adjacent to state forests. These state parks often provide higher density and more developed recreation and serve as gateways to more dispersed and primitive recreation on state forest lands.
In 1933, during the midst of the Great Depression, President Franklin D. Roosevelt signed the Emergency Conservation Work Act and created the Civilian Conservation Corps (CCC). The CCC was responsible for much of the infrastructure that is found on state forest land today. Many CCC projects resulted in improved access and were designed specifically to satisfy recreational demands. Projects included the construction of roads, bridges, foot trails, horse trails, cabins, and recreational impoundments. This program was halted in 1942 in response to the U.S. involvement in World War II.

The period from World War II to the 1990s witnessed considerable changes in forest management. The focus shifted from fire and watersheds to multiple uses and finally to ecosystem management. During that time, forest management shifted to the primary resources they provide, including timber, wildlife, soils, water, and recreation. Recreation was recognized as a fundamental resource of state forest lands. Non-traditional recreational use, such as motorized recreation, gained significant popularity and interest. The forests were changing and evolving, and so too, was the public’s desire and interest in how they were managed.

Today, state forest lands provide a unique opportunity for dispersed, low-density, outdoor recreation, but the bureau must balance the desires of various recreation users. Outdoor recreational pursuits are constantly changing, as influenced by a number of social and economic factors. The bureau strives to understand recreational preferences and provide recreation that is compatible with ecosystem management while retaining the wild character of state forest lands.

**Recreation Opportunities**

State forest visitors should be assured of a high-quality outdoor experience. Some people seek the peace and solitude that the forest’s wild character provides. Others enjoy more active and developed recreational pursuits, such as attending a large group race or using a developed campground. There are those who prefer traditional forms of forest recreation such as sightseeing, hiking, hunting, fishing, horseback riding, and cross-country skiing and others who find state forests ideal places to ride ATVs, snowmobiles, mountain bikes, hang gliders, and dog sleds.

In recent VUM surveys, scenic driving and hiking were found to be the largest recreational uses of state forest lands. Other popular activities include viewing scenery and wildlife, fishing, hunting, camping, picnicking, biking, and water activities such as swimming or kayaking. Most respondents indicated favorable ratings for access to state forests by both roads and trails. When visitors were asked to choose their most important reason for visiting the state forest, “enjoy being in the forest” was a primary reason. A substantial group of visitors went there because it’s “a good place to spend time with friends/family.” In some districts, visitors were more likely to focus on their chosen activities such as hunting, ATV riding, and horseback riding.

As opportunities for recreation on state forest lands have grown, so have the opportunities for conflict between user groups. For example, a hiker who seeks solitude in the forest might be disturbed by the noise of a nearby ATV. Increasing recreational use has the potential to impact recreational resources and forest ecosystems. With the influx of more people pursuing their own preferred types of recreation, it becomes increasingly important for the bureau to implement management strategies to provide quality outdoor experiences that minimize conflicts while maintaining ecological processes and wild character. Localized closures are among the management tools the bureau may use. Visitors should check the district web page or contact the district for localized closures before planning a visit.

**Roads**

Scenic driving is one of the more popular uses of state forest lands. Most recreational users participate in this activity coming to and from the state forest, but for many this is the sole purpose of their visit. The forest’s beauty, solitude, tumbling mountain streams, scenic vistas, and
ever-changing colors attract great numbers of visitors. The bureau maintains many miles of roads and beautiful vistas open to drivers and produces public-use maps to help drivers find their way through the backwoods.

Viewsheds and vistas are an important consideration when managing scenic driving and all public recreation use. Vistas have been established to provide views into or through the forest to unusual or attractive features of the landscape. The bureau maintains current vistas while considering opportunities to create new vistas. Careful planning must go into the creation of barriers and parking areas to alleviate safety hazards and maintenance problems. The size of the vista, parking area, need for signage, and naming also are carefully considered.

Public-Use Roads
Most state forest roads are improved dirt roads surfaced with shale, gravel, or limestone. A few miles are paved. They all receive routine maintenance and generally are open for travel by licensed motor vehicles. A large amount of resources and effort go into maintaining the current system of public-use roads. These roads are open to the public for use “at your own risk.” Winter maintenance is not provided.

<table>
<thead>
<tr>
<th>District</th>
<th>Public-use roads</th>
<th>Drivable trails</th>
<th>Admin. roads</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michaux State Forest</td>
<td>124</td>
<td>3</td>
<td>350</td>
<td>477</td>
</tr>
<tr>
<td>Buchanan State Forest</td>
<td>77</td>
<td>16</td>
<td>125</td>
<td>219</td>
</tr>
<tr>
<td>Tuscarora State Forest</td>
<td>99</td>
<td>24</td>
<td>160</td>
<td>283</td>
</tr>
<tr>
<td>Forbes State Forest</td>
<td>44</td>
<td>0</td>
<td>85</td>
<td>129</td>
</tr>
<tr>
<td>Rothrock State Forest</td>
<td>180</td>
<td>12</td>
<td>76</td>
<td>267</td>
</tr>
<tr>
<td>Gallitzin State Forest</td>
<td>17</td>
<td>11</td>
<td>23</td>
<td>51</td>
</tr>
<tr>
<td>Bald Eagle State Forest</td>
<td>263</td>
<td>79</td>
<td>208</td>
<td>550</td>
</tr>
<tr>
<td>Kittanning State Forest</td>
<td>16</td>
<td>1</td>
<td>56</td>
<td>72</td>
</tr>
<tr>
<td>Moshannon State Forest</td>
<td>245</td>
<td>72</td>
<td>138</td>
<td>455</td>
</tr>
<tr>
<td>Sprout State Forest</td>
<td>340</td>
<td>106</td>
<td>491</td>
<td>937</td>
</tr>
<tr>
<td>Pinchot State Forest</td>
<td>15</td>
<td>1</td>
<td>14</td>
<td>30</td>
</tr>
<tr>
<td>Tiadaghton State Forest</td>
<td>167</td>
<td>18</td>
<td>166</td>
<td>350</td>
</tr>
<tr>
<td>Elk State Forest</td>
<td>125</td>
<td>9</td>
<td>418</td>
<td>551</td>
</tr>
<tr>
<td>Cornplanter State Forest</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Susquehannock State Forest</td>
<td>163</td>
<td>53</td>
<td>407</td>
<td>624</td>
</tr>
<tr>
<td>Tioga State Forest</td>
<td>156</td>
<td>22</td>
<td>292</td>
<td>470</td>
</tr>
<tr>
<td>William Penn State Forest</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Weiser State Forest</td>
<td>29</td>
<td>4</td>
<td>55</td>
<td>88</td>
</tr>
<tr>
<td>Delaware State Forest</td>
<td>38</td>
<td>0</td>
<td>87</td>
<td>125</td>
</tr>
<tr>
<td>Loyalsock State Forest</td>
<td>124</td>
<td>10</td>
<td>177</td>
<td>311</td>
</tr>
<tr>
<td><strong>Total Mileage</strong></td>
<td><strong>2,224</strong></td>
<td><strong>441</strong></td>
<td><strong>3,330</strong></td>
<td><strong>5,994</strong></td>
</tr>
</tbody>
</table>

Table 1. Miles of roads on state forest lands by type and district

Drivable Trails
Drivable trails are limited-maintenance roads that are open to licensed motor vehicles. These roads typically receive very limited use and are not recommended for low-clearance vehicles. Maintenance of these roads is often limited just to the minimum amount necessary to control erosion and sedimentation.

Administrative Roads
These roads are for administrative use and are not normally open to motor vehicles operated by the public. Timber-sale haul roads are included in this classification. These roads may be open seasonally for public travel, such as during hunting season, but they are normally gated for a variety of reasons including soil erosion protection, dumping control, safety concerns, and wildlife habitat protection. Gating and closing these roads helps maintain the primitive conditions that can be obtained only through large blocks of forest.
**Joint-use Roads**

Joint-use roads are regular state forest roads, either public-use or drivable trails, that are open to both regular vehicle traffic and snowmobiles. The bureau typically does not perform winter maintenance on joint-use roads (plowing, cinderling, etc.), but some joint-use roads may be closed or plowed to support other state forest operations, such as timber harvesting, access to private lands, or access to leased lands. Due to shale-gas development, many joint-use roads traditionally open for snowmobiling have been closed for the safety of snowmobile riders. However, the bureau countered the decrease in joint-use trails by increasing the mileage of designated snowmobile trails, resulting in an overall increase in areas for use by snowmobiles.

**All-terrain Vehicles (ATVs)**

State forest roads and joint-use roads are open only to licensed vehicles. The bureau does not allow ATV use on state forest roads, but does offer opportunities on designated ATV trail systems. Illegal use of state forest roads by ATV riders can cause safety concerns. A large percentage of fatalities involving ATVs reported in the state occur on roads open to licensed motor vehicles.

DCNR plays a multi-faceted role with ATVs: registering their use statewide; managing registration-generated fees for the maintenance, enhancement, and enforcement of existing recreational trail opportunities on state forest lands; and working with partners to provide new recreational ATV trails off of state forest lands. In 2001, in response to documentation of the environmental damage ATV use was doing to some state forest resources, the department issued a moratorium on further expansion of ATV trails on state forest lands. That moratorium was rescinded briefly in 2002 and reinstated in 2003, and remains in effect. Given the increasing interest in ATV use in the commonwealth, DCNR continues to reexamine practices to ensure that registered ATV owners receive reasonable benefits for their registration funds while ensuring that ATV use does not harm the other resources and recreational uses of the state forest.

As ATV use has grown in popularity, illegal riding on state forest lands has remained near the top of recreational forest management problems identified by staff. In addition, illegal use of the state forest not designated as part of the existing 267-mile ATV trail system continues to impact many of the core functions these forest lands were acquired to address — protection of clean water, clean air, wildlife habitat, scenic beauty, rare and significant ecosystems, and wild plants.
DCNR has taken many steps to address these issues, including hiring more rangers and conducting better outreach, education, and enforcement within the ATV community. The department also has focused its resources on enhancing existing ATV trails through restoration and development of key connector trails and creating new opportunities on other public lands and on lands newly acquired for ATV use, such as the facility at Rock Run Recreation Area in Cambria County and the Anthracite Outdoor Adventure Area in southern Northumberland County. DCNR provides grants from the Community Conservation Partnership Program, which is administered by the Bureau of Recreation & Conservation, to federal and local agencies and organizations for developing and enhancing riding opportunities off DCNR land. DCNR is in the process of engaging a consultant to help identify new riding opportunities.

It is the policy of the department not to expand the current system of designated ATV trails on state forest lands. This policy does allow for the limited development of connectors, as deemed appropriate by the department, to increase usage within the designated ATV trail networks, but the department does not consider state forest roads to be a safe option for connectors between trail systems. The department will continue to work with counties and other regional organizations to create new ATV recreational opportunities on other lands. The primary management focus on DCNR lands will continue to be to repair and maintain already designated ATV trails, as well as to curtail illegal riding activity through enforcement.

**Trails**

Many types of trails on state forest land are open to various users. The majority of trails are shared-use, which are open to hiking, biking, horseback riding, and cross-country skiing. There are designated snowmobile trails in addition to the joint-use roads, which are open to snowmobiles, providing thousands of miles of designated snowmobile

<table>
<thead>
<tr>
<th>District</th>
<th>Hiking</th>
<th>Biking</th>
<th>Horse</th>
<th>XSkiing</th>
<th>ATV</th>
<th>Snowmobile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michaux</td>
<td>259</td>
<td>212</td>
<td>211</td>
<td>211</td>
<td>41</td>
<td>82</td>
</tr>
<tr>
<td>Buchanan</td>
<td>257</td>
<td>215</td>
<td>215</td>
<td>215</td>
<td>32</td>
<td>34</td>
</tr>
<tr>
<td>Tuscarora</td>
<td>330</td>
<td>300</td>
<td>300</td>
<td>305</td>
<td>0</td>
<td>41</td>
</tr>
<tr>
<td>Forbes</td>
<td>190</td>
<td>153</td>
<td>153</td>
<td>190</td>
<td>0</td>
<td>39</td>
</tr>
<tr>
<td>Rothrock</td>
<td>269</td>
<td>169</td>
<td>169</td>
<td>170</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
<td>Gallitzin</td>
<td>83</td>
<td>48</td>
<td>48</td>
<td>83</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Bald Eagle</td>
<td>577</td>
<td>460</td>
<td>462</td>
<td>577</td>
<td>15</td>
<td>98</td>
</tr>
<tr>
<td>Clear Creek</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Moshannon</td>
<td>11</td>
<td>37</td>
<td>18</td>
<td>12</td>
<td>0</td>
<td>19</td>
</tr>
<tr>
<td>Sproul</td>
<td>670</td>
<td>95</td>
<td>95</td>
<td>110</td>
<td>85</td>
<td>42</td>
</tr>
<tr>
<td>Pinchot</td>
<td>47</td>
<td>24</td>
<td>24</td>
<td>47</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Tiadaghton</td>
<td>426</td>
<td>228</td>
<td>191</td>
<td>414</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td>Elk</td>
<td>264</td>
<td>51</td>
<td>48</td>
<td>49</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Cornplanter</td>
<td>11</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Susquehannock</td>
<td>319</td>
<td>228</td>
<td>225</td>
<td>227</td>
<td>45</td>
<td>94</td>
</tr>
<tr>
<td>Tioga</td>
<td>372</td>
<td>301</td>
<td>261</td>
<td>345</td>
<td>0</td>
<td>34</td>
</tr>
<tr>
<td>William Penn</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Weiser</td>
<td>85</td>
<td>82</td>
<td>37</td>
<td>77</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Delaware</td>
<td>260</td>
<td>181</td>
<td>181</td>
<td>200</td>
<td>30</td>
<td>116</td>
</tr>
<tr>
<td>Loyalsock</td>
<td>326</td>
<td>260</td>
<td>260</td>
<td>262</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total Mileage</strong></td>
<td><strong>4,763</strong></td>
<td><strong>3,050</strong></td>
<td><strong>2,899</strong></td>
<td><strong>3,502</strong></td>
<td><strong>267</strong></td>
<td><strong>732</strong></td>
</tr>
</tbody>
</table>

Table 3. Miles of trails on state forest lands by type and district
trails for exploration. Other trail opportunities include rail trails, interpretive trails, and American Disabilities Act (ADA) accessible trails.

**Hiking**

Hiking trails on state forest land are classified as national trails, state forest hiking trails, local district trails (shared-use), and local district trails (specific-use). National scenic and national recreation trails are designated by the National Park Service and often cross state boundaries. Portions of the Appalachian Trail, a national scenic trail, and two national recreation trails, the North Country Trail and Laurel Highlands Trail, are located partly on state forest lands.

State forest hiking trails are of regional importance and often travel through more than one state forest. These trails usually are maintained by volunteer hiking groups with assistance from the districts. Most of these trails formerly were part of the district trail network, with many sections designated for hiking use only. Local district trails are by far the largest category of hiking trails and are of great local importance for accessing state forest lands. These trails often are open to a wide variety of user groups, not just hikers, and are classified as shared-use trails. However, local district trails may be classified for hiking only as specific-use trails. The bureau maintains these trails with considerable help from volunteers on some segments.

<table>
<thead>
<tr>
<th>District</th>
<th>National</th>
<th>State forest</th>
<th>Local district (shared-use)</th>
<th>Local district (specific-use)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michaux State Forest</td>
<td>36</td>
<td>4</td>
<td>205</td>
<td>5</td>
<td>250</td>
</tr>
<tr>
<td>Buchanan State Forest</td>
<td>0</td>
<td>29</td>
<td>213</td>
<td>14</td>
<td>257</td>
</tr>
<tr>
<td>Tuscarora State Forest</td>
<td>0</td>
<td>26</td>
<td>299</td>
<td>5</td>
<td>330</td>
</tr>
<tr>
<td>Forbes State Forest</td>
<td>15</td>
<td>0</td>
<td>176</td>
<td>0</td>
<td>191</td>
</tr>
<tr>
<td>Rothrock State Forest</td>
<td>0</td>
<td>40</td>
<td>169</td>
<td>59</td>
<td>269</td>
</tr>
<tr>
<td>Gallitzin State Forest</td>
<td>0</td>
<td>27</td>
<td>49</td>
<td>0</td>
<td>76</td>
</tr>
<tr>
<td>Bald Eagle State Forest</td>
<td>0</td>
<td>47</td>
<td>464</td>
<td>76</td>
<td>588</td>
</tr>
<tr>
<td>Clear Creek State Forest</td>
<td>135</td>
<td>0</td>
<td>43</td>
<td>9</td>
<td>187</td>
</tr>
<tr>
<td>Moshannon State Forest</td>
<td>0</td>
<td>60</td>
<td>244</td>
<td>24</td>
<td>328</td>
</tr>
<tr>
<td>Sproul State Forest</td>
<td>0</td>
<td>127</td>
<td>525</td>
<td>17</td>
<td>669</td>
</tr>
<tr>
<td>Pinchot State Forest</td>
<td>0</td>
<td>21</td>
<td>25</td>
<td>3</td>
<td>49</td>
</tr>
<tr>
<td>Tiadaghton State Forest</td>
<td>0</td>
<td>112</td>
<td>391</td>
<td>57</td>
<td>560</td>
</tr>
<tr>
<td>Elk State Forest</td>
<td>0</td>
<td>47</td>
<td>52</td>
<td>169</td>
<td>268</td>
</tr>
<tr>
<td>Cornplanter State Forest</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>Susquehannock State Forest</td>
<td>0</td>
<td>90</td>
<td>185</td>
<td>61</td>
<td>335</td>
</tr>
<tr>
<td>Tioga State Forest</td>
<td>0</td>
<td>59</td>
<td>310</td>
<td>12</td>
<td>381</td>
</tr>
<tr>
<td>William Penn State Forest</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Weiser State Forest</td>
<td>2</td>
<td>0</td>
<td>101</td>
<td>1</td>
<td>104</td>
</tr>
<tr>
<td>Delaware State Forest</td>
<td>0</td>
<td>24</td>
<td>188</td>
<td>49</td>
<td>261</td>
</tr>
<tr>
<td>Loyalsock State Forest</td>
<td>0</td>
<td>79</td>
<td>271</td>
<td>16</td>
<td>366</td>
</tr>
<tr>
<td><strong>Total Mileage</strong></td>
<td><strong>188</strong></td>
<td><strong>792</strong></td>
<td><strong>3,921</strong></td>
<td><strong>577</strong></td>
<td><strong>5,484</strong></td>
</tr>
</tbody>
</table>

Table 4. Miles of hiking trails on state forest lands by type and district
Shared-use trails in Table 4 are open to hiking, biking, horseback riding, and cross-country skiing. However, trails may be promoted for a particular use. Users from other categories may use such trails, but they were planned and designed for a particular recreation use, often through coordination with local user groups.

**Commercial and Special Activities**

Commercial and special activities are becoming increasingly popular on state forest lands for organized events or services. To administer these activities, the bureau uses a commercial activities agreement (CAA) or special activities agreement (SAA), which can span up to four years and cover multiple events. A CAA permits the bureau to consent to and regulate activities that are conducted by organizations on state forest lands, such as organized hikes, equestrian rides, canoe excursions, rock climbing, orienteering, snowmobile rides, fishing tournaments, guide services, and ecotourism. An SAA allows the bureau to permit and control activities on state forest lands that are organized, potentially dangerous, large, or otherwise atypical of common forest visitor activities. These may include races, contests, games of ability, and other competitive events. For activities that do not require a CAA or SAA, the forest district may require a letter of authorization (LOA).

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of CAAs</th>
<th>Number of SAAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>24</td>
<td>32</td>
</tr>
<tr>
<td>2009</td>
<td>19</td>
<td>36</td>
</tr>
<tr>
<td>2010</td>
<td>22</td>
<td>38</td>
</tr>
<tr>
<td>2011</td>
<td>27</td>
<td>37</td>
</tr>
<tr>
<td>2012</td>
<td>26</td>
<td>50</td>
</tr>
<tr>
<td>2013</td>
<td>36</td>
<td>34</td>
</tr>
<tr>
<td>2014</td>
<td>35</td>
<td>38</td>
</tr>
</tbody>
</table>

Table 5. Commercial Activities Agreements and Special Activities Agreements issued on state forest lands by year.

**Camping**

The bureau manages camping in three distinct categories: primitive backpack camping, motorized camping, and group camping. Camping on state forest lands is subject to *State Forest Rules and Regulations*.

Primitive backpack campers are those who camp at undeveloped sites and for not more than one night. These camping opportunities normally are located along trails, but virtually all state forest acreage, with the exception of natural areas, is open to such use. Permits are not required for this type of camping unless the camper plans to spend more than one night at a campsite.

Motorized camping is done by the roadside and in close association with a motorized vehicle. The vehicle continues to be used for storage or transportation during the camping experience. This is unlike backpack camping, where the camper carries all the gear for a day or more away from the vehicle. Motorized camping requires a permit from the local district office, and most districts have designated motorized campsites furnished with picnic tables and fire rings.

Group camping is defined as camping with 10 or more people and typically is restricted to areas where there will be little or no environmental impact. This type of activity requires a special activities agreement or letter of authorization from the forest district office serving that area.

**Picnicking**

Picnicking is permitted almost anywhere on state forest land. In addition, the bureau maintains 27 accessible picnic areas with pavilions, tables, parking areas, and restrooms.

**Access for Persons with Disabilities**

The bureau provides opportunities for people with disabilities to access and use state forest lands. Visitors with mobility disabilities may request permission to use a
powered mobility device on state forest property for their intended recreation activity. The bureau currently has 320 active permits for visitors with disabilities, and this number is expected to grow. Without obtaining a permit, persons with disabilities may access one of the designated areas for powered mobility devices on state forest lands.

**Hunting, Trapping, and Fishing**

State forest lands are open to hunting and trapping, two of the most popular state forest activities. From spring turkey season to small game and white-tailed deer, state forests have something to offer every hunting enthusiast. Hunting is also an important component of ecosystem management to help balance animal populations on state forest lands, particularly white-tailed deer. To enhance the hunting experience on state forest lands, the bureau created a hunting interactive map for hunters to find hotspots for their preferred game species. In addition, the bureau participates in the Deer Assistance Management Program, which allocates additional antlerless tags in areas impacted by high deer densities. The bureau also opens some gated roads during deer rifle season to increase hunters’ access to various parts of the state forest system.

The abundance of streams, ponds, and lakes on state forest lands supplies opportunities for cold-water and warm-water fishing. Fishing may include the cold headwater streams in mountain regions where native brook trout may be found or the ponds and lakes in the Pocono region. The DEP classifies almost 2,700 miles of waterways as high quality (HQ) and more than 1,500 miles as exceptional value (EV). In addition, the PFBC classifies more than 300 miles as wilderness trout streams. The Pennsylvania Fish and Boat Commission created interactive maps, which include information on access, fishing opportunities, habitat improvement areas, special regulation areas, directories and other materials.

**Other Recreational Uses**

Although scenic driving, trail use, camping, hunting, trapping, fishing, and picnicking were highlighted in this chapter, there are many other ways visitors may choose to recreate on state forest lands, such as canoeing or kayaking, bird watching, wildlife viewing, rock climbing, geocaching, and hang gliding. The bureau promotes the responsible use of state forest lands for healthful recreational opportunities that allow for the safety of visitors and maintain sustainability of forest resources.

**Recreation Experiences**

State forest lands offer not only a variety of recreation uses, but also a diverse set of experiences that sometimes conflict. Some people seek the peace and solitude that forests provide in order to promote mental and physical fitness. Others enjoy more physical activities to achieve the same outcome. Regardless of the recreation preference, the character of the forest or environment, as well as interactions with others, can influence one’s recreation experiences.

In recent visitor use monitoring reports, most respondents indicated favorable ratings for all of the recreation experience items they rated including: opportunity to recreate without feeling crowded, places to recreate without conflict from other users, compatibility of recreation activities in the area, helpfulness/courteousness of forest employees, and helpfulness/courteousness of people in surrounding communities. The vast majority of respondents agreed that the state forest they visited “means a lot to them,” and most also reported that they enjoy recreating in the state forest more than in other places and get more satisfaction out of visiting the state forest than visiting other places. Visitors’ most important motivations for visiting the state forest were to be outdoors and to experience natural settings. The bureau has duplicated a portion of the VUM survey on postage-paid index comment cards. The cards are placed in high-use recreation areas to collect ongoing visitor use data in the short term to inform district managers on visitor satisfaction. Average ratings for each value have been favorable.
**Wild Character**

The bureau accomplishes part of its mission to conserve forests in Pennsylvania by managing the wild character of the state forest. Wild character is a concept that has different meanings to different people. To a backcountry camper, wild character could mean having large expanses of open, undisturbed forest to experience along a narrow hiking trail. To those seeking scenic drives, it could mean experiencing a relatively intact canopy over forest roads through the state forests. To others, it could simply mean that the forest is characterized by little permanent human development. The bureau recognizes wild character as a value state forest lands provide to visitors and strives to retain wild character while managing the forest. Some components of wild character the bureau considers are scenic views, undeveloped “backcountry” character, aesthetic buffers, and noise impacts. The bureau also carefully considers signage and building colors to minimize impact to the primitive character of state forests.

**Recreation Opportunity Spectrum**

Since the perception of wild character varies from person to person, direct measurement is difficult or impossible. The bureau uses the recreation opportunity spectrum (ROS), an inventory system developed by the U.S. Forest Service, to characterize land by types of recreation experiences. The bureau utilizes ROS to make and communicate management decisions that are transparent, credible, and compatible with other state forest management goals.

ROS builds on the premise that people expect certain types of recreational experiences on public land and that land managers should be able to direct people to appropriate places for those experiences. ROS allows land managers to provide recreational opportunities across a spectrum, or continuum, of five land-use classes so that the user may find satisfying recreational experiences in a variety of recreational activities.
The ROS land-use classes follow a continuum from “primitive” to “developed,” and managers can use changes in the acreages associated with each class as a measure of wild character.

Land managers can use ROS as a long-term planning tool to guide management activities to provide a balance of experiences. State forests generally are managed to maintain the conditions that define each ROS land-use class or increase the primitive acreage, but not to increase developed acreage. Temporary activities may affect the condition of the forest but do not change the ROS land-use class, such as temporary roads used in timber harvesting. Permanent impacts can change ROS classes, such as new roads or buildings.

ROS uses proximity to roads as well as size criteria to determine the base layer for each ROS class. Further refinements to each ROS class can occur by analyzing slope, trail density, proximity to lease camps, pipeline density, utility right-of-way density, and other considerations. Due to long-term recreation and road uses, primitive categories may not exist on some state forest districts. However, other districts may contain large expanses of unfragmented forest.

<table>
<thead>
<tr>
<th>District</th>
<th>Primitive</th>
<th>Semi-primitive non-motorized</th>
<th>Semi-primitive</th>
<th>Semi-developed &amp; developed</th>
<th>Total Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michaux</td>
<td>0</td>
<td>4,493</td>
<td>27,112</td>
<td>53,897</td>
<td>85,502</td>
</tr>
<tr>
<td>Buchanan</td>
<td>0</td>
<td>8,532</td>
<td>17,212</td>
<td>43,959</td>
<td>69,703</td>
</tr>
<tr>
<td>Tuscarora</td>
<td>0</td>
<td>27,200</td>
<td>25,420</td>
<td>43,030</td>
<td>95,650</td>
</tr>
<tr>
<td>Forbes</td>
<td>0</td>
<td>8,753</td>
<td>19,462</td>
<td>30,083</td>
<td>58,298</td>
</tr>
<tr>
<td>Rothrock</td>
<td>0</td>
<td>7,815</td>
<td>30,843</td>
<td>57,254</td>
<td>95,911</td>
</tr>
<tr>
<td>Gallitzin</td>
<td>0</td>
<td>4,559</td>
<td>7,291</td>
<td>12,413</td>
<td>24,262</td>
</tr>
<tr>
<td>Bald Eagle</td>
<td>0</td>
<td>22,202</td>
<td>57,182</td>
<td>114,006</td>
<td>193,390</td>
</tr>
<tr>
<td>Clear Creek</td>
<td>0</td>
<td>1,190</td>
<td>2,784</td>
<td>11,990</td>
<td>15,965</td>
</tr>
<tr>
<td>Moshannon</td>
<td>528</td>
<td>26,961</td>
<td>47,834</td>
<td>114,710</td>
<td>190,033</td>
</tr>
<tr>
<td>Sproul</td>
<td>117</td>
<td>23,115</td>
<td>77,697</td>
<td>204,511</td>
<td>305,440</td>
</tr>
<tr>
<td>Pinchot</td>
<td>706</td>
<td>5,111</td>
<td>7,302</td>
<td>16,464</td>
<td>29,583</td>
</tr>
<tr>
<td>Tiadaghton</td>
<td>3,994</td>
<td>31,333</td>
<td>40,473</td>
<td>70,772</td>
<td>146,572</td>
</tr>
<tr>
<td>Elk</td>
<td>8,225</td>
<td>54,631</td>
<td>54,167</td>
<td>82,922</td>
<td>199,945</td>
</tr>
<tr>
<td>Cornplanter</td>
<td>0</td>
<td>0</td>
<td>358</td>
<td>1,131</td>
<td>1,489</td>
</tr>
<tr>
<td>Susquehannock</td>
<td>25,253</td>
<td>67,398</td>
<td>63,191</td>
<td>104,272</td>
<td>260,114</td>
</tr>
<tr>
<td>Tioga</td>
<td>3,376</td>
<td>35,775</td>
<td>45,903</td>
<td>76,837</td>
<td>161,891</td>
</tr>
<tr>
<td>William Penn</td>
<td>0</td>
<td>0</td>
<td>434</td>
<td>373</td>
<td>807</td>
</tr>
<tr>
<td>Weiser</td>
<td>127</td>
<td>8,406</td>
<td>8,127</td>
<td>11,396</td>
<td>28,056</td>
</tr>
<tr>
<td>Delaware</td>
<td>3,033</td>
<td>18,141</td>
<td>24,262</td>
<td>37,356</td>
<td>82,792</td>
</tr>
<tr>
<td>Loyalsock</td>
<td>0</td>
<td>29,729</td>
<td>36,646</td>
<td>48,175</td>
<td>114,550</td>
</tr>
<tr>
<td>Total</td>
<td>45,359</td>
<td>385,345</td>
<td>593,699</td>
<td>1,135,552</td>
<td>2,159,953</td>
</tr>
</tbody>
</table>

Table 6. Acres of Recreation Opportunity Spectrum classes by district. Note: ROS Acreage totals per district may not match overall acreage totals because not all lands have yet been classified in ROS.
and offer recreation users ample primitive experiences. The primitive classification itself does not define wild character, but does tend to provide experiences that are more of a backcountry nature. Many of the bureau's large wild areas are classified as primitive or semi-primitive non-motorized because they do not contain a high density of road and trail networks. Visitors also can find wild character in areas classified as semi-primitive and semi-developed, depending on the user's perception. In managing state forest lands, the bureau uses ROS to balance experiences across the spectrum and across the districts.

Recreation experiences may be impacted by user conflict, and not all uses of state forest lands are compatible with one another. Conflicts may arise when the balance of opportunities and experiences are not considered. There may be conflict between users; for example, recreation visitors seeking a semi-developed or developed use such as motorized recreation could conflict with visitors seeking a primitive experience. Bureau management practices such as road maintenance, timber sales, or natural gas development may also conflict with recreation use. Special activities such as large group activities or statewide events may conflict with local user groups or users. The bureau, however, seeks to balance various recreational uses and values with other management activities across the whole system.

The social setting and user density are important considerations in ROS. While the social setting should be evaluated in ROS zoning, some considerations are difficult to measure. Trail density and the capacity of developed sites are straightforward user density measures. Frequency of user interaction, evidence of other visitors, and the number of parties encountered per day are more difficult measures to obtain.

**Recreation Carrying Capacity**

Forest recreation carrying capacity can be derived by considering the specific activity mixes occurring on a given area of state forest, number of sites per developed facility, and number of participants involved. This requires applying human influence criteria and social setting criteria standards for each activity by ROS class. Carrying capacity is a management concept, not a scientific theory. Ultimately, managers must decide the uses that are appropriate and acceptable and the kinds and amounts of impacts that are tolerable.

Physical (resource) carrying capacity is the maximum amount of use that can take place without incurring unacceptable ecological change, i.e., soil compaction, erosion, water pollution, littering, and destruction of vegetation. Social carrying capacity is the maximum amount of use that can occur without unacceptable conflict and interface among visitors. For Bureau of Forestry purposes, capacity is defined as "the type and level of visitor use that can be accommodated while sustaining acceptable resource and social conditions that complement
the purpose of the land base.” It is intended to safeguard the quality of the natural, aesthetic, and cultural resources and of the visitor experience.

**Large Group Activities**

Forest managers have noted that large group activities are becoming more popular and frequently requested on state forest lands. These activities serve an important purpose, as they may be the user’s first or only exposure to state forests or outdoor recreation. However, these activities can exceed the limits of what is considered low density or dispersed recreation, as well as physical and social carrying capacities. Large group activities may conflict with other forest users seeking the primitive experience for which state forests are managed. The bureau must continuously evaluate and manage the effects of recurring large group activities and carefully consider the addition of new large group activities on state forest land.

To address recreation conflict, the bureau collaborates with various recreation groups, volunteers, and stakeholders to ensure that values and comments of users are considered in management decisions. This collaboration is conducted at a statewide level through the DCNR Recreation Advisory Committee and communication with legislative representatives, as well as at the district level through local meetings and field visits. Although recreation users want to enjoy state forest lands through their preferred activity, the sustainability of all recreation uses and impacts to other forest resources must be considered and communicated.

**Public Safety**

The bureau promotes safe experiences through administration of the Ranger Program and state forest officers. The role of state forest rangers is to provide visitor services, educational programs, and information and to enforce forestry rules and regulations and commonwealth laws. Rangers have full state police powers and address violations occurring on DCNR lands. The bureau employs 37 rangers across the state forest system. In addition, state forest officers have authority to enforce state forest rules and regulations but only have jurisdiction on state forest lands. The bureau has 288 personnel with state forest officer duties.

DCNR is the primary coordinator for search-and-rescue efforts on state forest and state park lands within the commonwealth. The [DCNR search-and-rescue website](#) provides search-and-rescue information and promotes outdoor safety to help ensure that visitors have safe and enjoyable experiences.
## Recreation Management Principle

Wild character and recreation opportunities and experiences on state forest lands are managed to provide dispersed, low-density recreation activities that are compatible with ecosystem management.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To provide and maintain healthful, low-density recreational opportunities and experiences across the landscape.</td>
<td>1.1 Develop and implement a strategic approach to evaluate and manage recreation.</td>
</tr>
<tr>
<td></td>
<td>1.2 Identify appropriate recreational levels to ensure conservation of ecological resources and minimize user conflict.</td>
</tr>
<tr>
<td></td>
<td>1.3 Direct high-density recreation activities and large groups to appropriate areas.</td>
</tr>
<tr>
<td></td>
<td>1.4 Inventory and assess recreation infrastructure to determine sustainability and maintenance needs.</td>
</tr>
<tr>
<td></td>
<td>1.5 Consider recreational opportunities and experiences during management activities.</td>
</tr>
<tr>
<td></td>
<td>1.6 Continue to monitor visitor use through visitor use monitoring, comment cards, surveys, and other means.</td>
</tr>
<tr>
<td></td>
<td>1.7 Utilize state parks to provide high-density and developed recreation opportunities, and as gateways to primitive low-density dispersed recreation on state forest lands.</td>
</tr>
<tr>
<td></td>
<td>1.8 Maintain the state forests as the largest land base for hunting opportunity in the commonwealth.</td>
</tr>
<tr>
<td>2. To develop and promote effective partnerships in managing recreational opportunities and experiences.</td>
<td>2.1 Collaborate with stakeholders and other state agencies to promote sustainable use of recreational resources.</td>
</tr>
<tr>
<td></td>
<td>2.2 Engage conservation volunteers, recreation groups, and local partners in planning, construction, and maintenance of recreation resources.</td>
</tr>
<tr>
<td></td>
<td>2.3 Consider recreation opportunities that improve experiences by creating connections to adjacent lands.</td>
</tr>
<tr>
<td>3. To provide information and assistance to the public while promoting safety.</td>
<td>3.1 Provide easily accessible information to visitors.</td>
</tr>
<tr>
<td></td>
<td>3.2 Create and maintain facilities that meet visitor use and management needs.</td>
</tr>
<tr>
<td></td>
<td>3.3 Provide public assistance and law enforcement through the Ranger Program and state forest officers.</td>
</tr>
<tr>
<td></td>
<td>3.4 Perform search-and-rescue operations and incident management to promote the safety of state forest visitors.</td>
</tr>
</tbody>
</table>
Guidelines, Tools, and Resources

Pennsylvania’s Statewide Comprehensive Outdoor Recreation Plan (SCORP)
http://www.paoutdoorrecplan.com

Pennsylvania’s outdoor recreation plan helps to guide strategy for local governments, state government and other outdoor recreation providers. Priorities, recommendations and action items delineate a course of action for five years and help to determine where best to make investments in recreation.

Bureau of Forestry Recreation Website
http://www.dcnr.state.pa.us/forestry/recreation/index.htm

This website includes an inventory of the most common recreational activities, including scenic driving, hunting, camping, hiking, and nature watching, and the sites, resources, and facilities available on state forest lands.

Trail Policies on State Forests Lands

This document describes different kinds of trail use within the state forest system. Motorized and non-motorized uses are included.

Guidelines for Marking Recreational Trails

These guidelines provide the parameters for marking bureau recreational trails in a consistent manner.

Procedures for Proposing Changes to Trails on State Forest Land
This document details the process for making changes to trail use, including allowed use, additions, permanent closures, and relocations.
Camping Policy for State Forest Lands
This camping policy is the operating procedure that the bureau uses to manage increasing recreational camper numbers and the resulting impacts on state forest ecosystems. The policy aims to provide consistency across the bureau in how camping is managed on state forest lands.

Primitive Camping Guidelines and Ethics
This pamphlet describes the rules for backcountry camping on state forest lands as well as provides guidance and recommendations. This document is presently undergoing revision.

Motorized Camping Guidelines and Ethics
Rules, guidance, and recommendations for motorized camping are provided here. This document is presently undergoing revision.

Hunting in Pennsylvania State Forests
http://maps.dcnr.pa.gov/bof/huntmap/index.html
To enhance the hunting experience on state forest lands, the bureau created an interactive map for hunters to find hotspots for their preferred game species.

Pennsylvania Fish and Boat Commission
http://fishandboat.com/gis.htm
The Pennsylvania Fish and Boat Commission created interactive maps that include information on access, fishing opportunities, habitat improvement areas, special regulation areas, directories, and other materials.

Access to DCNR Land for Persons with Disabilities
http://www.dcnr.state.pa.us/forestry/recreation/adaaccess/index.htm
The Department of Conservation and Natural Resources permits persons with mobility disabilities to use powered mobility devices for purposes of accessing DCNR lands. This website provides links to request permission or to obtain additional information on DCNR's policy and the permitting process.

Bureau of Forestry Sign Manual
This manual is designed to provide uniformity standards for public signage. The goals for the sign system are to: 1) conform to a uniform sign system, 2) reflect creativity and interest, 3) be appropriate for the area, and 4) inform and direct the visitor.

Forestry Gate and Barrier Specifications
This tool provides technical drawings and specifications for the different types of gates used by the bureau on state forest lands.

Forestry Gate and Barrier Painting Guidance
These guidelines provide a standard for uniform appearance of bureau gates and bollards.

Geocaching Guidelines
Geocaching rules and guidelines, including allowable placement locations, establishment of a contact person, and timeline restrictions, can be found here. The guidelines also apply to state parks.

Target Shooting Implementation Guidelines
This document summarizes the law regarding target shooting as per section 21.65 of State Forest Rules and Regulations. Additional guidelines are provided.

Recreational Opportunity Spectrum Manual of Procedure
The recreation opportunity spectrum (ROS) allows the bureau to provide recreational opportunities across a continuum of five land-use classes through a systematic and consistent inventory and assessment process as part of long-range planning.
Rock Climbing, Rappelling, and Bouldering Management Policy and Guidelines


This document states the DCNR rock climbing policy as well as articulates safety considerations, general rock climbing guidelines, ethics, and dispute resolution considerations. A lengthy list of climbing definitions is also provided.

DCNR Conservation Volunteer Program

https://www.volunteers.dcnr.state.pa.us/index.aspx

This web resource contains information on what volunteering for DCNR entails as well as what types of projects are available and a link to the volunteer application.

PA Code Title 17: Conservation and Natural Resources

http://www.pacode.com/secure/data/017/017toc.html

This contains state forest rules and regulations, found in Subpart C, as well as other conservation and snowmobile/ATV laws.

Guidelines for Snowmobile Trail Signing and Placement

This document provides guidelines for the effective placement of signs on recreational snowmobile trails.

Search and Rescue

http://www.dcnr.state.pa.us/forestry/recreation/searchandrescue/index.htm

DCNR is the primary coordinator for search-and-rescue efforts on state forest and state park lands within the commonwealth. This website provides search-and-rescue information and promotes outdoor safety to help ensure that visitors have safe and enjoyable experiences.

Organized and Commercial Activities


State forests often are used for organized events and commercial activities. The bureau manages these special requests through one of these agreement methods: 1) letter of authorization, 2) special activities agreement, or 3) commercial activities agreement.
Monitoring

- User satisfaction
  - Visitor use monitoring
  - Comment cards
- Forest Information Management System
- Ranger patrols
- Recreation infrastructure field inspections (district reports)

Critical Research Needs

- Recreational infrastructure assessment using LIDAR and other best technologies
- Integration of a science-based approach to developing statewide recreational best management practices
- Carrying capacity for recreational resources
- Best practices for large organized events
- Development of collaborative recreational planning and volunteerism model
- Ongoing visitor use monitoring, including consideration for districts not already covered and re-assessing previously surveyed districts
- Continuing work with the Center for Dirt and Gravel Roads on improving water runoff and minimizing dust from gravel roads
- Assessment of best management practices for storm-water runoff on dirt and gravel roads as dispersed sheet flow and natural forest infiltration compared to structural post-construction storm-water management methods
- Evaluation of implementation of ROS and determination of effectiveness
Infrastructure refers to buildings, equipment, roads, and other capital assets, tools, and resources used to meet an organization’s goals and objectives. Infrastructure also includes the systems, processes, procedures, and information flow of an organization. Successful accomplishment of the bureau’s mission cannot happen without proper inventory, planning, and administration. The bureau uses infrastructure to perform management activities and to provide for state forest use by others, including private industry and the general public. This requires accurate inventories, acquisitions, management, evaluation, and retirement of infrastructure, as well as adequate funding to make all of these tasks possible.
Increasing demand from public and private sectors for the use of forest resources is an important consideration in state forest management. Examples of such demands include increased recreational use, requested access to timber and mineral resources, and use of right-of-way corridors and water. State forest infrastructure must be systematically structured and designed to provide social, cultural, and economic forest benefits to present and future users within the constraints of sound ecosystem management. Through short- and long-range planning, effective information flow, careful administration of fiscal and staff resources, and public advocacy, the bureau will continue to balance competing infrastructure obligations to achieve its mission.

**Infrastructure Management**

Challenges in managing and administering bureau infrastructure include coordination of funding and the need to keep infrastructure current and properly maintained. Infrastructure such as buildings, maintenance sheds, vehicles and equipment, utilities, dams, bridges, roads, and trails are administered by various divisions and sections throughout the bureau as well as by the forest districts.

The bureau has centralized support for planning, administering, and maintaining its infrastructure needs and coordinates efforts between private entities and other state and federal organizations. The bureau administers right-of-way agreements on state forest lands including roads and trails, communication facilities, water use, and electric and natural gas transmission lines, leases (including land leases, campsite leases, state building leases, antenna site leases), and dams and bridges. State-owned buildings, vehicles, and heavy equipment are also part of the bureau’s infrastructure to support management activities. Administration of this infrastructure often requires coordination with local governments or other state agencies, such as the PFBC and Pennsylvania Department of Transportation.

Technology also is considered a valuable infrastructure resource to assist with state forest management. This could include computer hardware and software, as well as databases or websites that store or organize information. The bureau uses a custom, centralized geographic information management system (GIS) called the Forest Information Management System (FIMS) to manage spatial and tabular data, monitor forest conditions, produce maps, and conduct spatial analyses of the forest. This system acts as important infrastructure for storing spatial data that is relevant to implementing ecosystem management. In addition, the bureau created a separate system for managing data relating to gas development, known as the Oil & Gas Information Tracking System (OGIT). Other databases have been created to house data for a variety of resources and are used by the bureau on a regular basis to track and monitor information. The bureau maintains and continuously upgrades computers and other technology devices for use by bureau staff in performance of their job functions.

The bureau evaluates infrastructure needs and makes decisions on creating, retiring, or maintaining infrastructure based on the added benefits to state forest staff and users, benefits to society, and potential impacts to forest resources. Needed infrastructure is carefully planned and managed considering current needs and future maintenance or retirement. Similarly, keeping accurate inventories of existing and future infrastructure is imperative toward proper management and funding.

The cost of managing and maintaining infrastructure comes from many different funding sources including the Oil and Gas Lease Fund, Keystone Fund, Act 26 Fund, Dirt and Gravel Road Fund, Growing Greener, Liquid Fuels Fund, and the General Government Fund. Prioritizing and assigning funding for new projects, infrastructure maintenance, and retirement must be carefully planned and executed. Internal operating money often covers smaller, local projects. Larger scale or higher cost infrastructure spending normally comes from restricted funds that are
set aside for bureau use for certain purposes. Some funding pools are restricted to transportation infrastructure, while others are restricted to public use or ecological improvement purposes. For funding infrastructure projects, the bureau evaluates its needs, the needs of the public, and proposals from private industry; it must carefully weigh these sometimes conflicting needs within the context of proper ecosystem management.

**Infrastructure on State Forest Land**

The bureau maintains inventories of infrastructure on state forest land or owned by the bureau and secures and directs funding for bureau-owned infrastructure.

Existing infrastructure on state forest land includes:

- 31 dams
- 5,994 miles of roads (2,224 miles public use, 441 miles drivable trails, 3,330 miles administrative roads)
- 521 bridges
- 4,017 leased campsites
- 684 buildings
- 20 municipal water supply agreements
- 2 wastewater treatment facilities
- 27 picnic areas
- 18 state forest hiking trails (798 miles total)
- 1 shooting range (Michaux State Forest)
- 1 golf course (Michaux State Forest)
- Right-of-way administration
  - Electric line corridors and facilities
  - Water/sewage line corridors and facilities
  - Communication lines and tower facilities
  - Gas pipeline corridors and related facilities
  - Office and maintenance buildings
- Towers
  - 321 tower agreements:
    - 90 PSP radio projects office towers
    - 36 agreements with other government agencies
    - 195 commercial licenses
  - Approximately 50 fire towers

Infrastructure to support operations includes:

- Vehicle and equipment fleet
- Computers and other information technology devices
- Data sharing systems (FIMS, OGIT, etc.)

Increased road use has led to a higher cost for road maintenance. Most state forest roads are public-use roads, which are improved dirt roads surfaced with shale, gravel, or limestone. Forty-nine miles are paved asphalt, which over time will mostly be converted back to a manageable dirt and gravel road surface. All state forest roads receive routine maintenance and are generally open for travel by licensed motor vehicles. A large amount of resources and effort goes into maintaining the current system of public-use roads.

The bureau is strategically improving heavily used roads to handle current traffic needs and be more cost effective for future maintenance. At the same time, the bureau is decreasing the total mileage of public-use roads to reduce overall maintenance costs and to return the state forest road system to a more primitive state overall.

Drivable trails are limited maintenance roads that are open to licensed motor vehicles. These roads typically receive very limited use and are not recommended for low clearance vehicles. Maintenance of these roads is often limited to the minimum amount necessary to control erosion and sedimentation.

Administrative roads are for organizational use and are not normally open to motor vehicles operated by the public. Timber sale haul roads are included in this classification. These roads may be open seasonally for public travel, such as during hunting season, but they are normally gated for a variety of reasons including soil erosion protection, dumping control, safety concerns, and wildlife habitat protection. Gating and closing these roads helps maintain the primitive conditions that can only be obtained through large blocks of forest. More information on roads and trails for recreational purposes can be found in the Recreation chapter.
Where there are roads, many times there are bridges, which also are inventoried, inspected, and maintained by the bureau. Bridges must be kept to safe traveling standards, and some have been or need to be improved to meet current standards and to accommodate current and increasing traffic from public and industrial access and the hauling of forest products.

Office buildings, maintenance headquarters, and other buildings used by bureau staff require maintenance, improvements, replacement, or retirement and demolition. Office buildings also require frequent modernization to keep up with changing technology in order to help staff function efficiently and effectively. Likewise, structures built for public use — such as parking lots, latrines, trails, and pavilions — should be evaluated for public safety concerns, user needs, and whether continued maintenance is warranted by volume of use.

New state forest district offices are being rebuilt as Resource Management Centers, which serve as headquarters for district staff as well as public common areas that include conference spaces for use by outside parties. Resource Management Centers are open to the public and often include a forestry-related theme to educate visitors about the natural resources and recreation opportunities on the state forest district.

Increased demands for energy resources on state forest land and/or transportation of resources across state forest land have led to an increase in utility infrastructure on state forest land as well as an increase in road use. With the increased demand leading to a trending increase of infrastructure, the bureau has reacted by requesting more underground utility infrastructure and more aesthetically pleasing above-ground infrastructure, as well as co-location of utilities and facilities where possible.

Wind energy is considered a safe, clean, and renewable energy resource, but also has limitations because it can disrupt recreational opportunities, impact wildlife, and fragment habitat. Current legislation does not authorize wind development on Pennsylvania’s state forests. Similarly, authorization does not exist for solar energy development on state forests.

### Table 1. Miles of road on state forest land by category

<table>
<thead>
<tr>
<th>Road category</th>
<th>Length in miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public use roads</td>
<td>2,224</td>
</tr>
<tr>
<td>Drivable trails</td>
<td>441</td>
</tr>
<tr>
<td>Administrative roads</td>
<td>3,330</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5,994</strong></td>
</tr>
</tbody>
</table>
## Infrastructure Management Principle
Infrastructure on state forest lands is managed with consideration of societal needs, institutional constraints, and ecosystem management principles.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. To implement a strategic approach to address infrastructure needs.</strong></td>
<td>1.1 Actively secure funding resources and support partnerships that provide funding opportunities for infrastructure development and improvements.</td>
</tr>
<tr>
<td></td>
<td>1.2 Assess infrastructure needs and requests to ensure new infrastructure, improvements, or removal from the system are consistent with the management and sustainability of other resources.</td>
</tr>
<tr>
<td></td>
<td>1.3 Develop and implement plans for long-term management and maintenance of new and existing infrastructure with consideration of associated costs.</td>
</tr>
<tr>
<td></td>
<td>1.4 Maintain an accurate inventory of current infrastructure.</td>
</tr>
<tr>
<td><strong>2. To consistently administer non-state or private infrastructure while considering social, ecological, and economic values.</strong></td>
<td>2.1 Review private infrastructure requests in a consistent and timely manner and determine the overall potential benefit to society and suitability of other resources.</td>
</tr>
<tr>
<td></td>
<td>2.2 Evaluate potential impacts of new or existing private infrastructure on forest resources and develop mitigation strategies.</td>
</tr>
<tr>
<td></td>
<td>2.3 Build and strengthen relationships with stakeholders requesting infrastructure construction or maintenance.</td>
</tr>
<tr>
<td><strong>3. To manage state-owned infrastructure in support of resource management and public use.</strong></td>
<td>3.1 Develop, use, and update tools that provide accurate information to effectively manage infrastructure and other forest resources.</td>
</tr>
<tr>
<td></td>
<td>3.2 Evaluate infrastructure, technological resource, and equipment needs that facilitate forest management activities.</td>
</tr>
<tr>
<td></td>
<td>3.3 Assess and improve state-owned infrastructure supporting public use to ensure the overall safety, health, and satisfaction of state forest users.</td>
</tr>
</tbody>
</table>
Guidelines, Tools, and Resources

State Forest Road Manual
The bureau maintains roads for administration and management of the state forest system. The mission of this manual is to present and explain methods that have proven to reduce the erosion, sediment, and dust that pollute streams, as well as to allow safe access to motorists visiting or working on our state forests.

Bureau of Facility and Design
http://www.dcnr.state.pa.us/facdes/
This DCNR bureau provides multi-disciplined engineering and technical support to the other bureaus in DCNR, including the Bureau of Forestry, in the areas of project design, project inspections, construction management, contract administration, surveying, and other technical advice and consultation.

Guidelines for Leased Forest Campsites
These conditions set forth procedures for leasing state forest land. They are intended to guide both the person interested in leasing and the current lessee and guests. The general rules explain the terms of the lease and are intended to be fair, realistic, and consistent with the proper management of state forest land.

State Forest Leased Campsites Operations Manual
The contents of this manual describe operational procedures and policies for all phases of leasing and constructing camps on state forest lands.

Bridge and Dam Information
Provides information on bridge and dam maintenance, inspection, and reporting.

Forest Information Management System (FIMS)
This is the centralized database containing computerized forestry information accessed through the mapping software ArcGIS.

Guidelines for Right-of-Way Development on Pennsylvania State Forest and State Park Lands
DCNR considers requests to site right(s)-of-way (ROW) on the lands it manages when a clear and definitive need has been established. This document is intended to provide guidance and general information to applicants for such ROW.

Road Use Agreement
DCNR considers requests to use roads in a manner beyond normal visitation on the lands it manages when a clear and definitive need has been established. This is the formal road use agreement.

Monitoring
- Large projects review process
- FIMS
- Infrastructure field inspections (district reports)

Critical Research Needs
- Continue work with the Center for Dirt and Gravel Roads on improving water runoff and minimizing dust from gravel roads.
- Assess best management practices for storm-water runoff on dirt and gravel roads as dispersed sheet flow and natural forest infiltration compared to structural post-construction storm-water management methods.
- Develop methods for determining long-term optimum design for infrastructure.
- Develop methods to determine ecosystem impact of siting infrastructure.
The incorporation of social factors as a concept of ecosystem management and forest sustainability is an acknowledgement that people and their environments are related and interconnected. Part of any human society is the people's culture — the function of their beliefs, folkways, manners, creativity, knowledge, and philosophies as a whole. Culture is expressed in various physical forms including: art, dress, writings, architecture, and manufactured products, as well as in abstract forms including: recreation, music, storytelling, language, religion, etiquette, and lifestyles. Culture cannot be directly recorded at once onto any medium for preservation; however, evidence of past culture can be indirectly stored in the physical things it produced. These physical manifestations are called artifacts, and they often hold value for societies of the present. Artifacts are a type of cultural resource. For the sake of this document, a cultural resource is a site, structure, object, natural feature, or social account that is or was of significance to a group of people traditionally associated with it.
The bureau is committed to protecting Pennsylvania’s cultural resources as well as its wild ones. Much of Pennsylvania’s cultural history is tied to its historically forested landscape and geographic and geologic features, with hunting, fishing, berry and mushroom picking, and rattlesnake collecting being traditional pastimes for many citizens, and with timber, mining, metallurgy, and agriculture having been lead industries at various times in the state’s past, at least since European settlement. Prior to this time of settlement, the region had been the setting for Native American culture and activity for millennia.

The bureau follows cultural and historical preservation guidelines at the federal level in accordance with the National Register of Historic Places. At the state level, Article I, section 27 of the PA Constitution gives people the legal right to the “…preservation of…historic and esthetic values of the environment.”

The Landscape Exam Manual (2007) lists the following cultural features as specifically noteworthy: old building foundations, homesteads, graveyards, spring water collection sites, logging camps, logging railroad grades, Civilian Conservation Corps (CCC) camps, charcoal hearths, mill sites, quarries and mines, and recognized archaeological sites. Moreover, chapter XIX of the Silviculture Manual sets forth some guidelines relating to archaeological sites and culturally significant places and makes specific mention to suggested procedures upon the discovery of previously unknown cultural or historic locations. Broadly, data relating to cultural localities within state forest districts are collected by the individual districts themselves and are compiled into a centralized database operated by the bureau’s Geospatial Applications section.

Furthermore, the bureau cooperates with the Pennsylvania Historical and Museum Commission (PHMC), the official history agency of the commonwealth. PHMC is responsible for the collection, conservation, and interpretation of Pennsylvania’s historic heritage. The bureau cooperates with the commission’s Bureau of Historic Preservation (BHP), whose roles are to identify and protect the architectural and archaeological resources of Pennsylvania, to approve information or educational signs and plaques, and to maintain data about historical resources, including a spatial database. BHP historic data is classified into different sections with varying degrees of sensitivity, but hits from the Archaeological Sites section are the most sensitive and require clearance from the BHP.

On State Forest Land, oil and gas development, timber sales, and all activities that require an SFER are reviewed for damage to or destruction of archaeological and historic sites.

If a site contains cultural material at a high enough level of importance, the bureau can designate the area as a special management area, such as a High Conservation Value Forest (HCVF). In accordance with Principle 9 of the Forest Stewardship Certification (FSC) U.S. Forest Management Standards, one of the criteria for an HCVF is that it may contain “…areas critical to local communities’ traditional cultural identity (areas of cultural, ecological, economic, or religious significance identified in cooperation with such local communities).” Such areas receive the classification HCV 6. Presently, the bureau has designated 268 acres of HCV 6 regions. Locality data pertaining to the archaeological nature of these areas are sensitive.

Information regarding unlisted and new historic resources can be submitted to the BHP for review and possible inclusion in the National Register.

The bureau maintains a database for cultural resource locations and coordinates with external agencies when information is needed. Additionally, forest districts often have institutional knowledge of the types and locations of cultural and historic resources on their lands, and they can maintain their own sets of cultural resource data.
More than 5,000 culturally or historically significant sites are located on state forest land, with charcoal hearths representing the vast majority (Table 1). Additionally, the bureau works to catalogue artifacts relevant to its own history. A system is being developed to collect and organize bureau-specific memorabilia, such as field equipment or uniforms used in the bureau’s history and also archaeological findings relevant at a local level. The bureau is also working to develop a Flickr account where it can display historical photographs and to record firsthand personal accounts and stories related to state forest land and forestry of the past. Furthermore, the bureau shares indirect involvement in the Pennsylvania Forest Fire Museum at Caledonia State Park, which preserves and showcases the heritage of forest fire protection as it relates to forestry through the showing of significant artifacts and interactive exhibits. The museum exists to celebrate Pennsylvania’s pioneers in forest stewardship.

Locality data for cultural resources and maps containing them are maintained by the bureau and PMHC; however, actual management for the resources themselves lies almost solely with PHMC. At present, there is opportunity for the development of a cultural resources management policy as well as interpretive and maintenance programs at the bureau level.

While historic sites from recent centuries may be somewhat numerous, archaeological findings of ancient structures within state forest lands are relatively scarce. This absence of information could be due in part to the impracticality of surveying the rugged forested interiors of some “wild” areas with scant infrastructure. Additionally, the absence of ground-disturbing land developments over much of the land could result in opportunistic findings being few and far between. The lack of archaeological information from the state forest areas leaves opportunities to update PHMC or interact with local historical societies whenever future findings are discovered. Opportunities also exist to broadly disseminate knowledge about the cultural resource conservation process at the district level where the projects occur. A wider understanding of cultural resource management practices could result in a more sound understanding by all personnel involved in project undertakings.

<table>
<thead>
<tr>
<th>Site Category</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archaeological Site</td>
<td>6</td>
</tr>
<tr>
<td>CCC Camp</td>
<td>157</td>
</tr>
<tr>
<td>Cemetery</td>
<td>27</td>
</tr>
<tr>
<td>Charcoal Hearth</td>
<td>4457</td>
</tr>
<tr>
<td>Furnace</td>
<td>3</td>
</tr>
<tr>
<td>Grave Site</td>
<td>12</td>
</tr>
<tr>
<td>Homestead</td>
<td>75</td>
</tr>
<tr>
<td>Logging Camp</td>
<td>14</td>
</tr>
<tr>
<td>Logging RR Grade</td>
<td>37</td>
</tr>
<tr>
<td>Mill Site</td>
<td>27</td>
</tr>
<tr>
<td>Mine</td>
<td>15</td>
</tr>
<tr>
<td>Monument</td>
<td>20</td>
</tr>
<tr>
<td>Old Building Foundation</td>
<td>77</td>
</tr>
<tr>
<td>Quarry</td>
<td>38</td>
</tr>
<tr>
<td>Spring Water Collection Site</td>
<td>81</td>
</tr>
<tr>
<td>Tunnel</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 1. Numbers of various cultural or historic sites by category on state forest land.
### Cultural and Historic Resources Management Principle

The BOF incorporates identification and protection of cultural and historic resources as a part of ecosystem management.

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. To cooperate and communicate with PHMC and other agencies involved in cultural resource management for the protection of cultural and historic resources on state forest lands</td>
<td>1.1 Adhere to guidelines developed with PHMC for protection of known cultural resources when developing management plans and implementing bureau activities</td>
</tr>
<tr>
<td></td>
<td>1.2 Inform PHMC and local historical agencies of newly found, culturally significant resources when discovered</td>
</tr>
<tr>
<td></td>
<td>1.3 Communicate with PHMC when changes to cultural resources are proposed or have occurred</td>
</tr>
<tr>
<td>2. To develop strategy for inventorying, documenting, and protecting cultural resources</td>
<td>2.1 Identify significant cultural resources not listed for protection by PHMC</td>
</tr>
<tr>
<td></td>
<td>2.2 Develop management strategy for cultural resources on state forest land</td>
</tr>
<tr>
<td></td>
<td>2.3 Incorporate cultural resources management into district-level planning</td>
</tr>
<tr>
<td></td>
<td>2.4 Collaborate with History Committee, EMAC, local or county historical associations, and others to foster a vision for cultural resource conservation on state forest land</td>
</tr>
<tr>
<td>3. To increase awareness of cultural resources and the policies and practices pertaining to them for bureau personnel and the public</td>
<td>3.1 Clearly define and present policies and protocols for cultural resource management to bureau personnel</td>
</tr>
<tr>
<td></td>
<td>3.2 Continually update bureau data holdings through PHMC</td>
</tr>
<tr>
<td></td>
<td>3.3 Provide interpretive opportunities pertaining to cultural resources for the public</td>
</tr>
</tbody>
</table>

### Guidelines, Tools, and Resources

- **Landscape Exam Manual**
  Procedures at the landscape level articulate the cultural features to be considered during the landscape exam process.

- **Silviculture Manual**
  Chapter XIX of this manual details the approach to cultural and historic resource protection in the context of timber management.

- **Monitoring**
  Process for identifying and tracking archaeological and historic sites.
Mission

The Bureau of Forestry’s mission is to ensure the long-term health, viability, and productivity of the commonwealth’s forests and to conserve native wild plants. The bureau will accomplish this mission by:

• Managing state forests under sound ecosystem management to retain their wild character and maintain biological diversity while providing pure water, opportunities for low-density recreation, habitats for forest plants and animals, sustained yields of quality timber, and environmentally sound utilization of mineral resources.

• Protecting forestlands, public and private, from damage and/or destruction by fires, insects, diseases, and other agents.

• Promoting forestry and the knowledge of forestry by advising and assisting other government agencies, communities, landowners, forest industry, and the general public in the wise stewardship and utilization of forest resources.

• Protecting and managing native wild flora resources by determining status of, classifying, and conserving native wild plants.