



2016 State Forest Resource Management Plan





Letter from the State Forester



The state forest system of Pennsylvania, approximately 2.2 million acres, 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, timber products, water purification, 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 2016 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. Upon the foundation of *Penn's Woods* and previous SFRMPs, the bureau has developed an array of principles, goals, and objectives which will move the forest into the future. The 2016 SFRMP is the first update of the plan in nine years. One accomplishment of this SFRMP is to memorialize the various planning and management activities that the bureau has undertaken over the past nine 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, managing and monitoring Marcellus and other shale-gas development, and developing management plans for the influences of hemlock woolly adelgid and emerald ash borer. The 2016 SFRMP also provides points of emphasis for future management, such as climate change,

prescribed fire, lakes, river islands, cultural resources, and communication via social media and interpretive opportunities. We attempted to make this 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. As part of the early planning process, prior to developing a draft of the SFRMP, the bureau conducted an online survey to gauge public opinion on state forest management, to which we had over 3,250 respondents. After the draft SFRMP was released last fall, the bureau held a four-month public comment period and twelve public meetings to provide an opportunity for the citizens of Pennsylvania to have a say in how their land is managed. We received comments from nearly 4,800 people and organizations during the public comment period. This critical input from the public is reflected in the final SFRMP. Notable changes to the SFRMP that were influenced by public comment include the introduction of Core Forest and Wild Character Focus Areas, to better conserve these values on state forest land, and the development of a new position statement on oil and gas development on state forest and state park lands, which states that further leasing of state forest and state park lands will not be considered at this time.

The 2016 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 focus on local resources and values, and the development process for district-level plans will include additional avenues for public input.

The 2016 SFRMP is the culmination of months of hard work, and it sets the course for sustainable management of state forest land for years to come.



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Executive Summary



Introduction

The state forest system of Pennsylvania, approximately 2.2 million acres of forest land, 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. Our state forest system supports a multitude of resources, uses, and values. It provides water and air purification, recreational opportunities, aesthetic beauty, plant and animal habitat, and economic benefits through the provision of wood products to society and the environmentally sound utilization of mineral resources.

The mission of the Bureau of Forestry (herein, "the bureau") is to ensure the long term health, viability, and productivity of the commonwealth's forests and to conserve native, wild plants. Since 1955, the bureau has been developing State Forest Resource Management Plans (SFRMPs) that guide our management in furtherance of the mission and communicate our management principles and goals to the public.

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.

By following a periodic revision cycle, the plan continues to evolve, accounting 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.

The SFRMP is comprised of extensive introductory material, 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 and Historic 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 the bureau's vision for the future of the state forests.

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.

A Landscape Approach to Forest Ecosystem Management

The bureau takes a “landscape approach” to ensure ecological health, the sustainability of the full suite of forest values, and the integration and the coordination of management activities across the state forest system. Landscape management is both a philosophy and a practice. The bureau manages large tracts of forest land and considers how management activities affect land in the larger context across multiple temporal and spatial scales. Likewise, the evaluation of the spatial distribution of resources and management activities is essential for effective landscape management.

Landscapes can be considered mosaics of interacting communities or ecosystems. Landscape patterns change in time and space, reflecting impacts of human activity upon the system, as well as natural changes. Understanding the changes that occur and properly managing for them are challenging efforts that require partnerships between resource agencies and the public. Ecosystem management implemented at a landscape level and across ownerships best ensures that the sustainability of forest systems can be maintained while providing benefits to society.

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 will 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 will serve as a tool to facilitate cooperative management with adjoining forest districts, landowners, and agencies.

Biodiversity Conservation

Biodiversity Goal: To conserve or enhance eco-regional biological diversity through the management of state forest lands.

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.

Core Forests, Fragmentation, and Connectivity

Fragmentation and Connectivity Goal:

To consider forest fragmentation, connectivity, and patch distribution in management decisions affecting state forest resources.

One important consideration when overseeing the state forest system is maintaining core forest conditions and 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. These disturbances can be natural (e.g. forest fire, windfall, or flooding) or man-made (e.g., road construction, pipeline right-of-way clearing, wellpad construction). 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).

New in this management plan is the implementation of Core Forest Focus Areas. Core Forest Focus Areas represent the most extensive and exceptional core forests and unfragmented parcels in the state forest system. Core Forest Focus Areas are identified using the Bureau of Forestry's core forest analysis tool. The purpose of Core Forest Focus Areas is to assist in the inventory, management, maintenance, and monitoring of the most significant core forest tracts in the state forest system and to conserve the ecological values associated with interior forest conditions and unfragmented landscapes.

Climate Change

Climate Change Goals:

- To manage for the current and future impacts of climate change to the state forest system.
- To maintain and enhance the carbon storage and sequestration capacity of the state forest system.

Impacts to Forests

Climate change will likely have many impacts on Pennsylvania's forests. First, the state will become increasingly unsuitable for certain trees species, especially those associated with northern hardwood ecosystems. The warming climate will cause susceptible species to become increasingly stressed, leading to greater susceptibility to pests, pathogens, and environmental fluctuations. 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 bureau will monitor the effects of climate change on state forest land and develop strategies to help the forest adapt to these changes.

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. Sustainable forest management contributes to carbon sequestration and storage and provides society a valuable service in mitigating the impacts of climate change.

Priority Management Strategies

While specific guidelines for forest management in response to climate change still need to be 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.

Wild Character

Wild Character Goal: To maintain and promote the components of wild character and related visitor experiences across the landscape during management decisions.

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. The bureau recognizes wild character as a value

state forest lands provide to visitors and strives to retain wild character while managing the forest.

New in this management plan is the implementation of Wild Character Focus Areas. Wild Character Focus Areas represent exceptional areas in the state forest where visitors can expect primitive-type recreational experiences in an undeveloped setting where maintaining wild character and non-motorized recreational opportunities are a priority. Wild Character Focus Areas will be identified using the Recreational Opportunity Spectrum Analysis tool’s Primitive and Semi-Primitive/Non-Motorized designations. The purpose of Wild Character Focus Areas is to assist in the inventory, management, maintenance, and monitoring of primitive recreational opportunities and maintaining landscape conditions typically associated with undeveloped landscapes and the value of wild character.

Adjoining Lands

Adjoining Lands Goal: To implement strategies to address interactions between state forests and adjacent lands.

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 (LMU) requires consideration of the surrounding lands. Management of the state forest affects the surrounding landscape, and in turn the state forest is affected by the management of the adjacent land. 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 will 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.



Acquisitions

Acquisitions Goal: To implement a strategic state forest acquisition process to add valuable ecological and recreational resources to the state forest system.

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

Old Growth Goals:

- To protect existing old-growth systems on state forest lands.
- To promote future old-growth systems on state forest land by maintaining at least 20 percent of state forest land as potential or existing old growth.

DCNR has long recognized the value and need for protecting old-growth communities. 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 approximately 556,000 acres as proposed old growth, where succession to mature forest may be allowed to occur.

Land Classification Systems

Land Classification Systems Goals:

- To use landscape-level units built on ecological parameters to inventory, analyze, and plan management activities.
- To identify, designate, and manage special management areas to conserve unique ecological, geological, cultural, or social values.

Appropriately characterizing forest and landscape features facilitates accurate resource inventories, effective analyses, long-term monitoring, and informing and guiding management decisions. To this end, the bureau has a structured, multi-layered land delineation system 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 analyses from a multiple-resource perspective.

To organize its land delineation system, the bureau stratifies its designations into five subcategories: planning and operational boundaries, state forest management zoning, classification and typing, supra management areas, special consideration areas, and reference and analysis layers. 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.

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, such as the Continuous Forest Inventory, Landscape Exams, Early Detection – Rapid Response, and Shale-Gas Monitoring.

Project Planning and Review

The bureau has implemented several practices to ensure that specific projects and management activities conform with its ecosystem management approach, such as State Forest Environmental Reviews, the PA Natural Diversity Inventory tool, and specific planning processes for timber sales and prescribed fires.

Communications

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.

Communications Goals:

- To provide education and interpretive opportunities regarding the values, services, and benefits of sustainable forest management.
- To provide customer service and information that promote the use and enjoyment of the state forest system.
- To engage the public and consider input in state forest management decisions

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.

The bureau communicates through a variety of avenues and actions:

- Newsletters and publications,
- Websites and social media,
- Service Forester program,
- Project Learning Tree,
- Envirothon,
- Smokey Bear program,
- Forest demonstration sites, and
- Advisory committees.

Timber and Forest Products

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.

Timber and Forest Products Goals:

- To promote and maintain desired landscape conditions through planning and implementing appropriate, sustainable timber harvest levels.
- To promote natural regeneration of forest communities through sustainable silvicultural practices.
- To provide economic and social benefits through a sustained yield of forest products.
- To meet landscape goals by expanding silvicultural practices into areas previously considered economically or operationally unfeasible.
- To conserve and manage non-timber forest products (NTFPs) and consider the sustainability of these resources in allowing public consumption.

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.

Timber Management

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. Timber sales generate significant revenue for the commonwealth. From 2008 to 2014, Pennsylvania received income from timber sales averaging approximately \$22.5 million per year.

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. 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.

The bureau formed a partnership with Pennsylvania State University to develop a timber harvest allocation model. 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 parameters, inventories, constraints, and modelling approach help the bureau create feasible timber harvest schedules that achieve silvicultural goals.

One factor that the model accounts for is that the current age class distribution of the forest is unsustainable in the long term. 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. 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. Most of the goals set forth in the harvest allocation model will be achieved through the practice of even-aged management. 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, improve biodiversity, and promote forest health.

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.

NTFP Management

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 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.

Native Wild Plants

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.

Native Wild Plants Goals:

- To conserve and enhance habitats for a diversity of plant species and communities.
- To identify, protect and manage rare, threatened, or endangered plant species or other imperiled floral resources and habitats critical to their survival.
- To promote the use of native wild plants in management activities.

Pennsylvania is home to a wide variety of important plant species, which are essential to healthy, functioning ecosystems. 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.

Through legislated 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. Legislation 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. Projects throughout the state that require certain regulatory permits are required to screen for potential impacts to state-classified species and resources through the Conservation Explorer tool.

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, including the 136 classified Pennsylvania plant communities, both palustrine and terrestrial. 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. 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. Because species and communities are adapted to natural disturbance regimes, state forest management activities such as timber harvesting may enhance plant diversity while also meeting other resource objectives. This enhanced plant diversity may in turn increase insect diversity and the diversity of available food for a variety of wildlife species.

Wildlife

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.

Wildlife Goals:

- To conserve and enhance a diversity of wildlife habitat types across the landscape.
- To identify, protect, and manage habitats critical to the survival of threatened and endangered wildlife species.
- To conserve and manage wildlife populations and their habitats that provide specific benefits or impacts to the public and forest ecosystems.

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. 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. Although wildlife management falls under the jurisdiction of the PA Game Commission and the PA Fish & Boat Commission, 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.

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.

The bureau uses this information to develop strategies to protect, maintain, or enhance wildlife habitat features during management activities.

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. 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, certain silvicultural practices may enhance benefits to wildlife during timber harvests. For example, reserve trees are retained in overstory removal treatments, including mast trees for forage and cavity trees and snags for nesting, roosting, or denning; 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.

The bureau has developed species-specific management plans for some species, such the White-tailed Deer Plan, Brook Trout Conservation Plan, and the Habitat Conservation Plan for bats.

Water Resources

Water Resources Management Principle

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

Water Resources Goals:

- To conserve water resources for sustainable utilization for public benefit.
- To conserve and enhance riparian, wetland, and aquatic ecosystems and their ecological function.
- To manage lakes for their ecological and recreational values.
- To manage river islands throughout the state for their ecological and recreational values.
- To remediate impaired water resources due to point- and non-point source pollution.

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.

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.

The bureau recognizes that with projected increases in water use and environmental pressures, such as gas development, 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 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.

Soils

Soils Management Principle

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

Soil Goals:

- To manage state forest lands in a manner that soil quality and ecosystem integrity is maintained or improved.
- To use information on soil properties, quality, and limitations when determining appropriate management activities for desired vegetation communities.
- To address existing soil quality problems on state forest lands.

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 most effectively when they are comprised of diverse soil organism communities, containing a mixture of organic and mineral material, and maintaining suitable soil structure and density. *Penn’s Woods* states that soils should be maintained at the highest possible quality. 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. Soil characteristics, such as texture, wetness, and fertility affect vegetation that grows in the soil.

For these reasons, it is important to understand the soil type when managing forests and other plant communities. Forest management activities, such as timber harvesting, gas development, and road/trail construction, have the potential to negatively or positively impact soils. The bureau monitors such activities to evaluate their effects on forest soils, uses best management practices to limit impacts, and conducts mitigation measures when impacts are observed. 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.

Geologic Resources

Geologic Resources Management Principle

Subsurface geologic resources and unique geologic features on state forest lands are managed to provide long-term benefit to the citizens of the commonwealth while adhering to the principles of ecosystem management.

Geologic Resources Goals:

- To allow no new leasing for oil and gas development on state forest land subject to future advice and recommendations by DCNR.
- To provide technical guidance and oversight when geologic resources are developed on state forest lands.
- To pursue opportunities for the bureau to cooperatively manage geologic resource development where the commonwealth is not the fee-simple land owner.
- To mitigate adverse impacts resulting from historical development of geologic resources when funding or other mechanisms are available.
- To conserve state forest resources, uses, and values in conjunction with coal and hard minerals development.
- To identify and conserve unusual or exemplary geologic features and assist in the advancement of geologic knowledge in Pennsylvania.

Pennsylvania is divided into six physiographic provinces, each of which has a particular type of landscape and geology. The physiography and geology of the land has an effect on the soils, slopes and aspects, and vegetation communities found across the landscape.

Unique geologic features are managed by the Bureau of Topographic and Geologic Survey, and are a part of the Natural Heritage Program. The bureau works to conserve these features during land management.

The economic use and sound extraction and utilization of geologic resources is part of the bureau's mission in managing state forest 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 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 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 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.

In addition to oil and gas, the management of coal and hard minerals is also an integral program to 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.

Pennsylvania's state forests have been leased for valuable oil and gas reserves since 1947. The bureau held its first lease sale targeting the Marcellus Shale in 2008 and an additional two leases in 2010. 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. 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 issued that states: "As of the date of this Executive Order, to protect 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."

In support of the Executive Order, DCNR has developed a position statement that outlines how DCNR addresses natural gas development on state forest and state park lands. The position statement reflects ongoing work by DCNR and incorporates public input received during the SFRMP revision process. The position statement expresses that DCNR will not permit additional oil and natural gas leases on state forest and park lands where DCNR controls the subsurface rights.

Wildland Fire

Wildland Fire Management Principle

Wildland fire on state forest lands is prevented and suppressed to control threats to natural resources, infrastructure, and human life, but prescribed burning is also used as an ecological and silvicultural tool as a component of ecosystem management.

Wildland Fire Goals:

- To conduct wildfire suppression activities in a safe and effective manner that minimizes damage to forest ecosystems.
- To consider forest conditions impacted by wildland fire.
- To implement a safe and effective prescribed fire program as a management tool.

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 need to use fire as a tool in the landscape.

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." DCNR is legally mandated to provide for the reasonable protection of all wild lands in the commonwealth from damage by wildfire.

This mandate is accomplished through a combination of wildfire prevention, suppression, investigation, and preparedness.

Prescribed fire activities are governed by the Pennsylvania Prescribed Burning Practices Act. 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. Prescribed fire is an emergent tool that has potential for use in a variety of plant communities to promote desirable species compositions and structure. 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 timber 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.

Forest Health

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.

Forest Health Goals:

- To utilize integrated management techniques to study, survey, monitor, assess, and manage biotic damage causing agents.
- To address abiotic damage causing agents.
- 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.

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. 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 undesirable vegetative cover. Non-native 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.

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. The Bureau of Forestry monitors and manages insect and disease threats on state forest lands and throughout the commonwealth.

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). Exotic invasive plants are one of the most serious threats to native plant communities and biodiversity, second only to habitat loss. 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.

The bureau recognizes invasive plants as a serious problem to state forest lands and is developing strategies to more effectively manage them. 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.

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, but also addressed in other chapters of the SFRMP.

Recreation

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.

Recreation Goals:

- To provide and maintain healthful, low-density recreational opportunities and experiences across the landscape.
- To provide information and assistance to the public while promoting safety.
- To develop and promote effective partnerships in managing recreational opportunities and experiences.

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. 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.

In recent Visitor Use Monitoring (VUM) surveys, scenic driving and hiking have been among 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.

Part of the bureau’s mission is 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.

Infrastructure

Infrastructure Management Principle

Infrastructure on state forest lands is managed with consideration of societal needs, institutional constraints, and ecosystem management principles.

Infrastructure Goals:

- To implement a strategic approach to address infrastructure needs.
- To manage state-owned infrastructure in support of resource management and public use.
- To consistently administer non-state or private infrastructure while considering social, ecological, and economic values.

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. Proper planning, administration, and funding of the bureau’s infrastructure is essential to manage state forest land and carry out the agency’s mission.

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.

Cultural and Historic Resources

Cultural and Historic Resources Management Principle

The BOF incorporates identification and protection of cultural and historic resources as a part of ecosystem management.

Cultural and Historic Resources Goals:

- To develop a strategy for inventorying, documenting, and protecting cultural resources.
- To increase awareness of cultural resources and the policies and practices pertaining to them for bureau personnel and the public.
- To cooperate and communicate with the Pennsylvania Historical and Museum Commission (PHMC) and other agencies involved in cultural resource management for the protection of cultural and historic resources on state forest lands.

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. Hunting, fishing, berry and mushroom picking, and rattlesnake collecting were traditional pastimes for many citizens. 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 bureau's Landscape Exam Manual 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. These features are inventoried during the Landscape Exam process. More than 5,000 culturally or historically significant sites are located on state forest land, with charcoal hearths representing the vast majority.

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. On state forest land, oil and gas development, timber sales, and all activities that require a State Forest Environmental Review are reviewed for damage to or destruction of archaeological and historic sites.

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.

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.



1. Introduction



The State Forest System

The state forest system of Pennsylvania, approximately 2.2 million acres of forest land in 49 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.

Our state forest system provides a multitude of resources, uses, and values. The state forest serves as an expansive 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.

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. The forest lands also provide economic benefits to the commonwealth through leasing for natural gas development, supplying approximately \$100 million in annual revenue to the commonwealth from lease agreements and gas royalties, and additionally contributing to local communities.

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 state 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 quite 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 state forest lands.

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

The Constitution provides the legislated acknowledgement that natural resources are public property and that the state bears stewardship responsibilities on behalf of millions of Pennsylvanians. 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 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 (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 11. State Recreation Areas — 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.

Pennsylvania Forest Action Plan

Forest Action Plans grew out of changes in the Food, Conservation, and Energy Act of 2008 (the 2008 Farm Bill), when Congress tasked the states and territories to craft assessments of the forests within their boundaries and develop strategies to address threats and improve forest health. The resulting Statewide Forest Resource Assessments and Strategies, or Forest Action Plans, provide an analysis of forest conditions and trends and delineate priority forest landscape areas. They offer practical, long-term plans for investing state, federal, and other resources where they can be most effective in achieving national conservation goals.

Pennsylvania's nearly 17 million acres of public and private forests provide an array of values including clean air and water, recreation opportunities, wood products, and habitat for thousands of plants and animals. Taking stock of the forest is necessary for ensuring its sustainability for future generations. The Pennsylvania Forest Action Plan takes an in-depth look at the entire state's forest resources. It is separated into two parts: assessment (of forest conditions) and strategies (for addressing forest threats). These documents describe current forest conditions and trends, identify priority issues, delineate important landscapes and propose long-term strategies for achieving sustainability. This plan has valuable information and tactics for management of Pennsylvania forests across all ownerships. Because the majority of forests in Pennsylvania are privately-owned, cooperation among land owners is essential. In addition to managing state forest land, the bureau provides forest

management guidance to private landowners. The Forest Action Plan is instrumental for strategic forest planning across all Pennsylvania forests and for fostering partnerships between public and private land managers ([Summary](#)).

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. 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.

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.

Penn Nursery

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

State Forest Name	District	Acreage
Michaux	1	86,723
Buchanan	2	71,753
Tuscarora	3	96,052
Forbes	4	59,498
Rothrock	5	96,281
Gallitzin	6	24,437
Bald Eagle	7	194,392
Clear Creek	8	16,103
Moshannon	9	190,792
Sproul	10	307,138
Pinchot	11	46,571
Tiadaghton	12	146,926
Elk	13	217,181
Cornplanter	14	1,491
Susquehannock	15	260,222
Tioga	16	161,903
William Penn	17	1,414
Weiser	18	28,114
Delaware	19	83,519
Loyalsock	20	114,669
Total		2,205,178

Table 1.1. Names, numbers, and acreage of state forest districts. Report includes only acreage where SubType = 1-State Forest

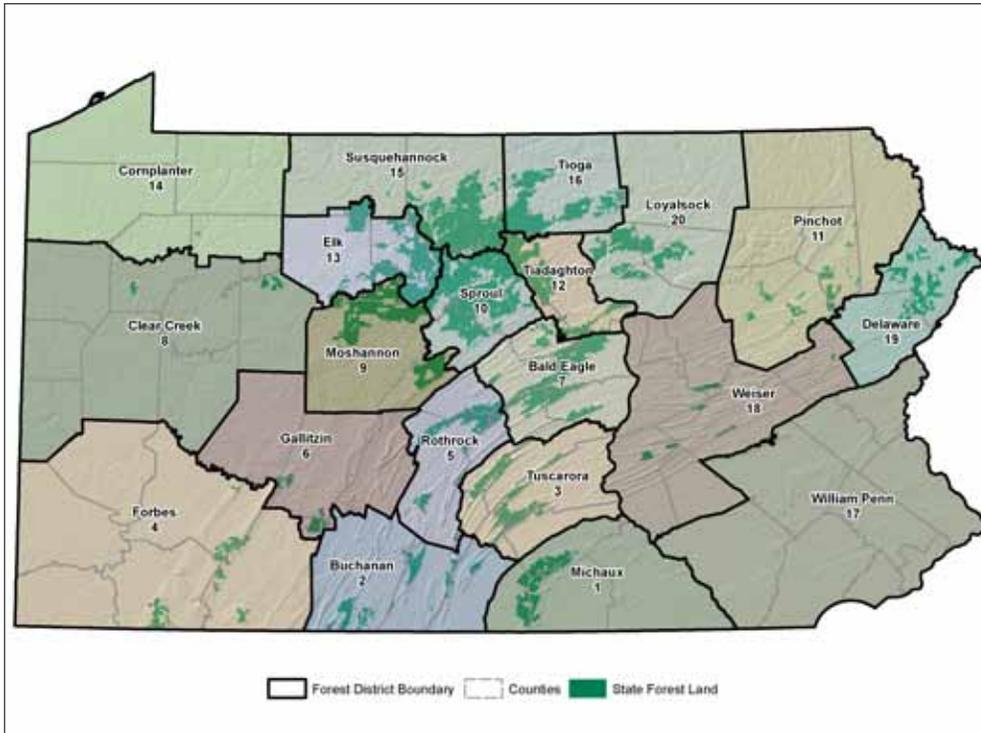


Figure 1.1. Map of state forest districts.

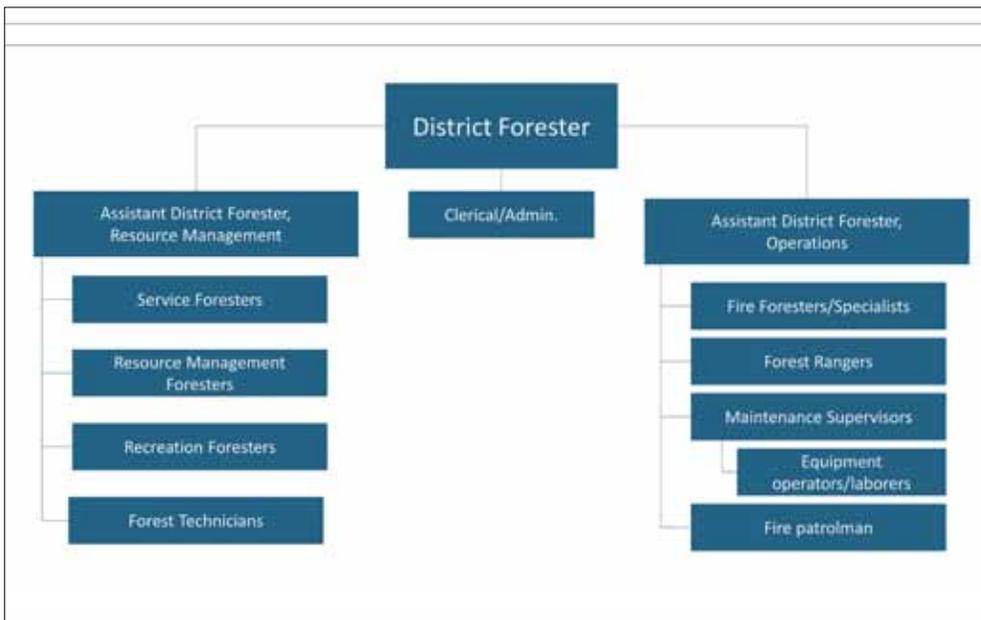


Figure 1.2. Typical Forest District structure.

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-

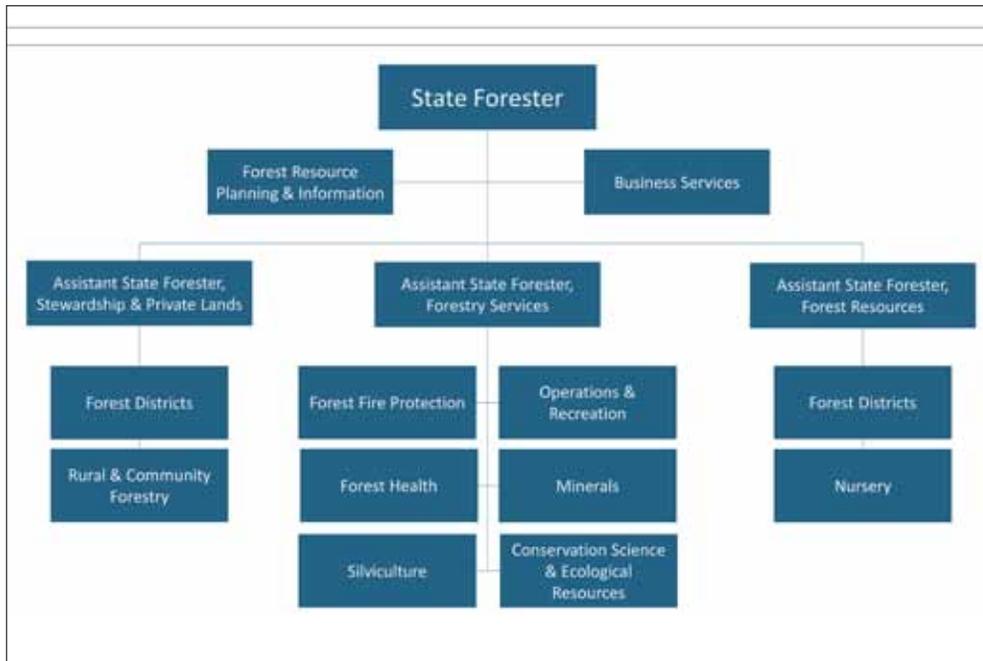


Figure 1.3. Central office structure.

density recreation, and environmentally sound utilization of 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.

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 comprises 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 funds for forest regeneration projects. 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 manages the leasing, exploration, and production activities of lessees and operators and manages industry activity on commonwealth lands where the commonwealth does not own the subsurface rights. It also manages water well drilling programs on these lands, monitoring of surface water resources related to shale-gas development as well as coordination with partner agencies on water issues, 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 comprises 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. In cooperation with Western Pennsylvania Conservancy, the division also administers and coordinates the activities of the online Conservation Explorer tool that provides conservation information on biological diversity, protected lands, streams and other natural resources for planning purposes and also allows users to screen a project area for potential impacts to threatened, endangered, and special concern species (PA Natural Diversity Inventory [PNDI] information). The division is responsible for providing guidance for plant and animal habitat management 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 comprises 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 comprises 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, administering 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 comprises 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 and 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 and Community Forestry Council.

Training & Employee Development

Training and career development are vital to the continued success of any organization. Training refers to the process of acquiring the essential skills required for a certain job but it is equally important to workplace safety, productivity and career satisfaction. The bureau has always sought to provide all staff with the depth and breadth of knowledge necessary to excel in their respective positions.



Training assists employees in performing their work safely and efficiently and aids in their understanding of the expectations of the organization. Courses such as first aid, defensive driving, and chainsaw safety focus on job safety, while broad courses such as New Employee Orientation help employees understand the structure, functions, and procedures of the organization. Specific job classifications require unique combinations of training topics depending upon their job function. For example, required training for foresters includes Oak Silvah and ArcGIS, while administrative and clerical employees have training regarding Commonwealth cost code structure and correspondence protocols. There are options for advancing general leadership such as Instructor Training Course, as well as topic-specific courses such as numerous courses relating to wildland fire control.

In 2015, the bureau developed a new and comprehensive training manual to replace the previous edition from 1998. This manual is a resource for managers and employees to obtain a list of relevant trainings, to examine recommended training timeframes, and to chart a course for employee development and achievement. The manual provides guidance for many programs and job classifications, but it is not an all-inclusive source for bureau training opportunities. The pace, selection and schedule of employee training and development ultimately remains between the supervisor and the employee.

Partnerships

The natural resources of Pennsylvania and the northeastern U.S. are distributed across many ownerships and interests, and therefore, management necessitates collaboration and communication across the countless groups that influence the landscape. The bureau relies on many partnerships and collaborations for shared expertise, understanding, and progress. The bureau cooperates with many state agencies within the commonwealth for projects and advisement, but has important associations with academic institutions, non-profit organizations, government agencies (federal, state,

and local), and many other special interest groups. These partnerships allow sharing of best management practices and lessons learned for procedures and challenges that are shared. Collaboration with other agencies and institutions provides results that allow the bureau to build on existing studies and helps alleviate redundant or repetitive efforts in striving to understand the complexities of the resources we manage. Communication and cooperation enable the use of consistent guidelines and practices employed at various scales, providing continuity across ownerships that have similar goals and priorities. Finally, DCNR Conservation Volunteers, other volunteer groups, and the new Pennsylvania Outdoor Corps also provide their time and energy to assist in the hands-on efforts that are required to carry out the management of our state forest system. The crucial partnerships and collaborators are too numerous to list, but can be found throughout the plan and throughout the many bureau documents and website.

Budget

In 2016, the bureau's annual operating budget is approximately \$65 million. Most of these funds currently come from resource management on state forest lands, including timber management (\$25.5 million) and transfers of royalties from the Oil and Gas Lease Fund (\$32.4 million). In recent years, there has been an effort to decrease the reliance on oil and gas royalties by gradually replacing it with general fund monies.

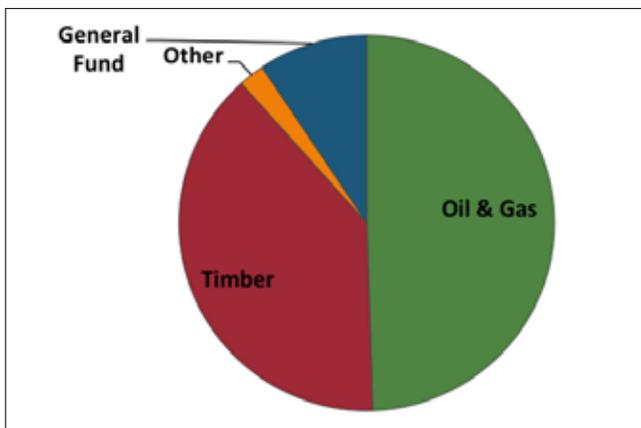


Figure 1.4. The bureau's annual operating budget allocations.



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 historical account, [*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 that focuses on the interdependency of biological and non-biological systems and cycles. 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 ensures 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 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 the stand 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 is an indicator of ecosystem health.

Intact habitats with well-functioning ecological processes generally have a higher diversity of native plants and animals. When poor management (e.g., fragmentation,

overexploitation, invasive species) impacts a habitat, the inherent species diversity typically declines, as does ecosystem function, nutrient and energy cycling, and other processes.

State forest lands contain nearly all of the 127 different plant communities found in Pennsylvania. These communities reflect a host of different species 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 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 DCNR. Due to the diverse responsibility for species management, 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 promote and enhance 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	
Goal	Objectives
1. To conserve and enhance eco-regional biological diversity through the management of state forest lands.	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.
	1.2 Assess forest management and/or activities resulting in disturbance for impacts to biodiversity. Tools such as the Conservation Explorer tool, PNHP inventories, and state forest land inventories should be consulted prior to the activity.
	1.3 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.
	1.4 Encourage natural regeneration and promote the use of suitable native plants and animals for management activities on state forest lands.
	1.5 Consider the importance of genetics in management on state forest lands.

Core Forests, 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 promoting core forest characteristics and 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.

Core forests can be defined as large tracts of intact forest with minimal fragmenting features. Core forest are important to ecosystem function and health by providing contiguous habitat for a variety of species; limiting the spread of invasive species; promoting species migration and genetic fitness; and maintaining water quality.

Core forests are commonly identified by their distance from permanent infrastructure or fragmenting features. The bureau promotes core forest conditions across the entire state forest system while balancing other uses and values. A recent analysis using the University of Connecticut’s CLEAR (Center for Land Use Education and Research) showed that 74 percent of the state forest system is characterized as core forests greater than 500 acres.

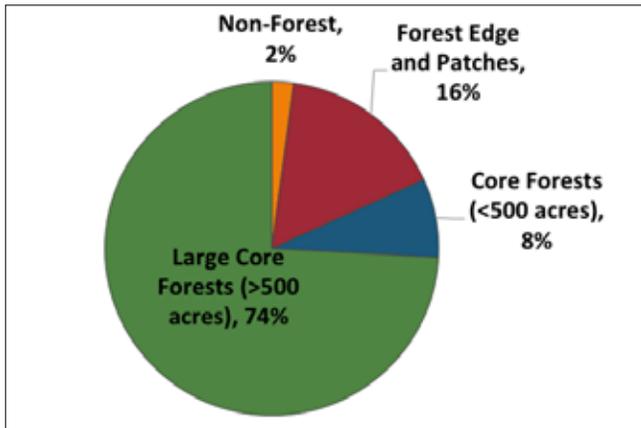


Figure 1.5. University of Connecticut's CLEAR analysis results.

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 pipeline right-of-way construction) 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. Conversely, many other species utilize interior forest and late successional forests. 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 condition, including but not limited to agricultural fields, residential development, or other human land uses, that leads 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.

Unlike conversion in other areas, on state forest land, forest loss typically occurs due to development for infrastructure, such as pipelines, roads, parking areas, or wellpads. Because these disturbances often exist in long, linear configurations, different strategies and considerations arise, such as impact of edge effects and creation of corridors for invasive plants, pests, and pathogens. Management strategies for addressing forest loss and conversion depend not only on the configuration of the disturbance, but also the anticipated time frame of the non-forested condition. For example, best management practices may dictate methods to minimize permanent disturbances or plans for timely reclamation on sites that will soon be returning from a temporary loss of forest.

Forest Connectivity

Alteration of forested areas can 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. In extreme cases, a species' success in isolation can result in new adaptations and potential speciation.

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 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. Among the bureau's various best management practice documents, guidance is provided for techniques to minimize the negative impacts of edge effects where the impacts are deemed unsuitable for the intended goals and species of an area.

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. 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

available ecosystem services across a larger landscape. 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.

Core Forest Focus Areas

New in this management plan is the introduction of Core Forest Focus Areas. Core Forest Focus Areas represent the most extensive and exceptional core forests and unfragmented parcels in the state forest system. They represent a variety of forest conditions, successional stages, and occur in a variety of forest management zones, from Wild and Natural Areas where very limited active management occurs, to Multiple Resource Management Zones where active timber harvesting, habitat management, prescribed fire, pest management, recreational trails and other forms of active management occur. Core Forest Focus Areas are identified using the Bureau of Forestry's core forest analysis tool.

The purpose of Core Forest Focus Areas is to assist in the inventory, management, maintenance, and monitoring of the most significant core forest tracts in the state forest system and to conserve the ecological values associated with interior forest conditions and unfragmented landscapes.

While the Bureau of Forestry manages for these values across the entire state forest system, Core Forest Focus Areas will serve as a means to ensure the appropriate balancing of these values in landscape-level forest management decisions. As such, special management guidelines will apply to these Core Forest Focus Areas. The following preliminary guidelines will guide the development of expanded management guidelines during the planning cycle.

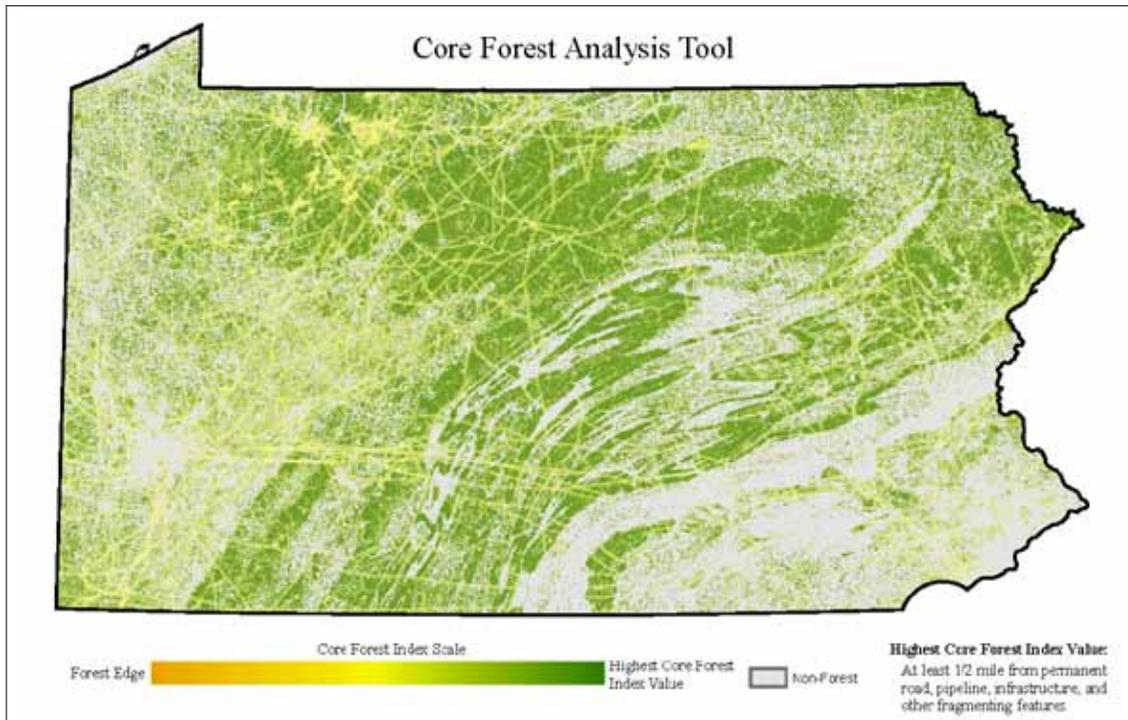


Figure 1.6. Example output of core forest analysis tool that will be used to identify, manage, and monitor Core Forest Focus Areas.

Preliminary Guidelines

1. No permanent conversion of forest land will occur in these areas, including roads, pipelines, recreational parking lots, natural gas infrastructure pads, and other activities that permanently convert forest to non-forest.
2. The most restrictive, underlying Management Zones still apply in Core Forest Focus Areas. Wild and Natural Area guidelines apply in designated areas. Timber harvesting and other active management that does not involve permanent conversion is allowed per Management Zoning.
3. The temporary disturbances associated with timber harvesting and other forms of habitat management are allowed per state forest Management Zoning. Special consideration should be given in Core Forest Focus Areas to reducing the amount of haul roads, ensuring appropriate restoration, and maintaining closed canopy conditions in haul road corridors.
4. Where the Bureau of Forestry does not own mineral rights beneath Core Forest Focus Areas, it will work cooperatively with operators to avoid forest conversion.
5. When possible, the Bureau of Forestry will strategically purchase and/or exchange real estate interests to protect Core Forest Focus Areas where mineral rights are currently severed.
6. The Bureau of Forestry will consider, when available, acquiring key tracts that ensure connectivity of and expand and protect existing Core Forest Focus Areas.
7. The Bureau of Forestry will continually monitor the status of Core Forest Focus Areas. Deviation from these guidelines requires a State Forest Environmental Review and state forester approval.
8. The Bureau of Forestry will identify regionally important core forest Landscape Management Units. In these identified landscapes, long-term management goals and conditions will emphasize the promotion core forest conditions. When balancing uses and values in these landscapes, management decisions and plans will favor the promotion of these values.

Core Forests, Fragmentation, and Connectivity Goal and Objectives

Goal	Objectives
1. To consider forest fragmentation, connectivity, and patch distribution in management decisions affecting state forest resources.	1.1 Use a landscape-level planning approach to encourage a mosaic of diverse forest habitats and patch sizes.
	1.2 Minimize permanent conversion from forest to non-forest.
	1.3 Minimize forest fragmentation.
	1.4 Maintain or improve connectivity and fluid corridors of high-canopy forests and other diverse forest habitats.
	1.5 Identify focus areas in which to maintain and promote core forest characteristics.
	1.6 Improve edge habitat to provide benefits for native wildlife species and to mitigate edge effects.
	1.7 Develop guidelines regarding patch management and connectivity.
	1.8 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.

Climate Change

Pennsylvania has undergone a long-term warming of more than 1°C (1.8°F) over the past 110 years. 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 from the state, 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. Mortality rates will increase and 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 acidic deposition and both native and non-native insects and diseases. Tree mortality could rise due to these secondary impacts. 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.

Representatives from the bureau are part of a team assembled by the Northern Institute of Applied Climate Science to write a vulnerability assessment for Mid-Atlantic Forests. The assessment will evaluate key ecosystem vulnerabilities to a range of future climate scenarios across the mid-Atlantic region of Pennsylvania, New Jersey, Delaware, Maryland, and New York.

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. According to bureau data, in 2015, state forests sequestered an estimated 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 to facilitate species migration.
- Limiting forest conversion and promote restoration.
- 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.

DCNR Climate Change Initiative

As Pennsylvania’s leading conservation agency and the steward of 2.2 million acres of state forests and 121 state parks, DCNR has a unique role and responsibility in helping the commonwealth reduce and adapt to climate change. For this reason, the department has designated climate change as one of its six strategic initiatives. The department is developing a climate change adaptation plan, strategies for increasing carbon sequestration from state forests, and incorporating climate change into environmental education programs and outreach to private landowners. [DCNR and Climate Change – Planning for the Future](#) provides a framework for the department’s climate response, and provides an overview of how climate change is currently impacting the state and what to expect in the future.

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

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 as articulated in its mission. 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 promote 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.

Wild and Natural Areas

One of the primary ways the bureau maintains wild character is through its Wild and Natural Area program. Wild Areas were specifically designated to protect the most undeveloped landscapes in the state forest system and to provide primitive recreation experiences and the pursuit of peace and solitude. There are currently 18 designated Wild

Areas in the state forest system totaling more than 150,000 acres. Additionally, many designated Natural Areas, which total approximately 80,000 acres, also provide for similar values and experiences.

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 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 area, but not to increase developed area. 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.



Figure 1.7. ROS classes and characteristics of those classes based on user experience.

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.

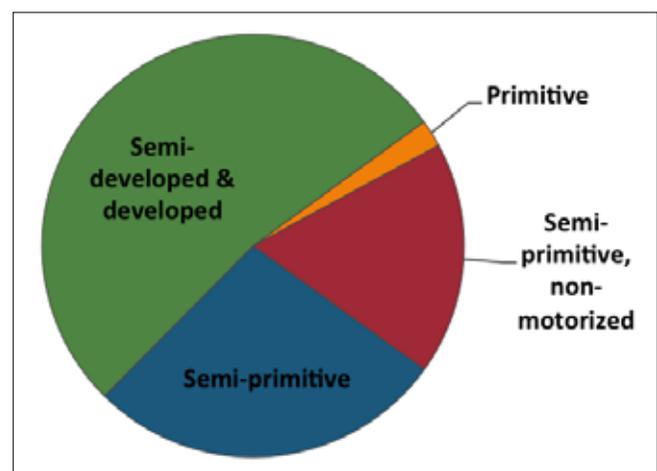


Figure 1.8. Acres and percentages of ROS classifications for the entire state forest system

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 for 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 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.

Wild Character Focus Areas

New in this management plan is the introduction of Wild Character Focus Areas. Wild Character Focus Areas represent exceptional areas in the state forest where visitors can expect primitive-type recreational experiences in an undeveloped setting where maintaining wild character and non-motorized recreational opportunities are a priority. Preliminary Wild Character Focus Areas will be identified using the Recreational Opportunity Spectrum Analysis tool’s Primitive and Semi-Primitive/Non-Motorized designations.

The purpose of Wild Character Focus Areas is to assist in the inventory, management, maintenance, and monitoring of primitive recreational opportunities and maintaining landscape conditions typically associated with undeveloped landscapes and the value of wild character.

While the Bureau of Forestry manages for these values across the entire state forest system, Wild Character Focus Areas serve as a means to ensure the appropriate balance of these values in landscape-level forest management decisions. As such, special management guidelines apply to these Wild Character Focus Areas. The following preliminary guidelines will guide the development of expanded management guidelines during this planning cycle.

Preliminary Guidelines

1. Recreational planning and management will favor non-motorized activities. No motorized recreation will be allowed in these areas, with the exception of existing snowmobile trails.
2. The most restrictive, underlying Management Zones still apply in Wild Character Focus Areas. Wild and Natural Area guidelines apply in designated areas. Timber harvesting and other active management that does not involve permanently opening additional roads and trails to motorized use is permitted per normal Management Zoning guidelines.
3. Roads in these areas will be gated and used only for occasional, administrative access. Temporary, gated haul roads for timber harvesting operations are permitted.
4. Dispersed, low-density, non-motorized recreation will be emphasized, and, as such, commercial and large-group activities will be limited or restricted.
5. Back-country hunting and fishing experiences should be maintained by limiting motorized access when feasible and consistent with habitat management objectives.
6. Where the Bureau of Forestry does not own mineral rights beneath Wild Character Focus Areas, it will work cooperatively with operators to limit motorized access and the impact of infrastructure on the undeveloped nature of the landscape.
7. When possible, the Bureau of Forestry will strategically purchase and/or exchange real estate interests to protect Wild Character Focus Areas in areas where it does not own the mineral rights.
8. The Bureau of Forestry will continually monitor the status of Wild Character Focus Areas. Deviation from these guidelines requires a State Forest Environmental Review and state forester approval.
9. The Bureau of Forestry will identify regionally important wild character Landscape Management Units. In these identified landscapes, long-term management goals and conditions will emphasize the promotion of wild character. When balancing uses and values in these landscapes, management decisions and plans will favor the promotion of this and associated values.

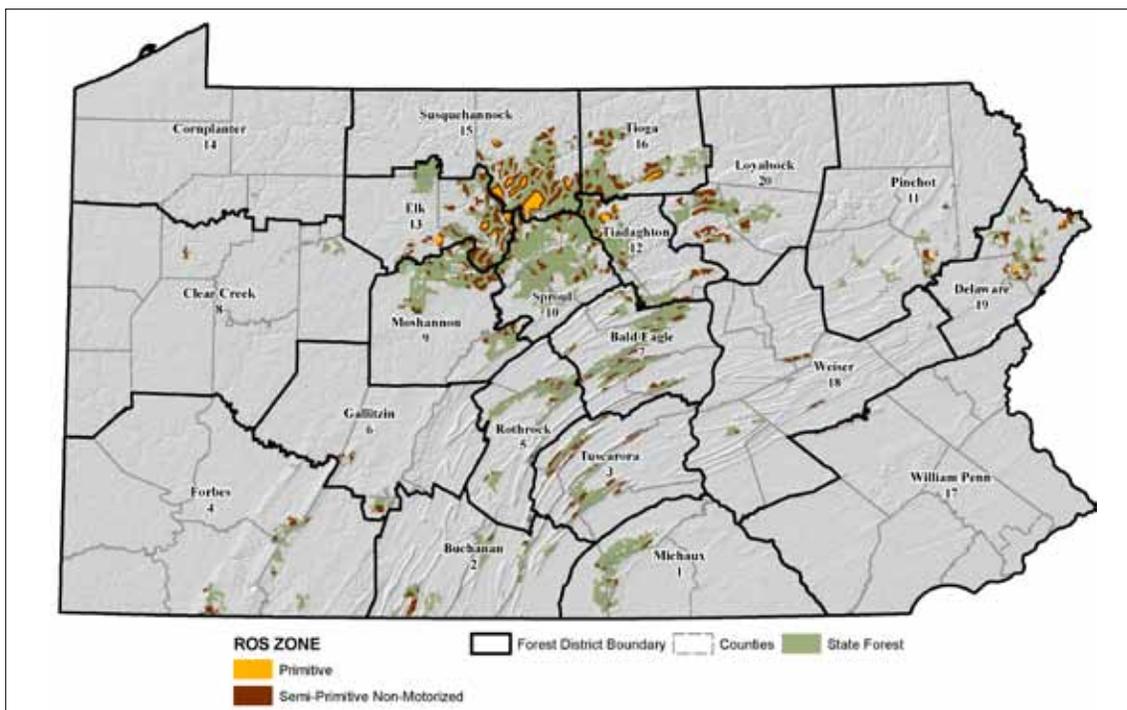


Figure 1.9. Preliminary analysis of Wild Character Focus Areas.

Wild Character Goal	
Goal	Objectives
1. To maintain and promote the components of wild character and related visitor experiences across the landscape during management decisions.	1.1 Designate areas that focus on providing primitive recreation experiences across the landscape during management decisions.
	1.2 Use tools such as ROS to assess and monitor wild character to guide management decisions.
	1.3 Maintain exceptional vistas and continue to identify and manage scenic viewsheds.
	1.4 Implement practices in buffer management to promote aesthetics and wild character of state forest land.
	1.5 Monitor and manage noise, light, and privacy impacts to solitude and wild character.

Adjoining Lands

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.

The bureau’s landscape management approach requires consideration of the surrounding lands. Management of the state forest affects the surrounding landscape and vice versa. The management and impacts of wildfire, damaging insects and disease, invasive species, aesthetics, and fragmentation on state forest land and adjacent lands are likely to affect each other.

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 sustainably manage their forested lands.

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

Adjoining Lands Goal and Objectives	
Goal	Objectives
1. To implement strategies to address interactions between state forests and adjacent lands.	1.1 Conduct landscape-level planning that includes consideration of adjacent lands.
	1.2 Consider impacts of adjacent lands on state forest uses and values, such as aesthetics, fragmentation, and invasive species infestations.
	1.3 Consider effects of state forest land management on the surrounding landscape.
	1.4 Provide advice and guidance on forest management to adjacent landowners.
	1.5 Cooperate with adjacent landowners.

Acquisitions

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)
- Oil, gas, and mineral rights associated with severed land holdings where conservation of wild character or core forest are a priority

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

Acquisitions Goal and Objectives	
Goal	Objectives
1. To implement a strategic state forest acquisition process to add valuable ecological and recreational resources to the state forest system.	1.1 Acquire key tracts of land that meet bureau priorities.
	1.2 Utilize effective partnerships to leverage available funding for acquisitions.

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 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 from one another.

The perception of old growth in Pennsylvania is further confused because not much virgin forest remains here. Native Americans had been altering 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.

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.

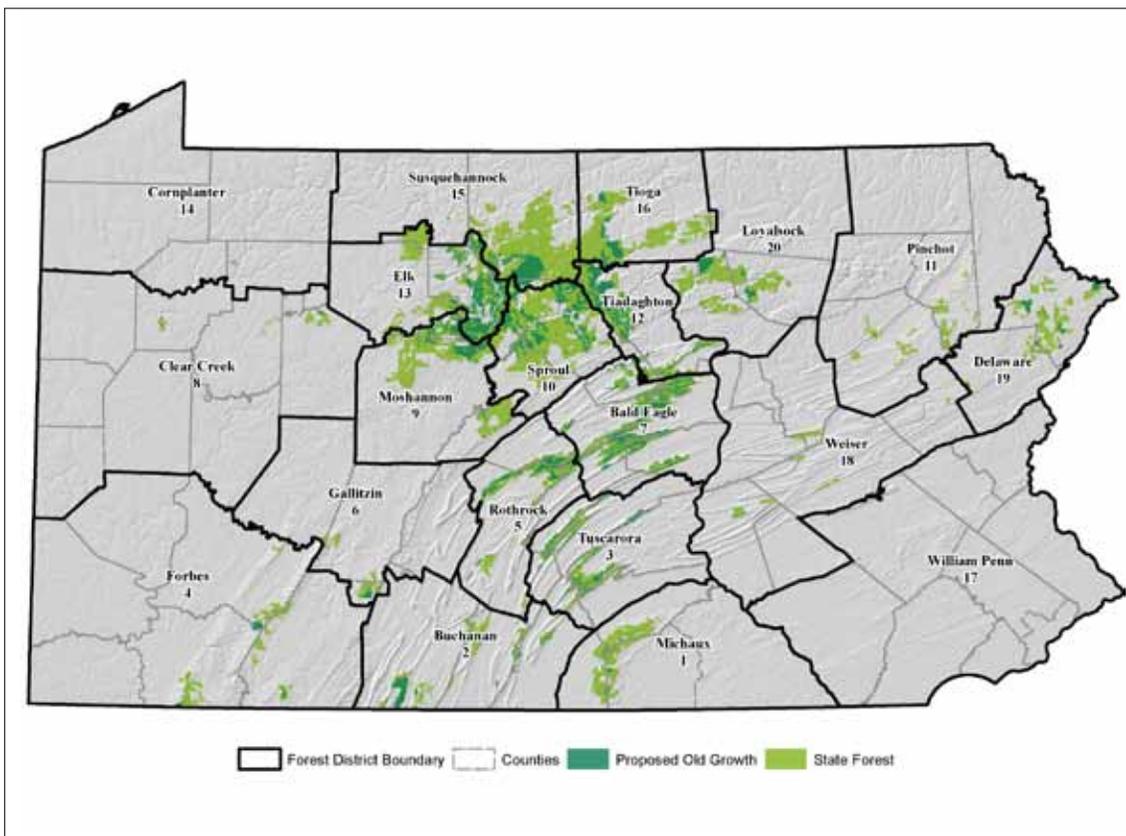


Figure 1.10. Proposed old growth areas within state forest land.

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.

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 identified certain areas as proposed old growth where succession may be allowed to occur (Figure 1.10). 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.

Old-Growth Goals and Objectives	
Goals	Objectives
1. To protect existing old-growth systems on state forest lands.	1.1 Protect all existing virgin or old-growth remnant forests by including these areas in the state forest natural area system.
	1.2 Promote research and study on existing virgin and old-growth remnant forests to fully understand the characteristics of these systems.
	1.3 Assess stressors to existing old-growth stands and develop management strategies to address them.
2. To promote future old-growth systems on state forest land by maintaining at least 20 percent of state forest land as proposed or existing old growth.	2.1 Investigate and evaluate active management strategies for promoting old-growth characteristics in developing, late-successional forests.
	2.2 Continue to evaluate and refine the bureau's 556,000 acres of proposed old growth areas.
	2.3 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 systems.
	2.4 Connect late-successional and old-growth systems where practical.

Land Classification Systems

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 planning and monitoring, in addition to informing and guiding management decisions. Furthermore, as noted in *Penn's Woods*, ecologically-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 organizing, 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 classification system, the bureau is proposing to stratify its designations into six subcategories: classification and typing, state forest management zoning, planning and operational, reference and analysis, special consideration, and supra management areas. These subcategories 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 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.



Figure 1.11. Proposed categories and examples of the bureau's land classification systems.

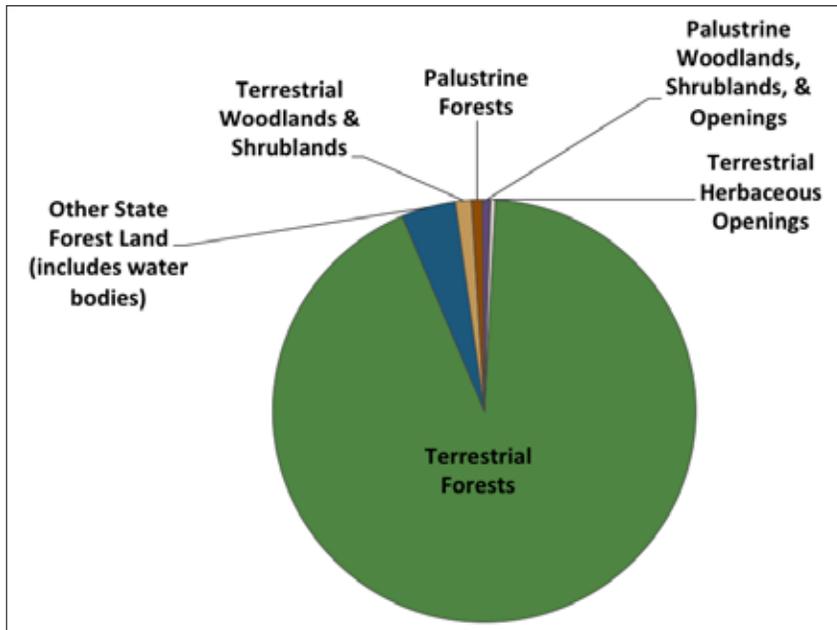


Figure 1.12. Major plant community distribution on state forest land.

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.

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 typing provides information on:

- Forest land area and acreage
- Management zone
- Plant community
- 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. Finally, “stocking” refers to the amount of timber in an area relative to some optimum condition. 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:

- 1 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. On northern exposures, Site 1 may extend higher up a slope than on southern exposures because of more favorable soil moisture conditions. In addition to the usual beech-birch-maple-cherry of northern and Allegheny hardwoods, white pine, hemlock, ash and basswood are generally present. In the oak types where red oak and white oak along with hemlock form the major portion of the stand, the presence of tulip-tree (yellow poplar) and ash indicates Site 1. Dominant and codominant total tree heights have the potential to average > 85 feet at maturity.

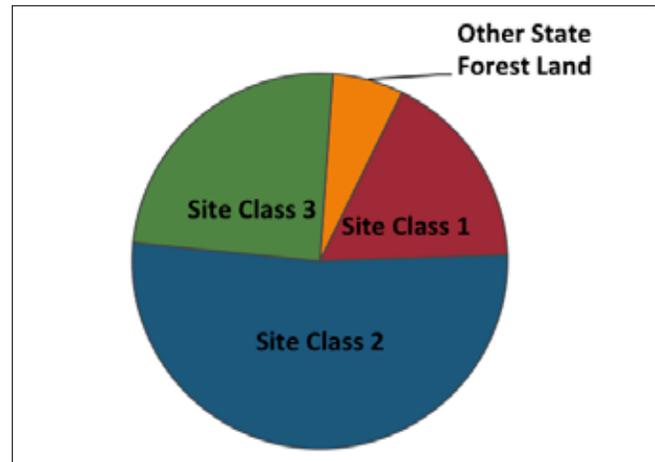


Figure 1.13. Site class distribution on state forest land.

- 2 Site 2: Characterized by soil intermediate in moisture, depth, drainage and fertility that may dry-out for short periods during the year. This site is usually located on slopes between the ridge tops and the coves and bottomlands. In the northern and Allegheny hardwood types, Site 2 is primarily a beech-birch-maple-cherry mixture with shorter heights than on site 1. In the oak types, site 2 has a preponderance of red oak, black oak, white oak and, to a lesser extent, scarlet oak and chestnut oak. Dominant and codominant total tree heights have the potential to average > 65 feet but < 85 feet at maturity.
- 3 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 < 65 feet at maturity. Note that in certain community types, species such as ash, black cherry, white pine and pitch pine may assume a super-dominant position in the overstory canopy. These individuals should be excluded in evaluating the prevailing tree heights for assigning site class.

Size/Stocking

Size/stocking classes are numbered 1 through 4 to represent stands that are fully stocked ranging from (1) large sawtimber, (2) medium sawtimber, (3) poletimber, and (4) to sapling stages or smaller. Size/stocking classes 5 through 8 are used for areas in the same four size categories that have experienced a disturbance and as a result, are understocked. The fifty-percent stocking line on the appropriate stocking chart is used as a guide for determining whether or not an area should be designated as understocked (<50% and >30%). This determination is most challenging when it is unclear what constitutes the prevailing or manageable forested overstory layer. In these circumstances, one must first determine what the manageable stand component is (this may be a regenerating cohort or residual trees following a disturbance). Once it is determined what the manageable overstory is, the size/stocking is determined based on the overstory. Forest community types falling below the 30% stocking level should be delineated as Woodlands (O5). Bureau size/stocking classes are designated as follows:

Stand is > 50 percent stocked

- 1 Majority of the dominant and codominant trees are > 18" diameter at breast height (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 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.
- 7 Majority of the dominant and codominant trees are 6-12" dbh.
- 8 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** is 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

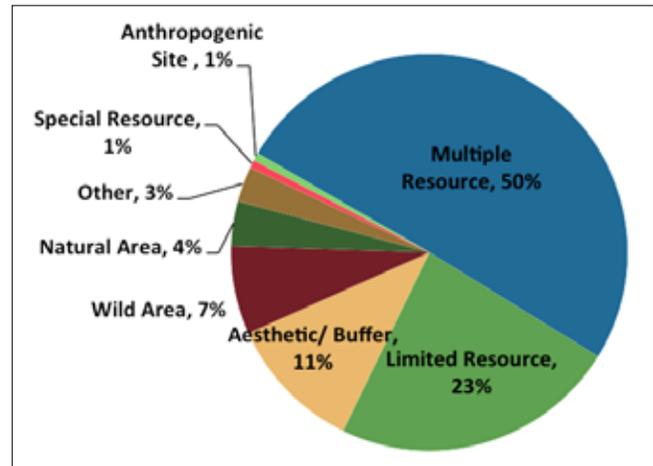


Figure 1.14. State forest management zone distribution.

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.

Wild and Natural Areas

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.

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."

To date, the Bureau of Forestry has designated 60 state forest natural areas on more than 78,620 acres and 19 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 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

The objective of a natural area is to protect areas of scenic, historic, geologic or ecological significance, which will remain in an undisturbed state, with development and maintenance being limited to that required for health and safety. Natural 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. Natural areas are maintained in a natural condition by allowing physical and biological processes to operate, usually without direct human intervention. Any unique or unusual biologic, geologic or historic areas can be considered for designation as natural areas. In addition to the 'unique' or 'unusual,' representative examples of all major forest types occurring in this Commonwealth were also included in the proposed natural area system. The size of these areas is generally small but may be as large as several thousand acres.

According to 27 PA code § 27.3 (relating to natural area definition and guidelines), the guidelines governing the administration of natural areas are:

1. Human habitation will not be permitted, except the primitive type, backpack camping may be permitted in designated areas only.
2. Access for all but essential administrative activities is restricted to foot trails.
3. Buildings and other improvements are restricted to the minimum required for public health, safety, and interpretive aids.
4. Tree cutting is not permitted except as may be required for maintenance of public safety.
5. Rights-of-way, leases and mineral development will be prohibited; provided, however, that subsurface oil and gas rights may be leased where no surface use or disturbance of any kind will take place on the Natural Area.

The bureau has developed operating [guidelines](#) that represent the implementation strategy to address the mandated guidelines for administration of natural areas.

District	Wild Area Acres	Proposed W.A. Acres	Natural Area Acres	Proposed N.A. Acres	Total WNA Acres
Forest District 1, Michaux	0	0	1,647	0	1,647
Forest District 2, Buchanan	11,676	0	2,109	0	13,785
Forest District 3, Tuscarora	5,345	0	1,366	0	6,711
Forest District 4, Forbes	6,094	0	4,130	0	10,224
Forest District 5, Rothrock	5,881	0	2,714	0	8,595
Forest District 6, Gallitzin	2,764	0	392	0	3,156
Forest District 7, Bald Eagle	6,285	0	7,442	0	13,727
Forest District 8, Clear Creek	0	0	0	0	0
Forest District 9, Moshannon	24,240	4,378	900	0	29,518
Forest District 10, Sproul	7,509	0	16,048	0	23,557
Forest District 11, Pinchot	0	0	70	0	70
Forest District 12, Tiadaghton	11,703	0	5,315	0	17,018
Forest District 13, Elk	26,932	4,689	11,822	0	43,443
Forest District 14, Cornplanter	0	0	99	0	99
Forest District 15, Susquehannock	29,836	0	1,654	0	31,490
Forest District 16, Tioga	2,783	0	14,518	0	17,301
Forest District 17, William Penn	0	0	169	0	169
Forest District 18, Weiser	0	0	115	0	115
Forest District 19, Delaware	2,706	0	6,733	0	9,439
Forest District 20, Loyalsock	9,162	0	1,357	0	10,519
Total WNA Acres	152,916	9,067	78,600	0	240,583

Table 1.2. Total acreage of Natural and Wild Areas on state forest lands.



Natural Area Designation Update

The bureau has finalized 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

The objective of wild areas is to set aside certain areas of land where development or disturbance of permanent nature will be prohibited, thereby preserving the wild character of the area. In Pennsylvania's state forest system, certain areas that retain an undeveloped, wild character are designated as Wild Areas to assure that this primitive character is perpetuated. 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. Development of a permanent nature will not be permitted so as to retain the undeveloped character of the area.

Because of the restrictions imposed on wild areas, careful consideration must be given to alternative uses before additional areas are so designated. The size of the area should be no less than 3,000 acres and seldom more than 15,000 acres. They should be located where there are few public roads or other human-made developments such as campsites, rights-of-way, etc. Only areas where the department owns sufficient subsurface rights to preclude development will be considered.

According to 27 PA code § 27.4 (relating to wild area definition and guidelines), these areas will be administered according to the principles of forest protection and management applied to Department-managed lands with the following restrictions:

1. Campsite leases will be prohibited.
2. A new public access road will not be constructed. Existing roads will remain open only where there is a public need. All motorized conveyances or vehicles will 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.
4. Buildings and other improvements will be restricted to the minimum required for public health, safety, and interpretive aids.
5. Rights-of-way, leases and mineral development will be prohibited; provided, however, that subsurface oil and gas rights may be leased where no surface use or disturbance of any kind will take place on the Wild Area.
6. Overnight camping will be limited to the backpack primitive type.

The bureau has developed operating [guidelines](#) to further refine the designation and management of wild areas.

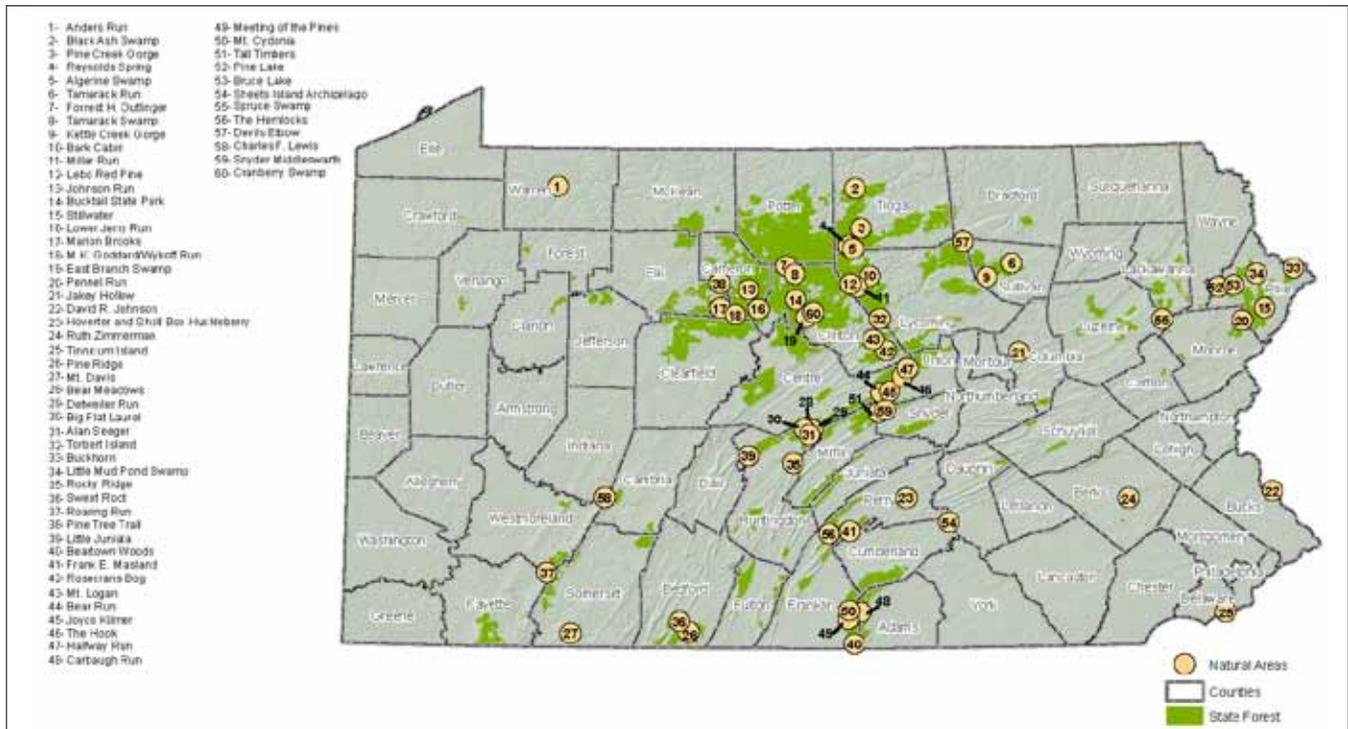


Figure 1.15. Natural areas on state forest land.

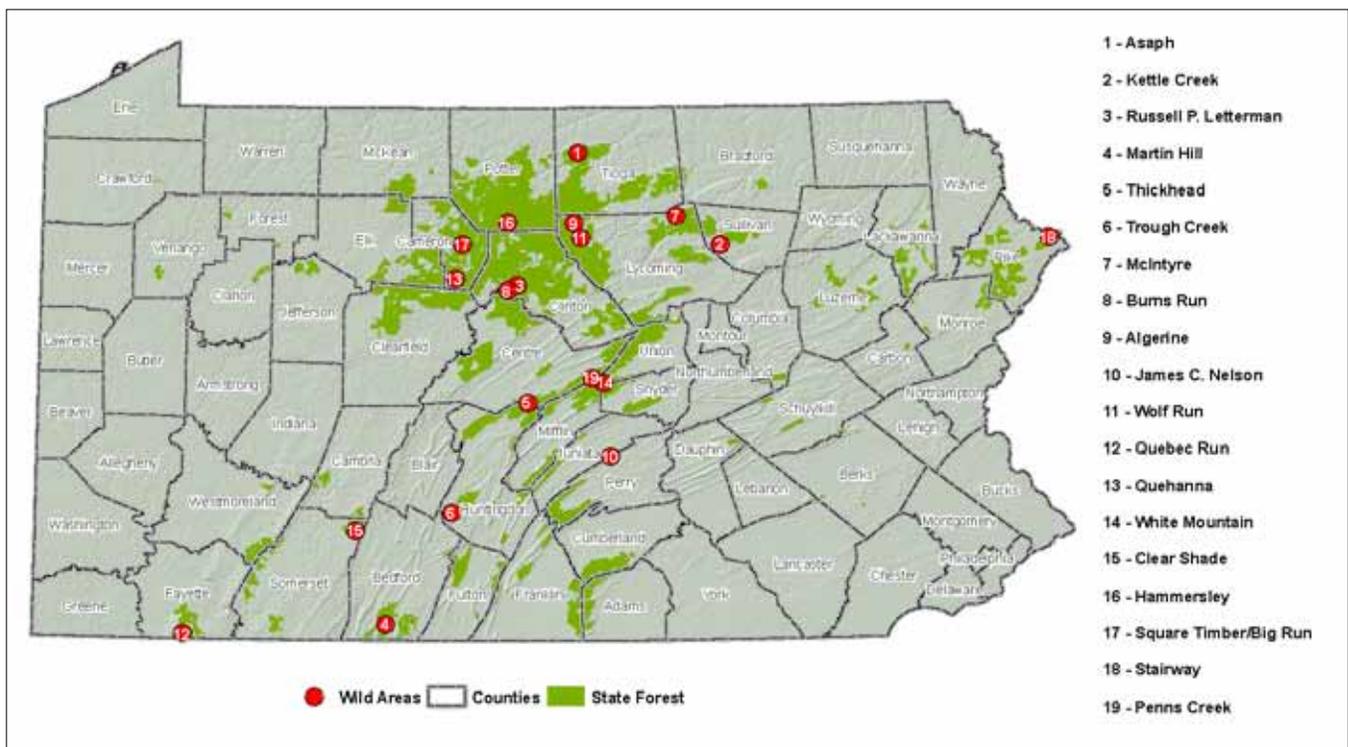


Figure 1.16. Wild Areas on state forest land.

2016 State Forest Resource Management Plan

Wild Area Designation Update

The following wild areas have been finalized and were published in the Pennsylvania Bulletin in 2016:

- [Square Timber/Big Run](#) (5,615 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 (3,810 acres) to form one Penns Creek Wild Area complex.

The following proposed expansion is still under review:

- Quehanna (9,066 acres, Elk and Moshannon state forests)

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. 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.

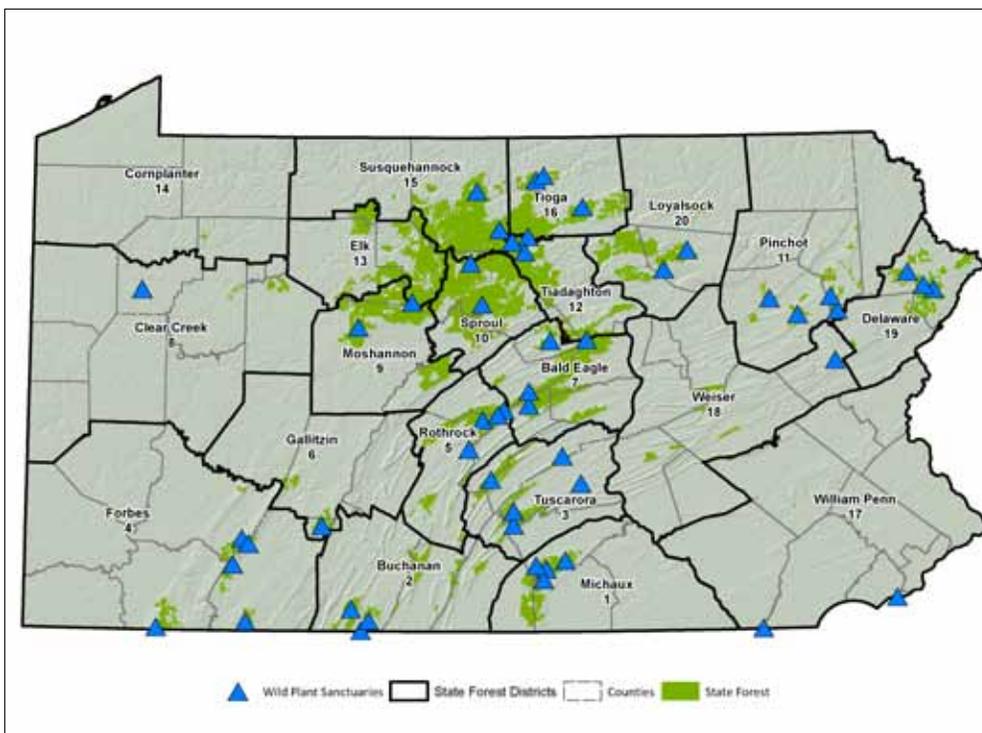


Figure 1.17. Proposed Wild Plant Sanctuaries on state forest land.



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.

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 help the bureau facilitate planning on a landscape scale that has ecological context, incorporate multiple forest uses and values, include all state forest land, and promote 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. While LMUs can be adjusted through time, their intent is to serve as a consistent delineation for landscape level planning, inventory, and monitoring.

2016 State Forest Resource Management Plan

LMU delineations will follow these general guidelines and considerations:

- An LMU is an aggregate of landtype association (LTA) units within the same ecoregion, grouped to consider ecological parameters or similarities.
- LMUs will be created considering LTA characteristics, landform, plant communities, soils/parent material, natural disturbance regimes, land use history, and watershed or eco-regional position. These should be the primary considerations for defining an LMU.
- Secondary considerations 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, LTAs with adjoining land should also be included and considered.
- LMUs may vary in size and shape as determined appropriate for the landscape and management considerations. Sizes can vary, but should generally be between 5,000 and 40,000 acres.

Reference and Analysis Layers

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. Some examples may include important bird areas, priority forest patches; ecological regions, landtype associations, watersheds, and ROS zoning.

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.

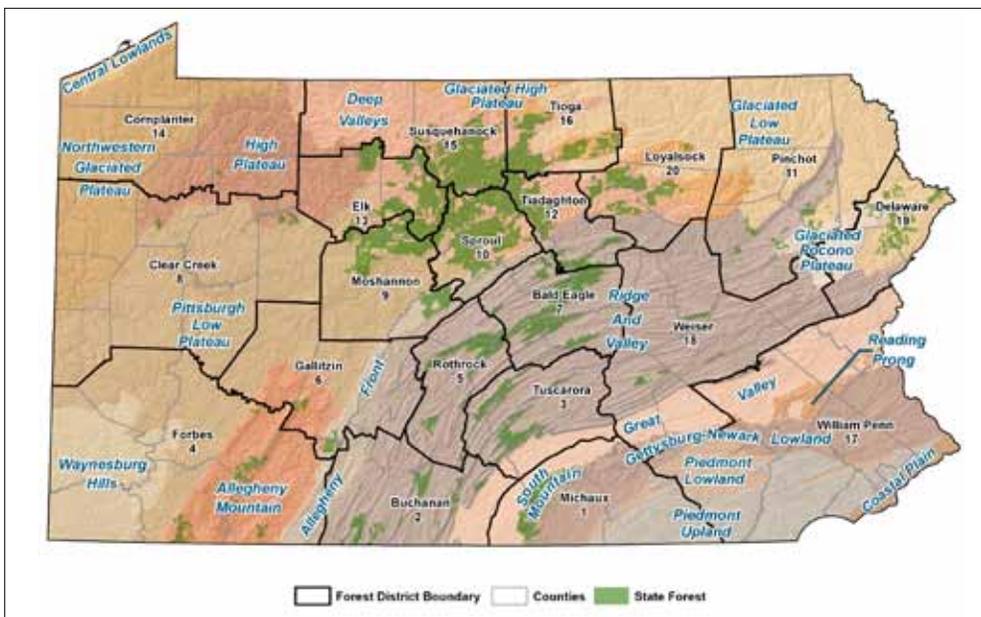


Figure 1.18. Pennsylvania Bureau of Forestry Ecological Regions with state forest land.

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 1.18). The bureau is continuing to develop eco-regional priorities that can be applied or considered during landscape planning.

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 landtype associations (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.

Special Consideration Areas

While Supra Management Areas are intended to address and tie together larger landscapes, the Special Consideration Area subcategory addresses site or tract level locations where specific restrictions, management goals and/or plans are in place that managers must consider when making management decisions. Areas listed as Special Consideration are often in place to promote specific resources or values. Management Zones still apply in these areas; however, managers should continually evaluate if the goals and/or restrictions associated with these areas warrant a change in the management zoning.

Examples of these areas could include Natural Heritage Areas; some High Conservation Value Forests; Core Forest Focus Areas; Wild Character Focus Areas; and certain vernal pond complexes.

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 1.3). 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. HCVFs that require specific management plans will be classified appropriately as a wild plant sanctuary, supra management area, or special consideration area. 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.

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

Table 1.3. Acres of High Conservation Value Forests by type.

Land Classification Systems Goals and Objectives	
Goals	Objectives
<p>1. To use landscape-level units built on ecological parameters to inventory, analyze, and plan management activities.</p>	<p>1.1 Use existing ecological units to develop a new forest management strategy that includes larger landscape management units (LMUs).</p>
	<p>1.2 Develop eco-regional profiles and priorities that consider factors unique to each eco-region and incorporate into management planning.</p>
	<p>1.3 Participate in efforts to reclassify terrestrial and palustrine plant communities and incorporate revisions into stand-level inventory and management.</p>
<p>2. To identify, designate, and manage special management areas to conserve unique ecological, geological, cultural, or social values.</p>	<p>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.</p>
	<p>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.</p>
	<p>2.3 Classify, manage, and monitor areas with unique management opportunities or conservation values to promote these characteristics.</p>

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 bureau 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 bureau 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 bureau 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. Adjusting to 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. The Shale-Gas Monitoring Program is a long-term effort and one that the bureau is committed to continuing. Additional information on shale-gas development can be found in the Geologic Resources chapter.



Implementation Monitoring

Implementation monitoring is designed to assess whether SFRMP objectives were carried out as specified. 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. The main challenge to this type of monitoring is in how one measures or evaluates the implementation.

The bureau develops annual District Management Activity Plans to describe activities taking place within each 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 the bureau’s 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 and reported more formally as information becomes available.

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 of state forest operations 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 project leaders, sometimes 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.



Rare Species and Resources Review

When reviewing projects, the bureau consults the Pennsylvania Conservation Explorer (Explorer) for information on Pennsylvania Natural Diversity Inventory (PNDI) information such as state and federally listed plants and animals, and other protected resources (i.e. natural communities or terrestrial invertebrates).

Data collection and management of PNDI information is performed largely by the Pennsylvania Natural Heritage Program, of which DCNR is a partner. The PNDI data is found within the Explorer and 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 that may require further investigation, or provides avoidance measures to avoid or minimize conflicts to the species in the project vicinity.

The bureau uses PNDI to screen projects for potential impacts to endangered, threatened and rare species as well as other protected resources and develop mitigation or protection strategies for these resources. Although, at a minimum, PNDI's are typically run for any project that require a permit from the Department of Environmental Protection (DEP), the bureau holds itself to higher standards and has expanded use of PNDI to activities that do not require DEP permitting but could still impact these species and resources. 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 ensures that potential impacts have been reviewed by a wildlife biologist or botanist and that mitigation strategies are incorporated into project specifications.

The bureau also has responsibility for state-listed native wild plants, terrestrial invertebrates, natural communities, and unique geologic formations, and performs PNDI reviews for these resources for projects found across the state.



Timber Sale Planning

The bureau uses its Harvest Allocation Model to plan for long term sustainable timber harvesting. The model uses forest inventory data, economic information, bureau policies, and target conditions to formulate timber harvest goals for each forest district. When implemented, these goals ensure that an adequate amount of mature forest is converted to young, vigorous stands that will balance the forest age-class distribution, benefit wildlife by providing a diversity of habitats, and ensure a consistent, sustainable supply of timber for future demand.

In furtherance of the Harvest Allocation Model, individual timber harvests are implemented to: 1.) promote, establish, and maintain desired landscape conditions; 2.) maintain and develop naturally reproducing forest communities; 3.) provide economic and social benefits through a sustained yield of forest products; 4.) achieve appropriate, sustainable timber harvest levels; and 5.) demonstrate and promote silvicultural practices that sustain ecological and economic forest values. The bureau uses its Silviculture Manual to guide the implementation of timber harvests.

As part of the timber sale planning process, management foresters, with District Forester approval, must submit a

timber sale proposal for each sale area to the Silviculture section for approval. Sale proposals contain the following at a minimum:

1. A current stand analysis. This should reflect the current stand conditions for each treatment type within a sale area. SILVAH, a computer tool for making silvicultural decisions, is the recommended program for achieving a standard analysis and prescription. Deviations from SILVAH must be justified.
2. A map of the sale area. The boundary of each sale must be surveyed with a global positioning system (GPS).
3. A current review for the presence of protected species using the Conservation Explorer tool. When search results reveal the presence of species of concern, managers must consult with the bureau's Ecological Services section to mitigate for potentially negative impacts. Conflicts may be resolved by seasonal restrictions, buffers, and in some cases, no-cut zones around sensitive areas and critical habitats.
4. A site-specific soil analysis.
5. Miscellaneous correspondences relating to sale-specific issues such as permits, reviews for cultural/ historic resources, notifications to forest leased camp owners, notifications for oil and gas lease tract operators, or notifications to rights-of-way.



The timber sale contract is a legally 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 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 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.

A prescribed fire 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 prescribed fire. 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. Silvicultural specialists also perform a review for all prescribed fires used for silvicultural purposes, and the bureau 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 plan is considered 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.





2. Communications



Since the inception of the Bureau of Forestry in the late 1800s, communication 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.” 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 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; 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 vital to conservation agencies, where efforts are tied to resource stewardship, on the parts of individuals and communities. The bureau employs effective communication, education, and public outreach in an effort to foster stewardship and convey a message of environmental sustainability. 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, such as conservation funding, forest land acquisitions, and community forestry programs, require a citizenry that appreciates and understands the benefits that forest resources provide to the community.

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 communicate with the public, especially youth. There is considerable concern that people are increasingly disconnected from the natural world. Resource professionals point to a public that does not necessarily draw direct links between certain benefits and the forest’s role in providing them. For example, kayakers may appreciate clean 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 bureau 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 2.1), 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.

Digital Media

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. The bureau and many of its districts have a presence on social media, on such platforms as Facebook, YouTube, and Twitter, which allow the bureau to quickly exchange information with interested audiences through news items, pictures, videos, and tips.

Publication	Description
Statewide Welcome Kit	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
Common Trees of Pennsylvania	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.
State forest map and recreation guides	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.
District newsletters	Several forest districts publish the details of their happenings, including some statistics and photos. These are updated periodically.
Press releases	Statements to the public prepared by the DCNR press office in conjunction with the Communications Section

The bureau also manages the [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 called the Pennsylvania State Parks and Forests Guide - Pocket Ranger App.

Table 2.1. Some notable Bureau of Forestry publications



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. Also, Forest Demonstration Areas are set aside to showcase firsthand 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.

State Forest District	
PA Bureau of Forestry	
William Penn	Rothrock State Forest
Delaware State Forest	Susquehannock State Forest
Elk State Forest	Tiadaghton State Forest
Forbes State Forest	Tioga State Forest
Loyalsock State Forest	Tuscarora State Forest
Michaux State Forest	Weiser State Forest

Table 2.2. Bureau Facebook pages

Key Messages

DCNR has developed a set of “key messages” to use in the development of publications, outreach, and interpretive material (bold text in this box). The bureau also has developed a set of forest-related key messages (bullets beneath bold text) 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 Forestry

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 at 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. Bureau staff, 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 twelfth 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 cooperated with various partners to develop 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 record 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.

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 that produces descriptive information about visitation including: activity participation, demographics, visit duration, measures of satisfaction, and monetary spending connected to the visit. The bureau uses this information

to understand needs and concerns in the short term and to inform state forest management. 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.

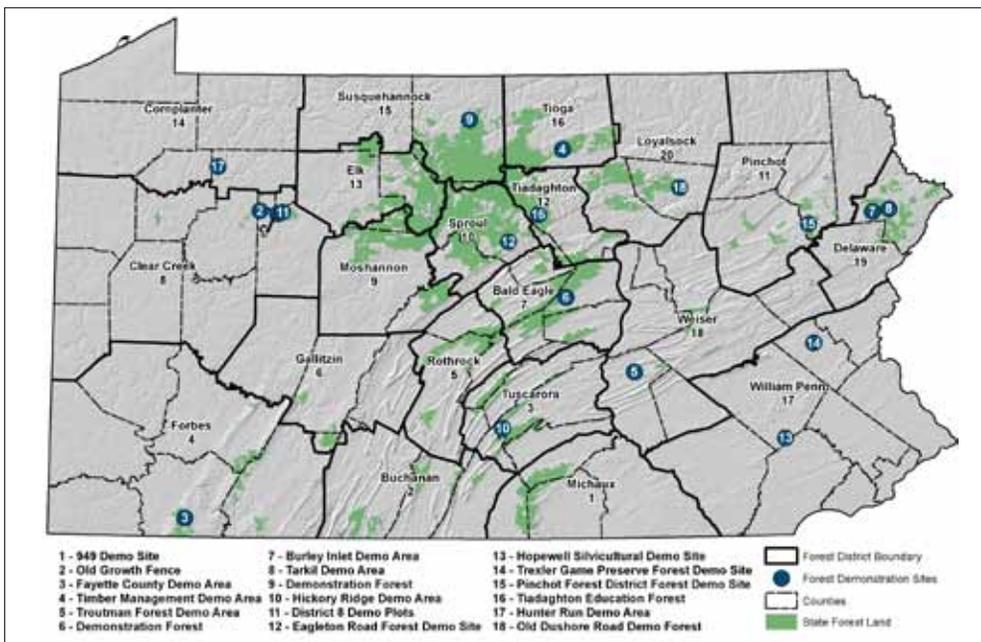


Figure 2.1. Locations of forest demonstration sites.



Advisory Committees

Collaboration, facilitation, information sharing, and informal dialogue are key principles that guide the management and work of bureau advisory committees (Table 2.3). 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 approach results in productive dialogue and transparency and produces recommendations and other products in which all perspectives are considered.

Committee Name
Conservation and Natural Resources Advisory Committee
Ecosystem Management Advisory Committee
Natural Gas Advisory Committee
PA Appalachian Trail Committee
PA Biological Survey and Technical Committees
PA Forest Stewardship Steering Committee
PA Greenways Partnership Commission
PA Rare Plant Forum
PA Urban and Community Forestry Council
Pine Creek Rail Trail Advisory Committee
Recreation Advisory Committee
Silviculture/Timber Advisory Committee
Snowmobile and ATV Advisory Committee

Table 2.3. Bureau 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.

Goals	Objectives
1. To provide education and interpretive opportunities regarding the values, services, and benefits of sustainable forest management.	1.1 Promote a public stewardship ethic regarding the commonwealth's forests and wild plant resources.
	1.2 Create statewide and district interpretive plans and increase the use of interpretive resources.
	1.3 Provide forest demonstration areas throughout the state forest system that show forest management practices.
	1.4 Develop state-of-the-art resource management centers to house educational displays and stimulate interest in forest conservation.
	1.5 Promote Project Learning Tree with Pennsylvania educators and youth leaders through workshops and material support.
	1.6 Promote forestry and conservation through public education and outreach such as the statewide Envirothon, natural gas tours, ECO Camp, Leave No Trace Principles, social media, and other public programming partnerships.
2. To provide customer service and information that promote the use and enjoyment of the state forest system.	2.1 Maintain a steady and available supply of our public use maps, guides, and printed materials.
	2.2 Continually update and use digital media, providing information in an engaging format on the bureau and its work.
3. To engage the public and consider input in state forest management decisions.	3.1 Provide information on forests, forest issues, and native wild plants.
	3.2 Use advisory committees to engage stakeholders.
	3.3 Coordinate responses to public inquiries on state forest management topics.
	3.4 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.
	3.5 Monitor and respond to social media questions and comments.

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, and newsletters.

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031026.pdf

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
 - o Online surveys
 - o Visitor use monitoring
 - o Comment cards
 - o Advisory committee meetings



3. Timber and Forest Products



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. 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 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 had produced and planted 179 million seedlings on state and private lands. 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.

2016 State Forest Resource Management Plan

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 3.1).

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 3.1). 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.

Aggregated Forest Type	Dominant Plant Communities
Allegheny hardwoods	Black cherry-northern hardwood forest
Northern hardwoods	Northern hardwood forest Sugar maple-basswood forest
Red oak	Red oak-mixed hardwood forest
Other oak	Mixed oak – mixed hardwood forest Dry oak – heath forest
Red maple	Red maple forest
Conifers	Dry white pine (hemlock) – oak forest Hemlock (white pine) – northern hardwood forest Hemlock (white pine) – red oak – mixed hardwood forest Red pine – mixed hardwood forest Spruce plantation
Other	Aspen-Grey (paper) birch forest Pitch pine-mixed oak forest Tuliptree-maple forest Black gum ridgetop forest

Table 3.1. Aggregated forest types and dominant plant communities

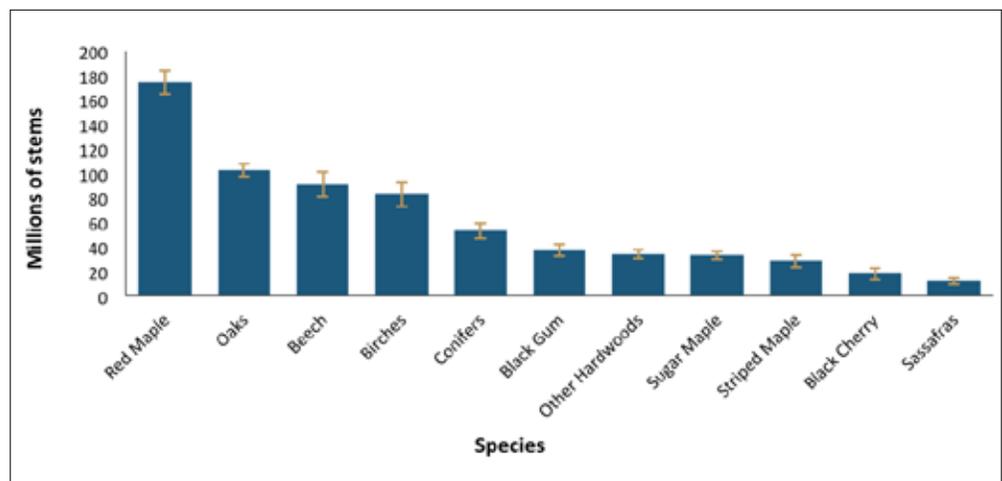


Figure 3.1. Estimated number of overstory and midcanopy stems on state forest land by species or species group. Based on the Bureau of Forestry’s Continuous Forest Inventory. Note: inventory plots are located within Multiple, Limited, and Buffer zones.

Timber Volume

The three completed CFI cycles show that the diameter class distribution has changed in the last 15 years (Figure 3.2). 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.

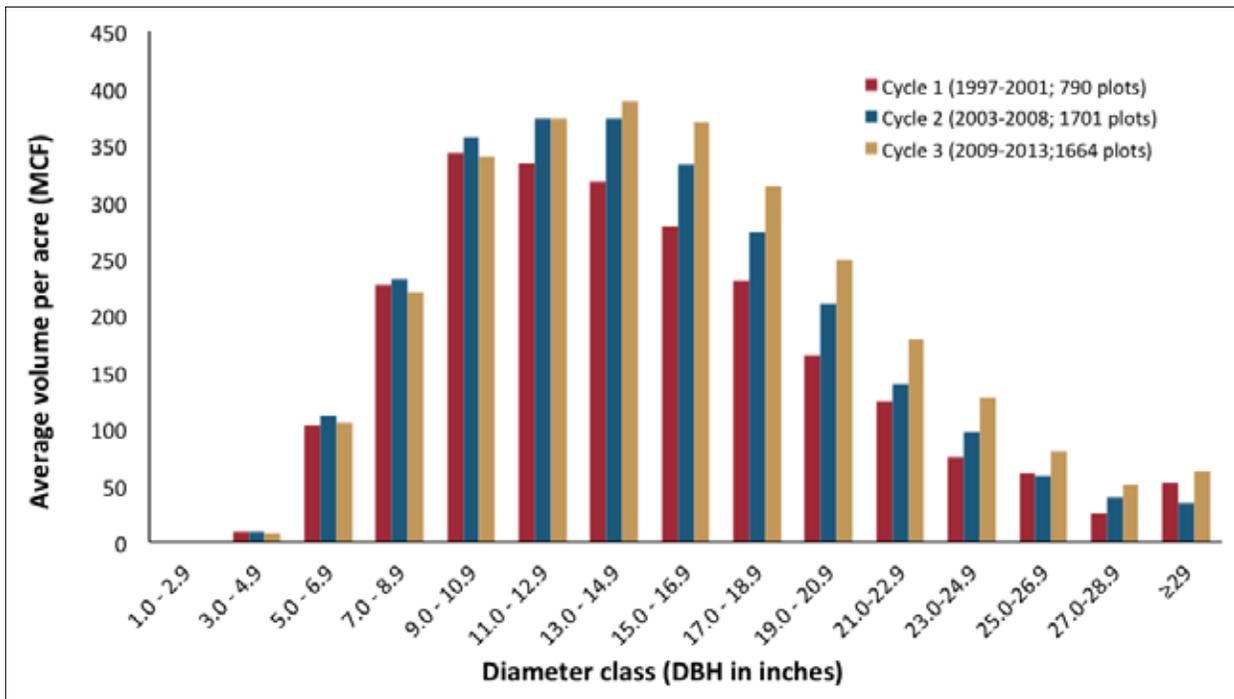


Figure 3.2. Average volume per acre by diameter class on state forest land. The majority of the CFI plots are located in multiple resource, limited resource, and buffer management zones. Note: volume estimates for diameters >11.5 inches dbh do not include volume beyond 8.5 inches dob merchantable height; trees <4.5 inches dbh are omitted from volume calculations.

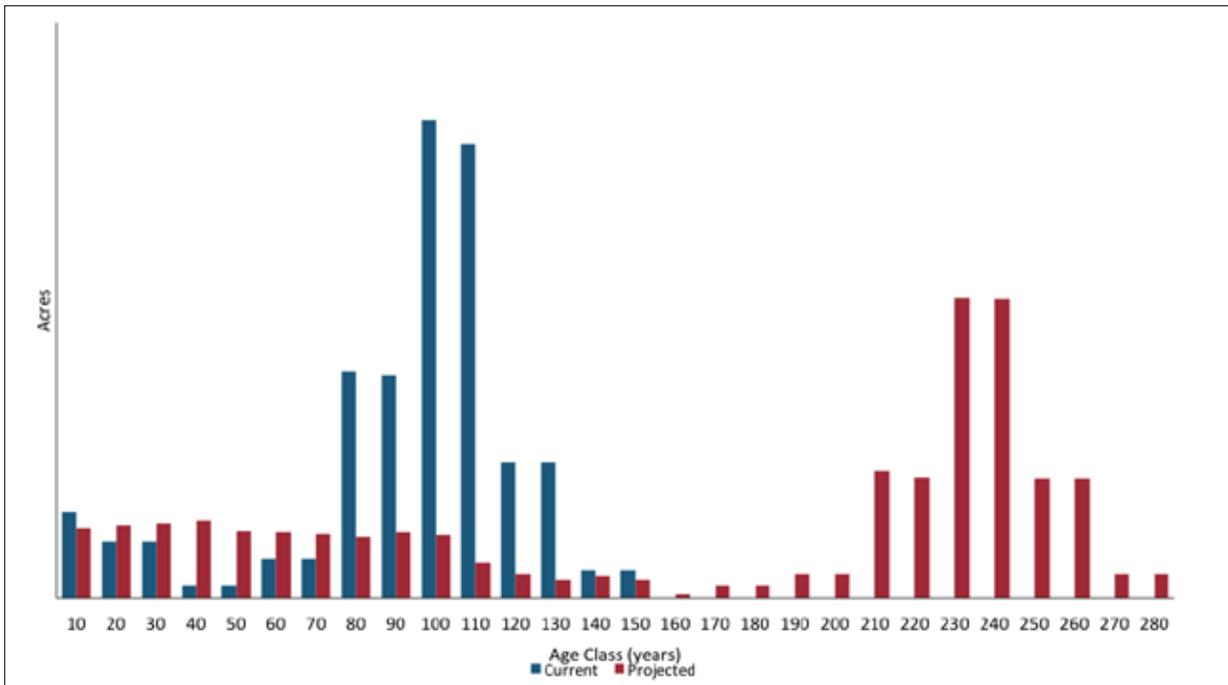


Figure 3.3. A forest district’s current age class distribution in 2014 (blue bars) and the projected age class distribution in the year 2140 (red bars), based on strict implementation of the harvest schedule. Currently, there is an overabundance of acres in the 70- to 100-year-old age classes. In 2140, the acreages are balanced in age classes up to 100 years old, which represent the majority of the multiple resource and commercial (M&C) land base. There is a “tail” of acres in the 100- to 200-year-old age classes. These are acres of the M&C land base that are being managed in extended rotations. The acres in the 200- to 280-year-old age classes are areas that are mostly part of the limited resource, natural area, wild area, and other zones that are not traditionally managed as part of the M&C or aesthetic/buffer-commercial designations; this is the portion of the state forest system that, without active management, will just continue to get older over time.

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.



Treatment	2008	2009	2010	2011	2012	2013	2014	2015
Fence installation	3,034	2,571	1,846	1,936	2,158	1,594	2,677	2,363
Herbicide contract	6,260	6,450	5,262	4,834	5,073	5,776	3,992	4,888
Mowing	553	369	380	537	768	701	505	1,680
Planting	1,374	1,879	4,314	3,995	3,961	4,576	3,795	3,558
District herbicide	2,859	1,373	953	1,776	1,715	918	1,136	499
Fence dismantling	2,688	1,662	2,111	2,802	2,094	1,447	3,099	2578
Prescribed Fire	0	0	113	158	152	598	266	1198

Table 3.2. Acres of regeneration treatments by treatment type and year

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.

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 are generally avoided unless districtwide salvage events, significant changes in typing, land acquisitions, or natural disturbance require a flexible course of action. The bureau focuses on regeneration 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 sets maximum sizes for regeneration harvests, shelterwoods, and other harvests expected to lead to regeneration harvests. The maximum size is 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 sometimes 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 10 to 20 square feet of basal areas (BA) per acre should be maintained across the entire stand area. For all two-aged stands, 20 to 40 BA per 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. 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. 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

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.

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 even-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.

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 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.

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 3.4 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.



Figure 3.4. Comparison of volume harvested to growth. The volume and growth in the figure above show only that of the M&C land base and exclude all other acres of the forest that are not eligible for timber harvesting. If the total land base of all state forest (including wild/natural areas, limited areas, and other non-commercial zones) were to be considered in the graph above, the total forest growth would far exceed the Bureau of Forestry's volume harvested.

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

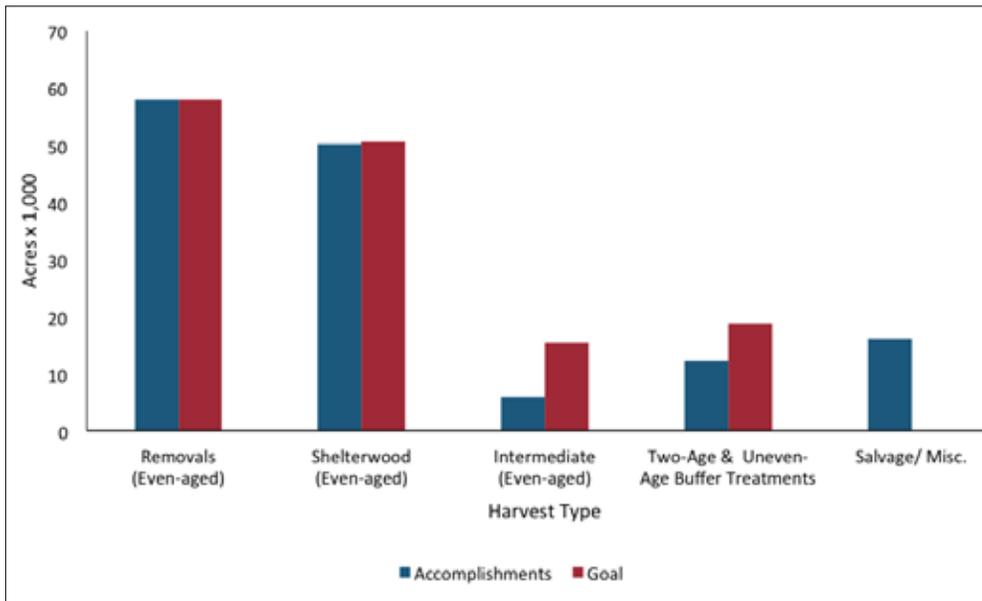


Figure 3.5. Summary of timber harvesting goals and accomplishments 2004 to 2013 (first harvest allocation Period).

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. 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.

Mechanized Harvesting

Mechanized harvesting is the process of removing timber where the operator never leaves the machine. Traditional timber harvesting is done by a logger on the ground, chainsaw felling, and logs are dragged using skidders. In mechanized harvesting, all cutting, skidding and loading is done from the cab of the machine. Timcos, tracked feller bunchers, forwarders and bell harvesters are a few of these types of machines.

The bureau allows mechanized harvesting on all contracts unless they are specified otherwise. Examples of reasons for restricting mechanized harvesting include sensitivity of forest regeneration, soil compaction concerns, or stands where the residual stand is so closely spaced that excessive damage may occur to the remaining forest. In addition, not every job lends itself to full mechanization. Operators may choose not to use mechanized harvesting because of excessively steep slopes, or large trees which may not be

2016 State Forest Resource Management Plan

ANNUAL HARVEST ALLOCATION ACREAGE GOALS FOR PERIOD 2 (2014-2023) BY DISTRICT									
District	Land-base multiple use & commercial (acres)	Even-aged					Two-aged/uneven		
		Over-story removal (acres)	Shelter-wood (acres)	Total volume (bdft. equiv.)	Inter-mediate (acres)	Total volume (bdft. equiv.)	Buffers (acres)	Volume (NBdft Int 1/4")	Total volume (bdft. equiv.)
1	56,599	439	123	3,732,566	43	73,725	225	450,000	699,722
2	36,855	232	189	2,648,343	67	209,162	70	140,000	217,691
3	42,567	264	212	4,481,045	61	189,702	50	100,000	155,494
4	27,037	285	200	3,719,678	20	111,297	50	160,000	215,494
5	38,874	258	172	2,532,824	67	208,162	90	225,000	324,889
6	9,316	80	74	996,515	15	46,648	15	30,000	46,648
7	64,122	415	13	3,549,511	0	0	162	243,000	422,800
8	9,123	81	80	1,455,389	40	124,395	21	42,000	65,307
9	107,092	990	535	9,912,804	370	1,338,183	74	185,000	267,131
10	109,478	874	409	6,640,181	96	202,148	125	187,500	326,234
11	3,886	38	0	288,488	0	0	18	36,000	55,978
12	54,762	520	153	4,571,685	37	55,100	125	187,031	325,765
13	65,384	552	460	7,857,451	22	45,957	25	375,000	402,747
14	964	10	0	83,303	0	0	0	0	0
15	160,692	1,100	681	19,343,079	337	1,221,383	331	662,000	1,029,368
16	86,531	483	383	7,925,444	299	778,852	254	508,000	789,908
17	0	0	0	0	0	0	0	0	0
18	19,743	183	0	1,217,760	0	0	25	25,000	52,747
19	25,777	226	0	1,497,403	55	171,043	64	56,000	127,032
20	60,161	621	33	4,741,439	0	0	155	232,519	404,550
Totals	978,963	7,651	3,717	87,194,908	1,529	4,775,757	1,879	3,844,050	5,929,505

Table 3.4. Timber harvest acreage goals from the harvest allocation model by district and management system including estimated volume

handled by most mechanized fellers and exceed the capacity of the machine. There are also economic considerations. Machinery for mechanized operations are much more expensive than traditional chainsaw felling and skidder operations. This often makes mechanized harvesting cost prohibitive for smaller operators.

There is often a fine line between balancing the desire to make logging as safe as possible with protecting the resource for future generations. Where practical and permissible, the bureau fully supports the use of mechanized equipment.

Whole Tree Harvesting

One method to harvest timber 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, damage to 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.

These harvests should always include practices that lead to healthy forest regeneration. Currently, fewer than 10 percent of all harvests receive a whole-tree harvesting waiver.

Safety

Mechanized harvesting is safer for the operator as the cab offers protection from injury. This is recognized by OSHA and workman's compensation rates are often less expensive for fully mechanized operations.

Since traditional timber harvesting may be required on state forest lands, the bureau utilizes other avenues to promote safety. The bureau requires all loggers on state forest land to have Sustainable Forestry Initiative Professional Timber Harvesting Training. The training program promotes sustainable forest management, operational safety, and skill improvement. It is also a provision of timber contracts that the operator must wear personal protective equipment.

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.

Year	Seedlings distributed
2008	789,505
2009	444,671
2010	487,466
2011	897,465
2012	754,120
2013	473,785
2014	637,156
2015	1,243,681

Table 3.5. Seedlings distributed by Penn Nursery to 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.

2016 State Forest Resource Management Plan



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. All revenue from timber receipts go into the bureau of forestry's operating budget.

Timber sales generate significant revenue for the commonwealth. From 2008 to 2015, Pennsylvania received income from timber sales averaging over \$22 million (Table 3.6). 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.

Year	Sawtimber MBF	Pulpwood HCF	Revenue
2008	48,258	31,090	\$28.9 million
2009	59,382	48,076	\$21.1 million
2010	45,304	38,333	\$23.3 million
2011	43,351	35,987	\$20.9 million
2012	47,000	27,855	\$21.3 million
2013	46,166	64,744	\$20.0 million
2014	42,665	48,848	\$22.1 million
2015	44,105	44,435	\$20.8 million

Table 3.6. Sawtimber volume, pulpwood volume, and revenue from timber sales on state forest lands from 2008 to 2014.

In addition, FSC certification has bolstered the market for pulpwood and lower quality timber, supplementing revenue when sawtimber prices slumped in 2007.

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 3.7a and 3.7b. 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.

Year	Permits	Sawtimber		Pulpwood		Fuelwood		Posts		Sawdust	
		MBF	Receipts	HCF	Receipts	Cords	Receipts	Number	Receipts	Cubic Yards	Receipts
2008	6,905	2,689	\$39,176	258	\$4,080	10,248	\$116,655	508	\$254	1	\$2
2009	6,925	677	\$65,757	1270	\$8,728	9,505	\$147,739	752	\$376	0	\$0
2010	6,637	528	\$51,696	106	\$1,369	9,494	\$148,468	1,172	\$784	0	\$0
2011	6,804	291	\$39,724	342	\$4,655	9,652	\$154,953	1,270	\$635	1	\$2
2012	5,729	244	\$39,362	886	\$6,552	8,024	\$128,127	750	\$375	1	\$3
2013	6,470	276	\$59,197	124	\$2,456	8,916	\$141,389	1,490	\$755	1	\$3
2014	6,718	170	\$41,058	396	\$4,331	9,722	\$201,123	560	\$280	2	\$8
2015	5,550	165	\$37,026	216	\$1,411	8,055	\$167,607	1,340	\$670	56	\$664

Table 3.7a. Receipts for sale of permits to collect or harvest non-timber forest products on state forest lands from 2008 to 2015

Year	Permits	Ground pine		Moss		Stone		Miscellaneous	Totals
		Permits	Receipts	Bushels	Receipts	Tons	Receipts	Receipts	Receipts
2008	6,905	0	\$0.00	0	\$0.00	556	\$1,933	\$42	\$162,142
2009	6,925	0	\$0.00	0	\$0.00	569	\$2,773	\$46	\$225,419
2010	6,637	0	\$0.00	0	\$0.00	642	\$2,706	\$26	\$205,049
2011	6,804	0	\$0.00	0	\$0.00	289	\$1,439	\$203	\$201,611
2012	5,729	0	\$0.00	0	\$0.00	300	\$1,231	\$420	\$176,070
2013	6,470	0	\$0.00	0	\$0.00	105	\$492	\$185	\$204,477
2014	6,718	0	\$0.00	0	\$0.00	120	\$600	\$30	\$247,430
015	5,550	3	\$15	0	\$0	93	\$485	\$35	\$207,913

Table 3.7b. Receipts for sale of permits to collect or harvest non-timber forest products on state forest lands from 2008 to 2015 (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.

Goals	Objectives
<p>1. To promote and maintain desired landscape conditions through planning and implementing appropriate, sustainable timber harvest levels.</p>	<p>1.1 Plan timber 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.</p>
	<p>1.2 Develop and use best management practices that protect forest resources and meet or exceed legal requirements.</p>
	<p>1.3 Maintain or improve overall forest resilience by managing for forest connectivity, native species diversity, genetic diversity, and structural diversity, including desirable commercial species.</p>
	<p>1.4 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.</p>
	<p>1.5 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.</p>
<p>2. To promote natural regeneration of forest communities through sustainable silvicultural practices.</p>	<p>2.1 Conduct regeneration harvests when natural regeneration is present or likely to follow.</p>
	<p>2.2 Use dedicated forest regeneration funds to ensure forest regeneration in areas affected by inhibiting factors.</p>
	<p>2.3 Establish forest cover in areas that failed to regenerate following disturbance.</p>
	<p>2.4 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.</p>
	<p>2.5 Evaluate forest regeneration success following silvicultural treatments.</p>
	<p>2.6 Support research to understand factors impacting natural forest regeneration.</p>

Timber and Forest Products Management Principle Cont.

Goals	Objectives
<p>3. To provide economic and social benefits through a sustained yield of forest products.</p>	<p>3.1 Provide a consistent flow of quality forest products to local, regional, and state economies.</p>
	<p>3.2 Promote the growth of high quality and desirable trees.</p>
	<p>3.3 Ensure that silvicultural operations are compatible with the protection, use, and development of other forest resources.</p>
	<p>3.4 Consider revenues from timber sales and cost to regenerate the site to make timber harvests financially advantageous to the commonwealth.</p>
	<p>3.5 Salvage dead commercial timber only when economically feasible and consistent with silvicultural practices and resource management goals.</p>
	<p>3.6 Promote the sale of Forest Stewardship Council (FSC) certified timber and maintain eligible acreage of state forest land as FSC certified forest.</p>
<p>4. To meet landscape goals by expanding silvicultural practices into areas previously considered economically or operationally unfeasible.</p>	<p>4.1 Conduct timber harvests to benefit wildlife habitat, reduce fuels, and create desired landscape conditions including low value timber, and poor growing sites.</p>
	<p>4.2 Develop recommendations for sustainably managing sites with limiting operational conditions or low economic value to meet landscape and ecosystem management goals.</p>
	<p>4.3 Consider managing a balance of high and low quality sites.</p>
<p>5. To conserve and manage non-timber forest products and consider the sustainability of these resources in allowing public consumption.</p>	<p>5.1 Manage harvest of NTFPs through permits.</p>
	<p>5.2 Develop mechanisms to determine the sustainability of non-timber forest product consumption at the district level.</p>
	<p>5.3 Develop and implement guidelines for harvest restrictions and remedial activities of non-timber forest products.</p>
	<p>5.4 Build and strengthen relationships with partners interested in the conservation of ginseng and other non-timber forest products.</p>

Guidelines, Tools, and Resources

Silviculture Manual

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031030.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031036.pdf

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)

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031038.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031033.pdf

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://www.dcnr.state.pa.us/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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031083.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20029768.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20030071.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20028770.pdf

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

Research Opportunities

- 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 (see also Wildland Fire chapter)
- Evaluation of mechanized harvesting impacts (see also Soils chapter)
- Oak regeneration study
- The potential of soil types to support desirable or undesirable vegetation communities (see also Soils and Native Wild Plants chapters)
- Determination of sustainable population harvest levels for NTFPs
- Research that investigates the effects of inadvertent herbicide applications on native plants and their associated pollinators (from Native Wild Plants chapter)
- Investigation on the allelopathic effects that some non- native, invasive plant species have on native plants and tree regeneration in forest soils (from Native Wild Plants chapter)
- Increase understanding of how deer density and other wildlife factors affect tree regeneration and plant species composition. (from Wildlife chapter)
- Long-term soil impacts of silvicultural activities such as timber harvesting, herbicides, fertilizing, and liming (from Soils chapter)
- Rutting during timber harvests and potential erosion and sedimentation controls related to rutting (from Soils chapter)



4. Native Wild Plants



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 invasive species issues in all ecosystems.

The term “wild plants” comes from the [Wild Resource Conservation Act](#) (WRCA) of 1982 (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 127 [unique plant community types](#), (Zimmerman et al., 2012).

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.

Plant group	Number of species
Trees	83
Shrubs	75
Vines	26
Ferns	30
Grasses	70
Forbs	291

Table 4.1. 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).



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.

Plant communities are groupings of plants that share a common environment and interact with each other, animal populations, and the physical environment. Grouping plant associations into defined communities can provide an efficient starting point for forest inventory and analysis. Maintaining plant communities through various successional stages can serve as a way to establish ecological reference conditions to track changes in community composition and ecosystem function over time. There are 127 classified plant communities found in Pennsylvania, including palustrine and terrestrial types.

The bureau has identified 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 marginally-represented 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 4.2 and Figure 4.1).

Aggregated Forest Type	Dominant Plant Communities
Allegheny hardwoods	Black cherry-northern hardwood forest
Northern hardwoods	Northern hardwood forest Sugar maple-basswood forest
Red oak	Red oak-mixed hardwood forest
Other oak	Mixed oak — mixed hardwood forest Dry oak — heath forest
Red maple	Red maple forest
Conifers	Hemlock (white pine) forest Dry white pine (hemlock) — oak forest Hemlock (white pine) — northern hardwood forest Hemlock (white pine) — red oak — mixed hardwood forest Red pine — mixed hardwood forest Spruce plantation
Other	Aspen-Grey (paper) birch forest Pitch pine-mixed oak forest Tuliptree-maple forest Black gum ridgetop forest

Table 4.2. Aggregated forest types and dominant plant communities

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 4.3. 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.

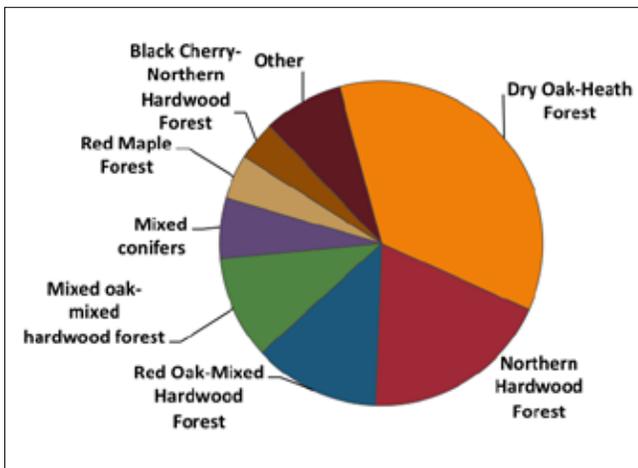


Figure 4.1. Plant community diversity on state forest land. Most of state forest land is comprised of a relatively few plant communities; however, uncommon communities contribute to overall plant species diversity. The “Other” category consists of 37 plant communities and aggregated plant communities, none of which comprises more than 1% of state forest land.

Terrestrial Pollinating Invertebrates

Bees and other pollinating insects are critical to the ecology of most 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. 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 incorporated into management planning to promote these species and biodiversity in natural communities.

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

Table 4.3. General species composition of the dry oak heath community

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, management 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.

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 bureau's mission includes the conservation of native wild plants, the responsibility of implementing Chapter 45 and the WRCA has been the bureau'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 4.4). 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.

The process for classifying native wild plants begins with DCNR identifying questions surrounding a species, taxa, or region of Pennsylvania which is in need of focused botanical 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.

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

Table 4.4. Pennsylvania plant status classifications and their definitions (from Chapter 45 Conservation of PA Native Wild Plants)

A duty set forth by the WRCA is to provide information on the management or conservation needs of classified plants. The bureau carries out this duty by performing environmental reviews for projects potentially impacting classified plants across the commonwealth and providing management recommendations. In addition, the bureau reviews proposals for potential impacts to 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 Conservation Explorer tool. Numbers of classified plant species can be found in Table 4.5. Numbers of ranked plant communities can be found in Table 4.6.

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, with 46 of 86 documented populations occurring on state forest lands.

State forest lands also provide habitat for at least seven plant species that have not been observed elsewhere in the state (Table 4.7). 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. All of these plants are state-ranked S1

Classification	Number of Species listed Statewide	Number of Species found on State Forest Lands
Extirpated	106	0
Endangered	228	47
Threatened	78	25
Vulnerable	3	3
Rare	41	17
Tentatively Undetermined	148	24
Special Populations	0	0
TOTAL	604	116

Table 4.5. Numbers of classified plant species within Chapter 45 regulations

Rank	Number of Plant Communities Ranked, Statewide	Number of Ranked Plant Communities found on State Forest Lands
S1 Critically Imperiled	37	6
S2 Imperiled	25	8
S3 Vulnerable	30	12
S4 Apparently Secure	30	no data
S5 Secure	13	no data

Table 4.6. Numbers of ranked plant communities statewide and on state forest lands. Ranks are according to NatureServe methodology.

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

Table 4.7. Pennsylvania plants which have only been documented on state forest lands

* denotes a globally rare species

+ denotes a population which may be extirpated

(critically imperiled, using [NatureServe methodology](#)), and listed or proposed to be listed as Pennsylvania endangered. Management strategies for rare species can be implemented on state forest lands to ensure their survival.

Management of Native Plants on State Forest Land

The bureau monitors the effects of management activities to adapt strategies to actively conserve native plant communities. Additionally, the bureau creates special designations for plant conservation, such as: some natural and wild areas, wild plant sanctuaries, some high conservation value forests, and other special resource management zones. The bureau manages these sites using appropriate techniques and practices to promote

and improve growing conditions for rare, threatened, or endangered plant species 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 threat to ecosystem health on state forest lands as they can out-compete native species, alter habitats, and disrupt life cycles of native invertebrates. Invasive species 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](#).

Management Approach to Species Diversity

From open areas to mature forests, the state forest system hosts a wide range of vegetation types, and the bureau considers the diversity of vegetation conditions in its ecosystem management approach to state forest land. A mosaic of communities in various successional stages is created by regular management in areas such as multiple resource zones.

Mature forest stands provide habitat for species that are more competitive in areas of closed canopy, lower light, and less competition on the forest floor. The bureau considers these factors in its approach to managing for old growth stands. By providing areas where limited management can occur, such as Natural and Wild Areas, buffers, limited resource management zones, and some HCVPs, the bureau is able to provide places where plant communities and aggregated forest types can exist with minimal human-caused disturbance.

Other vegetation types, such as early successional shrub land, provide a much different set of habitat parameters for species that require periodic disturbance to maintain habitat 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 typically results in more sunlight reaching the forest floor, often 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. 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.

Plant Inventory

The bureau serves as a partner member in the Pennsylvania Natural Heritage Program and 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 rare, threatened, and endangered plant populations, general forest composition, and opportunities to conserve plant diversity through active management.

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. 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, native wild plants are considered in a variety of ways, including presence of rare, threatened, and endangered species, general impacts to common plants, habitat diversity and interspersion, and biological productivity. For all SFERs, it is standard practice to include the results and incorporate the recommendations of a PNFI review for potential impacts on rare, threatened, and endangered species.

Public Wild Plant Sanctuaries

Public wild plant sanctuaries are located on public lands and are designations specifically for management of rare, threatened, and endangered plant species “when deemed necessary to protect wild plant species afforded consideration” under Section 10, Wild Resource Conservation Act. Typically, these areas are chosen due to the presence of viable or exemplary populations of rare, threatened, or endangered plants, unique plant populations in decline and in need of active management, invertebrate special concern species or their host plants, or habitats with high plant species diversity or values.

Public Wild Plant Sanctuaries on state forest lands vary in size from 6 to 600 acres. Management activities at the sanctuaries is varied, but can include annual, intensive monitoring; habitat management such as tree and shrub clearing; or invasive plant eradication.

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 FSC® 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. The bureau is working towards developing genetic guidelines and other assistance for dealing with genetics issues.

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.

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

Guidelines, Tools and Resources

Pennsylvania Conservation Explorer

<https://conservationexplorer.dcnr.pa.gov/>

The Pennsylvania Conservation Explorer (Explorer) is a tool that provides conservation information on biological diversity, protected lands, streams and other natural resources for planning purposes and also allows users to screen a project area for potential impacts to threatened, endangered, and special concern species (PA Natural Diversity Inventory-PNDI-information). A PNDI screening is required for all ground disturbing projects on state forest lands and can be accessed using the Explorer. The Pennsylvania Natural Heritage Program (PNHP) maintains the Explorer and PNDI information, which represents the most current and accurate information available on rare, threatened and endangered species in Pennsylvania.

Planting and Seeding Guidelines on State Forest Lands

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031083.pdf

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)

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031042.pdf

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 HCVPs and state forest lands in accordance with the FSC certification standard. HCVPs related to the conservation of native wild plants 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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/DCNR_008437.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/DCNR_008438.pdf

These HCVF areas represent more than 75 rare, threatened, or endangered plant species. 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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/DCNR_008433.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031037.pdf

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 rare, threatened, and endangered plant species

Research Opportunities

- Continuing research on reclaiming disturbed forested sites, using native grasses, herbaceous species, trees, and shrubs to promote native plant communities and habitat diversity (see also Geologic Resources chapter)
- Careful study of the ecology and threats posed to rare, threatened, and endangered plant species 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. (see also Forest Health chapter)
- Research that investigates the effects of inadvertent herbicide applications on native plants and their associated pollinators (see also Timber & Forest Products chapter)
- Investigation on the allelopathic effects that some non-native, invasive plant species have on native plants and tree regeneration in forest soils (see also Timber & Forest Products chapter)
- The potential of soil types to support desirable or undesirable vegetation communities (see also Timber & Forest Products and Soils chapters)



5. Wildlife



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 habitats 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 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 *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 diverse animal communities in furtherance of bureau’s mission “to ensure the long-term health, viability, and productivity of the commonwealth’s forests...”

Wildlife Diversity on State Forest Lands

Wildlife populations are integral components of ecosystems. 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. Most species are moderately abundant; few are very abundant or very rare.

The different types of land cover found on state forest land, including plant communities, have helped shape the animal diversity found there. Jurisdiction over wildlife species falls under other agencies (Table 5.1), and the bureau works cooperatively with these agencies by managing land and vegetation to benefit an array of species.

	Total Number of species	Number of species on state forest lands
Birds	30	9
Mammals	10	8
Reptiles	9	3
Amphibians	7	3
Fish	45	1
Mussels	40	6

Table 5.2. Wildlife species tracked by PNHP in Pennsylvania and on state forest lands

Threatened and Endangered Wildlife Species

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 5.2), and PNHP maintains records for two species that have only been observed on public lands (including state forest lands): the rock vole and the yellow-bellied flycatcher.

Jurisdictional agency	Animal group	Number of species statewide
PA Game Commission	Birds	414
	Mammals	66
PA Fish & Boat Commission	Reptiles	37
	Amphibians	36
	Fish	217
	Mussels	65
	Non-mussel aquatic invertebrates	>10,000

Table 5.1. Catalog of recognized PA animal species and relevant jurisdictional agency

The Pennsylvania Natural Diversity Inventory (PNDI) is a database that contains known records of species of special concern in the commonwealth. It is also part of 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 threatened and endangered species and develop mitigation or protection strategies for these resources. Although PNDI inquiries 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 among the bureau 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.

Threats to Wildlife Species

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 Habitat on State Forest Lands

Most animals are neither evenly nor randomly distributed across their geographical range, but rather occur in patches in response to the presence or absence of environmental factors. Habitat refers to an area occupied by a particular organism that supplies its needs, including food, structure, water, and ability to reproduce. A mature forest is a major habitat component for some wildlife species, such as scarlet tanager, but not necessarily for others. Likewise, an open herbaceous opening near a forest edge may be utilized by some species but not by others. Furthermore, the habitat concept can be discussed at different scales. For example, the large-scale habitat for a migratory bird species might include its entire migration corridor 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. Management activities should consider habitat at various scales for multiple species.



Habitat Factors on State Forest Lands

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).

Through wild processes and 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 most feasible 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 are also known to use 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.

Barrens

Barrens are lands or plains that grow small trees in sandy or thin soils over bedrock. In Pennsylvania, they are among the least common communities when one considers the current extent as a proportion of historic acreage. They host a variety of wildlife species including: black bears, frosted elfins, prairie warblers, whip-poor-wills, white-tailed deer, and barrens buck moth. Appropriate management strategies for some barrens types, including ridgetop, scrub oak, pitch pine, and serpentine, may include prescribed fire.

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.

Forested 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

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. Maximum diversity may be achieved by providing a mosaic of forest stands at different ages through management.

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 may accommodate different wildlife communities. The amount of wildlife diversity in an ecosystem is often a reflection of the variety and quality of resources across the landscape, and the bureau implements various management techniques to benefit a variety of wildlife.

Inventory and Planning

To assess 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, essential habitat elements, and 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 2015, the Game Commission and Fish & Boat Commission revised the State Wildlife Action Plan. This plan is a non-regulatory, proactive conservation strategy to conserve animal species of greatest conservation need in the state. The bureau uses the plan to identify targets for management activities, such as habitat improvements, and as justification for grant applications.

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

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 shaping forest structure through different management techniques, various local and landscape effects can be produced for wildlife benefit.

Landscape goals should be considered when determining silvicultural prescriptions. For wildlife implications, it is important to identify desired animal species composition and the necessary habitat factors. Silvicultural 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 include mast trees for forage and cavity trees and snags for nesting, roosting, or denning. These 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 Manual, including reservation guidelines, and various wildlife management guidelines contain directional assistance for the managing of lands for the benefit of wildlife.

Prescribed Fire

Prior to the fire suppression laws of the early 1900s, fires were a relatively frequent disturbance on the Pennsylvania landscape. Fire can be 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, a retired area may be managed for the creation of a new ecological function, such as habitat for grassland bird species.

Restoration end goals should be included in management activity pre-planning. Various restoration strategies can be implemented depending on the project phase. For example, interim reclamation may be carried out on sites where operational activity has temporarily halted, or final restoration may be carried out when the activity is finished and will not resume.

Restoration objectives may include 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.

Restoration suggestions for the benefit of wildlife habitat exist in various operational manuals, such as the Guidelines for Administering Oil and Gas Activity on State Forest Lands, and wildlife guidelines, such as Establishing and Maintaining Wildlife Openings.



Habitat Management Plans

Site-specific habitat management plans can direct management in a particular area to create or enhance particular habitats. Early successional habitats are underrepresented due to lack of timber 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.

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 rare, threatened, and endangered species, general impacts to common animals, habitat diversity and interspersion, and biological productivity. For all SFERs, it is standard practice to



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

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

Table 5.3. Reptile and amphibian protection areas on state forest lands and associated natural areas

include the results and incorporate the recommendations of a PNDI review for potential impacts on rare, threatened, and endangered species.

Wildlife Management Areas

Certain areas have been identified to conserve target wildlife species because the area hosts quality habitat or important populations. Habitat guidelines for terrestrial, wetland, aquatic/ riparian, and cave habitats direct the bureau’s normal operation on state forest lands. In conjunction with these guidelines, specific plans may be established for these species and/or areas.

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 (Table 5.3). 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.

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 threatened, or endangered species. These areas have been delineated to identify “hotspots” that include more than 75 plant species and 22 wildlife species (Table 5.4). Managing and monitoring these areas is usually done on a case-by-case basis, and efforts are under way to develop specific management plans. Currently, more than 34,000 acres are designated as ecological focus areas for HCVF.

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

Table 5.4. Wildlife species in ecological focus areas covered by HCVF 1.2 designation



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 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 5.5). The bureau considers the presence of IBAs in its management approach.

Patterned after the IBA project, the [Important Mammal Areas Project \(IMA\)](#) was launched in Pennsylvania in 2001 to conserve habitats critical to mammal survival 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 5.5), where much of the space is conducive to mammal occupancy and a diversity of some unique habitat types can be found.

	Number of areas	Total statewide acres	Acres on state forest lands
IBA	91	2,944,280	672,519
IMA	43	5,398,085	1,635,402

Table 5.5. Important bird areas and important mammal areas in Pennsylvania and on state forest lands.

Wildlife Species Management Plans and Programs

In order to best manage the 2.2 million acres of state forest land and the many wildlife species, the bureau has cooperatively developed many tools, programs, and plans to help consistently manage the forest while conserving habitat for these animal species. Although the diversity of animals on state forest lands is greater than what is mentioned below, the following are species commonly encountered or bear particular cultural significance.



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. To guide management, the bureau implements its White-tailed Deer Plan, and it participates in the Deer Management Assistance Program (DMAP).

Bats

Nine species of bats are known to inhabit Pennsylvania's forests, and bats are integral in managing insect pests and contribute to forest health. As understanding of the relationship between bats and forests increases, the bureau has identified adaptive management strategies to ensure

ecosystem sustainability. As a result of bats' small size and energetic requirements, they 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. Because bat species in Pennsylvania and across North America have suffered significant population declines in recent years, primarily due to white-nose syndrome and habitat loss/fragmentation, conservation and management plans for bat species are 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, 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. The Brook Trout Conservation 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. This species was listed by PFBC as “candidate rare” for a number of years and was recently delisted. However, because of the importance of state forest lands as timber rattlesnake habitat, the bureau developed a plan for the snake's continued conservation. This plan includes how the bureau implements PFBC's recommendations for establishing buffers around den and gestation sites as well as recommendations for identifying new sites, assessing new records, and improving habitat quality.

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. 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.

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.

Goals	Objectives
1. To conserve and enhance a diversity of wildlife habitat types across the landscape.	1.1 Consider landscape-level habitat conditions during management activities.
	1.2 Identify fundamental wildlife habitat types to serve as examples for effective management.
	1.3 Inventory and monitor fundamental wildlife habitats that are at risk of degradation and develop strategies for prioritizing management of these areas.
	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 threatened and endangered wildlife species.	2.1 Ensure that management activities avoid impacts to threatened and endangered wildlife species and their habitats.
	2.2 Conduct inventories for new or existing populations of state or federally listed wildlife species and their habitats.
	2.3 Develop and implement plans for the protection and viability of threatened and endangered wildlife species and their habitats.
	2.4 Provide training to district staff on species natural history and identification and report new locations for threatened and endangered species.
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

Pennsylvania Conservation Explorer

<https://conservationexplorer.dcnr.pa.gov/>

The Pennsylvania Conservation Explorer (Explorer) is a tool that provides conservation information on biological diversity, protected lands, streams and other natural resources for planning purposes and also allows users to screen a project area for potential impacts to threatened, endangered, and special concern species (PA Natural Diversity Inventory-PNDI-information). A PNDI screening is required for all projects requiring a state forest environmental review (SFER) and can be accessed using the Explorer. The Pennsylvania Natural Heritage Program (PNHP) maintains the Explorer and PNDI information, which represents the most current and accurate information available on rare, threatened and endangered species in Pennsylvania.

Planting and Seeding Guidelines on State Forest Lands

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031083.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/DCNR_008438.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20027101.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20027100.pdf

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.

Draft Bat Habitat Conservation Plan

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20028770.pdf

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.pgc.pa.gov/Wildlife/HabitatManagement/Pages/ImportantMammalAreas.aspx>

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://fishandboat.com/promo/grants/swg/swap/final2015/SWAP-CHAPTER-0-Intro.pdf>

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 threatened and endangered species.



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)

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031030.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031027.pdf

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

Research Opportunities

- Increase understanding of how deer density and other wildlife factors affect tree regeneration and plant species composition. (see also Timber & Forest Products and Forest Health chapters)
- Define a target percentage of forest plots that should contain an indicator species. (see also Forest Health chapter)
- Differentiate between elk and deer damage in order to better understand how to manage these species on state forest lands. (see also Forest Health chapter)
- 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. (See also Wildland Fire chapter)



6. Water Resources



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 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 6.1). 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 6.1).

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

Total	EV	HQ	CWF	HQ-TSF	TSF	WWF
4,996	1,528 (30.6%)	2,699 (54%)	639 (12.8%)	3 (0.1%)	90 (1.8%)	36 (0.7%)

Table 6.1. 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.

	Natural lakes and ponds	Human-made impoundments
Number	38	61
Acres	374	1,317

Table 6.2. 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](#) and [Bureau of Clean Water](#) 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 and monitoring 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. As of 2016, 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 6.3).

Total	AMD	AD	Ag	PCB & Hg	Misc
491	226	215	21	19	10

Table 6.3. 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 = Polychlorinated biphenyl or mercury; Misc = Unknown and “road runoff”

Palustrine Plant Community Classification

The Pennsylvania Natural Heritage Program recently updated the palustrine (wetland) section of the Terrestrial and Palustrine Plant Communities of Pennsylvania, 2nd ed. (Zimmerman et al. 2012), which incorporated over a decade’s worth of new plant community data and classification information. The classification of palustrine plant communities helps identify high priority plant communities for protection, better defines their state-wide distribution, and supports the planning, protection, and restoration efforts for wetlands and related water resources.

2016 State Forest Resource Management Plan

On state forest lands, palustrine plant communities include wetlands, active floodplains, 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 6.4).

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.

Palustrine forest types	Acres
Black spruce - tamarack peatland forest	100
Bottomland oak - hardwood palustrine forest	399
Hemlock - mixed hardwood palustrine forest	7,829
Hemlock palustrine forest	3,396
Miscellaneous palustrine/floodplain forest	1,374
Red maple - black ash palustrine forest	8
Red maple - black gum palustrine forest	1,581
Red maple - elm - willow floodplain swamp	7
Red spruce - mixed hardwood palustrine forest	228
Red spruce palustrine forest	1,397
Silver maple floodplain forest	1,276
Sycamore - river birch - box elder floodplain forest	575
Subtotal – palustrine forest	18,170
Palustrine woodland, shrubland, and opening types	
Bog/fen	641
Emergent wetland	2,888
Palustrine scrub/shrub	3,869
Palustrine woodland	5,713
Subtotal – palustrine woodland, shrubland, and openings	13,111
Total – palustrine and wetland communities	31,281

Table 6.4. Acres of palustrine and wetland communities on state forest lands

Water Resource Protection and Enhancement

Aquatic Habitat Buffer Guidelines

The bureau has established aquatic habitat buffer guidelines to protect areas around wetlands, vernal ponds, spring seeps, streams, lakes, ponds, and impoundments from management activities that might affect such ecosystems. These guidelines provide a standard set of operating procedures to be followed when conducting management activities in or near aquatic habitats on state forest land. The aim is to promote terrestrial factors that will positively influence aquatic health. Management efforts are intended to focus on providing connectivity, wildlife habitat, and protecting water quality. The following guidelines apply to all aquatic habitat buffers:

- Earth disturbance activities should be avoided whenever possible.
- Snags and cavity trees should be retained as they provide exemplary habitat for bats, woodpeckers, and other cavity nesters.
- Dead and downed woody material should be retained. It creates critical microhabitat for many species and provides large reservoirs of organic matter needed for nutrient cycling.
- If possible and where appropriate, aquatic habitat buffers should be linked to provide connectivity for wildlife.

The width of aquatic habitat buffers varies for different habitat types. For example, widths are greater for Exceptional Value versus High Quality streams. Each buffer has both an inner zone and outer zone. The inner zone functions as a core area of protection that allows minimal human disturbance. For instance, tree cutting is only permitted in the inner zone for the protection of property or human safety or to occasionally recruit habitat factors that will positively affect the aquatic ecosystem. The outer zone functions as a transition area. The goal of this zone is to maintain a diverse community of tree, shrub, and herbaceous plants and vertical stratification.

Aquatic Organism Passage

Aquatic organism passage through stream corridors, including intermittent streams, is vital to the health of aquatic communities by providing connectivity. Connectivity is important for dispersal and access to suitable habitat such as spawning areas and colder water refugia.

Aquatic organisms can experience difficulty in passing road culverts depending on the characteristics of the culvert. Common problems with culverts are blockages, being undersized, and not being installed properly. The bureau has Culvert Best Management Practices that will minimize the impacts of stream culverts on aquatic ecosystems. The Bureau of Forestry is also piloting a stream culvert assessment program. Culverts will be assessed, yielding data on the condition of stream crossings on state forest land in regards to aquatic organism passage. The data will be used to determine if the crossing is a barrier to organism passage, and if so, to what extent. This information will help the bureau prioritize culverts for replacement or repair.

Stream Restoration

The bureau works with partners to improve and restore stream habitat on state forest land. Some of these projects include instream habitat improvement, dam removal, and riparian plantings.

Introduction of Large Woody Debris

Due to previous timber harvesting practices, many of the streams on state forest land lack the large woody debris component normally found within mature, forested landscapes. This woody debris can be a beneficial habitat component for the aquatic community, including brook trout. Large woody debris can increase habitat diversity in a homogenous stream reach by creating scour and plunge pools, providing escape cover for trout, and providing substrate and food for aquatic invertebrates on which the trout feed. Large woody debris will naturally fall into streams, given time for the trees in riparian buffers to mature, die or blow-over, and eventually fall into the

stream. Until then, large woody debris can be added to streams where habitat diversity is lacking by directionally felling trees into the stream channel. The bureau, in cooperation with other agencies, is presently piloting projects that introduce large woody debris into streams that lack habitat diversity.

Forest Hydrology Studies

Hydrologic processes are important for forests not only for runoff and streams but also for forest floor and wetland ecosystems. Changes in hydrology can be caused by differing management techniques and infrastructure development. The bureau is currently looking at surface hydrology (wetness index) models to understand and plan gas development impacts, as well as to decipher water pathways important to wetlands, streams, and surrounding upland connectivity. The bureau is working with DEP and the Pennsylvania State University to better map and understand these changes in forest hydrology.

Erosion and Sedimentation Control

Erosion and sedimentation is a concern for aquatic ecosystems. New disturbances that remove existing vegetation, such as gas pads, parking lots and in particular, dirt and gravel roads, if not managed properly can be a source of increased runoff, erosion, and ultimately sedimentation. Surface water that is diverted from its natural course changes the adjacent soil moisture regimes potentially impacting vegetation, invertebrate, amphibian and reptile demographics. The bureau is examining how surface water management, including Post-Construction Stormwater Best Management Practices, may be impacting aquatic and terrestrial ecosystems. The bureau works closely with the Penn State Center for Dirt and Gravel Road Studies to develop and implement environmentally sensitive maintenance practices in order to greatly reduce the risk of erosion and sedimentation while maintaining natural surface flow patterns. These practices can also be used in the bureau's management of trails and other infrastructure.

Brook Trout Conservation Plan

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. The bureau has developed a Brook Trout Conservation Plan that establishes goals and objectives for brook trout conservation, provides an assessment of the most important threats, and recommends management actions for goal achievement.

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.

Water Management Principle

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

Goals	Objectives
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 Identify and prioritize dams for removal to restore natural stream flow and connectivity.
	2.5 Assess and then 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 Attempt to secure funding for remediation and monitoring of prioritized projects.
	5.3 Build and strengthen relationships with watershed groups interested in addressing impaired waters.

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031027.pdf

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.

Culvert Best Management Practices

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031930.pdf

This document provides guidance on how to properly size and install culverts to ensure aquatic organism passage at stream crossings.

Large Woody Debris Introduction Practice

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031933.pdf

This guidance addresses aquatic ecosystem restoration and habitat improvement by adding large woody debris to streams.

Brook Trout (*Salvelinus fontinalis*) Conservation Plan

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20027100.pdf

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.

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

Research Opportunities

- Monitoring Marcellus and other shale-gas development impacts on surface and groundwater resources (see also Geologic Resources chapter)
 - 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 (see also Geologic Resources chapter)
- Baseline chemical analysis data for lakes, ponds, and streams
- Aquatic life use inventories (see also Geologic Resources chapter)



7. Soils



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. *Penn’s Woods* 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 Center for Dirt and Gravel Road Studies 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 7.1 and Figure 7.1 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.



Soil order	Dominant characteristics	Acreage of state forest lands
Inceptisols	Soils with weak to moderate layer/horizon development; common on steep slopes	1,235,028
Ultisols	Acidic, highly weathered soils, typically with clayey subsurface layers	851,498
Alfisols	Similar to Ultisols, but more fertile and only slightly to moderately acidic	39,032
Spodosols	Sandy, acidic, leached soils; typical of coniferous forests	29,314
Entisols	Little to no layer/horizon development; commonly found in flood plains or unconsolidated deposits	24,690
Histosols	Organic-rich soils; common in wetlands	7,236
Mollisols	Very deep and dark surface layer; common in grasslands	181
Not Defined	Soil order not defined in NRCS data	17,751

Table 7.1. Soil orders occurring on state forest land, based on NRCS data

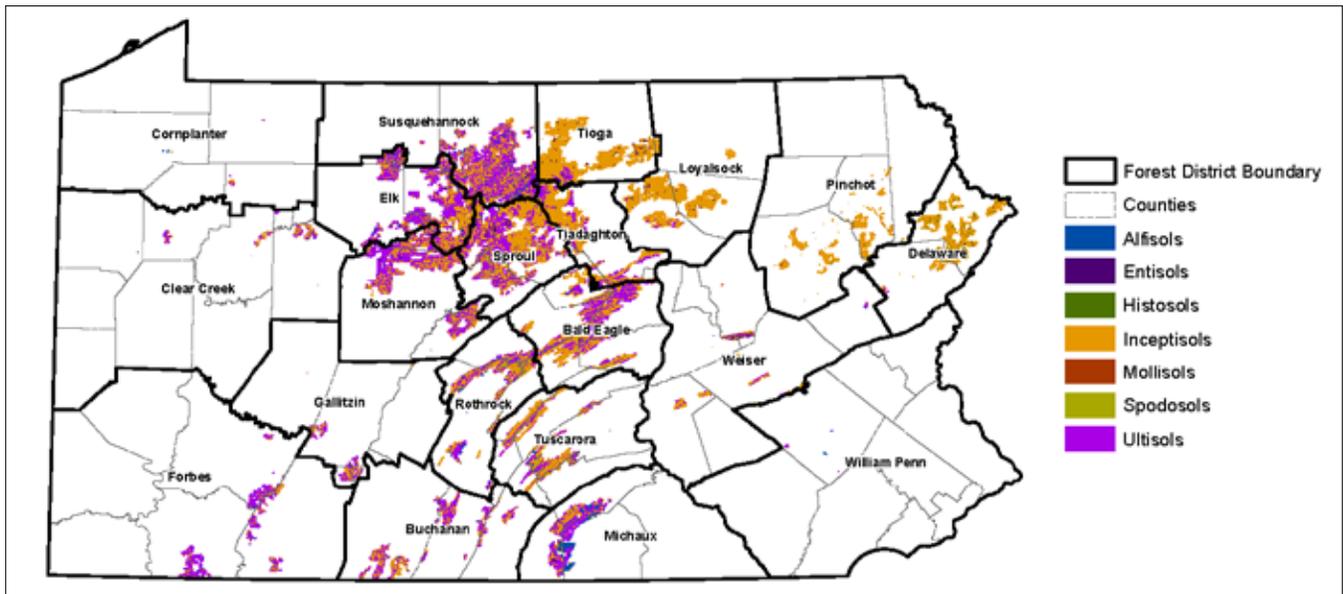


Figure 7.1. Map of soil orders on state forest land, based on NRCS data. Soils on state forest land are predominantly Inceptisols and Ultisols, with Michaux District having a significant proportion of more fertile Alfisols. Spodosols and Entisols tend to be scattered throughout state forest land in lower 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.

Goals	Objectives
<p>1. To manage state forest lands in a manner that soil quality and ecosystem integrity is maintained or improved.</p>	<p>1.1 Identify and address soil limitations, such as poorly drained soils, compactable soils, rocky soils, and highly erodible soils, when planning management activities.</p>
	<p>1.2 Implement and improve best management practices and guidelines relating to soil impacts during management activities.</p>
	<p>1.3 Manage road system and other infrastructure to minimize risk for erosion, sedimentation, compaction, or drainage problems.</p>
<p>2. To use information on soil properties, quality, and limitations when determining appropriate management activities for desired vegetation communities.</p>	<p>2.1 Assess and improve data resources regarding soils.</p>
	<p>2.2 Determine the potential of soils to support desirable and undesirable vegetation communities and work this understanding into management planning.</p>
	<p>2.3 Continue to fund research to understand biotic and abiotic soil dynamics, particularly effects on tree regeneration and other plant community establishment.</p>
<p>3. To address existing soil quality problems on state forest lands.</p>	<p>3.1 Identify, characterize, and inventory existing soil problems on state forest lands.</p>
	<p>3.2 Develop remediation strategies and best management practices for dealing with problems relating to soils.</p>

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031030.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20028601.pdf

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

Research Opportunities

- Methods for improving soils that have experienced long-term impacts (e.g. mining and gas development) (see also Geologic Resources and Forest Health chapters)
- The potential of soil types to support desirable or undesirable vegetation communities (see also Timber & Forest Products and Native Wild plants chapters)
- Appropriate soil evaluation/sampling protocols for foresters to use in field assessments (e.g., CFI or landscape exams)
- Long-term soil impacts of silvicultural activities such as timber harvesting, herbicides, fertilizing, and liming (see also Timber & Forest Products chapter)
- 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 (see also Geologic Resources chapter)
- Rutting during timber harvests and potential erosion and sedimentation controls related to rutting (Timber & Forest Product chapter)
- Evaluation of mechanized harvesting impacts (from Timber & Forest Products chapter)



8. Geologic Resources



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 were prepared by the Bureau of Topographic and Geologic Survey.

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. Following the Alleghanian orogeny, this was an area of grand mountain ranges. After millions of years of erosion, rolling hills are the only remnants of that early grandeur.

The next province moving inland, the Ridge and Valley, contains one of Pennsylvania's most distinctive landscapes.

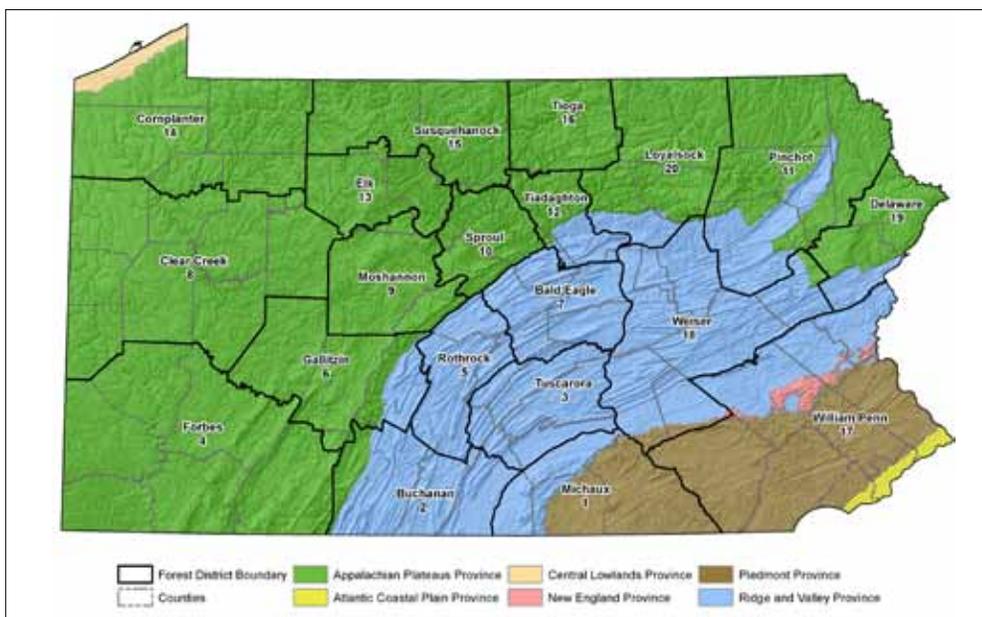


Figure 8.1. Physiographic provinces of Pennsylvania

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

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 Conservation Explorer 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, 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.

PNDI classification	Number of PNDI sites
Erosional remnant	21
Kettlehole	3
Springs	5
Waterfalls and rapids	3
Total	32

Table 8.1. 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 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 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, moderately over-pressured 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, over-pressured 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

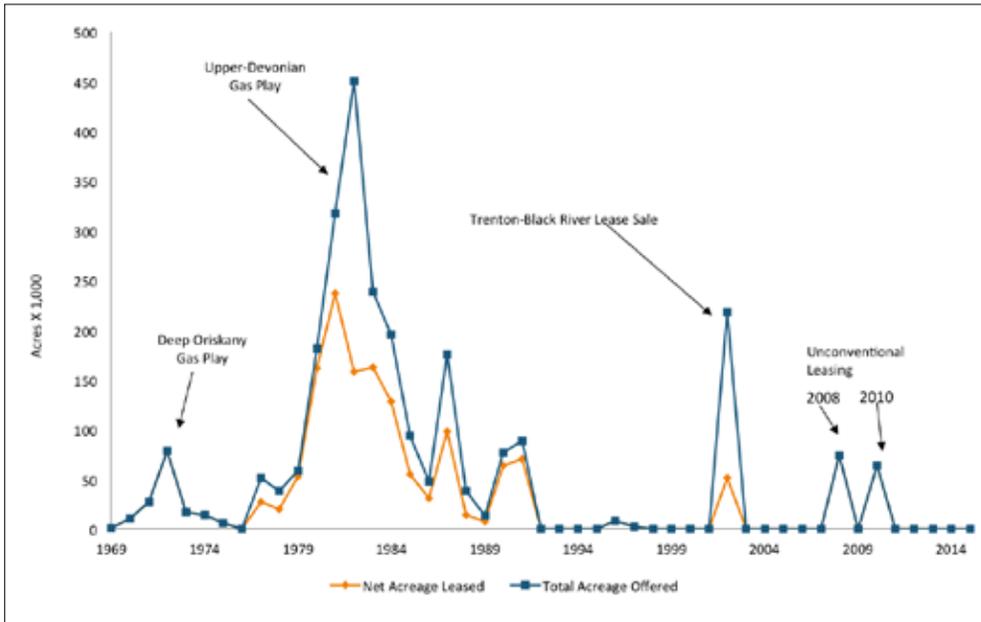


Figure 8.2. Historical oil and gas lease sales by acreage

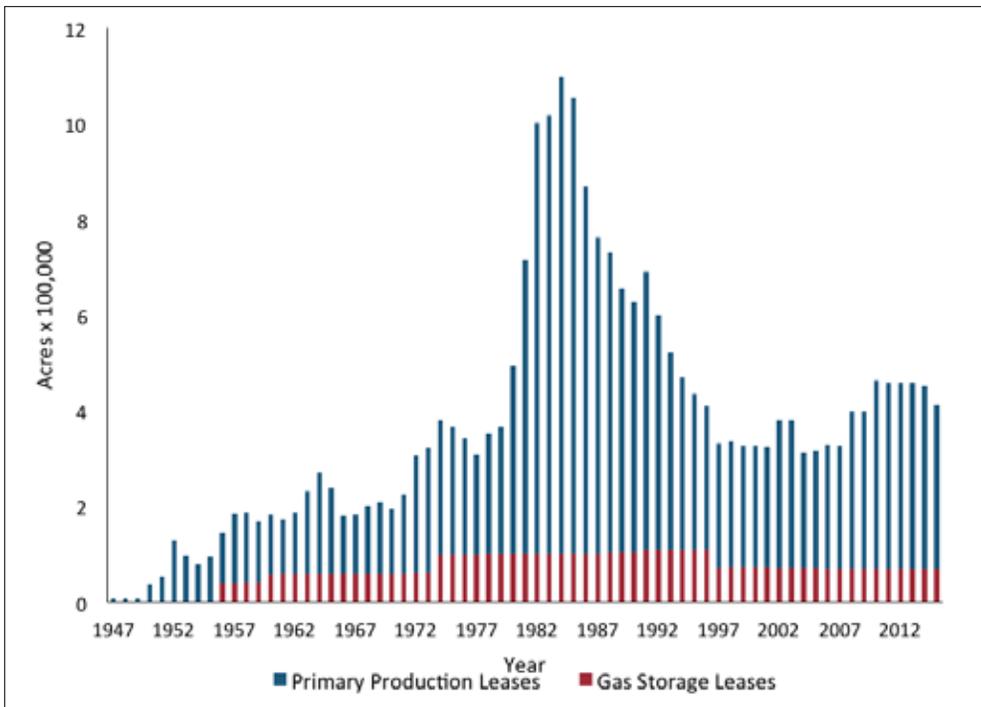


Figure 8.3. Historical oil and gas lease sales by acreage

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. Commercial development of low permeability, organically-rich shale requires the use of technologically advanced, or "unconventional," extraction processes. 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 shale-gas development 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 issued that states: "As of the date of this Executive Order, to protect 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."

In support of the Executive Order, DCNR has developed a [position statement](#) that outlines how DCNR addresses natural gas development on state forest and state park lands. The position statement reflects ongoing work by DCNR and incorporates public input received during the SFRMP revision process. The position statement expresses that DCNR will not permit additional oil and natural gas leases on state forest and park lands where DCNR controls the subsurface rights.

Oil and Gas Revenue

Since the inception of the oil and gas leasing program in 1947, the ability to issue leases set out in the Department's statutes has allowed the bureau to derive revenue from leasing for oil, gas, coal, and hard minerals extraction. Figure 8.4a illustrates the income streams realized by the department from 1947 through 2008 on an annualized basis for oil and gas rentals, gas storage rentals, and gas royalty paid to the commonwealth. The cyclical nature of the graph is related to different gas plays that were in demand at particular times. In the case of the Deep Oriskany sandstone gas play, most of the gas fields discovered and produced on state forest lands by 1960 were converted to gas storage. The bureau benefited from having the three largest gas storage fields east of the Mississippi River on its lands, which have produced consistent income over the years. The third cycle is the unconventional Marcellus gas play, which began for the bureau with the 2008 competitive lease sale shown as the first spike in income in 2008.

Figure 8.4b illustrates the combined income streams from 1947 to 2015, which includes the income for the first seven years of the unconventional Marcellus gas play. The left scale of income has changed from less than \$14,000,000 maximum in Figure 8.4a to over \$250,000,000 maximum in Figure 8.4b, which is reflective of the large income effect of the Marcellus gas play. Also, the previous years' income is dwarfed to near insignificance by the Marcellus effect. The total income to the Commonwealth through 2015 for the oil and gas leasing program is \$1,086,927,946 in actual dollars. To put the economic impact of this long running program into perspective, the program income since 1947, adjusted for inflation, is just over \$2 billion. The future benefits are also expected to be significant and continue for decades into the future.

Oil and gas leasing revenue goes to the Oil and Gas Lease Fund. Portions of this fund are used for department operations and special projects, such as infrastructure improvements and land acquisitions.

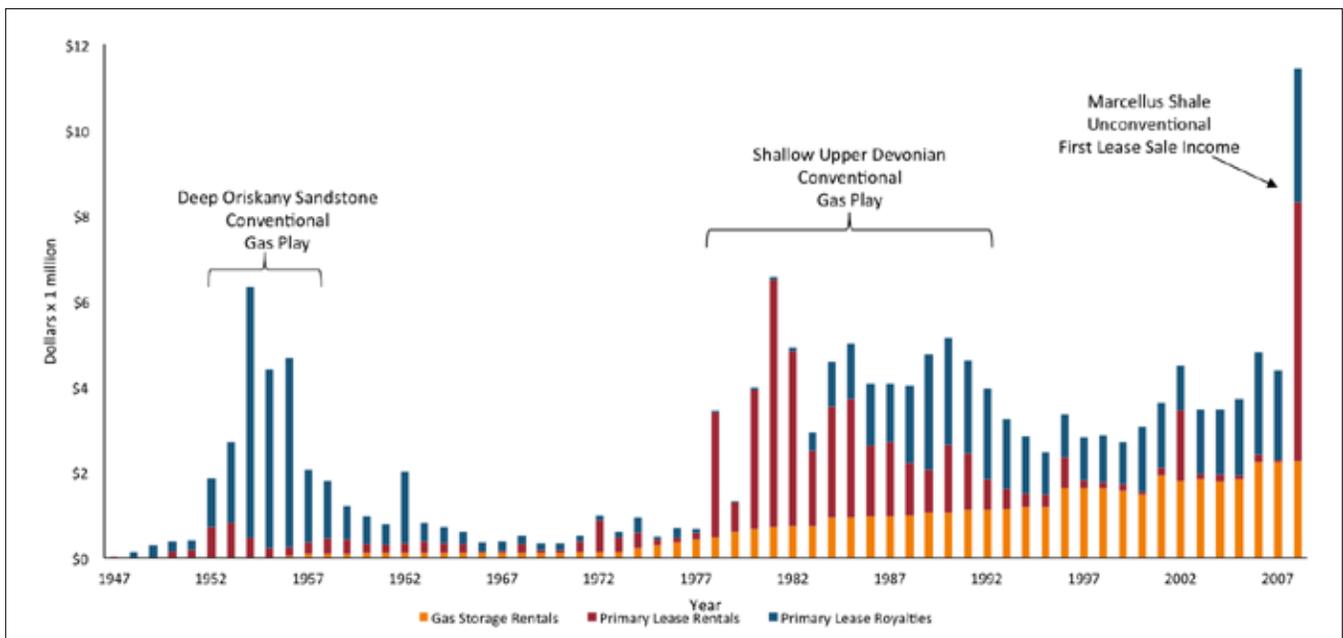


Figure 8.4a. Historical department Income streams for oil and gas rentals, gas storage rentals, and gas royalty paid to the commonwealth.

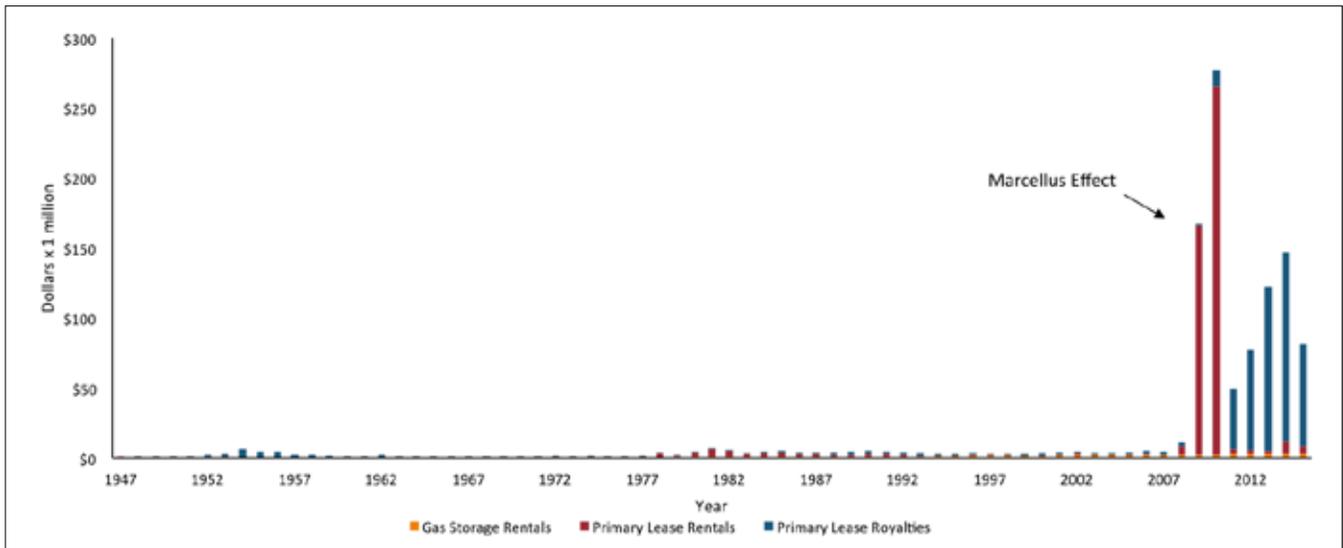


Figure 8.4b. Combined income streams from 1947 to 2015, including the first seven years of the unconventional Marcellus gas play.

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 economically viable. 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

Of the 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

As of 2016, the bureau currently has 123 oil and gas leases on state forest lands. These leases encompass approximately 301,136 acres, primarily in northcentral Pennsylvania.

Status	State-Wide Acreage	Shale-Gas District Acreage
Leased for Gas Storage, Fee Simple	36,525	33,728
Leased for Development, Fee Simple	264,611	257,868
Severed Subsurface Ownership	347,258	294,329
Unleased, Fee Simple	1,556,167	812,403

Table 8.2. Lease status and ownership of state forest oil, gas, and mineral rights both state-wide and within shale-gas districts. Development is considered unlikely in areas leased for gas storage. Area indicated as severed includes fractional interests. Data is subject to change as the bureau conducts additional research on ownership.

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

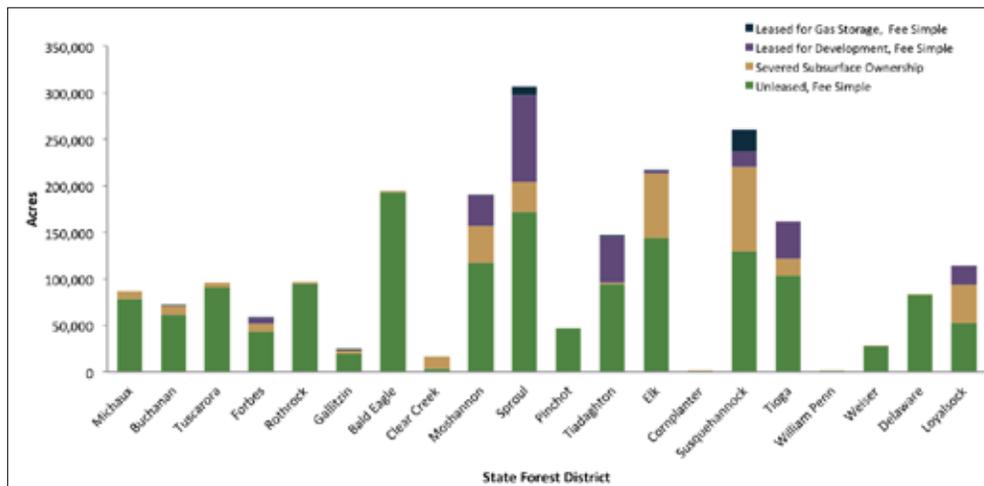


Figure 8.5. Lease status and ownership of state forest oil, gas, and mineral rights by district. Total height of bar represents total acreage in the district. Colors represent proportion of that acreage in various ownership situations, whether unleased fee ownership, leased fee ownership, leased as gas storage, or severed ownership.

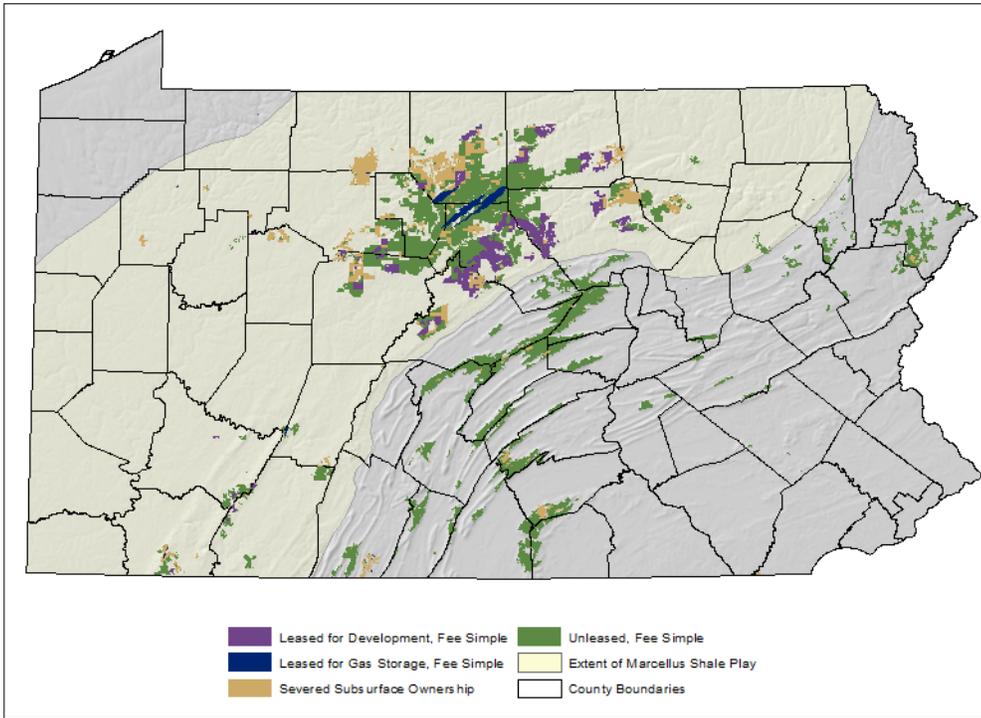


Figure 8.6. Map of state forest oil, gas, and mineral rights ownership

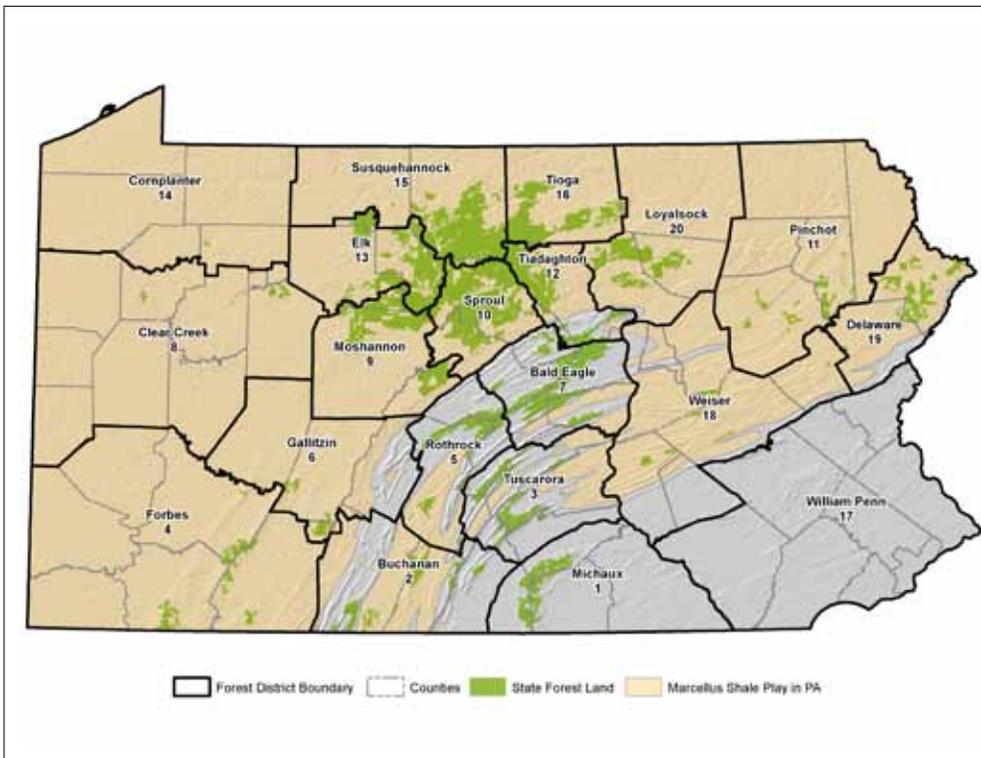


Figure 8.7. Overlay of state forest land and the Marcellus Shale

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. In 2016, oil and gas operators drilled and completed 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

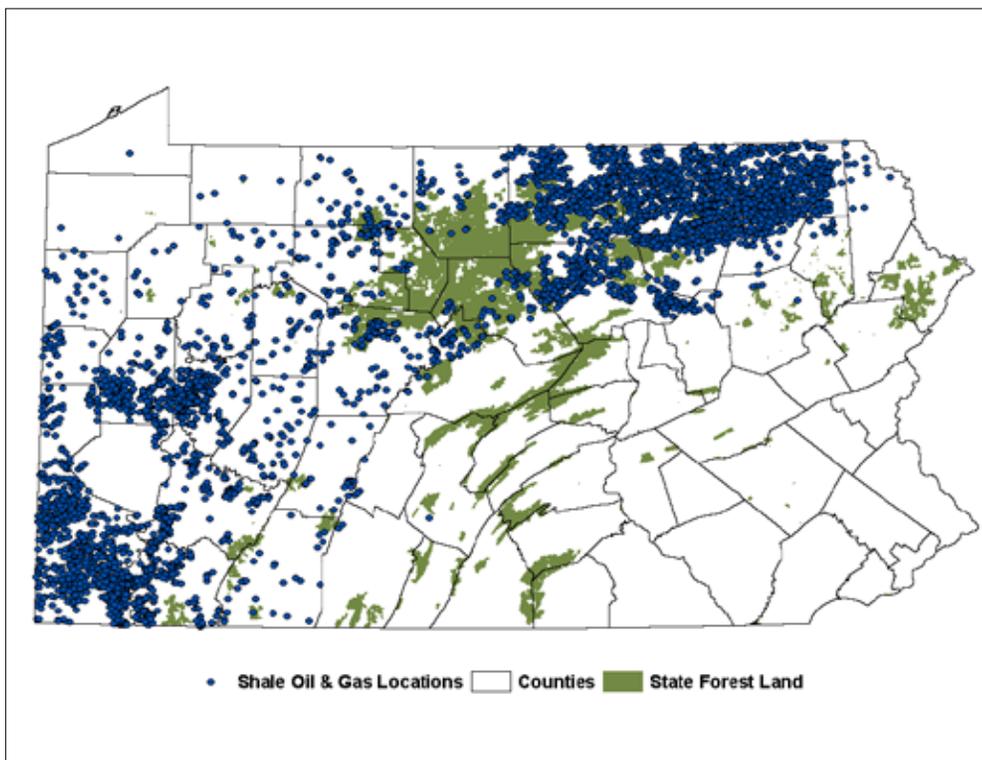


Figure 8.8. Overlay of unconventional oil and gas wells with state forest land

and bridges, increases 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.

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 once all applicable permits have been obtained and final approval has been received 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 various distances from certain important features, such as buildings, bodies of water, and trails or roads.

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. The bureau has developed Guidelines for Administering Oil and Gas Activity on State Forest Lands to provide best management practices for the development of this infrastructure.

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 compressor stations 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 consistency 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 or recreational resources, as well as the method of water transport, expected duration of the withdrawal, and the volume of the withdrawal. Each request for a water withdrawal is evaluated on a case-by-case basis. 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.

The bureau has site rehabilitation guidelines for gas infrastructure in its Guidelines for Administering Oil and Gas Activity on State Forest Lands. All site rehabilitation must be approved by the bureau before the activity is undertaken, and the bureau provides or approves a custom plan at the time it is required. DEP has the regulatory primacy on when stabilization is to occur, but the bureau specifies the details of additional site rehabilitation projects. Reclamation and restoration activities on state forest lands require the use of native warm season grasses, wildflowers, shrubs, and trees to provide additional habitat value to disturbed sites. The bureau requires its land to be restored in such a manner that the lands transition back into a productive forest or other desired habitat.

All gas leases have the requirement for the lessee to provide bonding for performance and well plugging. This bonding is aside from and in addition to any regulatory bond the DEP, SRBC, or other government agency may require in PA. There are two types of bonding required by all gas leases. The first is performance bonding for general liability for financial and damages coverage, and the second is well plugging bonds for specific wells and amounts. The performance bonds are general in nature and may be called for unpaid obligations, uncompensated damages, disputes involving facility installation or removals, and final lease termination general cleanup obligations. For the approximate 100 leases in effect, DCNR has a total of \$7,465,000 in performance bonds on file, or approximately \$75,000 per lease contract. The well plugging bonds on file cover approximately 600 shale-gas wells and 400 older shallow conventional wells. Each shale well is required to have \$100,000 plugging bonding on file and the older conventional wells vary with depth from \$10,000 each to \$50,000 each to be on file. DCNR is holding a total of \$65,292,500 plugging bonding on file currently, which is calculated to be sufficient to address any well abandonment

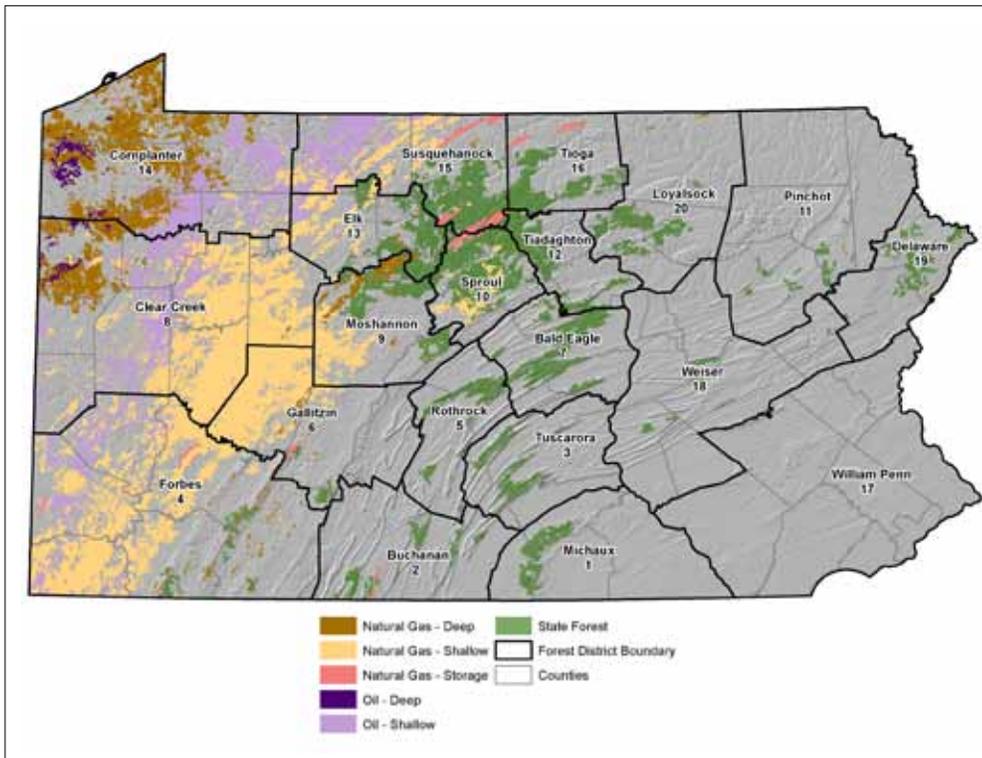


Figure 8.9. Overlay of conventional oil and gas fields and state forest lands

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.

issues for its leasing program. As new wells are drilled and produced more bonding is required to be added to the total.

Status of Conventional Oil and Gas Development

Development of conventional oil and gas fields, as defined in Act 13 of 2012, 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 on severed lands within 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. A significant number of these wells have become uneconomic or ceased production altogether and have been plugged and abandoned.

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

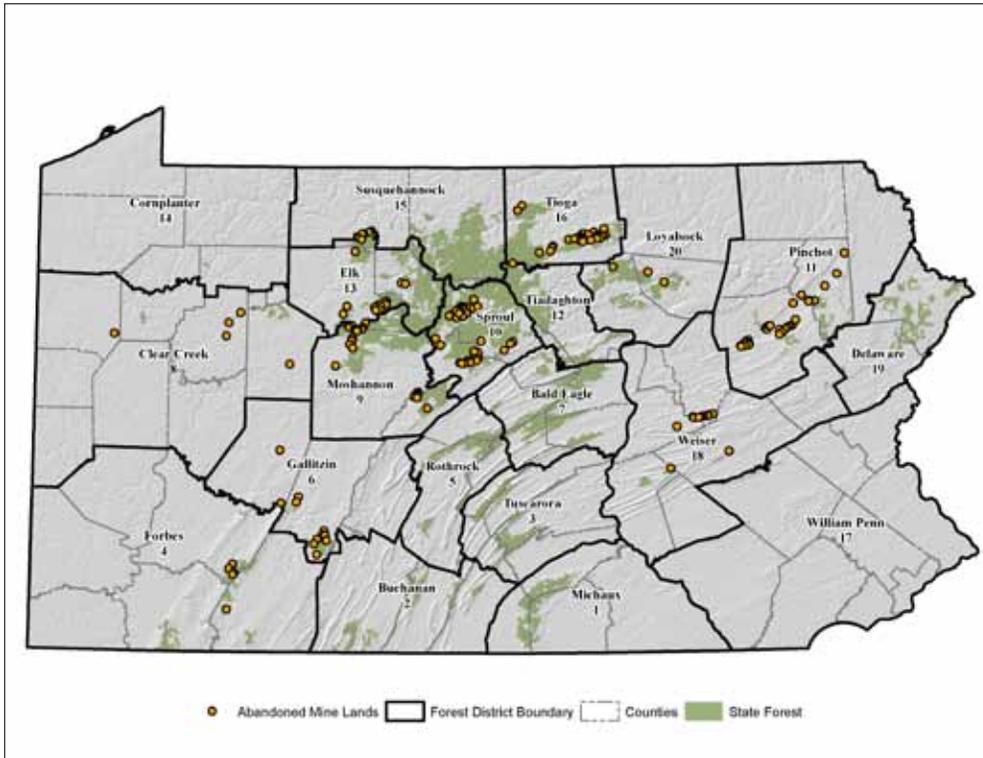


Figure 8.10. Abandoned mine lands on state forest lands

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 re-mining and reclamation interest in the coal industry.

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 re-mine 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.

Geologic Resources Management Principle

Subsurface geologic resources and unique geologic features on state forest lands are managed to provide long-term benefit to the citizens of the commonwealth while adhering to the principles of ecosystem management.

Goals	Objectives
<p>1. To allow no new leasing for oil and gas development on state forest land subject to future advice and recommendations by DCNR.</p>	<p>1.1 Manage the ongoing extraction of oil and natural gas, from existing leases and severed lands, by implementing best management practices and careful oversight.</p> <p>1.2 Continue the shale-gas monitoring program to assess potential effects of shale-gas development on state forest resources, uses, and values.</p> <p>1.3 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.</p>
<p>2. To provide technical guidance and oversight when geologic resources are developed on state forest lands.</p>	<p>2.1 Monitor the effects of shale-gas development on state forest resources, uses, and values, and continuously adapt guidelines based on monitoring results and other experiences.</p> <p>2.2 Continuously adapt guidelines based on monitoring results and other experiences.</p> <p>2.3 Communicate and promote the use of current best management practices consistent with bureau guidelines.</p> <p>2.4 Enforce current lease terms and conditions.</p> <p>2.5 Collaborate with the DEP and other organizations on monitoring, training, and research.</p>
<p>3. To pursue opportunities for the bureau to cooperatively manage geologic resource development where the commonwealth is not the fee-simple land owner.</p>	<p>3.1 Endeavor to obtain a voluntary bonded surface-use agreement from the operator to conserve state forest resources in severed-rights situations.</p> <p>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.</p> <p>3.3 Give preference to fee-simple land purchases for new acquisitions, whenever possible.</p>

Geologic Resources Management Principle Cont.

<p>4. To mitigate adverse impacts resulting from historical development of geologic resources when funding or other mechanisms are available.</p>	<p>4.1 Mitigate public nuisances and safety hazards resulting from historical development.</p>
	<p>4.2 Mitigate environmental hazards and repair environmental damage resulting from historical development.</p>
	<p>4.3 Identify orphaned wells on state forest land and coordinate efforts with the responsible party and jurisdictional authority to prioritize, plug, and properly abandon them.</p>
	<p>4.4 Coordinate with watershed groups and similar organizations to identify external funding sources for these activities and attempt to secure funding for remediation and monitoring of prioritized projects.</p>
<p>5. To conserve state forest resources, uses, and values in conjunction with coal and hard minerals development.</p>	<p>5.1 Allow surface extraction of coal resources only when the activity is part of land reclamation and mitigation efforts.</p>
	<p>5.2 Permit hard mineral extraction when operations can be conducted entirely underground and the circumstances benefit the commonwealth.</p>
<p>6. To identify and conserve unusual or exemplary geologic features on state forest land and assist in the advancement of geologic knowledge in Pennsylvania.</p>	<p>6.1 Work with the Bureau of Topographic and Geologic Survey to identify and catalog unusual and exemplary geologic features on state forest land.</p>
	<p>6.2 Develop and implement best management practices to protect unusual or exemplary geologic features during management activities.</p>

Guidelines, Tools, and Resources

DCNR Position Statement on Oil and Gas Development on State Forest and State Park Lands

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20032020.pdf

This position statement outlines how DCNR addresses natural gas development on state forest and state park lands. Policies and practices listed within it reflect ongoing work by DCNR and incorporate public input from the SFRMP revision process.

Guidelines for Administering Oil and Gas Activity on State Forest Lands

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20028601.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031028.pdf

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).

2014 Shale-Gas Monitoring Report and Supporting Information

<http://www.dcnr.state.pa.us/forestry/NaturalGas/monitoringreport/index.htm>

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. Information at this link includes the 2014 Shale-Gas Monitoring Reports, subject-specific updates to the report, data associated with the report, and an online geo-spatial tool regarding shale-gas infrastructure on state forest land.

Monitoring

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

Research Opportunities

- 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.
- Continuing research on reclaiming disturbed forested sites, using native grasses, herbaceous species, trees, and shrubs to promote native plant communities and habitat diversity (from Native Wild Plants chapter)
- Monitoring Marcellus and other shale-gas development impacts on surface and groundwater resources (from Water chapter)
- 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
- Baseline data for monitoring changes to biological diversity, pH, dissolved oxygen, chemical levels, sedimentation, and temperature change (from Water chapter)
- Aquatic life use inventories (from Water chapter)
- Methods for improving soils that have experienced long- term impacts (e.g. mining and gas development) (from Soils chapter)
- Appropriate post-construction storm-water management practices in forested settings (from Soils chapter)
- 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 (from Recreation chapter)
- 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. (from Infrastructure chapter)
- Develop methods to determine ecosystem impact of siting infrastructure. (from Infrastructure chapter)



9. Wildland Fire



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:

- Forest Fires, 32 P.S. §§ 191-424 (Fire Laws, Penalties, Cooperative Fire Protection, Mid-Atlantic Compact).
- Prescribed Burning Practices Act, 32 P.S. §§ 425.1-425.11.
- Statewide Burn Ban, 35 P.S. §§ 1451-1452.
- County Burn Bans, 16 P.S. §§ 13201-13204.
- State Forest Regulations, 17 Pa. Code §§ 21.101-21.123.

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 as a tool during intertribal conflicts, as well as to modify the forest, encourage food production, prepare sites for agriculture, control undesirable pests, clear forests for villages, and move preferred game species during hunting (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 9.1). In most cases

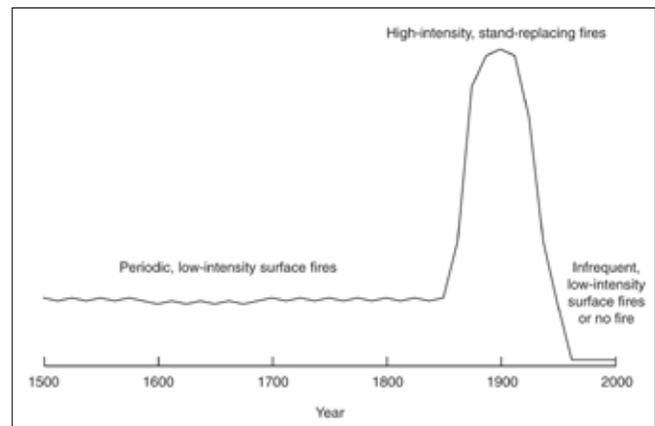


Figure 9.1. Conceptual model of the changes in fire regimes for the mixed-oak forests of the Appalachian Mountains since 1500 (Brose 2001).

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.

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.

Wildland Fire Collaboration

The Bureau of Forestry enters into partnerships with other state and federal agencies to share knowledge and resources. A cooperative agreement with the USDA Forest Service has allowed the bureau to mobilize firefighting resources to assist other states during wildfire emergencies. This program has been in existence since the early 1970s and provides valuable training and experience for our personnel. Additional coordination and cooperation occurs with the Pennsylvania Emergency Management Agency, the Office of the State Fire Commissioner, the Middle Atlantic Forest Fire Protection Compact, county emergency management agencies, and the 2,000-plus rural fire companies in the Commonwealth's 2,500 townships and municipalities. Funding for volunteer fire departments to purchase wildland fire tools and equipment is annual made available through the Volunteer Fire Assistance Grant program. Memorandums of understanding have been developed with the Pennsylvania Game Commission and The Nature Conservancy regarding cooperation on wildland fires within Pennsylvania. Other opportunities for collaboration exist with the North Atlantic Fire Science Exchange, and Central Appalachians Fire Learning Network.

The past two decades have seen a rapid escalation of severe fire behavior, home and property losses, higher costs, increased threats to communities and worsening conditions on wildlands nationwide. In response to this trend, the Federal Land Assistance, Management and Enhancement Act of 2009 (the FLAME Act) was passed in 2009. The FLAME Act directs the federal wildland fire management agencies to develop a cohesive wildfire management strategy addressing seven specific topic areas ranging from how best to allocate fire budgets at the Federal level to assessing risk to communities, and prioritizing hazardous fuels project funds. This effort was ultimately termed the National Cohesive Wildland Fire Strategy. The cohesive strategy established the following vision: safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and as a Nation, live with wildland fire.

Nationally, three long-term goals were identified to deal with the challenges faced by wildland fire:

- Restoring and maintaining resilient landscapes
- Creating fire-adapted communities
- Responding to Wildfires

Additionally, the cohesive strategy dictated that regional action plans would be established in the west, south, and northeast. The Northeast Regional Action Plan details the goals, desired outcomes, investment options, outcome measures, and priority implementation actions for the Northeast Cohesive Strategy Region. These actions, as identified by the Northeast Regional Strategy Committee (RSC), will help guide all the partners in wildland fire management in the Northeast Region to make progress in achieving the overarching national goals: Restore and Maintain Resilient Landscapes, Fire Adapted Communities, and Wildfire Response.

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 has a network of approximately 50 fire towers that can be used for detection of wildfires. A large effort to replace high-priority fire towers is currently under way. All existing fire towers were

assessed for condition, importance for wildfire detection, and location in order to determine a statewide priority ranking for the towers most needing replacement. The new towers will be direct replacements for the old towers and built to a standard design using modern engineering and construction methods and materials. 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 wildland 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, Education and Outreach

[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.

Year	Statewide (including state forest land)		State forest land	
	Number of fires	Acres burned	Number of fires	Acres burned
2008	689	7,670	22	4,394
2009	619	6,065	34	290
2010	569	3,398	43	303
2011	202	579	14	19
2012	719	3,186	33	252
2013	632	1,785	27	606
2014	871	4,511	19	43
2015	817	4,165	42	281
Average, 2008-2015	640	3,920	29	774

Table 9.1. Wildfires Reported by the Bureau of Forestry, 2008-2015

The [Pennsylvania Firewise Communities Program](#) was first introduced in the Pocono region and targeted gated communities. In 2003, 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 and focused outreach in areas of high risk for wildfires. 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 9.2). 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.

Year	Number of prescribed fires	Acres treated	Average size (acres)
2010	12	186	14
2011	11	189	17
2012	10	208	21
2013	33	844	26
2014	22	357	16
2015	47	1,317	28

Table 9.2. 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.

2016 State Forest Resource Management Plan

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.

Wildland Fire Management Principle

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.

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

Guidelines, Tools, and Resources

Pennsylvania Prescribed Fire Standards

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031034.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031035.pdf

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.

Pennsylvania Air Operations Guide and Reference Manual

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)

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031044.pdf

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

Research Opportunities

- Effect of prescribed fire on species of special concern
- Effect of prescribed fire on invasives (see also Forest Health chapter)
- 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
- Prescribed fire meta-analysis of current prescribed fire monitoring plots (from Timber & Forest Products chapter)
- Study effects of prescribed fire on wildlife (from Wildlife chapter)



10. Forest Health



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 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. The spotted lantern fly, *Lycorma delicatula*, is an exotic pest from northern China that

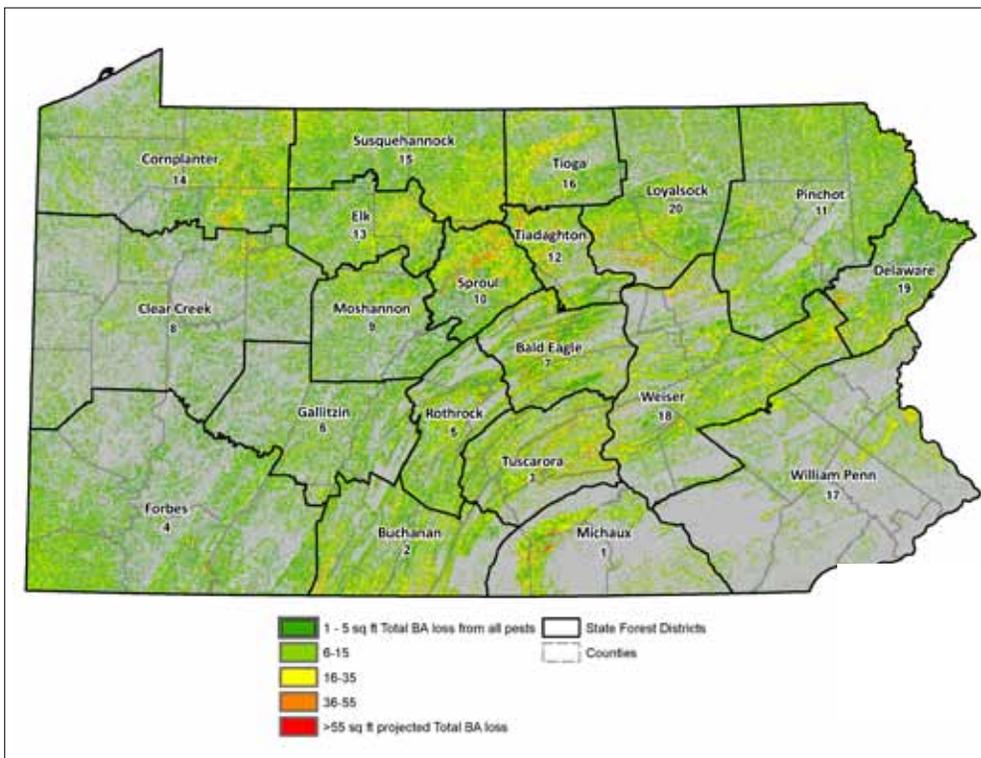


Figure 10.1. Tree mortality risk map for Pennsylvania in terms of predicted basal area loss due to insects and diseases http://www.fs.fed.us/foresthealth/technology/pdfs/2012_RiskMap_Report_web.pdf

was recently detected in eastern Pennsylvania and is a threat to fruit trees, ornamental trees, and various other woody trees and vines. 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 10.1 and 10.2).

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 10.3 and 10.4). 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 10.3 and 10.4). Additional deforestation and mortality events have occurred due to increased winter and frost severity (“Others” category in Figures 10.3(b) and 10.4(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. In an effort to forestall the impact of hemlock woolly adelgid, the bureau has developed the *Eastern Hemlock Conservation Plan* and has been treating high value hemlocks in State Parks and State Forests since 2004. Predatory beetle releases have been conducted since 1999. The purpose of treating high value hemlocks with insecticides is to keep hemlock habitat and trees protected until predatory beetles become established and contribute to the control of hemlock woolly adelgid. Continued monitoring of hemlock woolly adelgid will

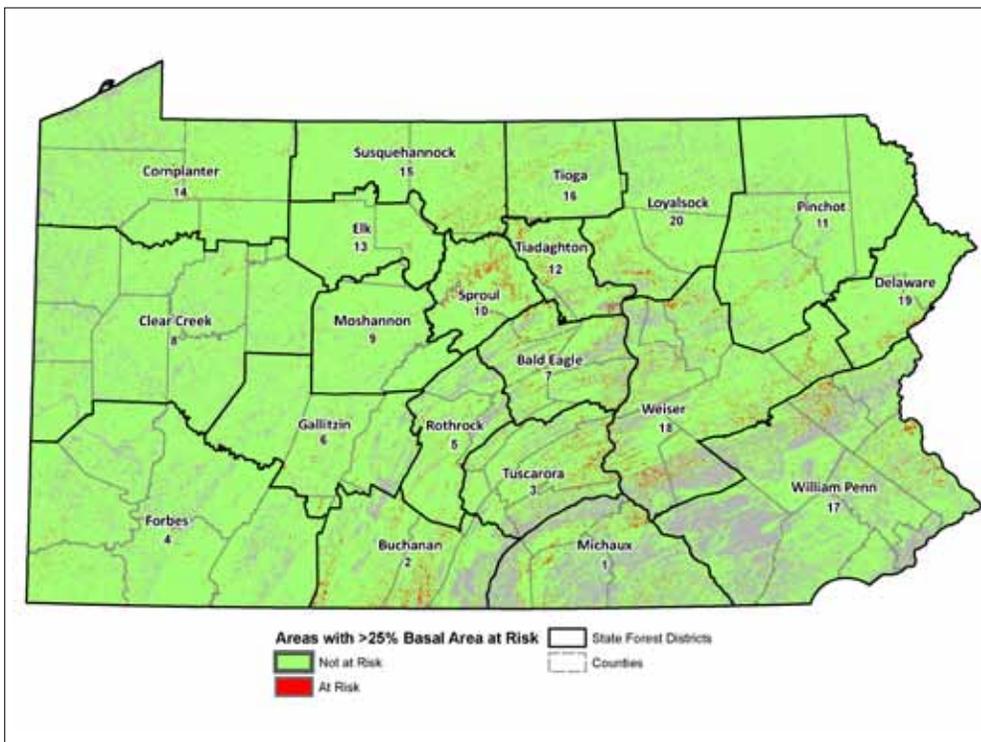


Figure 10.2. Tree mortality risk map in terms of areas at risk to lose more than 25% basal area due to insects and diseases only http://www.fs.fed.us/foresthealth/technology/pdfs/2012_RiskMap_Report_web.pdf

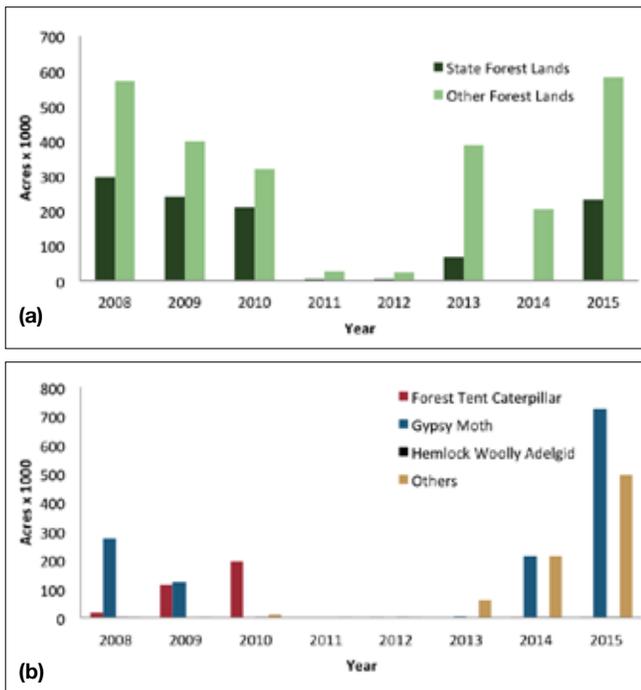


Figure 10.3. (a) Acres of forest damage in Pennsylvania by year. **(b)** Acres of forest damage on state forest land by year by causal agent. “Forest damage” incorporates indicators of negative forest health that fall short of mortality, e.g., broken limbs (i.e., dieback), defoliation, discoloration.

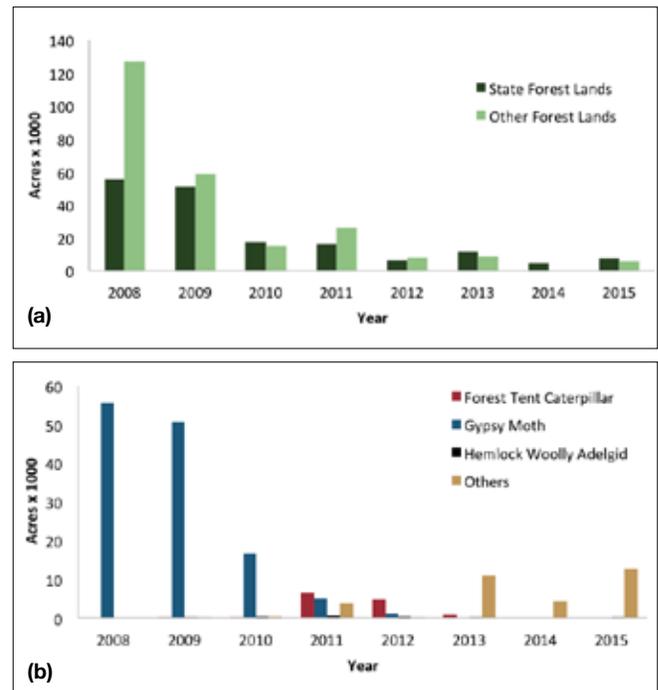


Figure 10.4. (a) Acres of tree mortality in Pennsylvania by year. **(b)** Acres of tree mortality on state forest land by year by causal agent.

be critical to research and management efforts aimed at understanding and projecting the impact on hemlock ecosystems.

Additionally, the emerald ash borer is spreading rapidly across the state (Figure 10.5). 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.

To address the immediate and long-term impact of emerald ash borer on state forest lands in Pennsylvania, the bureau developed a comprehensive ash management plan: *Ash Management in State Forest Lands Under Pressure from the Emerald Ash Borer*. Currently, there are three control options for the emerald ash borer: tree removal, chemical control, and biological control. Field surveys are conducted within the state forests to determine the number of ash trees that have a significant value within a forest district. Chemical

treatments to save ash trees that have a historic or ecological significance are currently being treated in the state forest. In predetermined locations, the bureau has treated 1,477 ash trees within the state forest system for emerald ash borer between the years 2014-2015.

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 2013 to 2016, and this pest has been the principal agent of tree mortality on state forest land since 2008 (Figure 10.6). A total of 4.3 million acres were defoliated in the state during the historical peak year of 1990. 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. Suppression programs have been carried out by the bureau since 1972 to minimize its impacts on the forests.

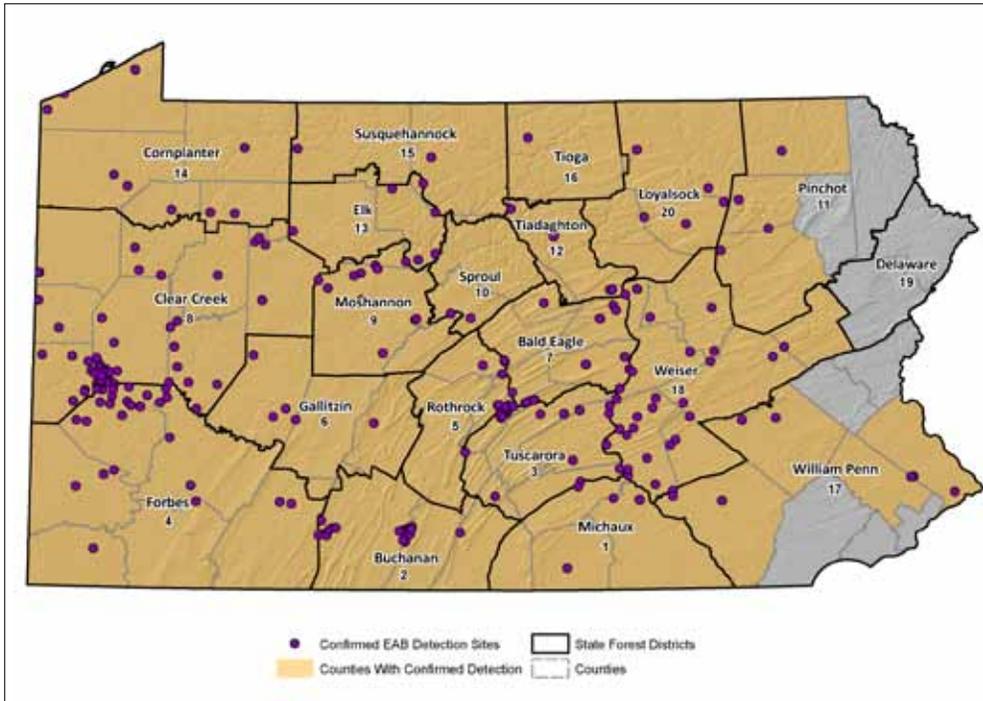


Figure 10.5. Pennsylvania confirmed emerald ash borer detections 2007 to 2015. At the time of writing, emerald ash borer had been observed in 54 counties in Pennsylvania.

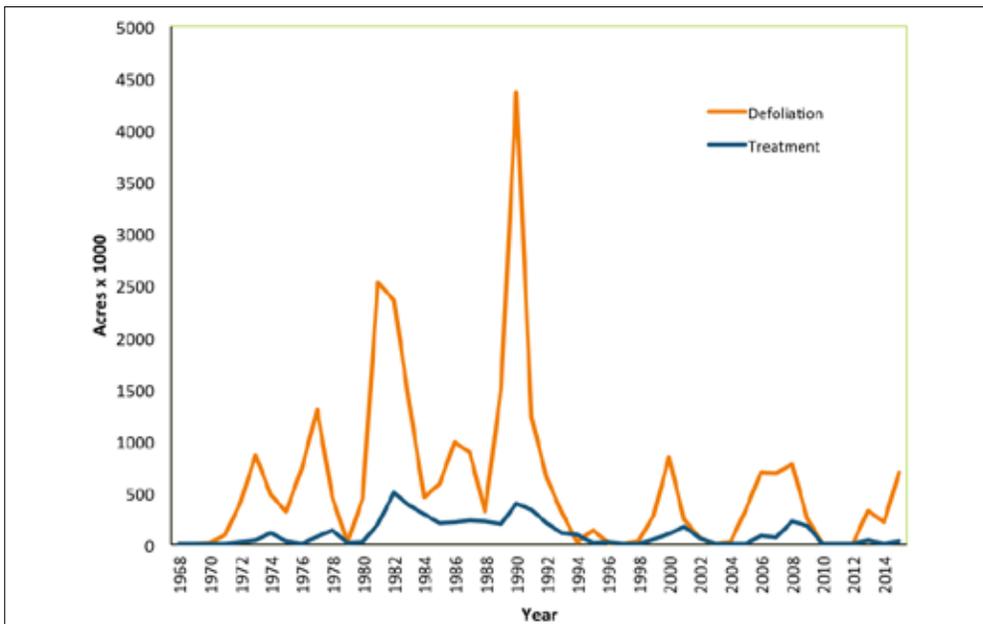


Figure 10.6. Acres of Gypsy moth defoliation in Pennsylvania and treatment over time

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. Treatment of Japanese barberry is a priority in many areas, and the best way to limit populations is by treating it along roadsides to stop or slow its spread into interior forests.

The bureau follows Integrated Pest Management (IPM) that utilizes a combination of prevention, monitoring, and control methods to deal with invasive plants. 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. Among the various control methods, biological controls are used when available. Insect biological controls have been released on

state forest land for mile-a-minute, spotted knapweed, and purple loosestrife. In addition, the bureau has developed exhibits for gas leases and rights-of-way projects regarding the surveying and prioritized treatment of invasive plants. Also, the bureau is adopting Early Detection and Rapid Response (EDRR) protocols to track novel populations of invasive plants and treat them promptly to slow their spread on state forest lands. The focus of this protocol is on high priority species that are either new or uncommon to a particular district. EDRR was adopted in shale-gas districts in 2013, and it is now being piloted in several other districts. Additional invasive plant management activities are carried out by each forest district at a local level. The bureau works with trail groups to get assistance with invasive plant mapping and treatment. 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

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

Table 10.1. Invasive species with substantial instances of occurrence and/or increase on CFI sample plots that were measured in both cycles 2 and 3

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 10.1. 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

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

Table 10.2. Target species for early detection and rapid response

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 10.2) 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.

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 [2015 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.

A warming climate likely will result in changes to the composition of Pennsylvania's forests. Though no net loss of forest acreage is expected, a change in forest composition may be likely. Such a change may vary the species composition of the canopy, understory, and plant and animal communities. A warming climate will lead to declines of some species, yet habitats will improve for others. See the climate change goals in the introductory material of this document.

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.

Air Pollution

Several emission sources such as shale-gas development, automobiles, and other industries release pollutants that are considered harmful to public health or the environment above certain levels. Ambient levels of those pollutants, such as carbon monoxide, nitrogen dioxide, and ozone are monitored throughout the state by the DEP Bureau of Air Quality and Penn State University. DEP conducts air quality monitoring to determine potential effects of air emissions from the shale-gas industry. Statewide, there has generally been a decrease of air pollutants due to the increase use of natural gas for power generation and the installation of pollution control measures within power generation industry. DEP is conducting several additional studies to evaluate localized effects around shale-gas infrastructure. A future area of interest may be whether ground-level ozone is increasing enough to damage plant life.

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 54 percent of sampled stands have adequate regeneration to develop into high-canopy dominant forests (Albright et al., 2016 draft). When only considering commercially desirable species, the number drops to 36 percent (Albright et al., 2016 draft). 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.

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 10.3).



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. See the fragmentation goals and objectives in the introductory material of this document.

	2009	2010	2011	2012	2013	2014	2015
Number of coupons	14,859	12,089	12,081	12,296	16,259	15,775	16,213
Number of units	64	58	72	61	67	67	64
Acres	910,462	830,621	936,802	798,261	980,115	928,329	958,603

Table 10.3. The number of DMAP coupons awarded and individual DMAP units designated on state forests and total acres by year

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.

Goals	Objectives
1. To utilize integrated management techniques to study, survey, monitor, assess, and manage biotic damage causing agents.	1.1 Identify and compile relevant data on biotic forest damage causing agents and adopt new inventory and monitoring protocols as appropriate to fill gaps in existing information.
	1.2 Develop and implement integrated management plans and practices to address significant biotic damage causing agents.
	1.3 Develop and enforce preventative measures to reduce introduction of new non-native invasive species.
	1.4 Develop and implement a plan for early detection and rapid response for non-native invasive species in Pennsylvania.
	1.5 Prioritize restoration projects on areas impacted by biotic damage causing agents.
	1.6 Identify high risk areas subject to environmental stressors to prioritize adaptive management needs.
	1.7 Continue efforts to actively manage invasive plant species by improving the statewide tracking system, implementing the bureau's Invasive Plant Management Strategy, and working with conservation partners to update the statewide management plan.
2. To address abiotic damage causing agents.	2.1 Develop and implement climate change adaptation strategies.
	2.2 Develop and implement programs to address illegally deposited waste, including remediation, recycling, and education.
	2.3 Assess acid mine drainage and other hazardous or environmental problems causing ecosystem degradation and develop strategies for remedial action.
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.	3.1 Incorporate the selection and integration of resistant host genotypes to significant diseases or insect pests through seed orchards and pedigree certification.
	3.2 Consider species translocation opportunities in response to climate change.

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20029768.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031023.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20026634.pdf

Find the list of PA invasive plants and "watch list" plants here.

Invaders of the Commonwealth, Pennsylvania Invasive Species Management Plan

http://www.invasivespeciescouncil.com/Documents/FINAL%20Plan_low_res.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031083.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_001957.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20028601.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20030071.pdf

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

Research Opportunities

- 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
- 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. (from Native Wild Plants chapter)
- Increase understanding of how deer density and other wildlife factors affect tree regeneration and plant species composition.(from Wildlife chapter)
- Define a target percentage of forest plots that should contain an indicator species. (from Wildlife chapter)
- Differentiate between elk and deer damage in order to better understand how to manage these species on state forest lands. (from Wildlife chapter)
- Methods for improving soils that have experienced long-term impacts (e.g. mining and gas development) (from Soils chapter)
- Effect of prescribed fire on invasives (from Fire chapter)



11. Recreation



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. 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, or a snowmobiler and cross-country skier may be trying to use the same trail. 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 to 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.

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.

District	Public-use roads	Drivable trails	Admin. roads	Total
Michaux State Forest	124	3	355	483
Buchanan State Forest	78	16	125	220
Tuscarora State Forest	99	21	169	289
Forbes State Forest	44	0	85	129
Rothrock State Forest	180	12	104	296
Gallitzin State Forest	20	8	25	53
Bald Eagle State Forest	266	79	207	552
Clear Creek State Forest	16	1	56	73
Moshannon State Forest	196	63	150	408
Sproul State Forest	335	112	488	935
Pinchot State Forest	16	1	14	31
Tiadaghton State Forest	170	18	167	355
Elk State Forest	130	12	481	623
Cornplanter State Forest	0	0	2	2
Susquehannock State Forest	160	52	524	737
Tioga State Forest	157	14	305	476
William Penn State Forest	1	0	1	2
Weiser State Forest	29	4	53	86
Delaware State Forest	38	0	88	126
Loyalsock State Forest	124	9	181	314
Total Mileage	2,184	427	3,579	6,189

Table 11.1. Miles of roads on state forest lands by type and district

Joint-use Roads - Snowmobiles

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, cindering, 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

District	Miles of joint-use road
Michaux State Forest	83
Buchanan State Forest	59
Tuscarora State Forest	84
Forbes State Forest	38
Rothrock State Forest	180
Gallitzin State Forest	22
Bald Eagle State Forest	262
Clear Creek State Forest	0
Moshannon State Forest	36
Sproul State Forest	335
Pinchot State Forest	15
Tiadaghton State Forest	101
Elk State Forest	95
Cornplanter State Forest	0
Susquehannock State Forest	136
Tioga State Forest	141
William Penn State Forest	1
Weiser State Forest	38
Delaware State Forest	28
Loyalsock State Forest	120
Total Mileage	1,775

Table 11.2. Miles of joint-use roads on state forest lands by district

the mileage of designated snowmobile trails, resulting in an overall increase in areas for use by snowmobiles.

All-terrain Vehicles (ATVs)

Pennsylvania has seen a steady rise in the popularity and use of ATVs across the commonwealth. With the increased number of ATV riders has come increased pressure on DCNR and other land managers to expand opportunities for safe riding. In 2016, DCNR launched a comprehensive study and survey to find out what ATV riders would like to see, and what public-private opportunities off of state-managed lands could be provided through partnership efforts and grants. DCNR has also been in discussion with a number of ATV clubs about limited expansion of connector trails where it makes strategic and environmental sense.

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 causing 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, unauthorized riding on state forest lands has remained near the top of recreational forest management problems identified by staff. In addition, unauthorized 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 has engaged a consultant to help identify new riding opportunities.

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. 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 improve 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

District	Hiking	Biking	Horse	XSkiing	ATV	Snowmobile
Michaux	251	203	203	203	41	53
Buchanan	255	211	211	211	32	34
Tuscarora	334	305	305	309	0	46
Forbes	191	153	153	191	0	39
Rothrock	294	184	182	184	0	27
Gallitzin	94	59	59	94	0	23
Bald Eagle	601	482	485	601	17	103
Clear Creek	184	38	27	47	0	0
Moshannon	331	78	123	231	0	62
Sproul	727	195	194	197	90	102
Pinchot	53	26	24	49	0	26
Tiadaghton	642	404	366	599	18	75
Elk	273	56	55	52	0	7
Cornplanter	11	8	0	9	0	0
Susquehannock	336	232	228	229	45	94
Tioga	402	319	273	357	0	40
William Penn	2	0	0	0	0	0
Weiser	98	87	39	81	0	20
Delaware	261	183	183	201	30	115
Loyalsock	369	280	281	283	0	21
Total Mileage	5,710	3,503	3,390	4,127	273	885

Table 11.3. Miles of trails on state forest lands by type and district

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of designated snowmobile trails for exploration. Other trail opportunities include rail trails, interpretive trails, and Americans with 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 district. 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.

District	National	State forest	Local district (shared-use)	Local district (specific-use)	Total
Michaux State Forest	36	4	198	5	243
Buchanan State Forest	0	29	206	20	255
Tuscarora State Forest	0	26	303	5	334
Forbes State Forest	15	0	177	0	192
Rothrock State Forest	0	42	185	69	296
Gallitzin State Forest	0	27	68	0	95
Bald Eagle State Forest	0	48	472	79	599
Clear Creek State Forest	135	0	43	9	187
Moshannon State Forest	0	60	250	26	336
Sproul State Forest	0	119	577	34	730
Pinchot State Forest	0	21	25	9	54
Tiadaghton State Forest	0	107	443	85	636
Elk State Forest	0	46	56	172	274
Cornplanter State Forest	0	0	10	3	13
Susquehannock State Forest	0	82	202	61	345
Tioga State Forest	0	59	324	16	399
William Penn State Forest	0	0	0	2	2
Weiser State Forest	2	0	102	1	104
Delaware State Forest	0	24	188	49	261
Loyalsock State Forest	0	80	274	14	368
Total Mileage	188	775	4,102	657	5,723

Table 11.4. Miles of hiking trails on state forest lands by type and district

Shared-use trails in Table 11.4 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).

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.

Year	Number of CAAs	Number of SAAs
2008	24	32
2009	19	36
2010	22	38
2011	27	37
2012	26	50
2013	36	34
2014	35	38
2015	48	38

Table 11.5. 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](#) and the [motorized and primitive camping guidelines and ethics](#) should be followed.

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.

Leased Camp Sites

The bureau maintains more than 4,000 leased camp sites across Pennsylvania. A State Forest Leased Campsite is a small parcel of state forest land, approximately ¼ acre that is leased to an individual or group to maintain a cabin solely for recreational purposes. Some have historic value as they were built by CCC members, and some utilized chestnut logs. DCNR stopped leasing campsites in 1970, but existing leases are still utilized by the public. Camp lessees are important members of the recreating public, contributing to local economies and serving as active stewards of state forest land.

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 Management Assistance 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, night skies, and noise, light and privacy 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

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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 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



Figure 11.1. The recreational opportunity spectrum classes and characteristics of those classes based on user experience.

District	Primitive	Semi-primitive non-motorized	Semi-primitive	Semi-developed & developed	Total Acres
Michaux	0	4,493	27,112	53,897	85,502
Buchanan	0	8,532	17,212	43,959	69,703
Tuscarora	0	27,200	25,420	43,030	95,650
Forbes	0	8,753	19,462	30,083	58,298
Rothrock	0	7,815	30,843	57,254	95,911
Gallitzin	0	4,559	7,291	12,413	24,262
Bald Eagle	0	22,202	57,182	114,006	193,390
Clear Creek	0	1,190	2,784	11,990	15,965
Moshannon	528	26,961	47,834	114,710	190,033
Sproul	117	23,115	77,697	204,511	305,440
Pinchot	706	5,111	7,302	16,464	29,583
Tiadaghton	3,994	31,333	40,473	70,772	146,572
Elk	8,225	54,631	54,167	82,922	199,945
Cornplanter	0	0	358	1,131	1,489
Susquehannock	25,253	67,398	63,191	104,272	260,114
Tioga	3,376	35,775	45,903	76,837	161,891
William Penn	0	0	434	373	807
Weiser	127	8,406	8,127	11,396	28,056
Delaware	3,033	18,141	24,262	37,356	82,792
Loyalsock	0	29,729	36,646	48,175	114,550
Total	45,359	385,345	593,699	1,135,552	2,159,953

Table 11.6. 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.

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.

2016 State Forest Resource Management Plan

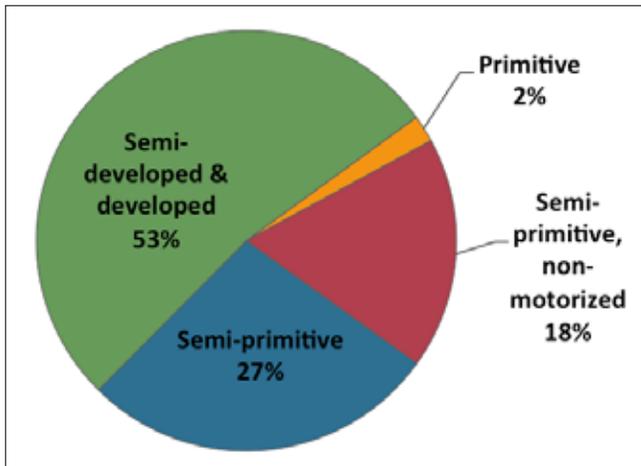


Figure 11.2. Acres and percentages of ROS classifications for the entire state forest system

Physical (resource) carrying capacity is the maximum amount of use that can take place without incurring unacceptable ecological change, e.g., 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.

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.

Goals	Objectives
<p>1. To provide and maintain healthful, low-density recreational opportunities and experiences across the landscape.</p>	<p>1.1 Develop and implement a strategic approach to evaluate and manage recreation.</p>
	<p>1.2 Consider recreational opportunities and experiences during management activities.</p>
	<p>1.3 Inventory and assess recreation infrastructure to determine sustainability and maintenance needs.</p>
	<p>1.4 Identify appropriate recreational levels to ensure conservation of ecological resources and minimize user conflict.</p>
	<p>1.5 Continue to monitor visitor use through visitor use monitoring, comment cards, surveys, and other means.</p>
	<p>1.6 Direct high-density recreation activities and large groups to appropriate areas.</p>
	<p>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.</p>
	<p>1.8 Maintain the state forests as the largest land base for hunting opportunity in the commonwealth.</p>
<p>2. To provide information and assistance to the public while promoting safety.</p>	<p>2.1 Provide easily accessible information to visitors.</p>
	<p>2.2 Create and maintain facilities that meet visitor use and management needs.</p>
	<p>2.3 Provide public assistance and law enforcement through the Ranger Program and state forest officers.</p>
	<p>2.4 Perform search-and-rescue operations and incident management to promote the safety of state forest visitors.</p>
<p>3. To develop and promote effective partnerships in managing recreational opportunities and experiences.</p>	<p>3.1 Collaborate with stakeholders and other state agencies to promote sustainable use of recreational resources.</p>
	<p>3.2 Engage conservation volunteers, recreation groups, and local partners in planning, construction, and maintenance of recreation resources.</p>
	<p>3.3 Consider recreation opportunities that improve experiences by creating connections to adjacent lands.</p>



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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031040.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031041.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031025.pdf

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.

Motorized and Primitive Camping Guidelines and Ethics

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031808.pdf

This pamphlet describes the rules for camping on state forest lands as well as provides guidance and recommendations.

Guidelines for Leased Forest Campsites

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_009385.pdf

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.

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031022.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031031.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_009412.pdf

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)

Research Opportunities

- Recreational infrastructure assessment using LIDAR and other best technologies (see also Infrastructure chapter)
- 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 (see also Infrastructure chapter)
- 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 (see also Infrastructure and Geologic Resources chapter)
- Evaluation of implementation of ROS and determination of effectiveness



12. Infrastructure



Infrastructure refers to buildings, equipment, roads, and other capital assets, tools, and resources used to meet the bureau’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 for proper management and funding.

The cost of managing and maintaining infrastructure is funded from many different 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 specific 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 otherwise owned by the bureau and secures and directs funding for bureau-owned infrastructure.

Infrastructure on state forest land includes:

- 31 dams
- 6,189 miles of roads (2,184 miles public use, 427 miles drivable trails, 3,579 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
 - 336 tower agreements:
 - 78 PSP radio projects office towers
 - 82 agreements with other government agencies
 - 176 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, FPM tracking, 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 more 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 condition 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.

Road category	Length in miles
Public use roads	2,184
Drivable trails	427
Administrative roads	3,579
Total	6,189

Table 12.1. Miles of road on state forest land by category

The bureau determines rates for proper road bonding based on two categories of hauling for commercial activities defined by gross vehicle weight. These two categories are light hauling and heavy hauling. Beyond vehicle weight, the bureau also takes into consideration the length or mileage of road(s) being used, the number of bridges crossed within that area, and the existing road surface materials. The figures are evaluated periodically to determine if updates or changes to current rates are necessary. The purpose of the bureau retaining bond for use of a road is to cover the cost of repairs if needed due to degraded conditions that are a result of the hauling activity. Road bonding guarantees that the appropriate funds are necessary to keep the road in as good as or better condition than prior to the commercial use of the road.

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.

When new Resource Management Centers are built on state forest lands, the bureau strives to utilize environmentally responsible building practices, particularly the use of sustainable local products. Leadership in Energy & Environmental Design (LEED), is a green certification program that recognizes best-in-class building strategies and practices. To receive LEED certification, building projects satisfy prerequisites and earn points to achieve different levels of certification. Though not all LEED prerequisites are appropriate on state forest land, the bureau supports LEED sustainability concepts. The principles behind green certification are more important to the bureau than the certification level or labels. The bureau will continue to investigate the most appropriate green building certification systems.

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.

There is currently a moratorium on the placement of additional communications towers on state forest lands. However, there are exceptions, such as a new tower that provides a public safety benefit.

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.

Infrastructure Management Principle

Infrastructure on state forest lands is managed with consideration of societal needs, institutional constraints, and ecosystem management principles.

Goals	Objectives
1. To implement a strategic approach to address infrastructure needs.	1.1 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.
	1.2 Maintain an accurate inventory of current infrastructure.
	1.3 Develop and implement plans for long-term management and maintenance of new and existing infrastructure with consideration of associated costs.
	1.4 Actively secure funding resources and support partnerships that provide funding opportunities for infrastructure development and improvements.
2. To manage state-owned infrastructure in support of resource management and public use.	2.1 Develop, use, and update tools that provide accurate information to effectively manage infrastructure and other forest resources.
	2.2 Evaluate infrastructure, technological resources, and equipment needs that facilitate forest management activities.
	2.3 Assess and improve state-owned infrastructure supporting public use to ensure the overall safety, health, and satisfaction of state forest users.
3. To consistently administer non-state or private infrastructure while considering social, ecological, and economic values.	3.1 Evaluate potential impacts of new or existing private infrastructure on forest resources and develop mitigation strategies.
	3.2 Review private infrastructure requests in a consistent and timely manner and consider the overall potential benefit to society and suitability of other alternatives.
	3.3 Build and strengthen relationships with stakeholders requesting infrastructure construction or maintenance.

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031019.pdf

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.

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_003513.pdf

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

http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_20031032.pdf

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)

Research Opportunities

- Continue work with the Center for Dirt and Gravel Roads on improving water runoff and minimizing dust from gravel roads. (see also Recreation chapter)
- 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. (see also Geologic Resources chapter)
- Develop methods for determining long-term optimum design for infrastructure.
- Develop methods to determine ecosystem impact of siting infrastructure. (see also Geologic Resources chapter)
- Recreational infrastructure assessment using LIDAR and other best technologies (from Recreation chapter)
- 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 (from Recreation chapter)



13. Cultural and Historic Resources



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.

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 features or resources from the Archaeological Sites section are the most sensitive and some protected resources require clearance from the BHP prior to commencing a project with the potential to impact such sites.

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.

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.

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More than 5,000 culturally or historically significant sites are located on state forest land, with charcoal hearths representing the vast majority (Table 13.1). 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. The state forest leased camps are of additional cultural significance, as many of the cabins were built with chestnut logs and/ or built by CCC workers.



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.

Site Category	Number
Archaeological Site	6
CCC Camp	157
Cemetery	27
Charcoal Hearth	4457
Furnace	3
Grave Site	12
Homestead	75
Logging Camp	14
Logging RR Grade	37
Mill Site	27
Mine	15
Monument	20
Old Building Foundation	77
Quarry	38
Spring Water Collection Site	81
Tunnel	4

Table 13.1. Numbers of various cultural or historic sites by category on state forest land

Cultural and Historic Resources Management Principle

The bureau incorporates identification and protection of cultural and historic resources as a part of ecosystem management.

Goals	Objectives
<p>1. To develop a strategy for inventorying, documenting, and protecting cultural resources</p>	<p>1.1 Develop management strategy for cultural resources on state forest land</p>
	<p>1.2 Incorporate cultural resources management into district-level planning</p>
	<p>1.3 Identify significant cultural resources not listed for protection by PHMC</p>
	<p>1.4 Collaborate with Bureau of Forestry advisory committees, local or county historical associations, and others to foster a vision for cultural resource conservation on state forest land.</p>
<p>2. To increase awareness of cultural resources and the policies and practices pertaining to them for bureau personnel and the public</p>	<p>2.1 Clearly define and present policies and protocols for cultural resource management to bureau personnel</p>
	<p>2.2 Continually update bureau cultural and historic resources data.</p>
	<p>2.3 Provide interpretive opportunities pertaining to cultural resources for the public</p>
<p>3. To cooperate and communicate with Pennsylvania Historical and Museum Commission and other agencies involved in cultural resource management for the protection of cultural and historic resources on state forest lands</p>	<p>3.1 Adhere to guidelines developed with PHMC for protection of known cultural resources when developing management plans and implementing bureau activities</p>
	<p>3.2 Coordinate data sharing with PHMC and local historical agencies of newly found, culturally significant resources when discovered</p>
	<p>3.3 Communicate with PHMC when changes to cultural resources are proposed or have occurred</p>

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.

Glossary

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.

Age Class — An interval into which the age range of trees or forest stands is divided for classification or use (e.g., 0–10 years, 10–20 years).

Basal Area — The area of the cross section of a tree stem, including the bark, generally at breast height (4.5 feet above the ground).

Clearcut — The removal of the overstory in the absence of advance regeneration. Regeneration may be dependent on natural seed, root suckers, stump sprouts or from artificial plantings. The differentiating factor that sets this cut apart from an overstory removal is that less than 50% of the site is stocked with adequate advanced regeneration and relies on seedlings or sprouts that will become established after the cut. For clearcuts, as with overstory removals on State Forest Lands, 10-20 square feet per acre of basal area must be reserved per acre. Clearcuts on State Forest Lands can be referred to as “clearcuts with residuals.”

Climate Change — The long term fluctuations in trends in temperature, precipitation, wind, and all other aspects of the earth’s climate.

Crop Tree Thinning — Crop tree thinning is done for many of the same reasons as improvement cuts but at a much younger, pre-commercial age. The primary reason for entering a stand in the pre-commercial stage versus waiting until merchantable volume can be extracted is to alter the species composition of the stand prior to the most desirable stems losing positions of competitive advantage. No more than 50 crop trees should be selected per acre and a crown-touch release should be used, cutting all trees that touch the crown on a crop tree on three out of four sides. Co-dominant and intermediate trees should be the focus of crown-touch release treatments. Trees in the dominant stage will most likely be in the stand at the time of commercial thinning and most likely already enjoys dominance over its closest competitors.

Cultural Resources — A site, structure, object, natural feature, or social account that is or was of significance to a group of people traditionally associated with it. A significant cultural resource is defined as one which is listed or eligible for listing in the National Register of Historic Places. Archaeological sites are considered to be important in elucidating information about past cultural behavior.

Damage-causing agents — non-natural or exotic pests, disease and invasive plants, climate change, inadequate forest regeneration, acid mine drainage, acid deposition, waste and littering, habitat fragmentation, overabundant deer populations and wildfire.

Deer Management Assistance Program (DMAP) — DMAP is a Pennsylvania Game Commission program that provides additional means for landowners to meet land-use goals by allocating additional antlerless deer tags in an effort to reduce deer populations in specific areas.

Ecoregion — A contiguous geographic area having a relatively uniform macroclimate, possibly with several vegetation types, and used as an ecological basis for management or planning.

Ecosystem — A conceptual unit comprised of organisms interacting with each other and their environment, having the major attributes of structure, function, complexity, interaction and interdependency, temporal change, and no inherent definition of spatial dimension.

Extirpated — species is eliminated from a certain geographic area, while it still exists elsewhere.

Fee Simple Ownership — The landowner owns both the surface and subsurface rights.

Forest Fragmentation — The process by which a forest landscape is converted into forest patches.

Group Selection — A treatment in which the desired outcome is to create an uneven-aged or all-aged stand structure over time by performing small group overstory removals or clearcuts, creating patches of younger trees. Through time, the entire stand is removed in groups (3 or 4 harvests spaced 20–30 years apart) creating patches of several age classes throughout the stand.

Habitat Diversification — The process by which a forested landscape is broken into a mosaic of seral or successional stages of vegetation types, through management practices and/or natural processes.

High Canopy — The uppermost vegetative layer of a mature forest. High-canopy species, such as oaks and hickories, have the potential to form the dominant overstory layer of the forest. Species that would NOT be considered high-canopy species include trees that reach their full potential in the understory or mid-canopy layers, such as dogwood or striped maple.

Important Bird Areas — (IBA) As identified by the Audubon Society, these are geographic regions that offer key habitat factors for the occupancy and survivability of some bird species. There are over 80 IBA sites encompassing over two million acres of Pennsylvania's public and private land. These areas include migratory staging areas, winter roost sites and prime breeding areas for songbirds, wading birds, and other species.

Improvement Cutting — An intermediate treatment (after establishment of the new stand and prior to final harvest) is conducted to remove trees that will improve residual stand composition and improve residual tree quality, and where the intention of the harvest is not to establish natural regeneration. The goal of this treatment is to expedite growth of higher quality trees by allowing more light and nutrients to residual trees by reducing competition. This is a non-reproductive treatment and the stand's residual basal area should be at least B level stocking or greater. The difference between this and a crop tree treatment is that this type of treatment is performed later in the rotation and through a commercial sale.

Invasive Plants — Non-native plant species that grow quickly and aggressively, spreading and displacing other native plants. Their establishment causes or is likely to cause economic, environmental or human harm. Invasive plants are usually introduced by people either accidentally or on purpose, into a region far from their native habitat.

Landscape — A land area of generally large size and commonly a mosaic of land forms and plant communities irrespective of ownership or other artificial boundaries.

Natural Area — A Natural Area is a state forest zone that 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.

Natural Regeneration — A new age class of trees created from natural seeding, sprouting, or suckering that will serve to replace trees removed from the canopy, either through aging or harvesting.

Overstory — The portion of the trees, in a forest of more than one story (stratum), forming the upper most canopy layer.

Overstory Removal — The complete removal of the overstory to release established advanced regeneration. The differentiating factor between this cut and a “clear cut,” is that advanced regeneration is present and established with at least 50% stocking of the site. On State Forest Lands, 10-20 square feet of basal area per acre must be retained. Overstory removals on State Forest Lands are referred to as “Overstory Removals with Residuals”.

Pennsylvania Conservation Explorer (Explorer) — An online tool designed to facilitate conservation planning and environmental review (PNDI) for threatened and endangered species, species of special concern, and other natural resources of concern. The environmental review portion of Explorer screens projects for potential impacts to species under the jurisdiction of PA Game Commission, PA Fish and Boat Commission, PA DCNR, and the US Fish and Wildlife Service. All silviculture and land management activities should be submitted through the PNDI system. The purpose of this system is to call attention to the forester that species of concern, threatened or endangered nature are nearby or within the project area.

Pennsylvania Natural Heritage Program — The Pennsylvania Natural Heritage Program (PNHP) is a member of NatureServe, an international network of natural heritage programs that gather and provide information on the location and status of important ecological resources (plants, vertebrates, invertebrates, natural communities and geologic features). Its purpose is to provide current, reliable, objective information to help inform environmental decisions. PNHP information can be used to guide conservation work and land-use planning, ensuring the maximum conservation benefit with the minimum cost.

Pennsylvania Scenic Rivers Program — Scenic river designations are intended to preserve the primitive qualities the natural, and aesthetic values of a river and to protect the existing character and quality of both the river and its adjacent land environment. They shall be free-flowing and capable of, or under restoration, to support water-cased recreation, fish and aquatic life. The view from the river or its banks shall be predominately wild, but may reveal some pastoral countryside. The segment may be intermittently accessible by road. The Pennsylvania Scenic Rivers Act of 1982 authorized the statutory designation of outstanding aesthetic or recreational rivers.

Recreational Opportunity Spectrum Continuum (ROS) — ROS is an inventory system developed by the U.S. Forest Service, to characterize land by types of recreation and experiences. This version adopted by the Bureau of Forestry defines five recreation classes for the state forests (primitive, semi-primitive non-motorized, semi-primitive, semi-developed, developed).

Regeneration — Seedlings or saplings existing in a stand or the act of renewing tree cover by establishing young trees naturally or artificially.

Regeneration period — The time between the initial regeneration treatment and the successful re-establishment of a new age class by natural means, planting, or direct seeding.

Reserve or Residuals trees — Trees, pole sized or larger, retained after an intermediate or partial cutting of a stand.

Rotation — In even aged systems, the period between regeneration establishment and final cutting.

Salvage Harvest — A harvest in which only dead and dying trees are harvested while they still retain a degree of economic value, or in conjunction with other treatments in which the goal is both economic salvage and a silvicultural goal such as salvage-overstory removal, salvage-shelterwood, salvage-improvement, etc. Sales in which 20% or more of the volume being removed is dead or dying should be classified as salvage, or salvage along with any other treatment being implemented.

Seed Tree Cut — The attempted establishment of a new stand from a partial overstory removal and retention of scattered trees for genetically superior seed production and seedling establishment. Usually less than 40 BA is retained to allow almost full exposure of a site to sunlight. Species that are shade intolerant and wind dispersed usually benefit under this type of cut. Once advanced regeneration is established the seed trees are removed.

Severed Ownership — The surface landowner has either partial ownership of the subsurface or the subsurface is owned completely by another entity.

Shelterwood — The attempted establishment of a new cohort of natural regeneration from the partial removal of the overstory. A shelterwood harvest may be a single treatment or a series of cuts to ensure that adequate seed source is retained and light levels are manipulated to allow the establishment or promotion of a target species or group of species. The essential characteristic is that the new stand is being established naturally or artificially under the overstory or the “shelter” of the original stand. The characteristic difference between this cut and a seed tree cut is that a relatively contiguous canopy is retained (approximately ≥ 40 BA) and most often species regenerated under this system are moderate to shade tolerant species. Once advanced regeneration is established, the overstory is removed.

Single Tree Selection — A harvest in which the desired goal is to create an all-aged stand by removing a uniform number of trees from each age class in an uneven-aged stand or size class in an even-aged stand. This leaves an inverse j-shaped curve for diameter distribution, creating space for the establishment of new seedlings and increased growth of remaining trees.

Silvicultural System — A planned process whereby a stand is tended, harvested, and re-established. The system name is based on the number of age classes and/or the regeneration method used.

Stand — A contiguous group of trees sufficiently uniform in age class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit.

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.

Sustainability — The capacity of forests, ranging from stands to ecoregions, to maintain their health, productivity, diversity, and overall integrity, in the long run, in the context of human activity and use.

Two-Aged Harvest — The final overstory removal or clearcut in a stand in which a significant portion of the stand will be retained until the next rotation. Usually 20 to 30 square feet of BA is retained in oak stands and 10 –20 BA in northern hardwood stands. The residual stand is not removed upon successful regeneration, but instead carried as an older age class (creating two distinct age classes on the same site) well into the next rotation, and usually removed before the next age class reaches maturity.

Two-Aged Shelterwood — This treatment is a preparatory cut for a two aged harvest. A shelterwood treatment or treatments performed in a stand to establish or promote advanced regeneration, once there is seedling establishment a two-aged harvest will occur.

Wild Area — A Wild Area is a state forest zoning category which characterizes 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 in order to retain the undeveloped character of the area.

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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.