NEW JERSEY STATE FOREST Action Plan

December 2020

State of New Jersey
Department of Environmental Protection
NJ Forest Service

New Jersey State Forest Action Plan
December 2020

Prepared and Published By:
New Jersey Department of Environmental Protection
Division of Parks and Forestry
NJ Forest Service
501 East State Street, Mail Code 501-04
PO BOX 420
Trenton, NJ 08625

In Cooperation with:
USDA Forest Service, Eastern Area, State & Private Forestry, Region 9
USDA Forest Service, Forest Inventory and Analysis (FIA)

Dear Friend of New Jersey's Forests,

Forests are among our state's most critical natural resources. Forests cover 40 percent of New Jersey and help to clean our air and water, provide recreation for our residents and visitors, and are home to wildlife and rare plant habitat that enrich our natural environment. New Jerseyans do not just experience their forests in rural or undeveloped areas, but within our largest cities and throughout our densest suburbs. These forests reduce stormwater runoff, filter the air around us, keep us cooler in the summer, and add more beauty to communities across our state.

New Jersey's forests are also one of our greatest resources in the fight against climate change.

I am pleased to share with you the New Jersey State Forest Action Plan, a document that presents strategies for how New Jersey will manage its two million acres of forests over the coming decade. Ten years may seem like a long time to us, but less so in the life of a tree. This plan is a product of extensive study, engagement with many stakeholders, and deep experience within forests across New Jersey. This plan explains the challenges our forests face and the opportunities we will have over the coming decade to maintain and expand this vital natural resource for the benefit of all New Jerseyans and those well beyond our borders.

We invite you to join the New Jersey Forest Service in our unending mission to keep our forests healthy and to share in their wonder.

50 CELEBRATING 1970 • 2020
STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION

John Sacco, *State Forester*
NJ Forest Service

FOREST SERVICE
DIV. OF PARKS & FORESTRY
NJ

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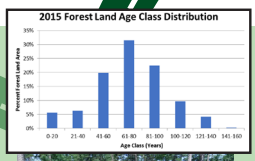
NJ STATE FOREST ACTION PLAN ROADMAP



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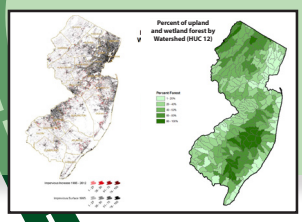

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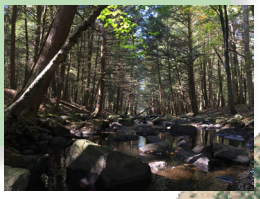

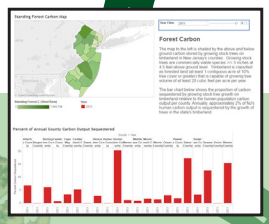

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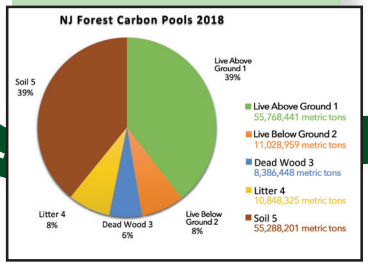
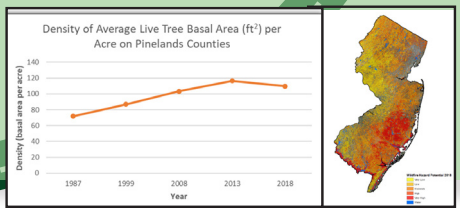


Density explained and examined starting in Criterion 1 and National Priority 1.



ORGANIZATION OF NEW JERSEY'S 2020 FOREST ACTION PLAN

Guided by the criteria of the Montréal Process, the NJ SFAP begins with an "Assessment" of New Jersey's forest resources. The Assessment section describes the current status and observed trends of the state's forested resource. Topics discussed in this section range from species of trees and their overall abundance to the policies that drive our ability to manage them.

The Strategies section synthesizes research, data, and professional expertise in a goal-oriented fashion to provide potential solutions to the larger issues discussed within the Assessment section through long-term sustainable management. The strategies and performance measures outlined follow the US Forest Service's National Priorities and the Cooperative Forestry Assistance Act.

Appendices, located at the end of the Strategies section, provide additional detailed information to the reader along with the documentation required by the US Forest Service. This includes information such as the assessment of need, a glossary, a list of stakeholders, as well as a summary of the stakeholder outreach process the NJ Forest Service used.

Several key findings noted in the development of the plan, that transcend ownership boundaries, programs and affect all trees and forests are represented in the graphic and points below:

Density: New Jersey's forests are becoming increasingly dense. Where appropriate, silvicultural mechanical thinning will help reduce stress-induced mortality, fuels and the risk for catastrophic carbon emissions while improving health, diversity, and growth of remaining trees, understory and herbaceous plants. *(Page 112)*

Age: The majority of New Jersey's forests are of relatively uniform age distribution. Promoting and managing for various age classes across the landscape will help the state's forests to remain resilient and more diverse. *(Page 110)*

Species of concern: Various species (tree, plant or animal), some very important to ecosystem integrity have declined across the landscape and will benefit from conservation efforts through forest management. *(Page 121)*

Biodiversity: Enhancing biodiversity (i.e. fragmentation, invasive species, land use change/disturbance, and climate change) will be a hallmark of the forest management process and every effort will be made to reverse or reduce the deleterious effects of fragmentation, invasive species and climate change. *(Page 166)*

Climate and carbon: In the face of climate change, forest density and saltwater intrusion are two of the greatest challenges to New Jersey's forests. The primary climate change and carbon budget goals for our forests are to diversify forest carbon resources, promote resilient ecosystem function, enhance carbon sequestration, and prevent our forest resources from becoming a net carbon emitter. Diversity and density management are critical in maintaining carbon pools as well as healthy forests. *(Page 145)*

Fragmentation and habitat: Connectivity and continuity are important considerations in managing forests at a landscape scale. Landowner succession, education and sustainable management should be included for a successful private land management program. *(Page 162)*

Damage Causing Agents: Strategies that use a variety of long-term solutions such as silviculture, genetics and monitoring, in conjunction with or in place of traditional suppression efforts, will be critical. An integrated approach to managing the state's forests for a wide variety of species, structure and successional stages is crucial to successful mitigation of damage causing agents. *(Page 152)*

INTRODUCTION:

NJ STATE FOREST ACTION PLAN AND NJ FOREST SERVICE MISSION

Located within the New Jersey Department of Environmental Protection's Division of Parks and Forestry, the Forest Service (NJDEP Forest Service) is the steward of all forests and trees across the state. Through sustainable science-based management and conservation practices, the NJDEP Forest Service promotes the resilience of New Jersey's forests and their interdependent natural systems in the face of societal needs and a climate crisis that demands urgent and decisive action.

While forest managers may have previously looked at forests through a narrow lens focused on commercial value of timber, New Jersey embraces a holistic approach to forestry management that values the multitude of natural resources services that our forests provide including habitat and recreational areas, and ecosystem services such as contributions to clean air, water, global carbon cycles, wildfire and flood mitigation.

The 2020 NJ State Forest Action Plan (NJ SFAP) reassesses the state's forest resources and provides forest owners, land managers, and other natural resource professionals with the ability to make informed decisions about forest resources across the state.

FOREST RESOURCE CONDITIONS AND TRENDS

The 2020 Assessment of New Jersey's Forest Resources

The 2008 Farm Bill mandates each state forestry agency to develop a "Statewide Assessment and Strategies for Forest Resources" document, collectively referred to as a State Forest Action Plan (SFAP). These plans are required for each state to be eligible to receive funding under the authorities of the Act. The USDA Forest Service, Region 9, State and Private Forestry has provided guidance to states developing SFAP's within this region. The following section is the Statewide Assessment of New Jersey's forest resources, arranged by the seven criteria recognized under the Montréal process.

CRITERION 1.
CONSERVATION OF BIOLOGICAL DIVERSITY

Area of Total Land, Forest Land, Reserved Forest Land and Forest Ownership

Understanding where your forests are located, the area of forested land, neighboring landowners and the history of the state serves as an indicator and the basis of sustainable forest management at a landscape scale. These components are important for landowners, taxpayers and other stakeholders to provide strategic and holistic planning. Accurate insight for conservation of biological diversity begins with the amount of forested land within the state and how much of that land is considered reserved or protected.

Reserved land, by national definition, is land that is withdrawn by law(s) prohibiting the management of the land for the production of wood products. Reserved lands are generally publicly owned and include areas such as natural monuments or unique features.

Protected land is less prohibitive than reserved land, has a lower level of protection and may only be temporary. Protected lands could include those specifically within conservation programs (Shifley et al., 2016). Individual states may reserve land for conservation or preservation using state defined definitions which may be more or less restrictive.

Figure 1 indicates the spatial distribution of these types of land in forested areas across the northern United States. The amount of forest or reserved and/or protected forest can be a broad indication of society's interest in preserving forested ecosystems (USDA Forest Service et al., 2003).

Forest ownership is an indicator for conservation of biological diversity as well. From reserved or protected land to state to Non-Governmental Organizations (NGOs), forest land ownership is a key component of making well informed decisions about forest related issues. Not only is the ownership of forest land important from the state of New Jersey's perspective,

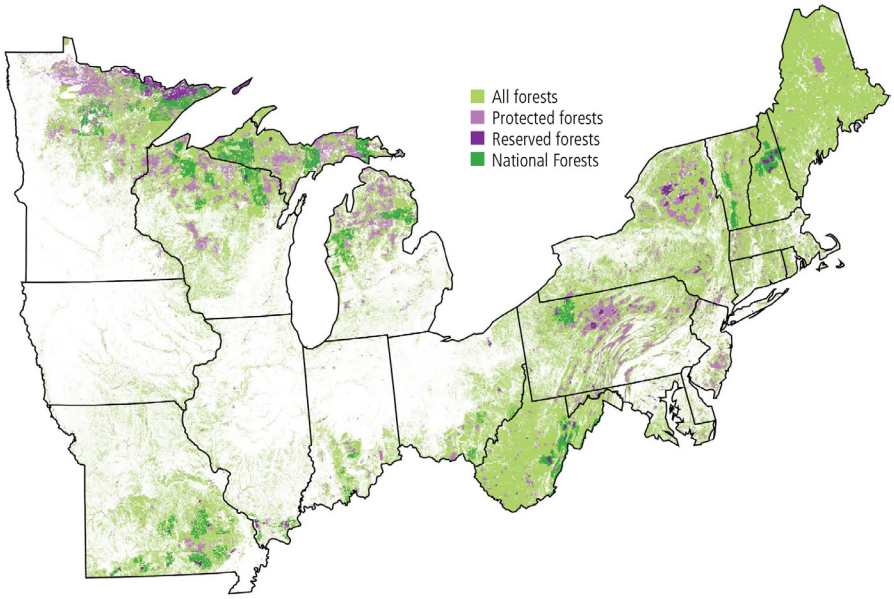


Figure 1. Spatial distribution of land covered by forests including reserved, protected and national forest across Northern States in 2001. (Shifley et al., 2016)

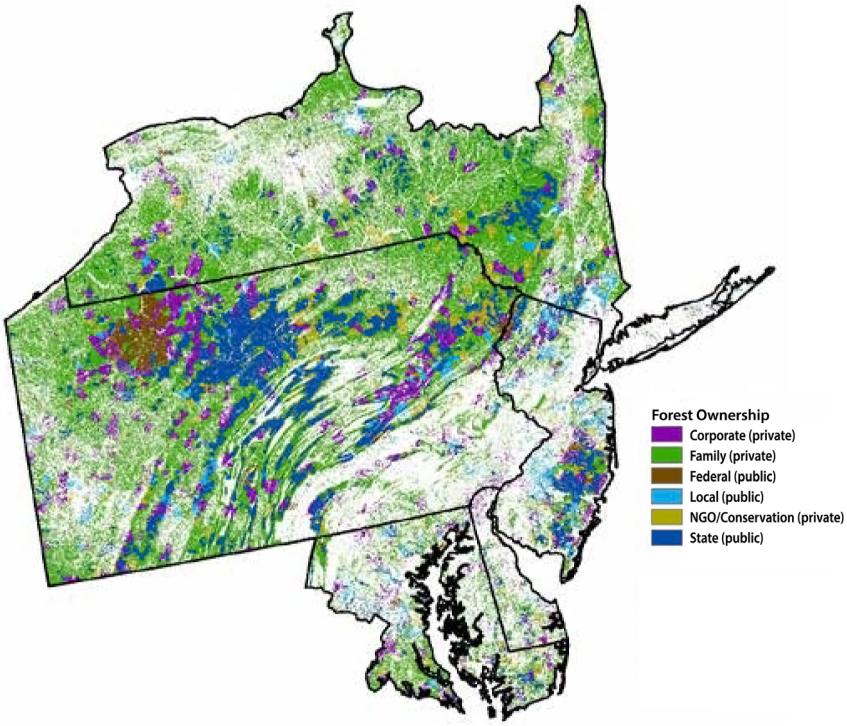


Figure 2. Spatial distribution of forest land ownership across the Mid-Atlantic Region. (Butler-Leopold et al. 2018)

but regionally as well. This allows for the scaling of strategic decisions up or down. **Figure 2** indicates the spatial distribution of forest ownership across the mid-Atlantic region.

Goals and objectives for the management of forested resources may differ depending on whether land is publicly or privately owned. The forest ownership indicator also measures the amount of forest land under different management designations including areas designated to protect ecological, cultural and social values. Protecting forest land from conversion to urban development is essential to achieving sustainability of forested resources (USDA Forest Service et al., 2003).

Forests provide many benefits to the public such as recreation, natural water filtration/purification, the removal of carbon dioxide, habitat for wildlife and are sources of renewable energy and economic development. In such a densely populated state as New Jersey, it is critical to maintain forested areas and to manage them sustainably. Decreases in forest land cover can affect the amount of overall habitat available for plant and animal species, as well as the ability for various forest species to interact with each other.

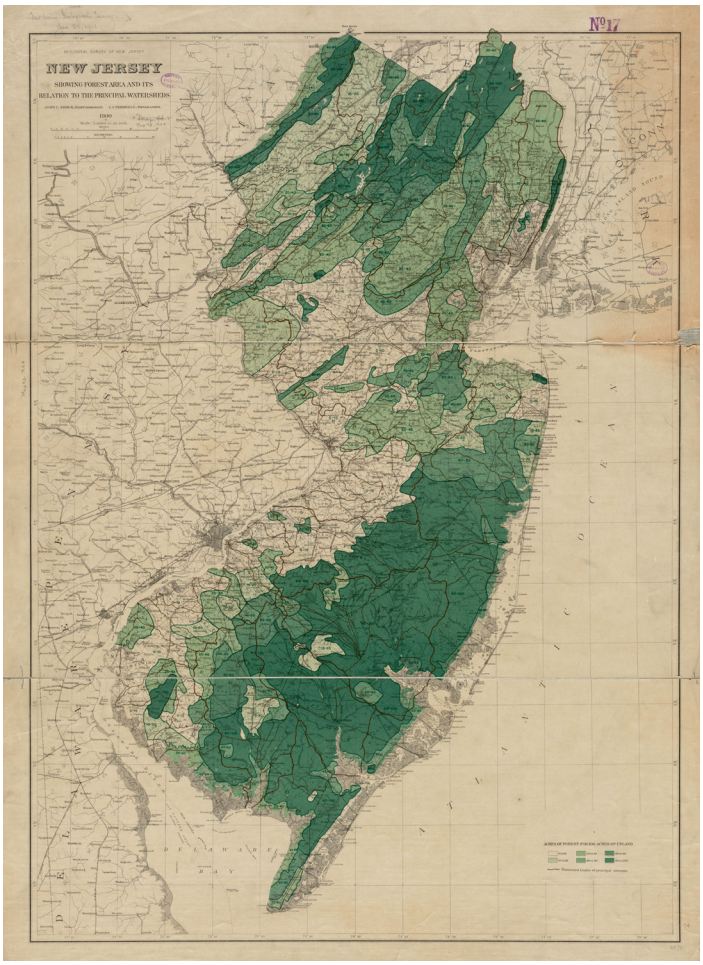


Figure 3. Distribution of forest land, New Jersey, 1900. (Vermeule et al. 1900)

The first statewide assessment of forested area within New Jersey was conducted in 1899 by C. C. Vermeule. This assessment was reported in the 1900 Annual Report of the State Geologist for the year 1899, Report of Forests. By the year 1850, New Jersey had reached a peak of deforestation, before stabilizing between 1860 and 1900. At the time of Vermeule's assessment in 1899, **(Figure 3)** approximately 2,069,819 acres of forest land was reported. The 2,069,819 acres of forest land reported, accounted for nearly half (46%) of the state's overall land acreage. By 1986, however, nearly 428,540 acres of upland forest was converted to other land uses. During the 26-year period between 1986 and 2012 there was a 6.9% loss (113,907 acres) in upland forest in New Jersey (Lathrop, Bognar & Hasse 2016). Also, during this time period as upland forest land was lost, urban land use saw an increase of nearly 29%. **Figure 4** illustrates the approximate distribution of forest land in 2009.

> "Although forest land cover dominates New Jersey and has remained relatively stable since the 1970s, this trend is not expected to continue as forested land area is under severe development pressure."

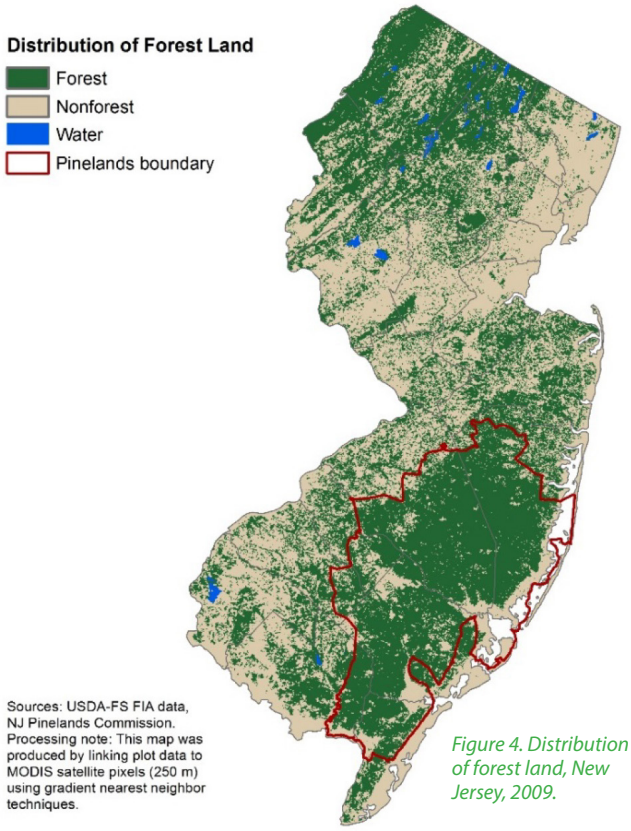


Figure 4. Distribution of forest land, New Jersey, 2009.

Today, New Jersey's forests cover approximately 40% of the total land area of the state (1,990,425 acres). Forest land has remained relatively stable since the 1970s **(Figure 5)**. Although forest land cover dominates New Jersey and has remained relatively stable since the 1970s, this trend is not expected to continue as forested land area is under severe development pressure. Approximately 247,643 acres of New Jersey's forest land is currently under reserved status for increased protection (Crocker et al. 2017). The Forest Legacy Program (FLP) also provides a means for protection of forest land through either the establishment of easements on private property or through the purchase of property through the Green Acres Program.

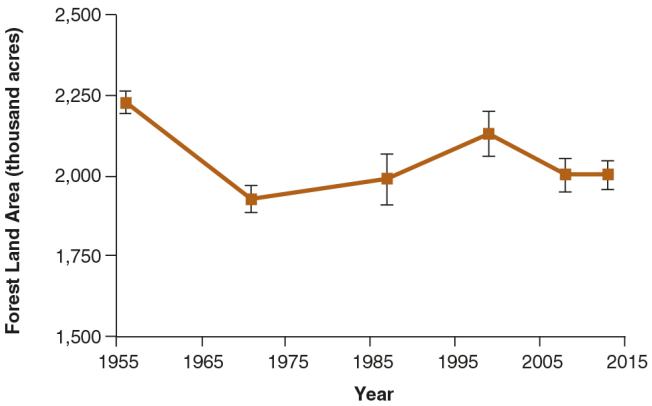


Figure 5. Change of forest land acreage over 60 years. (Crocker et al. 2017)

Ownership

In New Jersey, private landowners possess approximately 950,000 acres of forest land. This accounts for about 48% of the total amount of forested land within the state (Crocker et al. 2017). The state of New Jersey owns the next largest expanse of forest land at 626,000 acres or 31% of total forest land. Local municipalities and counties own 279,353 acres or approximately 14% of New Jersey's forests and federal ownership comprises 131,210 acres or approximately 7% of New Jersey's forests. **(Figure 6)**.

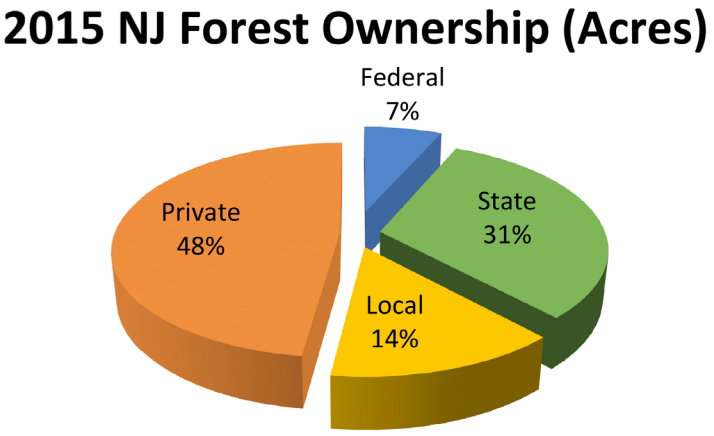


Figure 6. Percent ownership of forest land in New Jersey in 2015. (Crocker et al. 2017)

There are more than 52,547 acres throughout New Jersey certified under the American Tree Farm System (2016) and approximately 15,500 acres certified under the Forest Stewardship Council standards. The American Tree Farm System and the Forest Stewardship Council are two organizations which provide certification to forest owners who manage their forests sustainably.

In an effort to acquire land, understand and manage forest and tree resources, ownership and location should be known. In New Jersey there are 1,355,035 acres of public open space, not including farmland. Preserved farmland makes up an acreage of approximately 230,040 acres. State, federal, county and municipal agencies have acquired 1,219,953 acres of public open space,

Table 1: County Preserved and Developed Acreages

County	Acres	Preserved Acres*	Developed Acres
Atlantic	390,814	111,314	67,416
Bergen	153,490	21,932	111,448
Burlington	525,001	184,962	109,484
Camden	145,650	27,076	76,206
Cape May	183,126	81,766	34,151
Cumberland	321,149	105,689	44,814
Essex	83,035	10,313	64,135
Gloucester	215,166	19,293	76,105
Hudson	32,982	3,311	23,840
Hunterdon	202,148	39,831	69,985
Mercer	125,865	27,730	70,934
Middlesex	191,669	22,357	116,429
Monmouth	277,000	49,699	145,390
Morris	296,335	89,585	120,745
Ocean	479,604	161,825	111,882
Passaic	126,467	67,016	47,289
Salem	143,259	29,390	28,056
Somerset	167,774	27,065	89,197
Sussex	307,961	143,645	54,334
Union	67,352	6,306	55,756
Warren	178,386	50,472	40,666
Total	4,614,233	1,280,577	1,558,262

*Table 1. New Jersey County acreage and corresponding preserved and developed acreage. (SCORP 2018) *Does not include preserved farmland and Pinelands and Highlands Development Credits acreage; total preserved land acreage is 1,583,960 acres.*

of which state government agencies administer 837,230 acres, counties manage 132,334 acres and municipalities are responsible for 132,836 acres of parkland; the remaining acreage is administered and owned by nonprofits and "other" (SCORP 2018). **Table 1** outlines the acreage of preserved and developed land (not including farmland) in each of the corresponding counties. Nonprofit conservation organizations have acquired nearly 68,660 acres. The National Park Service and the United States Fish and Wildlife Service manages 115,100 acres across New Jersey.

The New Jersey Highlands Council prepared a land preservation status report which found that of the 314,796 acres comprising the Highlands Region, about 37%, was preserved. This report also identified a total of 150,835 acres potentially available for development. The Pinelands Region of New Jersey contains more than 463,000 acres of preserved open space, 94% of which is in conservation-oriented management areas such as the Preservation Area District (SCORP, 2018). Almost 20% of approved Forest Stewardship Plan sites on privately owned lands were located in the core of the NJ Pinelands Commission's jurisdictional Preservation Area District between 2015 and 2020.

"Using FIA data from 2015, this puts the average number of acres of forestland per person in the state of New Jersey at nearly 0.22 acres."

Forest Land and Population – Acres of Forest per Person

The US Census Bureau's definition of urban areas includes densely developed territory and encompasses residential, commercial and other non-residential urban land uses. "An urban area comprises a densely settled core of census tracts and/or census blocks that meet minimum population density requirements, along with adjacent territory containing non-residential urban land uses as well as territory with low population density included to link outlying densely settled territory with densely settled core." Urbanized areas (UAs) include 50,000 or more people, whereas urban clusters (UCs) have at least 2,500 people and less than 50,000 people.

"Rural encompasses all population, housing and territory not included within an urban area." In 2010, the urban population for New Jersey was approximately 8,326,000; this means that by this definition, more than 94% of the state's population is in urban land (the second highest within the United States behind California) (Nowak and Greenfield, 2018). "The definition of community, which includes cities, is based on jurisdictional or political boundaries delimited by US Census Bureau definitions of incorporated and designated places. Community areas may consist of all, some or no urban land within their boundaries. Urban land is where the highest concentrations of people reside; urban/community is a larger geography that includes the urban land plus politically defined areas of communities."

The mid-west and northeast regions are home to half of the American population (McWilliams, 2018). New Jersey's total population in 2010 was approximately 8,799,624, with estimates for 2015 at 8,870,869 and estimates for 2018 at 8,908,520. Using FIA data from 2015, this puts the average number of acres of forestland per person in the state of New Jersey at nearly 0.22 acres. Population increased by 213,691 from 2010 to 2017 with an increase of population density by 1,224 persons per square mile for a total growth rate of 2.4%. As of 2018, New Jersey was still the most densely populated state in the nation and has been for approximately the last 60 years (SCORP, 2018).

Urban and Community Land

Several northeastern Atlantic coastal states have the greatest percent of urban land of all the United States, especially of those with large populations and relatively small state land area. These states include New Jersey, Rhode Island, Massachusetts, Connecticut and Delaware (Nowak and Greenfield,

2018). More than 39% of New Jersey's state land area was considered urban land in 2010, an increase from 36% in 2000 (highest of all States in both 2000 and 2010). This was the third highest increase in the United States behind Delaware and Massachusetts respectively (Nowak and Greenfield, 2018). From 2007 to 2012 the state saw a rate of 4,850 acres of new development per year, a 70% decrease from the previous five-year rate. For the first time, however, the percent rate of population growth had exceeded the percent rate growth of urban land (Lathrop, Bognar & Hasse 2016). By 2012, more than 31% of New Jersey's five-million-acre area had become urbanized.

Urban/community land in New Jersey comprised about 44.2% of the state land area in 2000 (highest percent of state land area of all the United States), an increase from 40.3% in 1990. Although New Jersey had the highest percent of state land area of urban/community land in 2010 at more than 45%, New Jersey was not among the top five states with the greatest percent of urban/community land growth between 2000 and 2010. In fact, neighboring states of Delaware and Maryland were among the greatest in urban/community land growth between 2000 and 2010.

> "The projected increase in urban land between 2010 and 2060 for New Jersey was estimated at 22.6%, the fifth highest of all states."

In 2020, land in New Jersey was projected to be more than 44% urban land, as depicted in **Figure 7**. This trend is projected to increase to 62% by 2060 (Nowak and Greenfield, 2018). The projected increase in urban land between 2010 and 2060 for New Jersey was estimated at 22.6%, the fifth highest of all states. Rhode Island, Delaware, Connecticut and Massachusetts are the only other states with a higher projected increase in urban land than New Jersey.

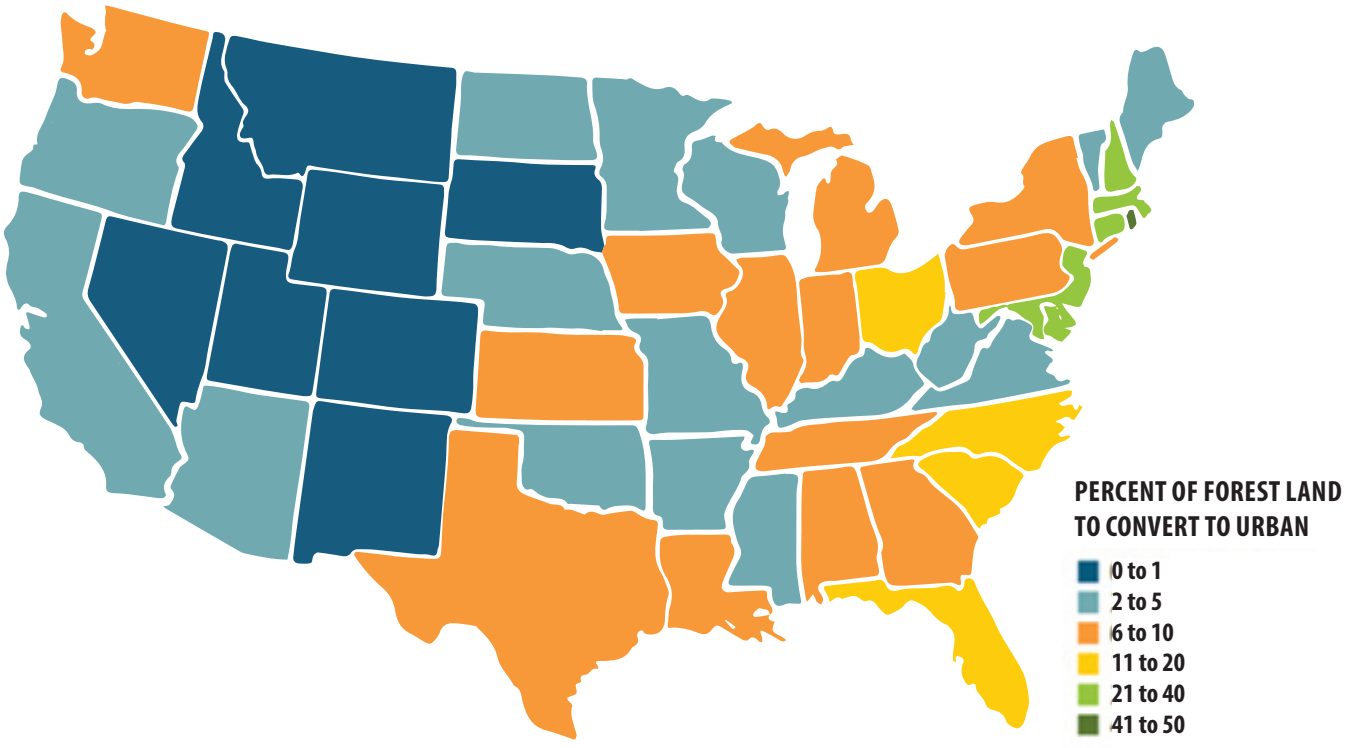


Figure 7. U.S. non-urban forested land projected to be converted to urban land, 2000-2050. (Nowak and Walton 2005)

Topmost common trees found on the streets of New Jersey (Sanders et al., 2013)

Acer platanoides – Norway maple
Acer rubrum – Red maple
Acer saccharinum – Silver maple
Acer saccharum – Sugar maple
Gleditsia triacanthos – Honey Locust
Pryus calleryana – Callery pear
Quercus palustris – Pin oak
Quercus rubra – Northern red oak
Tilia cordata – Littleleaf linden
Zelkova serrata – Japanese zelkova

The term heat island describes developed areas that are hotter in temperature than neighboring rural areas. Heat islands can affect communities by increasing summertime peak energy demand, cooling costs, air pollutants, greenhouse gas emissions, heat related illnesses and mortality and water pollutants (US EPA, 2019). Urban heat islands are mitigated by, among other things, ecosystem services provided by trees and green spaces. These services include moderating climate, reducing building energy use, reducing atmospheric carbon dioxide, improving water and air quality, enhancing human health and well-being, mitigating issues associated with urbanization such as heat islands, pollution, runoff and flooding and lowering noise impacts (Nowak & Greenfield, 2018).

No less important than the greening of New Jersey's urban centers is the maintenance and growth of urban and community forests in our coastal zone. Urban growth in the Coastal Area Facilities Review Act (CAFRA) zone increased 6.8% between 2002 and 2012. Annual development in coastal municipalities occurred at a slightly higher rate than the statewide average, 0.39% compared to 0.32% from 2007 to 2012 and 1.23% compared to 1.13% in 2002 to 2007 (Lathrop, Bognar & Hasse 2016). While many of these expanding coastal areas are sensitive to the impacts of climate change, trees and forests can help mitigate some of these impacts especially those associated with runoff and flooding. **Figure 8** outlines the participation of communities across New Jersey in 2018 through NJUCF.

NJ Urban & Community Forestry Program **By the Numbers**

Total Population	**8,791,894**
Residents assisted	**7,576,847**
Population assisted	**86 %**
Municipalities with a Community Forestry Management Plan	**224**
Municipalities accredited	**141**
Counties with a Community Forestry Management Plan	**38 %**
Counties accredited	**24 %**
Tree City USA Communities in NJ	**160**
Residents living in a Tree City USA Community	**46 %**

Figure 8. NJ Urban & Community Forestry Program demographics. (NJDEP Annual Report 2018)

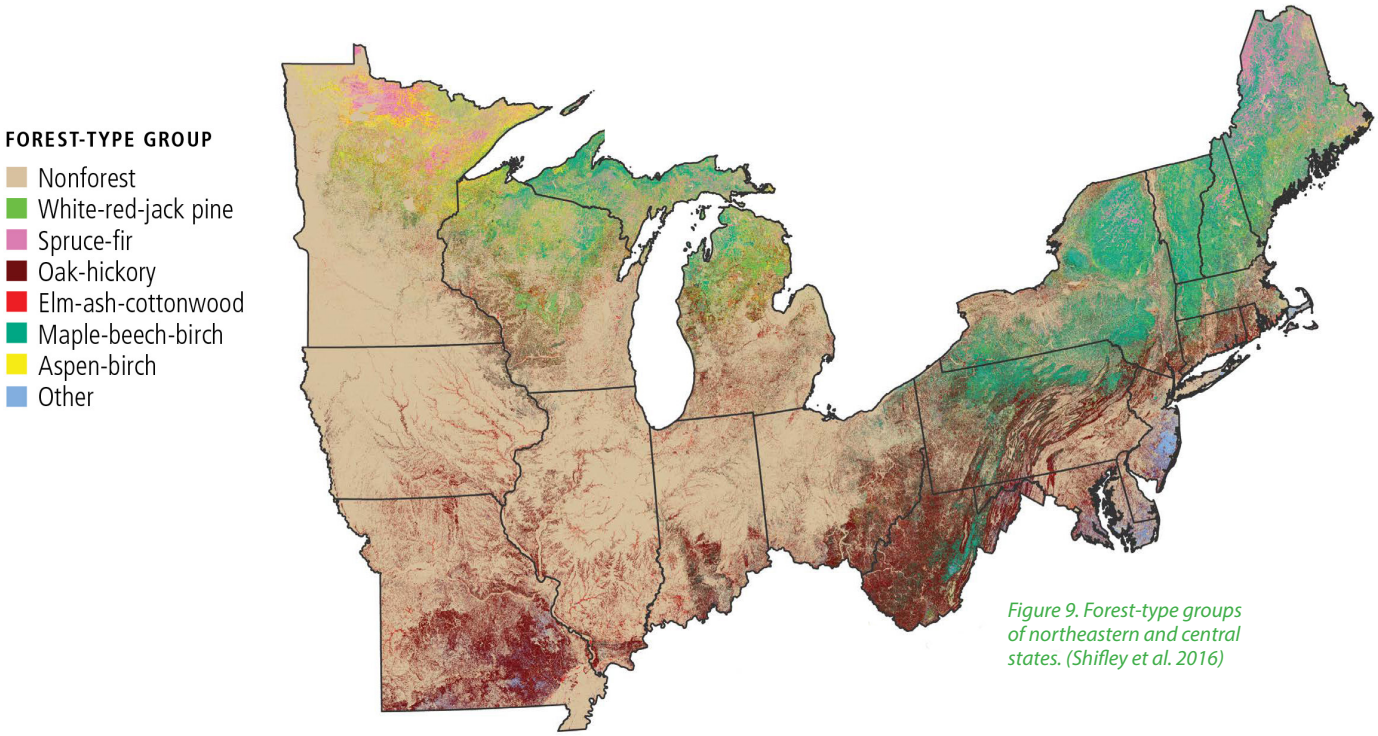


Figure 9. Forest-type groups of northeastern and central states. (Shifley et al. 2016)

Percent forest land of the most common forest type-groups for Mid-Atlantic Region

Forest-type group	Percentage of forest land	Taxa	Percentage of aboveground biomass
Oak/hickory	61	Maple	20
Maple/beech/birch	18	Cottonwood/aspen	18
Elm/ash/cottonwood	5	White oak	14
Oak/pine	5	Yellow-poplar	7
Other coniferous	3	Hickory/walnut	6
Other	8	Other	35
Total Acres:	**42,800,614**	**Total short tons:**	**2,839,611,768**

Table 2. Percent forest land of the most common forest type-groups for the Mid-Atlantic region. (McWilliams, 2018)

Forest Type, Size Class, Age Class and Successional Stage

Forest type, size class, age class and successional stages describe the variability of forest resources within the state. A balance of forest types and successional stages provides a resource that is capable of being utilized sustainably for traditional and nontraditional forest products (USDA Forest Service, et al. 2003). The number of successional stages gives an indication of the diversity of species that can be supported across an ecosystem. However, it is important to note that quantifying the amount of forest statewide that is present in each successional stage is notoriously difficult.

The Northeast-Midwest State Foresters Alliance (NMSFA) with input from the USDA Forest Service, Eastern Area, have recommended that metrics surrounding age classes and age groups be used rather than unreliable data on succession to address this difficulty (NMSFA FRPC, 2019).

Forest type-groups and forest types can be used to understand how forest composition varies across the landscape; forest type-groups consist of multiple, similar forest types. A variety of forest type-groups are represented not only across the northeastern and central United States, **Figure 9**, but across New Jersey's landscape as well **(Figure 10)**. This variety in forest type-groups showcases the diversity of

the forest resources throughout the state. **Table 2** shows the relative area of forest type-groups across the state highest to lowest, proportionally. New Jersey's forests contrast greatly from north to south, characterized generally by oak types in the north with increasing frequency of pine types in the south. Oak-hickory forests are the most dominant forest type group in New Jersey (Crocker, Barnett, et al. 2017). This forest type-group also extensively covers the eastern broadleaf province (Cleland, et al. 2007). In northern New Jersey, forest composition is dominated by mixed oak and hickory species along with northern hardwoods, white pine, eastern hemlock and a variety of other species, including isolated stands of red spruce. In the southern part of the state, southern yellow pines, such as pitch and shortleaf and to a lesser extent, Virginia and loblolly, represent the major forest types. Various oak species, such as southern red, scarlet, chestnut and white are also prevalent. In **Appendix I**, a Forest Type vs Forest Type-Group table is provided with specifics of how the two groups correspond.

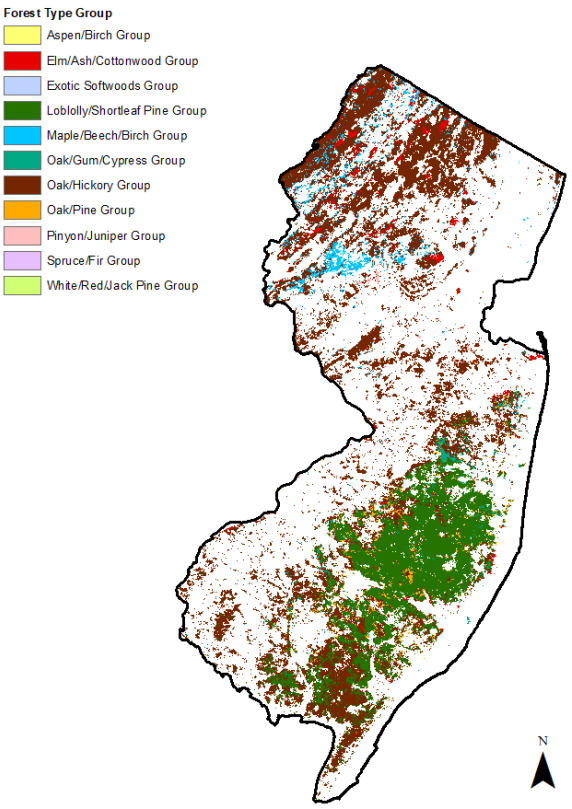


Figure 10. Major forest type-groups of New Jersey Forests. (NJFS, 2019)
forest land by forest type and size class in 2015. (FIA, 2018)

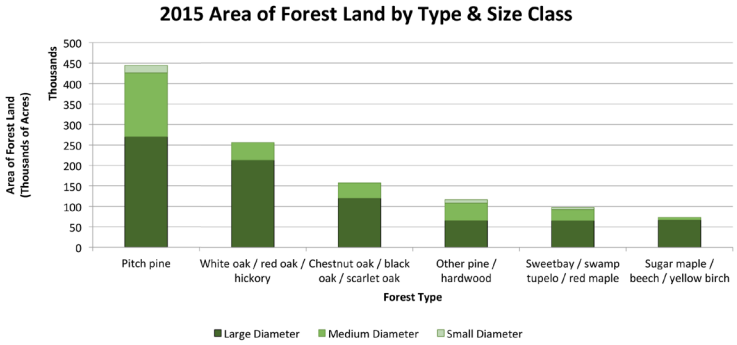


Figure 11. Area of forest land by forest type and size class in 2015. (FIA 2018)

The two most common tree species in New Jersey, both by number of trees and volume, are pitch pine and red maple. Notably, red maple is now the most numerous tree in the United States (Oswalt et al. 2019).

Atlantic white-cedar (AWC) is relatively high in number of trees, yet the AWC forest type covers less than 30,000 acres statewide (FIA, 2018). This is most likely related to the growth characteristics of AWC, which is known to grow at extremely high densities, resulting in high tree counts even when covering a relatively small amount of forested area.

In terms of tree volume corresponding with overstory presence of larger sized trees, five species of oaks are the most common: northern red oak, white oak, chestnut oak, black oak and scarlet oak (FIA, 2018). However, only white oak remains one of the most abundant oaks in terms of numbers of trees (FIA, 2018). This indicates that oak species are becoming less common in smaller size classes, implicative of regeneration concerns for the oak genus (*Quercus*).

The USDA Forest Service, Forest Inventory and Analysis (FIA) program conducts continuous inventories of forest resources throughout the United States. The FIA data in **Figure 11** refers to three different tree size classes: small, medium and large; small representing trees of sapling or seedling size, medium representing trees of pole timber size and large representing trees of sawtimber size. This figure also shows the area of forest land among New Jersey's six most widespread forest types within these various size classes.

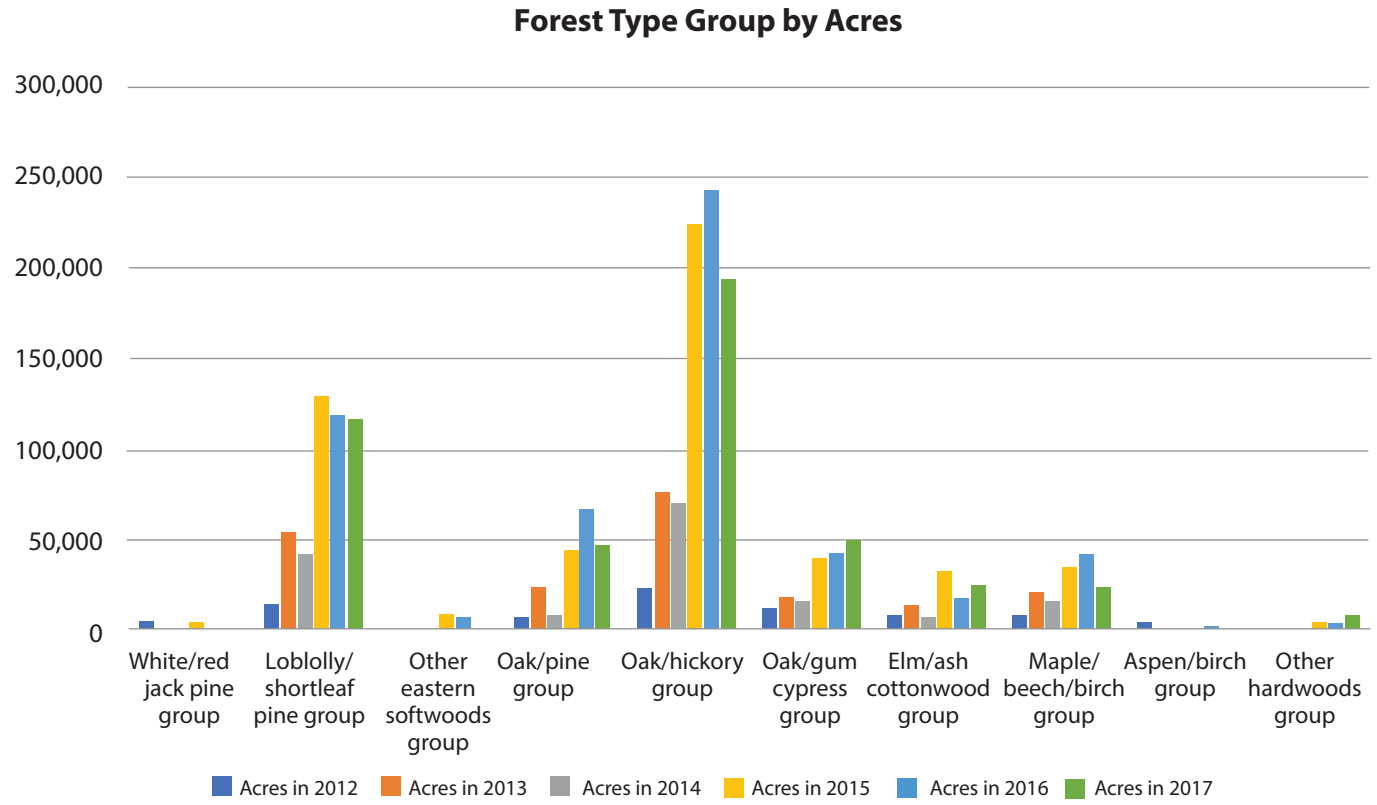


Figure 12. Common forest-type groups from 2012 to 2017 by acres. (FIA, 2018)

The oak/hickory forest type-group has been the most common forest type-group in New Jersey over all of the inventory periods from 2012 to 2017, as indicated in **Figure 12**. This trend can be found to continue dating back to 1987 via FIA. This forest type-group overall makes up approximately 43% of New Jersey's forested area. In the mid-Atlantic region alone, the oak/hickory forest type- group makes up approximately 61% of forestland **(Table 2)**, whereas the maple/beech/birch forest type-group makes up nearly 18% (McWilliams, 2018). The most prevalent taxa in the mid-Atlantic region includes maple with 20% of total aboveground biomass and white oak with 14% of total aboveground biomass.

The oak/hickory forest type-group includes tree species such as white oak, northern red oak, hickory species, white ash, walnut, yellow poplar and red maple. This type-group contains a significant amount of mast producing species that provide important forage for wildlife. The loblolly/shortleaf pine group, which includes the pitch pine type, grows primarily in the New Jersey Pinelands within the southern part of the state and is the second most widespread forest type-group. Together, the oak/hickory group and the loblolly/shortleaf pine group, comprise more than 65% of New Jersey's forested lands. Due to their widespread nature, these groups are particularly important regarding the character of New Jersey's forests and the protection of statewide biodiversity and resilience in the face of global climate change. However, the oak/hickory forest type-group faces significant impacts from insect and disease, economic influence, change in land management patterns, shifts in climatic conditions and changes in landowner values (McWilliams, 2018). This type-group also faces potential compositional changes due to deer browse effects on regeneration. This is largely due to the high palatability and lesser shade tolerance of species in this forest type-group. In fact, this forest type-group has the most forest land under browse stress. The most prevalent taxa in the mid-Atlantic region includes maple with 20% of total aboveground biomass and white oak with 14% of

total aboveground biomass. Unlike the oak/hickory taxas, the maple taxa is less palatable to deer and more shade tolerant. Maples capitalize on smaller canopy gaps for regeneration.

Notably, AWC stands are part of the oak/gum/cypress forest type-group. Estimates from the NJ Forest Service in 1997 concluded that approximately 26,100 acres were comprised primarily of AWC out of a total 41,700 acres that had at least some AWC component. Pre-European presence of this species has been estimated at approximately 115,000 acres statewide (NJFS, 1997). AWC is of particular importance to biodiversity because it provides benefits to a wide range of plant and animal species, including several threatened and endangered species (Mylecraine and Zimmerman, 2003).

> "Although the number of trees present on the landscape has been decreasing, the amount of growing space these trees occupy has been increasing."

New Jersey's forests are getting thicker and older. Currently, New Jersey's forested lands average approximately 111 square feet of basal area per acre and 430 live trees per acre, with a quadratic mean diameter of approximately 7 inches (FIA, 2018). **Figure 13** illustrates the trajectory of basal area per acre (proxy for occupied growing space) from 1987 to 2018 for the Pinelands region of New Jersey exclusively. This trajectory shows a significant increase in density to a point where trees are utilizing as much growing space as possible and are competing against each other, inducing stress and mortality. Currently these levels of density are far above those recommended for prevention of southern pine beetle (SPB) at approximately 80 square feet of basal area per acre. Infestation by SPB across the southern region of the United States has consistently been linked to areas of significantly high density of pine, as well as slow individual tree

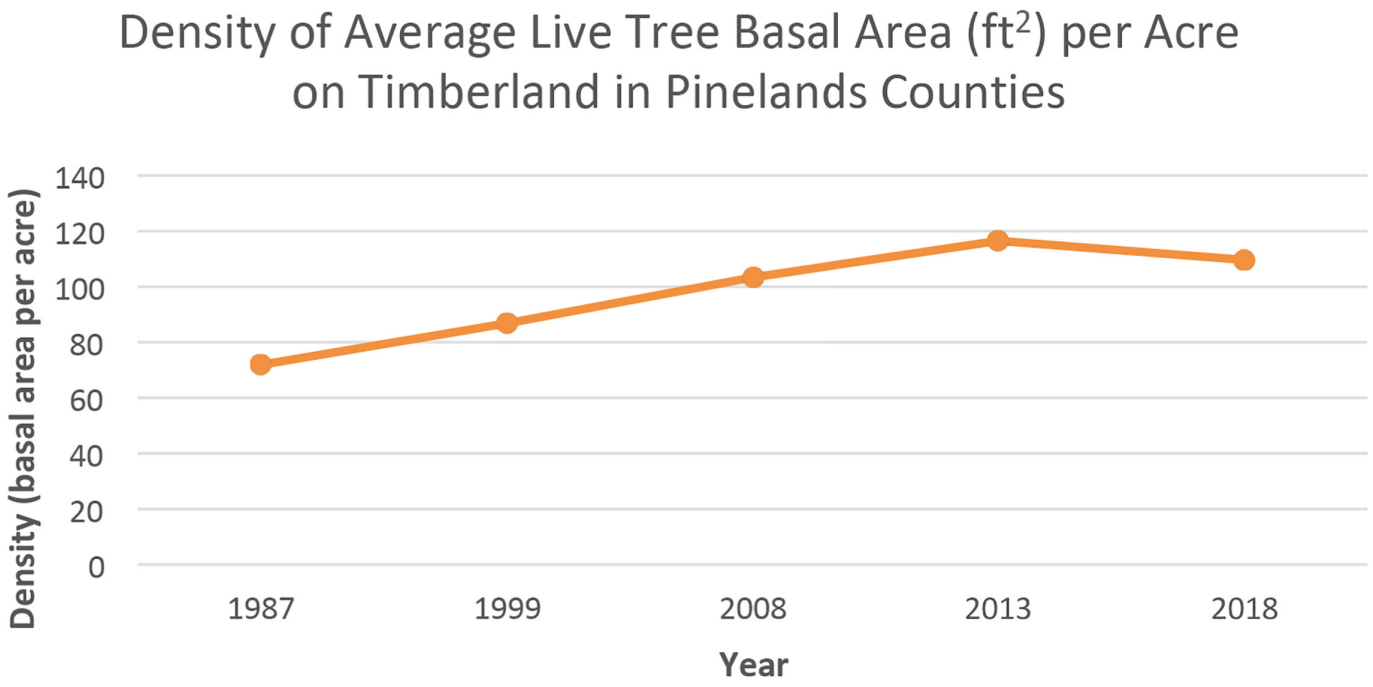


Figure 13. Average basal area per acre in square feet within counties located in the Pinelands region with SPB BA threshold. (FIA, 2018)

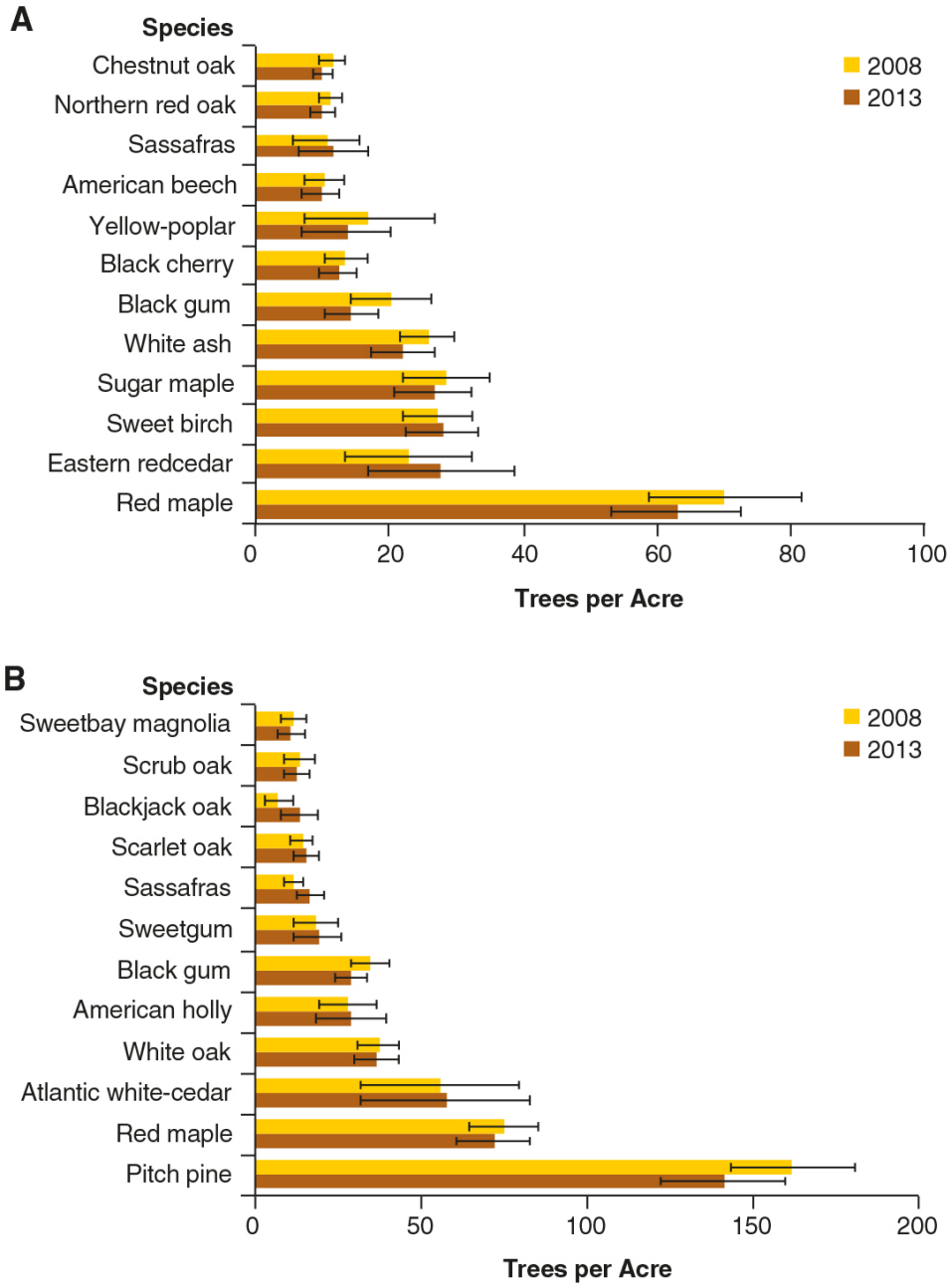


Figure 14. Trees per acre of 12 species with highest densities on forest land in (A) northern New Jersey and (B) southern New Jersey. Dark bars represent error bars at 68 percent confidence interval. (Crocker et al. 2017)

growth rates and older forests (Coulson & Klepzig, 2011). These are all forest characteristics of the southern New Jersey pine resource, where 65% of our southern pine forest is occupied by high density pine stands (Crocker et al., 2017). **Figure 14** illustrates the highest density tree species by trees per acre for the northern and southern regions of New Jersey.

Although the number of trees present on the landscape has been decreasing, the amount of growing space these trees occupy has been increasing (Crocker et al., 2017; **Figure 15 and Figure 16**).

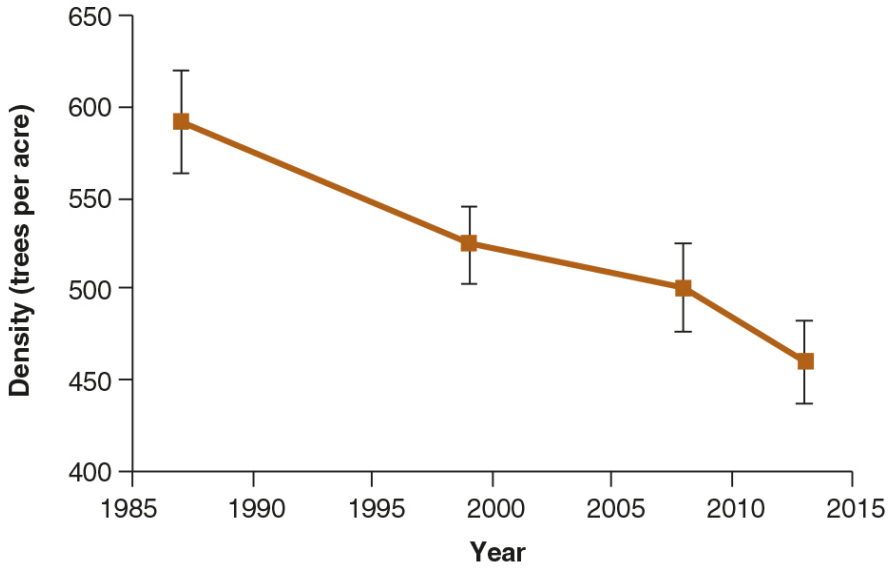


Figure 15. Density of live trees on New Jersey timberland by inventory year. (Crocker et al. 2017)

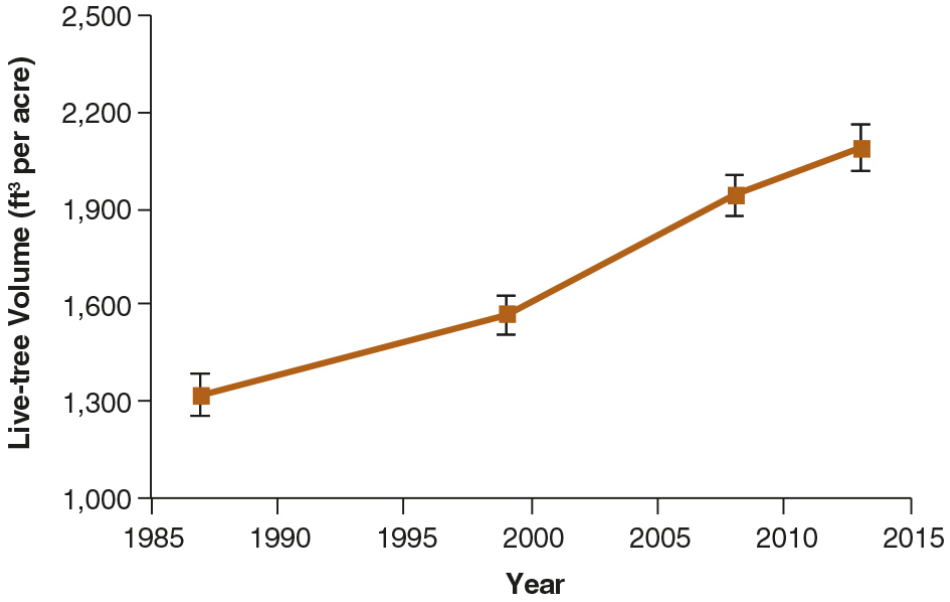


Figure 16. Live-tree volume per acre on New Jersey timberland by inventory year. (Crocker et al. 2017)

This means the number of small and medium diameter trees is decreasing and the number of large diameter trees is increasing. The trend is indicative of a decrease in the number of younger trees growing in to replace larger trees across New Jersey. This is further demonstrated through decreases in the amount of land area covered by forest stands averaging in the "small" and "medium" size classes, while land area represented in the "large" stand size class has been increasing **(Figure 17)**.

Figure 18 illustrates this disparity through forest stand age classes as well. The amount of forested area with age classes of 81 to 100 years old and 100+ years old has increased from 2008 to 2013; meanwhile young and intermediate aged forests have declined in area. Historical comparisons of age class distribution of forests throughout New Jersey, however, are problematic due to changes in age-class definitions (Crocker et al., 2017).

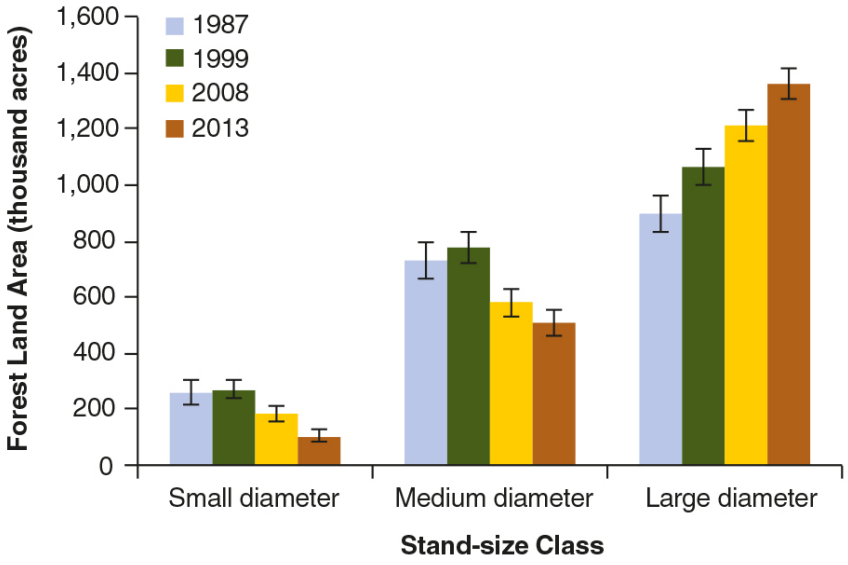


Figure 17. Area of forest land by stand-size class and inventory year for New Jersey. (Crocker et al., 2017)

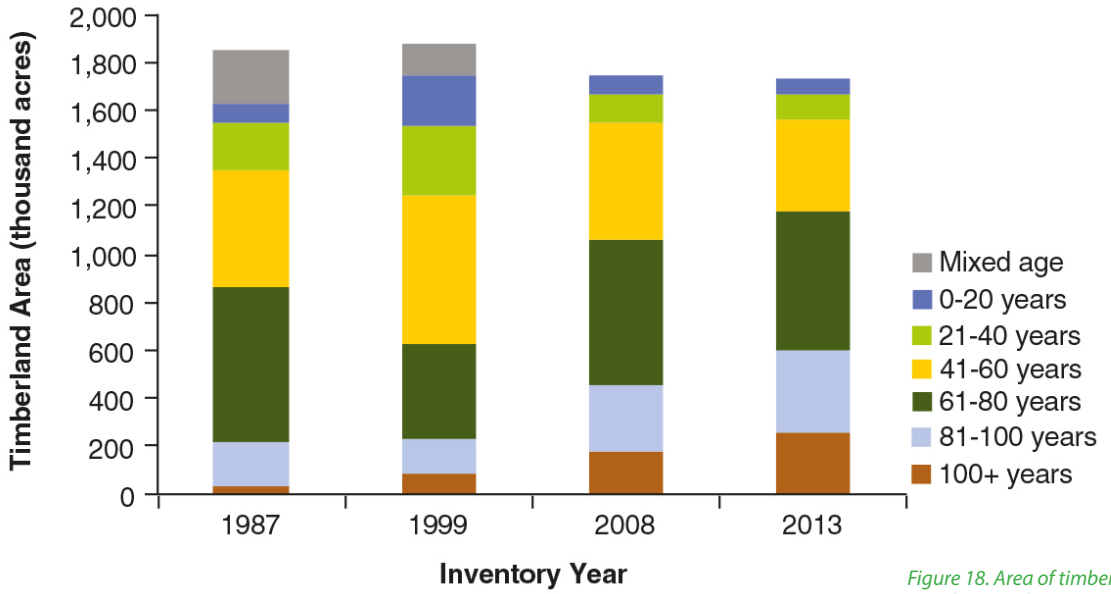


Figure 18. Area of timberland by stand age and FIA inventory year. (Crocker et al. 2017)

> "The trend is indicative of a decrease in the number of younger trees growing in to replace larger trees across New Jersey."

Many of the changes occurring in New Jersey's forests can be attributed to their age and overall pattern of maturity. **Figure 18** indicates that trees in New Jersey forests have gotten larger overall within the last 30 or more years. In fact, nearly 70% of New Jersey forests were in the large diameter class in 2015 (**Figure 19**). Roughly 15% of New Jersey's forested acres statewide fall within a stand age class of greater than 100 years old, while roughly 40% of

the forested acres found within the NJ Sourlands Region fall within this same stand age class (FIA 2018).

Stand-size class and stand-age class are indicators of forest structural/successional stage. The smallest stand-size class (seedling and sapling or <1" to <5" DBH) and the youngest age class (0-20 years old) are consistent with one another but stands become progressively more heterogeneous as they become larger and older. Such mixtures of different aged or sized trees provide a vertical diversity of vegetation structure that can enhance habitat conditions for some species. Managing forest conditions in both younger and older age classes (and smaller and larger structural stages) to maintain both early and late successional habitats for a diversity of forest-associated species may also conserve habitat and viable populations of many forest-associated wildlife species. (Crocker et al., 2017)

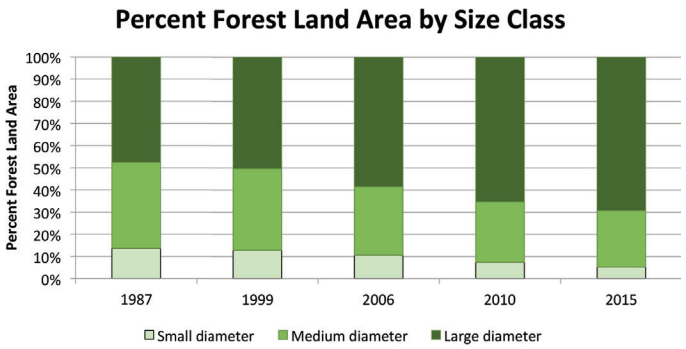


Figure 19. Percent of forest land by size class. (FIA, 2018)

> "Roughly 15% of New Jersey's forested acres statewide fall within a stand age class of greater than 100 years old, while roughly 40% of the forested acres found within the NJ Sourlands Region fall within this same stand age class (FIA 2018)."

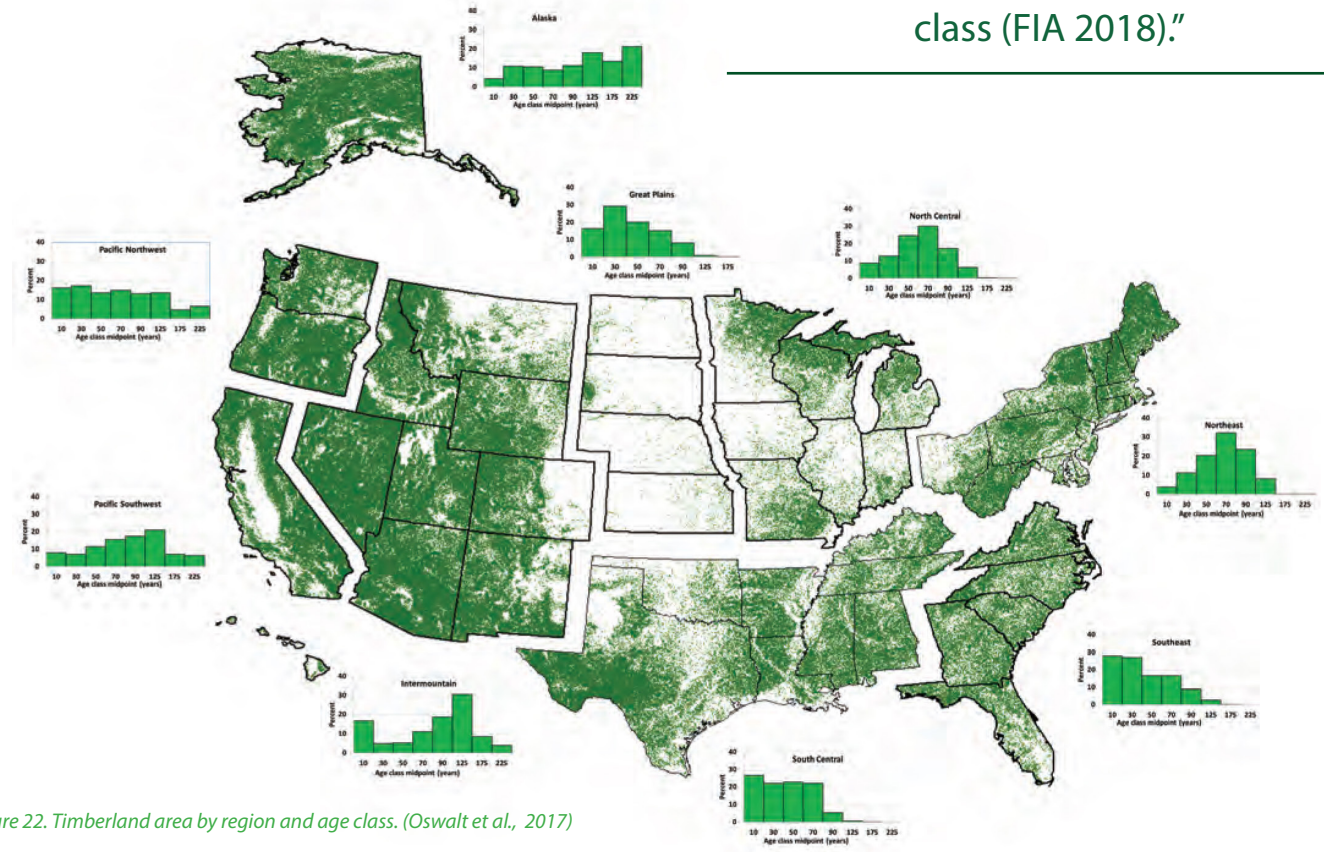


Figure 22. Timberland area by region and age class. (Oswalt et al., 2017)

In 2005, Widmann attributed this trend to many acres of forest land in the state being abandoned farmlands that have reverted back to forest since the 1940's. This is still supported by many researchers today. The increase in average forest age and the decrease in the amount of early successional forested habitat area further support this idea (Shifley et al. 2016). In fact, most of the urban expansion across the United States has occurred in forests (37% in the north) and agricultural land (42% in the north), indicating potential future declines in forested area due to fewer acres of abandoned farmlands reverting to young forest (Shifley et al., 2016; **Figure 21**).

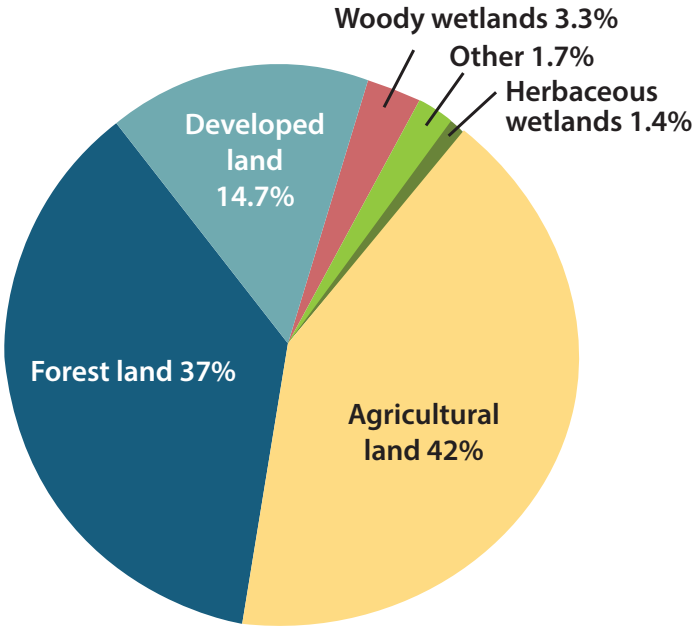


Figure 21. Percent of land by land cover categories converted into urban land for the northern United States from 1990-2000. (Shifley et al. 2016)

Therefore, acreage in young stands will most likely decrease over time as supported by the nearly "bell-shaped" distribution of age classes for 2015 centered around the 61-80-year old age class seen in **Figure 20**. This distribution is endemic to northeastern states and lake states within the United States and can be attributed to land-use patterns following European settlement as indicated in **Figure 22** (note the broadly "bell shaped" age class distributions in the corresponding regions).

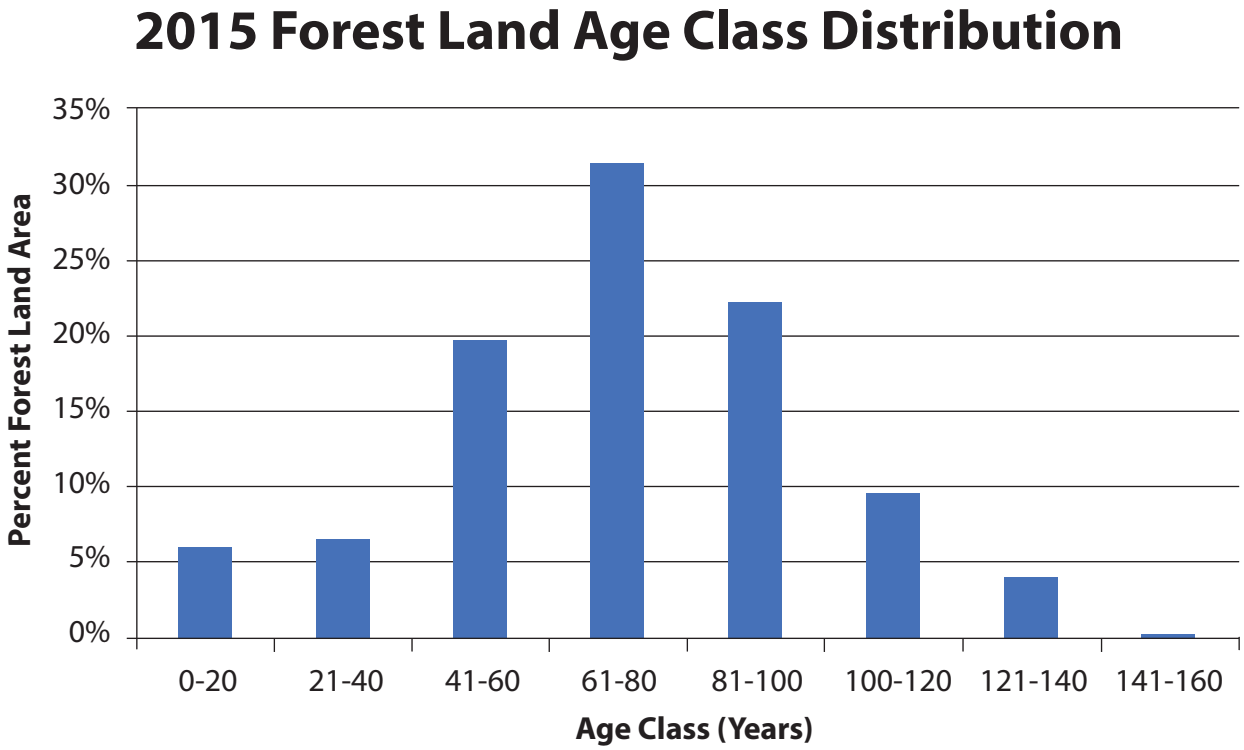


Figure 20. illustrates that overall New Jersey's forests are relatively even-aged with a mean age within the 61 to 80-year-old age class. Age class distribution on forest land in 2015 by percent forest land area. (FIA, 2015)

Latin Name	Common Name
Gaylussacia baccata	Black Huckleberry
Smilax rotundifolia	Greenbriar
Rosa Multiflora	Multiflora Rose
Vaccinium angustifolium	Lowbush Blueberry
Vaccinium pallidum	Blue Ridge blueberry
Clethra alnifolia	Sweet Pepper Bush
Berberis thunbergii	Japanese Barberry
Gaylussacia frondosa	Blue Huckleberry
Lyonia mariana	Piedmont Staggerbush
Vaccinium corymbosum	Highbush Blueberry

Table 3. Top ten most common understory shrub species. (FIA, 2018)

Shrubs

Understory vegetation is an important component of forested habitats because it provides both food and cover for wildlife. **Table 3** highlights the top ten most common understory shrub species in New Jersey by percent frequency of occurrence on FIA plots. Native species of huckleberry, greenbrier and blueberry appear as the most common across the entire state. Invasive plants are also becoming much more prevalent within the understories of our forests and are causing a variety of negative ecological effects, especially when viewed across New Jersey's landscape. The abundance of invasive plants can be attributed to their high adaptability, the availability of fragmented and disturbed habitats and the lack of natural enemies. These factors allow invasive plant species to outcompete and further displace native plant species. Invasive plants were found across the state of New Jersey, with the greatest abundance in northern New Jersey (Crocker et al., 2017). Non-native multiflora rose and Japanese barberry are among the top ten most common shrubs growing in New Jersey forests. Since Japanese barberry is infrequently browsed by deer and is ultimately less palatable than regenerating tree species and other shrubs, high deer populations can contribute to the spread of this non-native plant (Widmann, 2005). The NJ Forest Service conducts state forest inventories on all state-owned parks and forestry lands on a rotational basis. The collection of better understory data is an important component of these inventories, as it provides an understanding of forest biodiversity, forest health and successional stages. Landscape level understory sampling can also be used to narrow focus in certain locations for full-scale botanical surveys where rare plants may be present. The combination of these tools, with the FIA data presented here paint a picture of the overall pressure by invasive plant species across the New Jersey landscape.

"The abundance of invasive plants can be attributed to their high adaptability, the availability of fragmented and disturbed habitats and the lack of natural enemies. These factors allow invasive plant species to outcompete and further displace native plant species."

Extent of Forest Land Conversion, Fragmentation and Parcelization

When a large portion of contiguous forest land is lost to new development, the remaining forest land is often broken up into smaller non-contiguous or isolated tracts; this is known as fragmentation (Wilcox and Murphy, 1985). Forest fragmentation is of growing concern to land managers and planners throughout the Northeastern United States for a variety of reasons. It can result in a reduction of continuous or core forest land and an increase in edge habitat. The increased noise, light and human activity near edge habitats may also cause some species to move further inland, away from habitat edges. Other deleterious effects of fragmentation can include the loss of interior wildlife habitat, possible losses of species diversity, an increase of invasive species (especially along newly created forest edges) and a greater number of landowners per given area (Honnay et al., 2005; Crocker et al., 2017). Fragmentation also causes changes in habitat connectivity essential to the migration of animals, preventing movement of species through wildlife corridors. Habitat issues that can occur include the lack in establishment

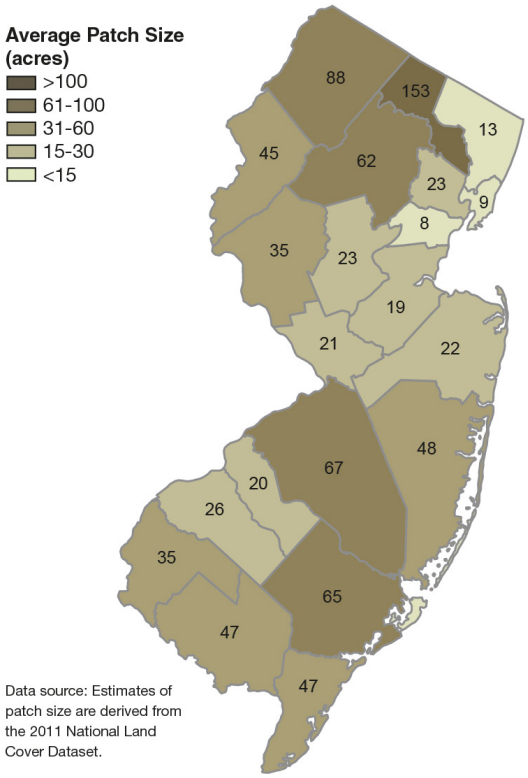


Figure 23. Average forest patch size, in acres, of New Jersey counties. (Crocker et al. 2017)

and spread of important native plant species as well. Additional consequences of forest fragmentation can include impacts on the integrity of rare plant populations through the degradation of habitat conditions and a reduction of overall ecosystem resiliency which has been linked to the spread of forest pests and diseases.

The value of large, resilient, connected forested landscapes for the conservation of biodiversity, plant and wildlife migration corridors and climate resiliency is well-documented (Anderson et al, 2016). Effective high-quality land-use conversion data can serve as an indicator in determining the amount of fragmentation of land as it moves from one land use category to another (i.e. forest land to non-forest land). Most often, this change in land use is almost always permanent (USDA Forest Service et al., 2003). Urbanization is a major cause of fragmentation, particularly when housing development occurs in or near forest land (Radeloff et al., 2005).

To fully understand the effects of forest fragmentation, the NJ Forest Service monitors and assesses additional indicators including the spatial relationships between forested patches, the ability of plant and animal species to effectively utilize and travel between patches and the cultural aspects of forest landownership.

Forest connectivity is the highest in northwestern and southeastern New Jersey; it remains the lowest within the New York City/Philadelphia/Delaware corridor. This raises significant concerns for habitat continuity along the New York City/Philadelphia/Delaware corridor, which stretches from the northeastern portion of the State to the southwestern portion. In New Jersey, average forested patch sizes by county ranged from 8 to 153 acres **(Figure 23)**. Large forest patches are more prevalent in the northwestern portion of the State, while smaller patches can be found primarily adjacent to developed locations across the state. The conversion of forest land to developed land was found to be highest in Hudson, Bergen and Essex Counties. In each of these counties, average patch sizes have decreased by one acre since 2006.

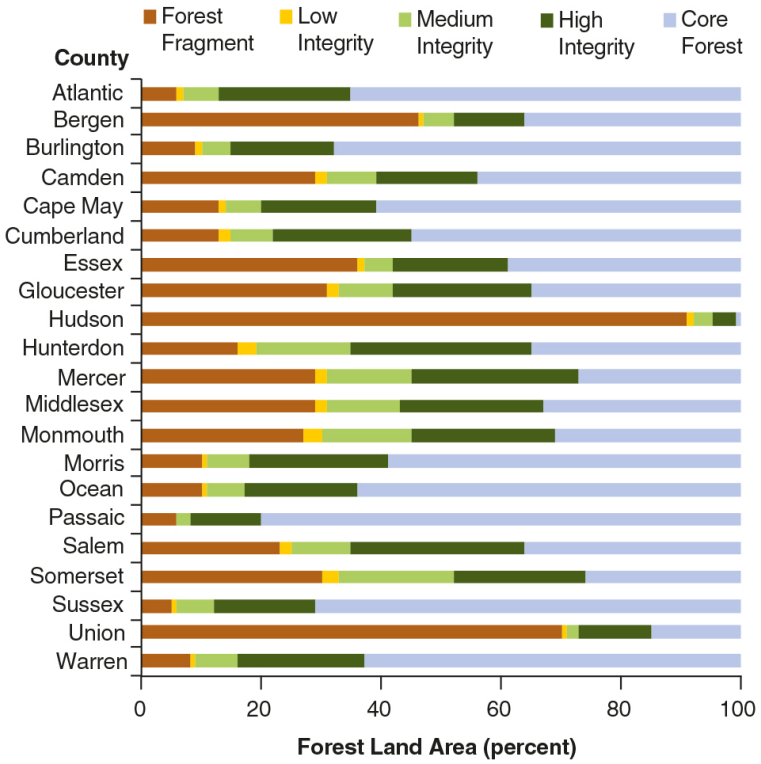


Figure 24. Forest land area by spatial integrity class of New Jersey counties. (Crocker et al., 2017)

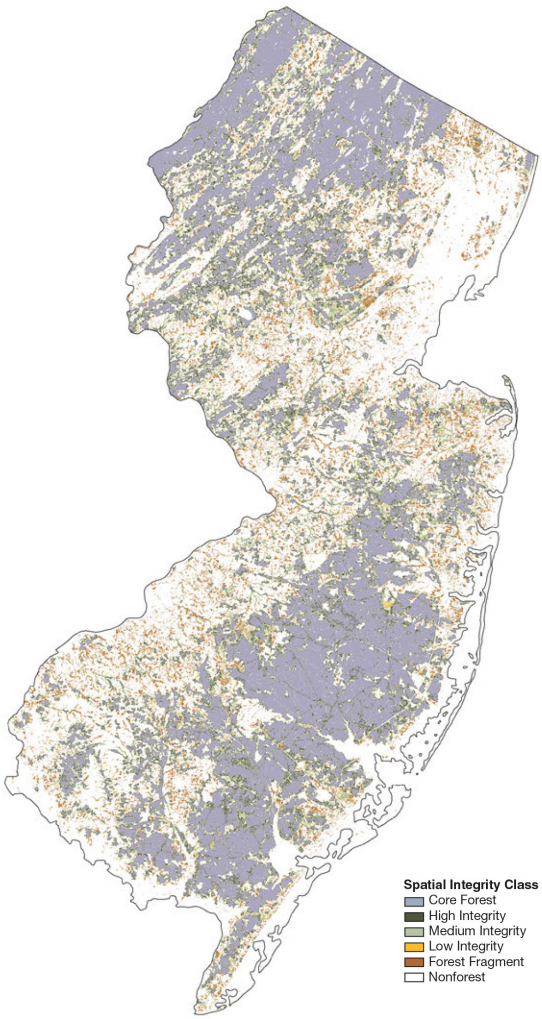


Figure 25. Spatial distribution of integrity across New Jersey. (Crocker et al., 2017)

According to FIA, approximately 55% of New Jersey's forestland is considered core forest, 21% is considered to be high integrity forest, 9% is considered medium or low integrity and 14% is considered unconnected or fragmented forest (Crocker et al., 2017). **Figure 24** breaks down forest integrity class further by New Jersey counties, while **Figure 25** demonstrates how this looks spatially across the state of New Jersey.

A study by Lathrop, Bognar and Hasse (2016) further confirms that core forests are located primarily in the northwest and southeast portions of the state, with some concentrated core forest areas located throughout the central portion of the state. During the 1986 to 2012 study period by Lathrop, Bognar and Hasse core forest habitat loss was approximately 135,781 acres or 11.2%. Upland forest had the greatest number of acres converted to human altered land use such as urban, barren or agriculture at a loss of 21,045 acres of forest from 2007 to 2012 (down from the previous time period). Agriculture was the next highest conversion to other land uses including barren, forest and urban at 19,438 acres during the 2007 to 2012 period. However, there has been a steady decline

Land-use	2007 Acres	2012 Acres	Change in Acreage
Agriculture	556,045	545,818	-10,227
Barren Land	51,329	47,960	-3,369
Forest	1,526,330	1,527,487	1,157
Urban Land	1,532,295	1,558,260	25,965
Wetlands	996,783	992,613	-4,170

	1986 (Acres)	1995 (Acres)	2002 (Acres)	2007* (Acres)	2012 (Acres)	26 year Change	26 yr % change
Urban	1,208,553	1,334,542	1,452,503	1,534,612	1,558,862	350,309	29%
Agriculture	744,382	652,335	594,696	559,615	545,813	-198,569	-26.70%
Forest	1,641,279	1,616,522	1,568,809	1,531,128	1,527,372	-113,907	-6.90%
Water	783,260	800,610	803,185	811,468	810,437	27,177	3.50%
Wetlands	1,049,269	1,022,253	1,005,636	994,836	992,566	-56,703	-5.40%
Barren	57,223	56,698	59,138	52,216	48,826	-8,397	-14.70%

Table 4. Level 1 land use/land cover for 1986, 1995, 2002, 2007 and 2012 time periods. (Lathrop, Bognar & Hasse 2016)

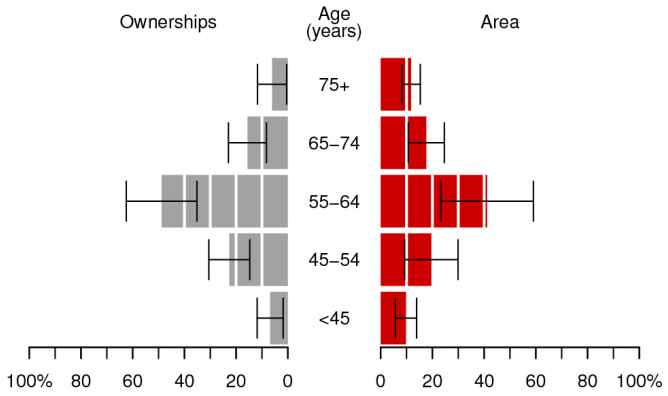


Figure 26. Distribution of forested land ownership and area across age classes in New Jersey. (Butler et al., 2016)

in the rate of coastal wetland conversion to urban land uses (Lathrop, Bognar & Hasse 2016). General land use changes over the 26-year study period by Lathrop, Bognar and Hasse (2016) are summarized in **Table 4**. Again, there was a significant increase in the amount of urban land over the study period and a predominant loss of agricultural land, while forest land has decreased approximately 6.9% over 26 years. This data is further supported by the land use changes from the 2018 Statewide Comprehensive Outdoor Recreation Plan (SCORP) between 2007 and 2012 which can be found in **Table 5**.

The fragmentation of forests through urban influence can also degrade watersheds, reduce wildlife habitat, increase site disturbance and favor invasion by exotic plant species. Many wildlife biologists conclude that fragmentation is a contributing factor in the decline of a variety of bird and wildlife species as well. Though fragmentation also favors some wildlife species such as raccoons, squirrels and white-tailed deer. The latter are considered habitat generalists, which have become accustomed to living near humans. Forest fragmentation can also affect the character of rural forested areas; unlike owners of large tracts, owners of small parcels are less likely to manage their forests in general and/or allow access to their land for activities such as fishing and hunting (Widmann, 2005). As New Jersey's population increases and land continues to become subdivided for development of urban and suburban areas, contiguous forested patch size will continue to decrease.

The New Jersey State Wildlife Action Plan (SWAP) cites habitat loss as the great threat to NJ wildlife with fragmentation a close second. Tools developed by the NJDEP Division of Fish & Wildlife, such as Connecting Habitat Across New Jersey (CHANJ) and other analyses conducted as part of the SWAP process, have led to similar conclusions regarding the importance of forest integrity statewide. The mission of CHANJ is: "To envision and guide a landscape strategy that preserves, restores and maintains habitat connectivity for terrestrial wildlife across New Jersey, helping to ensure that healthy populations can persist long into the future."

Specifically, Conservation Focal Areas (CFAs) in landscape regions like the Piedmont, Pinelands and Skylands areas are identified for their continuity;

"Many wildlife biologists conclude that fragmentation is a contributing factor in the decline of a variety of bird and wildlife species as well. Though fragmentation also favors some wildlife species such as raccoons, squirrels and white-tailed deer. The latter are considered habitat generalists, which have become accustomed to living near humans."

while concerns are raised about connectivity across more urbanized areas throughout the state. Intense fragmentation can also impede the migration of genetic material from one forest population to another. This is only one of the considerations that gets weighted when determining priority forested areas for protection of both interior and forest edge loving species.

New Jersey has one the highest percentages of forest land in public ownership at 52%; approximately 48% of New Jersey's forests are privately held (FIA, 2015). Family forest owners make up the majority of the privately held forested landholdings, which of whom shape much of the New Jersey rural culture. The average age of family forest owners in New Jersey is about 60 years old and nearly 44% of family forest land is held by people who are 65 years of age or older (Crocker et al., 2017).

A more detailed distribution of forest land ownership across owner age class is depicted in **Figure 26**. Most family forest owners, approximately 83%, own between 10 to 49 acres (Crocker et al., 2017). However, 50% of land owned by family forest owners is in holdings of 50 acres or more (Crocker et al., 2017). With so much family forest land being held by an aging population, there is an ever-growing concern and uncertainty as to what will happen when this land changes hands. Taxes can also have a large influence over forest fragmentation and land use or even forest management. One of the main concerns of family forest landowners is the cost of taxes and one of the leading incentives for forest management is participation in a tax relief program. It has become quite evident that tax policies are playing a role in keeping forested parcels contiguous (Butler et al., 2016).

"Conservation of plant and animal species therefore serves to protect the overall health of New Jersey's forested ecosystems and tracking of their abundance (or lack of) can indicate shifts in biodiversity."

Increasing forest fragmentation can also often be associated with increases in the amount of area where forests and developed landscapes "interface." These landscapes are of particular importance because they present a special set of risks regarding wildfire protection. The Wildland-Urban Interface (WUI) is known as the area where forest land or wildlands and development or urban land come together; however, there are variations in the definition of WUI and how it can be applied. Firefighting organizations often characterize WUI as any place where structural and wildland firefighting tactics must be used in combination for fire suppression. FIA describes WUI as the zone where undeveloped wildland vegetation intermingles with human development (with at least one house per 40 acres). Housing development which takes place in the WUI contributes to the effects of fragmentation and further introduces homes and structures built within the WUI to significant risk from wildfire (Radeloff et al., 2005). Forested WUI areas are steadily growing and are primarily clustered along forested margins and within core forest parcels throughout the state, particularly in the Pine Barrens of southern New Jersey and in the Highlands of northern New Jersey (Crocker et al., 2017).

Status of Forest/Woodland Communities and Associated Species of Concern

New Jersey's forests and woodlands provide significant habitat for a host of species including animals and vascular plants, mosses, liverworts and fungi such as mycorrhizae. Assemblages of plants and animals occur in various patterns across the state's landscape, dependent on geographic location and geologic history. Vegetation communities form habitats for an array of plant and animal populations of threatened, endangered and common status (USDA Forest Service, et al. 2003). By identifying the conservation status of forest/woodland communities of special concern and associated species of concern, such species can be used as key indicators of biodiversity. Conservation of plant and animal species therefore serves to protect the overall health of New Jersey's forested ecosystems and tracking of their abundance (or lack of) can indicate shifts in biodiversity.

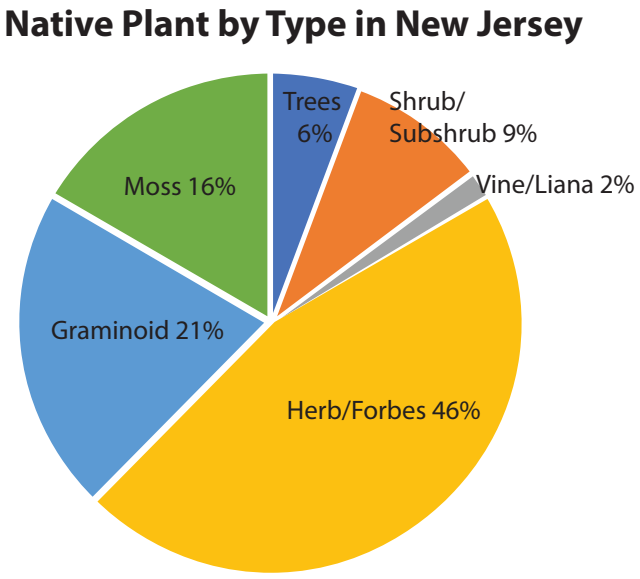


Figure 27. Native plants by type in New Jersey. (NJDEP ONLM, 2019)

NJDEP's Office of Natural Lands Management (ONLM) maintains a database to monitor and track rare plant species across New Jersey. Additionally, NJDEP's Natural Heritage Program maintains a catalog of rare ecological communities and takes the lead in providing reports in response to data requests on rare species (plant and animal). Examples of which can be found in **Appendix A** along with global and state rarity ranking information.

NatureServe, a network of more than 80 Natural Heritage Programs in the United States as well as Conservation Data Centers in Canada, Mexico and Latin America, works with state ecologists to describe, classify and track terrestrial ecosystems on a state, regional and global scale. Ecological communities or habitats, are often described as the coarse filter for conservation of biodiversity to protect a complex of ecological processes and functions that support individual species. This coarse filter/fine filter approach, utilizing habitats as conservation units, can provide protection for suites of common and at-risk species across the landscape.

The NJ Natural Heritage Program has identified approximately 2,002 native vascular plants in New Jersey. Of these native vascular plants 142 are trees, 212 are shrubs/subshrubs, 48 are vines, 1,095 are forbes/herbs and 505 are graminoids. **Figure 27** illustrates this native plant break-down by type within New Jersey. Approximately 860 taxa or 43% of the identified plants, are associated with forest and woodland habitat. There are nearly 398 moss taxa in New Jersey, 27 of which (all Sphagnum) are rare. A majority of those moss taxa, about 85%, are associated with forest or woodland habitat as well.

The flora in the state of New Jersey includes a significant proportion of rare plants including four plants that are found exclusively (endemic) in New Jersey, 37 plants that have had only one population in New Jersey and 52 plants that are rare worldwide. Nearly 1,180 plants found in New Jersey are common (59%), 413 species are rare (21%), 356 species are endangered (18%) and 52 species have been extirpated (2%). **Appendix B** lists the number of endangered plants and species of conservation concern tracked by the Natural Heritage Program within specified forest and woodland habitats, as well as the state and global rarity ranks and a list of rare plants that occur within those habitats. NJDEP has identified more than 300 Natural Heritage Priority Sites within New Jersey. Natural Heritage Priority Sites are created to identify critically important areas for the conservation of New Jersey's biological diversity, with particular emphasis on rare plant species and ecological communities. Boundaries of these sites often include additional buffered lands that should be managed in order to protect the sensitive habitat (SCORP, 2018). Natural Heritage Priority Sites are also identified as Forest Legacy (FL) areas by the NJ Green Acres Program as a part of the state's **Assessment of Need**, also known as **AON (Appendix C)**.

In the 2018 NJ SWAP, the NJDEP has identified 656 wildlife species as Species of Greatest Conservation Need (SGCN). Of those, 107 species were selected as focal SGCN based on their state and regional imperilment, the importance of NJ's populations within the range-wide distributions, and the feasibility of undertaking actions that would yield successful results. While the 2018 SWAP is focused on 107 species, it is not being suggested, nor should it be implied, that the state's conservation interests are limited to these species. SGCN are determined based on state and

federal listing status, International Union for the Conservation of Nature's (IUCN) status, published evaluations by taxonomic expert groups and taxonomic conservation plans that listed or ranked at-risk species based on a variety of vulnerability factors. **Appendix D** includes a list of SGCN by animal taxa group that depend on forested habitat and a species list of SGCN which depend on forested habitat. *The 107 focal SGCN were selected based on the following criteria:*

- State or federally endangered, threatened or candidate species;
- Listed as SGCN in the northeast region;
- Passed a fatal flaw assessment that considers practical knowledge of the species;
- New Jersey's importance to the species regional and global status;
- These steps make up Tier 2 of F&W's species selection process.

Other important factors for designating CFAs are the quality, integrity, connectedness, habitat quality and likeliness of implementing successful conservation actions within the New Jersey landscape. Along with the tracking of individual species and CFAs, the NJDEP maintains maintains the New Jersey Landscape Project *(https://www.state.nj.us/dep/fgw/ensp/landscape/)*. The New Jersey Landscape Project depicts areas of contiguous habitat known to be used by or necessary to sustain state endangered and threatened species and other priority wildlife.

Although the total area of New Jersey forests has remained relatively stable, the location and composition of the forest has been in a constant flux due to several selective forces, many of which fall outside of the region's range of historic variability.

> "Locations where eastern hemlock trees once stood in the northern reaches of the state have been replaced with fast-growing competing hardwood species as well as invasive vegetation."

Examples of these selective forces include changing climate, deer browse, native and introduced forest pests and diseases, as well as changes in where people live and how they utilize the land. As these forest compositional changes continue to shift, the following tree species/genera are identified for special concern.

Eastern Hemlock *(Tsuga canadensis)*

Eastern hemlock is a shade tolerant and slow to establish keystone riparian tree species in northern New Jersey. It has incurred widespread mortality over the last several decades due to the invasive pest, hemlock woolly adelgid (HWA). Cool humid conditions and moist soils are vital to the establishment and successful growth of eastern hemlock trees. Eastern hemlock forests have an especially unique role in reducing water temperatures and improving water quality through shading, reducing water turbidity, stabilizing steep slopes, intercepting precipitation and in improving the overall water quality of streams and rivers by providing filtration.

Eastern hemlock is also associated with a number of rare ecological communities, plants, wildlife and in particular, aquatic life. Not only have eastern hemlock forests been significantly impacted from HWA, but from rising tempatures, extended periods and herbivory pressure from deer to the extent that the eastern hemlock forest type is no longer detected across the New Jersey landscape through the FIA nationwide inventory system. This forest type is therefore considered extirpated from New Jersey according to FIA program data.

FIA estimates that of all 851,592,944 living trees with a DBH of 1 inch or greater on forestland in New Jersey, only approximately 3,848,227 of these trees or 0.45%, are eastern hemlock. (FIA, 2018) These eastern hemlock trees currently make up a

few vestigial populations of eastern hemlock forests across the historic New Jersey range.

The loss of eastern hemlock forests to date has already altered the forest ecosystem across the northern portion of the state and will continue to affect not only hydrologic features and conditions, but overall watershed conditions.

Locations where eastern hemlock trees once stood in the northern reaches of the state have been replaced with fast-growing competing hardwood species as well as invasive vegetation. This type of stand conversion has been identified in many other eastern hemlock forests across the species range in the northeastern United States (Marshall, 1927; Pennsylvania DCNR, 2014). However, there is one study site within New Jersey with eastern hemlock trees identified as having an induced resistance to HWA. These trees indicate traits which show a resistance or tolerance to HWA infestations. These findings are encouraging and will foster the ability of further restoration of this critical species of concern throughout the northern portion of the state.

> "Butternut canker has caused widespread mortality in butternut trees within its entire native range."

Butternut *(Juglans cinerea)*

Butternut, commonly called white walnut, contributes to wildlife populations as an important hard mast producing tree. Butternut is one of two native walnuts in the state of New Jersey. Butternut in particular prefers a cooler climate as opposed to its close relative, the black walnut.

In 2019, butternut was reclassified as an "S1" species (refer to **Appendix B** for State Element Ranking classification), due to the dramatic decline in its population, caused by butternut canker. Butternut canker has caused widespread mortality in butternut trees within its entire native range. In New Jersey, the range of butternut is concentrated in the northwestern portion of the state.

Historically, butternut was not a prevalent species, nor a long-lived one, which only exacerbates the impacts of butternut canker on the species. Currently, there are seven known populations of butternut left in the state (according to NJ ONLM), however, it is unknown if these populations are pure butternut trees or hybrid butternut trees. Hybrid butternuts, also called buartnuts, are a cross between native butternut *(Juglans cinerea)* and Japanese heartnut *(Juglans ailantifolia)*. This cross occurs naturally in the wild and buartnuts are more resistant to butternut canker than pure butternut. Buartnuts also produce more seed than pure butternut and therefore have the capacity to produce more offspring. For these reasons, the majority of butternut trees which exist today are likely buartnuts, not pure butternut.

The success of future restoration projects for butternut relies heavily on the tree's natural ability to tolerate butternut canker and in producing sufficient seed for natural regeneration of offspring. This can be achieved by encouraging a population of parent trees best acclimated to New Jersey's ecosystem and through the conservation of New Jersey native butternut genetics, in addition to seeking butternut genetics from similar growing zones.

Pumpkin Ash *(Fraxinus profunda)* **and Black Ash** *(Fraxinus nigra)*

Pumpkin ash and black ash are the two less common of the native ash that occur in the state and are considered critically endangered by the IUCN Red List. Although all native ash is considered critically endangered due to the impacts of Emerald Ash Borer (EAB), pumpkin and black ash are prioritized becausepumpkin ash is listed as state endangered and black ash is a plant species of concern.

Pumpkin and black ash commonly occur in wet sites, but not often together, with pumpkin ash requiring periods of standing water throughout the year. The presence of emerald ash borer has caused an increased concern in the survival of these two

species of ash. According to FIA, black ash only makes up 0.06% of all of New Jersey's trees greater than 1" DBH and pumpkin ash are so rare that they don't appear in any FIA statistics for New Jersey. (FIA, 2018)

EAB can infect trees well before they reach sexual maturity and can remain in the environment, even when few hosts remain. Pumpkin ash seeds are only viable in the seed bank for 2-3 years and black ash seeds for 7-8 years. Natural regeneration is also obstructed by herbivory and poor site conditions for germination and establishment.

Conserving the genetics of the few trees that remain in the state is a priority and is currently being done by seed conservation and by pesticide treatments to protect healthy trees from EAB attack.

American Chestnut *(Castanea dentata)*

American chestnut was historically considered an impressive forest tree in the Northeastern United States. These trees had great stature, growing upwards of a hundred feet tall and up to ten feet in diameter. They were also considered a common tree of the forest canopy, producing chestnuts which benefited wildlife and strong timbers that were used for various products including building material for houses and other wooden structures.

However, the introduction of chestnut blight from Asia in the early 1900s to the United States essentially decimated the American chestnut population and nearly eliminated the American chestnuts' ability to produce viable seed. Although blight infected American chestnut trees can re-sprout from root suckers, these stems quickly become infected with blight before they can reach maturity. This significantly limits the tree's ability to reproduce and develop viable seed. Therefore, this species is considered functionally extinct.

However, today scattered American chestnut sprouts can still be found throughout forests within the state. Extensive work to create a blight resistant hybrid of American chestnut and Chinese chestnut continues but has not yet led to a successfully resistant cross/hybrid. On the other hand, transgenic chestnuts are also being researched (wheat gene spliced into the American chestnut gene). These transgenic chestnuts have shown promise in their resistance to chestnut blight and are currently under FDA review for potential release into the wild.

> "A critical factor affecting the oak genus includes cultural shifts in land management, in particular, the alteration of fire regimes across the state. Fire is a necessary component for oak species to thrive, as it provides a natural seed bed, reduces competition and increases the amount of sunlight reaching the forest floor."

Oak *(Quercus spp.)*

The oak genus includes a wide range of species, each with unique site requirements and conditions, yet overall the success of oaks within the forest ecosystem depends on deep roots, healthy root stocks, full available sunlight, viable seed production, advanced reproduction, natural disturbance and fire (Ward, 2015; Clark & Watt, 1971).

The oak genus serves an extensive ecological role within the state of New Jersey by colonizing a range of sites, especially those of poor quality with little soil moisture. Additionally, they comprise a significant component of wildlife food production as hard mast (acorns).

Unfortunately, numerous factors and damage causing agents (DCAs) affect or have affected the oak genus over time. Such factors include increasing forest density, deer browse/density, lack of fire, successional changes, invasive species proliferation

and preponderance of competition with species of increased shade tolerance. Clark and Watt (1971) specifically cite New Jersey as a problem area for advanced oak regeneration, indicating this was an issue as early as the 1970s. Specific DCAs include gypsy moth, bacterial leaf scorch orange striped oak worm, gouty oak gall, oak wilt and oak decline.

A critical factor affecting the oak genus includes cultural shifts in land management, in particular, the alteration of fire regimes across the state. Fire is a necessary component for oak species to thrive, as it provides a natural seed bed, reduces competition and increases the amount of sunlight reaching the forest floor.

The oak genus makes up quite a significant portion of New Jersey's forest cover. Overall, the oak-hickory forest type-group encompasses approximately 16 different oak forest types and constitutes more than 842,984 acres of forestland across New Jersey (FIA, 2018).

The Natural Heritage database concludes that approximately 20 different species of oak are found throughout New Jersey. The top five species of oak by volume alone make up nearly 24% of New Jersey's total tree volume on forest land (FIA, 2018). The oak forest types also extensively dominate the northern portion of the state, with an overall presence in nearly all reaches of New Jersey. Five oak species – shingle, overcup, mossy-cup, water and basket oak – are rare in New Jersey, four of which are listed as state endangered.

As deleterious effects continue to plague the oak genus, this causes serious concerns for future populations as well as forest composition and structure, especially when such a large proportion of the state is comprised of oak species.

Atlantic White-Cedar *(Chamaecyparis thyoides)*
AWC is another keystone wetland tree species; it is considered New Jersey's only obligate wetland tree species (Reed, 1988). AWC forests are also classified as a globally threatened ecosystem. This species is primarily concentrated in the Pinelands region of southern New Jersey where it grows and thrives within freshwater wetlands.

"Not only are AWC swamps home to a large variety of wildlife, but they are home to some of New Jersey's rarest plant populations and rarest ecological communities."

AWC stands have ecological significance as they filter and purify water by absorbing and filtering pollutants and sediment, shade streams and wetlands, stabilize stream flows by storing floodwaters, store carbon via exclusive muck soils and improve/maintain water quality.

Not only are AWC swamps home to a large variety of wildlife, but they are home to some of New Jersey's rarest plant populations and rarest ecological communities. Hydrology, however, plays a crucial role in the success or failure of AWC trees in occupying an area.

AWC forests have been in constant decline as a result of centuries of exploitation through cutting without planning for regeneration, development, deer browse, hardwood competition, salt-water intrusion from storms, as well as sea level rise from a changing climate and flooding due to beaver activity.

AWC once occupied nearly 500,000 acres along its entire range from Maine to the Gulf states. Recent estimates of the overall range of AWC are a mere 125,000 acres. This figure equates to a historical occupation of AWC in New Jersey alone. FIA data (2013-2018) currently estimates that the AWC forest type covers approximately 30,996 acres of forestland across New Jersey. However, statewide estimates of AWC forest are less than 25,000 acres (NJFS, 2019). This decrease in acreage is due in part to the NJ Forest Service's efforts to identify pure cedar stands as opposed to stands with an integration of other species. Such data provides

for an overall better understanding of why past restoration initiatives succeeded, in addition to valuable information for future restoration activities. Historically, forest management has successfully been used to return AWC to appropriate sites across forestland ownerships in New Jersey. As mentioned in the 2010 NJ SFAP, AWC continues to be a species of concern. The restoration of AWC is so vital to the state of New Jersey that a proposal to restore 10,000 acres of the forest type over the next 10 years has had funding appropriated for this purpose by the legislature.

Shortleaf Pine *(Pinus echinata)*

Shortleaf pine is a native species predominantly found within the Pinelands Region of southern New Jersey. This species is found on a wide range of soils but is primarily found on sandy xeric uplands to mesic lowlands. Shortleaf pine grows at elevations as low as ten feet in southern New Jersey and up to 3,000 feet in the Appalachian Mountains. This species of pine, which is native to the eastern and southern United States, is found as far west as Texas and Oklahoma. As with oaks, shortleaf pine is dependent on a frequent fire and disturbance regime to maintain a healthy and productive forest ecosystem.

A variety of plant and wildlife species, especially birds, depend on open shortleaf pine ecosystems for habitat. Historically, shortleaf pine forests consisted of a more open structure, low in density, with significant levels of sunlight reaching the forest floor and a proliferation of grasses present within the understory.

“Like oaks, shortleaf pine has also become a species of decline due to increased forest density, the lack of fire or changing fire regimes, successional and land use changes and competition with hardwood species of less fire tolerance.”

Short leaf pine at the Forest Resource Education Center in Jackson, NJ.

Like oaks, shortleaf pine has also become a species of decline due to increased forest density, the lack of fire or changing fire regimes, successional and land use changes and competition with hardwood species of less fire tolerance. Decline of this species can also be attributed to its historic exploitation through cutting because of its desirable wood properties such as its straight form compared to pitch pine. Shortleaf pine is also susceptible to southern pine beetle infestation and damage from other native forest pests and pathogens.

Shortleaf pine dominated forest types were once a major component of the nation's forests along the coast and interior south. Over the last 30 years, however, these ecosystems have lost more than 50% of their former acreage, with most of the decline occurring east of the Mississippi River (Shortleaf Pine Initiative).

The shortleaf pine forest type is represented within the loblolly/shortleaf pine forest type-group and although this is the second most prominent forest type within New Jersey, shortleaf pine is not as prevalent as pitch pine or loblolly pine (FIA, 2018). A summary from USDA Forest Service, FIA from 1987 to 1999 showed an increase in the shortleaf/oak forest type by 500 acres of timberland and a decrease in the shortleaf pine forest type by 25,500 acres on timberland.

In 1999, there were 8,000 acres of the shortleaf/oak forest type on timberland and approximately 9,100 acres of the shortleaf pine forest type. In 2014, however, the shortleaf/oak forest type declined to approximately 6,679 acres, which equates to a loss

of approximately 1,500 acres. Additionally, the shortleaf pine forest type declined to approximately 6,000 acres, equating to a loss of approximately 2,500 acres. The number of shortleaf pine trees across the New Jersey landscape is approximately 2,489,162 or less than 0.3% of all the trees in New Jersey (FIA, 2018). The concern for this species is so immense that a 22-state initiative (including New Jersey) to restore these unique shortleaf pine ecosystems was launched in 2013.

Many landowners have worked with state and private foresters, in addition to professional timber harvesters, to help suppress southern pine beetle (SPB) throughout the southern half of the state of New Jersey. Initiatives to increase stand thinning prescriptions for density reduction make pine stands (including those with a shortleaf pine component) more resilient to SPB attack and are covered by cost-share programs provided by the USDA's Forest Stewardship Program.

The protection and conservation of rare plant species are important in the maintenance of biodiversity and as such need the same protection and dedication as tree species of concern. Some of these species are American Chaffseed, Broom Crowberry, Pickering's Morning Glory and the Pine Barren Gentian and are discussed below.

American Chaffseed *(Schwalbea americana)*
Broomrape Family *(Orobanchaceae)*

American Chaffseed, *Schwalbea*, is an herbaceous perennial growing from one to three feet in height. Single or multiple stems can support numerous flowers that are bee or self-pollinated. The fruit is a brown, dry dehiscent capsule containing about 200 flat winged seeds. The *Schwalbea* plant flowers between April and June, with fruits maturing between July and August.

The species range for *Schwalbea* formerly occurred from Massachusetts to Texas, but populations have disappeared from the northern half of the historic range above North Carolina, except for two remaining known extant occurrences in New Jersey and Massachusetts respectively.

Schwalbea was formerly widespread in the New Jersey Pine Barrens with 19 to 20 populations known from six coastal counties. This herbaceous perennial now only has one natural occurrence within Burlington County.

Schwalbea is a hemi-parasitic (root-dependent) species. Seeds must germinate in close proximity to the roots of a host plant to survive and grow in its early stages; individuals do not depend upon these parasitic relationships once established. Host plants include those within the *Asteraceae* family, with Maryland Golden Aster *(Chrysopsis mariana)* the preferred host in New Jersey.

Although seed dormancy has been documented for several years in controlled conditions, experiments in New Jersey found viability to diminish after one to two years in the field. Preferred habitat for *Schwalbea* exists within coastal plain forests and other isolated areas in eastern North America with sandy, acidic soils that are seasonally moist to xeric. The current global rarity rank of *Schwalbea* is "G2G3" (imperiled globally, with 6-20 occurrences or few remaining individuals or acres or other factors) making it vulnerable to extinction throughout its range.

Schwalbea is also listed as federally and state endangered and is on the NJ Pinelands Commission list of 92 species of threatened and endangered plants in the New Jersey Pinelands. Fire suppression and resulting forest succession, suburban development, incompatible right-of-way maintenance and illegal off-road vehicle use have all contributed to the diminishing populations and host species of/for *Schwalbea*. New Jersey's only natural occurrence is in a precarious location and has experienced considerable variation in overall health and viability.

Broom Crowberry *(Corema conradii)*
Empetraceae Family

Broom crowberry occurs in early successional openings on acidic, siliceous bedrock or sand with limited shading and competition from trees and shrubs. Major New Jersey populations are limited to sandy openings within dwarf pine plains, with minor populations in adjacent pine barrens. Broom crowberry is dependent on frequent fire to maintain early successional habitats in pine plains and barrens, but plants and seeds are killed by higher intensity fire after prolonged fire exclusion. Soil seed banks allow populations to recover from moderate fires, but often fail to survive after severe, intense fires. With limited seed dispersal capability as it is facilitated by ants, the species colonizes new habitats only if located a short distance from extant populations. Below is the broom crowberry taxonomic description:

Low growing, evergreen ericaceous shrub, up to 30 cm tall in New Jersey, 60 cm tall in Canada. Fruits: 3-4 carpellate and drupaceous; mature drupes closed at maturity.

The current range of broom crowberry occurs along the coast from Nova Scotia to New Jersey, except for Ulster County, NY where it is found further inland. The overall distribution of broom crowberry includes the following states of Massachusetts, Maine, New Jersey, New York and some eastern Canadian provinces. Broom crowberry is a Plant Species of Concern and is on the NJ Pinelands Commission list of 92 species of threatened and endangered plants in the New Jersey Pinelands.

In the New Jersey dwarf pine plains, high intensity prescribed burning or wildfire after prolonged fire exclusion kills broom crowberry plants and seeds. Successional impacts from prolonged fire exclusion, causing canopy closure, increased shading, loss of open sandy habitats and increased fuel loading are also a threat to broom crowberry populations. Frequent moderate intensity fire and mechanical disturbances are needed to maintain open pine plains habitat, early successional habitat and broom crowberry population recruitment. Illegal off-road vehicle use has also impacted populations.

Pickering's Morning Glory
(Stylisma pickeringii var. pickeringii)
Convolvulaceae Family

Pickering's morning glory is a perennial herbaceous vine that reproduces sexually. Established plants flower profusely, often producing hundreds of flowers and seeds, flowering from mid-July through late August. Flowers open in early morning and are pollinated by bees and other small insects. Often abundant seeds are visible on sand surrounding plants, which can remain viable for approximately two years. While fire can decimate a population, it may also increase the population by removing competing vegetation and providing the necessary bare, sandy soil requirements for germination.

Pickering's morning glory is described as a prostrate perennial herb with stems branching and rising from a central crown (up to two meters in length) with tawny pubescence. Flowers of the plant are white and funnel-shaped with five rounded lobes on hairy stems (3-7 cm long) that originate in the angle of the leaf and stem with two leaf-like bracts (1.5-2.5 cm long) that resemble leaves. Fruits of the Pickering's morning glory are ovate-elliptic, thin-walled capsules (6 mm wide) with one to two seeds each.

This plant can be found growing on bare sandy mineral soil, sandy ridges and dry roadsides in the New Jersey Pine Barrens and outer coastal plains. Pickering's morning glory can also be found along railroad tracks in some locations and is often found with associated species of pitch pine, scrub oak, hudsonia, lowbush blueberry, black huckleberry, switchgrass and coastal jointweed.

The range of this perennial herbaceous vine occurs across Alabama, Georgia, South Carolina, North Carolina and New Jersey. The three New Jersey counties of Ocean, Burlington and Atlantic support seventeen naturally occurring Pickering's morning glory populations. The current global rarity rank of Pickering's morning glory is "G4T3" (refer to **Appendix B** for description) and has a State Element Rank of "S1" (one to five occurrences). This plant is also considered State Endangered for New Jersey and is on the NJ Pinelands Commission

list of 92 species of threatened and endangered plants in the New Jersey Pinelands. Threats limiting Pickering's morning glory plant populations and occurrences include habitat loss due to succession, disruption of the natural fire regime, damage to habitat by vehicle traffic, mowing and herbivory.

Pine Barren Gentian *(Gentiana autumnalis)*
The Pine Barren gentian *(Gentian)* is a fall flowering perennial plant that is disturbance adapted and has the potential to remain dormant for at least two years. Flowers of the *Gentian* are protandrous and bloom time is staggered in populations. Gentian flowers are visited by a high diversity of insects, with species in the family *Syrphidae* constituting the majority of visits in New Jersey populations.

Roots from plants in New Jersey show a high level of mycorrhizal fungi colonization. *Gentian* plants have also shown the ability to break dormancy and set seed within the same year of cool season prescribed burn treatments. The *Gentian* is described as having decumbent to erect, glabrous stems, with linear to narrowly oblanceolate leaves and obtuse to acute lower leaves.

Gentian flowers are solitary, occasionally also terminating one or two branches, with deep blue coloring on corolla and greenish-yellow dots adaxially on lobes. While the seeds of the *Gentian* plant are winged.

This perennial has a range across states of South Carolina, Virginia, North Carolina and New Jersey. Within the NJ Pine Barrens, Gentian occurs in Atlantic, Burlington, Camden, Cape May, Cumberland and Ocean counties. Preferred *Gentian* habitat includes wet or dry sandy, open areas; moist open woods; roadsides; bogs; swamps; and moist coastal plain pine barrens. This unique plant is known to be threatened by fire suppression, changes to local hydrology, mowing during the growing season and herbivory in reduced populations. The *Gentian* has a State Element Rank of "S3" (Plant Species of Concern, with 21 to 50 occurrences statewide).

CRITERION 2.

MAINTENANCE OF PRODUCTIVE CAPACITY OF FOREST ECOSYSTEMS

Area of Timberland

Understanding the dynamics of New Jersey's wood supply is necessary for sustainable management of the state's forested resources for existing and future generations. The area of timberland serves as an indicator of the productive capacity of forest ecosystems by measuring how much land is available for the harvesting of timber products as compared to the total forested area for the benefit of society.

FIA defines timberland as forest land with potential available resources for commercial use with the capability of growing at least 20 cubic feet per acre per year. However, lands classified as "reserved" are not included within the timberland definition (Crocker et al., 2017). If a forested area is labeled as timberland, it does not necessarily mean that it is suitable or available for commercial use. In fact, suitability and availability rely heavily on policy, economic or market constraints, cultural shifts and ownership objectives.

Forest land, on the other hand, is defined by FIA as any land with at least 10% crown cover of live trees and consisting of at least one acre in size with a width of at least 120 feet. This means that all timberland is forest land, but not all forest land can be considered timberland.

Historically, the majority of New Jersey forest land has been classified as timberland. Statewide in 2015, New Jersey had approximately 1,990,000 acres of forestland, while the total amount of timberland was approximately 1,700,000 acres (FIA, 2018). During that time, more than 626,000 acres of forested land was under state ownership and of that area approximately 507,000 acres or roughly 87% was considered timberland. This has not changed substantially since 1987 **(Figure 28)**.

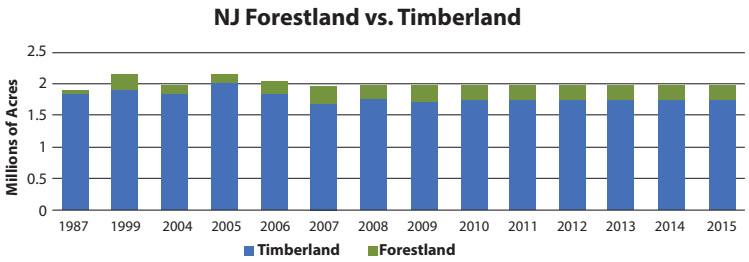


Figure 28. Acres of New Jersey forest land and timberland between 1987 and 2015. (FIA, 2018)

State-owned lands include State Parks, State Forests and Wildlife Management Areas (WMAs) that are located throughout the state in all ecological provinces. Publicly owned land overall (federal, state and local government) includes approximately 1,040,000 acres of forestland with nearly 769,000 acres of that considered timberland. Privately owned land in New Jersey includes approximately 950,000 acres of forestland, all of which is classified as timberland.

Annual Net Growth vs Removal

Analyzing the differences between average annual net growth and harvest rates of timberland are a key component for understanding the role of forest sustainability and conservation in the state of New Jersey. However, determining growth relative to removals is essential in understanding forest sustainability regardless of whether timber is an objective or not. Although these are viable interests, they are not the only ones involved in forest management decision-making and planning throughout the state. There are a wide variety of collaborative efforts to increase the status of forest

sustainability within the state of New Jersey. In each area of the forest throughout the state, tree species and soil characteristics will determine how much net growth (cubic feet per acre) can be expected from a given stand, forest or property. These expected growth values can then be used to determine measurable sustainable harvest levels (USFS et al., 2003). To meet sustainability goals relative to timber, the net growth must equal or exceed removals.

Growing-stock volume in New Jersey has steadily increased since 1956 and totaled approximately 3.3 billion cubic feet in 2013 (Crocker et al., 2017). Of all the tree species in New Jersey, pitch pine is the most voluminous species on timberland and accounts for nearly 14% of all growing-stock volume alone (Crocker et al., 2017). However, a large proportion of this volume is not classified as sawtimber, either due to not making grade or minimum size requirements.

There have also been notable increases in growing stock volume from species groups such as the other yellow pines, yellow-poplar and select red oak groups since 1987 (Crocker et al., 2017). Even with these increases in overall growing stock volume, **Figure 29** shows that the overall annual growth rate declined between 2008 and 2015 (Crocker et al., 2017).

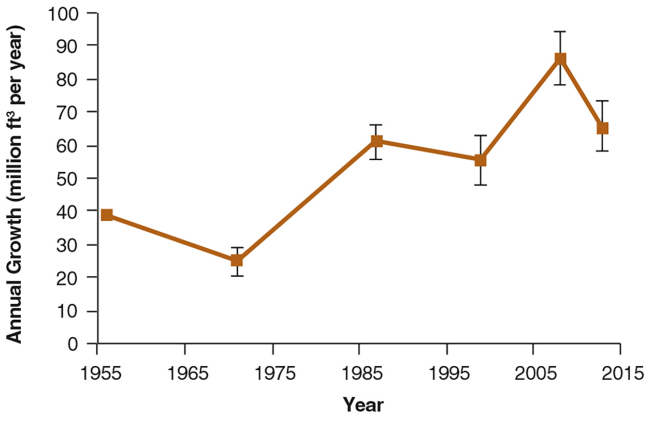


Figure 29. Average annual net growth of growing stock on timberland by inventory year in New Jersey. (Crocker et al. 2017)

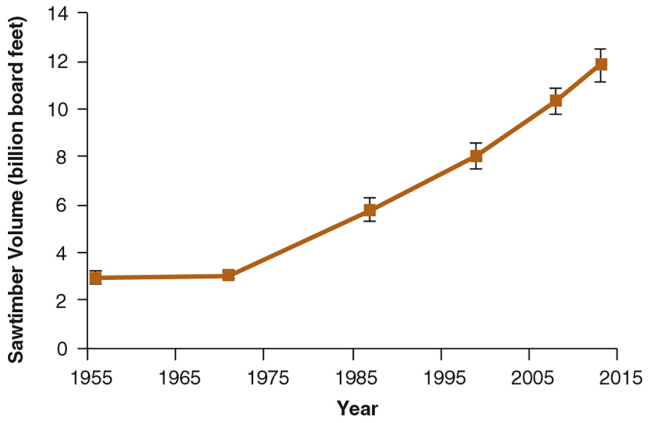


Figure 30. Sawtimber volume on timberland by inventory year in New Jersey. (Crocker et al. 2017)

As the forests of New Jersey mature and smaller trees grow into larger size classes, the amount of sawtimber available on timberlands statewide increases. The volume of sawtimber on New Jersey timberland has quadrupled since 1956, reaching an estimated 11.8 billion board feet in 2013 (Crocker et al., 2017). This progressively upward trend can be seen in **Figure 30**.

This also means that many New Jersey species groups have had significant gains in sawtimber volume on timberland over the last several decades. In particular, the eastern white pine and red pine species group, as well as the yellow-poplar species group have experienced the greatest increases by species group of sawtimber volume from 2008 to 2013 **(Figure 31)**.

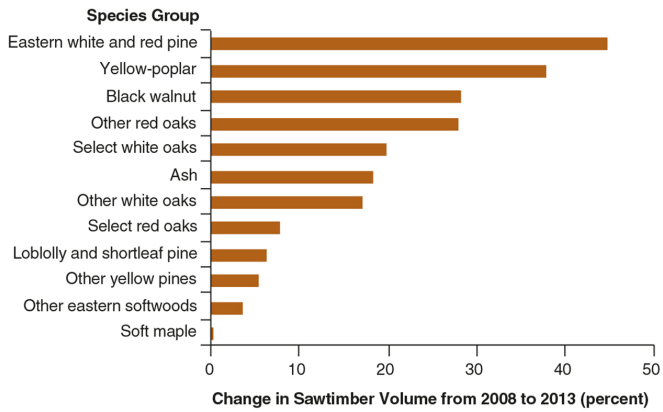


Figure 31. Percent change in sawtimber volume on timberland for 12 selected species groups in New Jersey. (Crocker et al. 2017)

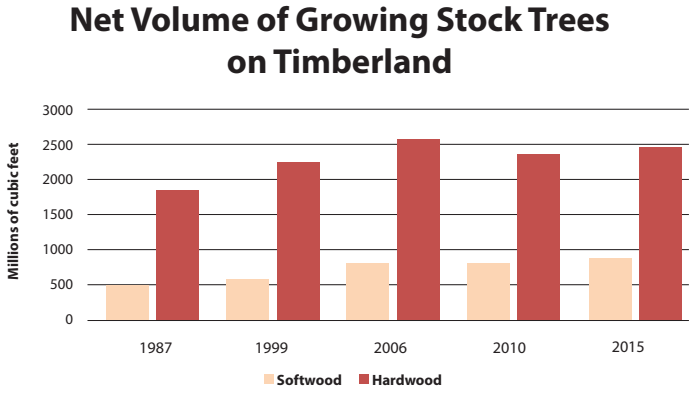
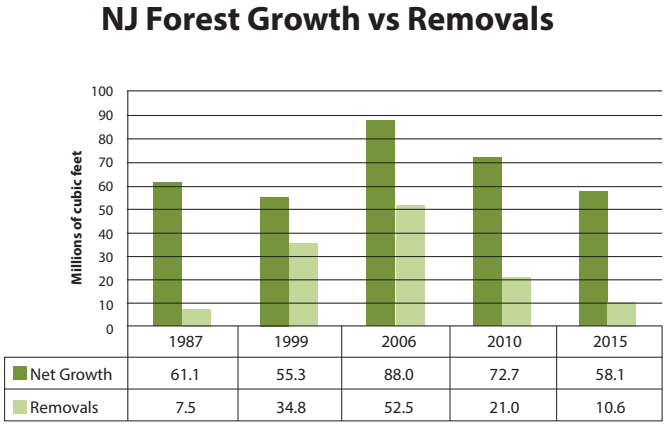


Figure 32. Net volume of growing stock trees of both hardwoods and softwoods on Timberland in New Jersey. (FIA, 2018)



	1987	1999	2006	2010	2015
Net Growth	61.1	55.3	88.0	72.7	58.1
Removals	7.5	34.8	52.5	21.0	10.6

Figure 33. New Jersey forest growing stock growth to removals from 1987 to 2015. (FIA, 2018)

Overall, hardwood growth statewide is almost triple that of softwood growth, especially since the hardwood forest type-groups cover most of the forested area across New Jersey **(Figure 32)**.

In 2015, the estimated net growth on New Jersey's timberland was 49.1 million cubic feet annually (FIA, 2018). While average annual removals were approximately 7.1 million cubic feet on timberland (FIA 2018). Of the average annual removals, approximately 6.2 million cubic feet are from private lands (FIA, 2018).

Figure 33 compares New Jersey's overall forest growth versus removals from 1987 to 2015. During the 1990s and early 2000s, there was a significant increase in tree removals, largely a result of land clearing for development during statewide booms.

> "When considering individual tree species, the highest growth rate is predictably seen in pitch pine and red maple which are the most common trees in New Jersey."

The figure accounts for growth in growing stock trees only, because growth and removal data for trees not considered growing stock is not available prior to 2004 in New Jersey. Accounting for growth in the sound bole volume of all trees with diameters greater than 5 inches yields an estimated average net growth to removal ratio on timberland in 2015 of approximately 7:1; further demonstrating that New Jersey's timber resource is largely underutilized and the amount of growing space occupied by trees is increasing (FIA, 2015).

When considering individual tree species, the highest growth rate is predictably seen in pitch pine and red maple which are the most common trees in New Jersey. On the other hand, net growth (annual gross growth in cubic feet minus losses to rot and mortality) for white ash in New Jersey is merely 3% of gross growth (annual growth in cubic feet for the FIA inventory cycle, 2017 FIA reporting cycle). This is most likely attributed to high mortality rates in all species of ash occurring in New Jersey due to emerald ash borer.

Other species with notable differences between net growth and gross growth are AWC—net growth approximately 44% of gross growth, scarlet oak—net growth 20% of gross growth and black oak—net growth 55% of gross growth. Counties to note with regards to proportion of net growth to gross growth are Atlantic County—net growth is approximately 40% of gross growth, Cumberland County—net growth is approximately 25% of gross growth and Sussex County—net growth is approximately 40% of gross growth. Mercer County was also notable, however for exhibiting negative net growth for the 2017 FIA reporting cycle. These trends should be investigated more closely to determine the underlying cause(s).

CRITERION 3.

MAINTENANCE OF FOREST ECOSYSTEM HEALTH AND VITALITY

Area and Percent of Forest Land Affected by Abiotic and Biotic Processes and Agents

The mid-Atlantic region which includes Pennsylvania, New York, New Jersey, Delaware and Maryland supports a mosaic of forested ecosystems. These forests supply important benefits to the people of the area. Changes in climate, weather extremes and fire regime, habitat fragmentation, species invasions, insect pests and diseases and other alterations to the landscape continually shape our forest ecosystems potentially impacting these forest benefits (Butler et al., 2018).

With respect to forested areas, Damage Causing Agents (DCAs) are those that cause decline and mortality of vegetation. Identifying and monitoring forested areas impacted by DCAs is critical in understanding the overall health of the state's forests. The NJ Forest Service recognizes DCAs as either native or exotic and biotic or abiotic. Interface, urban and traditional forests are affected differently by DCAs and may require different strategies to address. For example, climate change is quickly becoming a major DCA, threatening the stability of the state's forested resources; wildfire, although a natural force that is critical in shaping forests over time, is a causal agent that can necessitate immediate suppression in New Jersey; and native and non-native invasive plants, insects and diseases also affect the landscape in varying ways.

Abiotic Damage Causing Agents

Climate Change

Climate change is the defining issue of our time. The world's scientists agree that global warming trends observed over the past century are caused by human activities, specifically the emissions of heat-trapping greenhouse gases (GHG). Further, the consequences of climate change make clear the urgency of decarbonizing our economy so as to protect and improve upon the quality of life of all New Jerseyans. Due to its geography, population and other factors, New Jersey is especially vulnerable to the adverse impacts of climate change. In distilling the most current climate science and its particular relevance to the Garden State, the 2020 New Jersey Scientific Report on Climate Change explains the worsening impacts to our state under low-, moderate- and high-emission scenarios (NJDEP, 2020). **Key findings of the report underline the urgency for concerted action across all levels of government:**

- New Jersey is warming faster than the rest of the Northeast region and the world. Since 1895, New Jersey's annual temperature has increased by 3.5° F.
- Annual precipitation in New Jersey is expected to increase by 4% to 11% by 2050.
- Sea-levels are rising at a greater rate in New Jersey than other parts of the world.
- New Jersey is likely to experience sea-level rise by as much as 1.1 feet by the year 2030 and 2.1 feet by the year 2050 due to climate pollutants we have already emitted.
- Sea-levels could rise by as much as 5.1 feet by the year 2100 and 8.3 feet by the year 2150 under a moderate emissions scenario.
- New Jersey's billion-dollar commercial fishing industry—the fifth largest in the country—will be adversely impacted by increased ocean acidification and "dead zones" from hypoxic events.
- The effects of climate change are likely to contribute to an increase in air pollution, lead to increased respiratory and cardiovascular health problems, like asthma and hay fever, and a greater number of premature deaths.

- Water supplies will be stressed from the increase in the growing season and extreme temperatures expected due to climate change.
- New Jersey could become unsuitable for one of our greatest exports—blueberries—by the middle of this century.
- The frequency and intensity of harmful algal blooms are likely to increase, disrupting swimming and fishing in NJ's lakes, and posing risks to drinking water reservoirs.
- Wildfire seasons could be lengthened, and the frequency of large fires increased due to the hot, dry periods that will result from increased temperatures.
- New Jersey could even loose its state bird—the American Goldfinch—as it may become too hot for the species to nest here.

General observations about the temperature and precipitation in New Jersey (Climate of New Jersey, 2019):

- **Temperature** differences between the northern and southern parts of the state are greatest in the winter and least in summer. All weather stations have registered readings of 100° F or higher and have records of 0° F or lower.
- **Freeze-free days** in the northern highlands have an average of 163 annually, while the central and southern interior and seacoast have 170 and 217 freeze free days respectively.
- **Average annual precipitation** ranges from about 40 inches along the southeast coast to 51 inches in the north-central parts of the state. Many areas average between 43 and 47 inches.
- **Snowfall** ranges from about October 15th to April 30th in the highlands and from about November 15th to April 15th in the southern counties.
- **Thunderstorms** in most areas receive 25 to 30 annually, with fewer storms near the coast than inland areas. Approximately five tornadoes occur each year and, in general, tend to be weak.
- **Precipitation days** that are measurable fall on approximately 120 days. Fall months are usually the driest with an average of eight days with measurable precipitation. Other seasons average between 9 and 12 days per month with measurable precipitation.

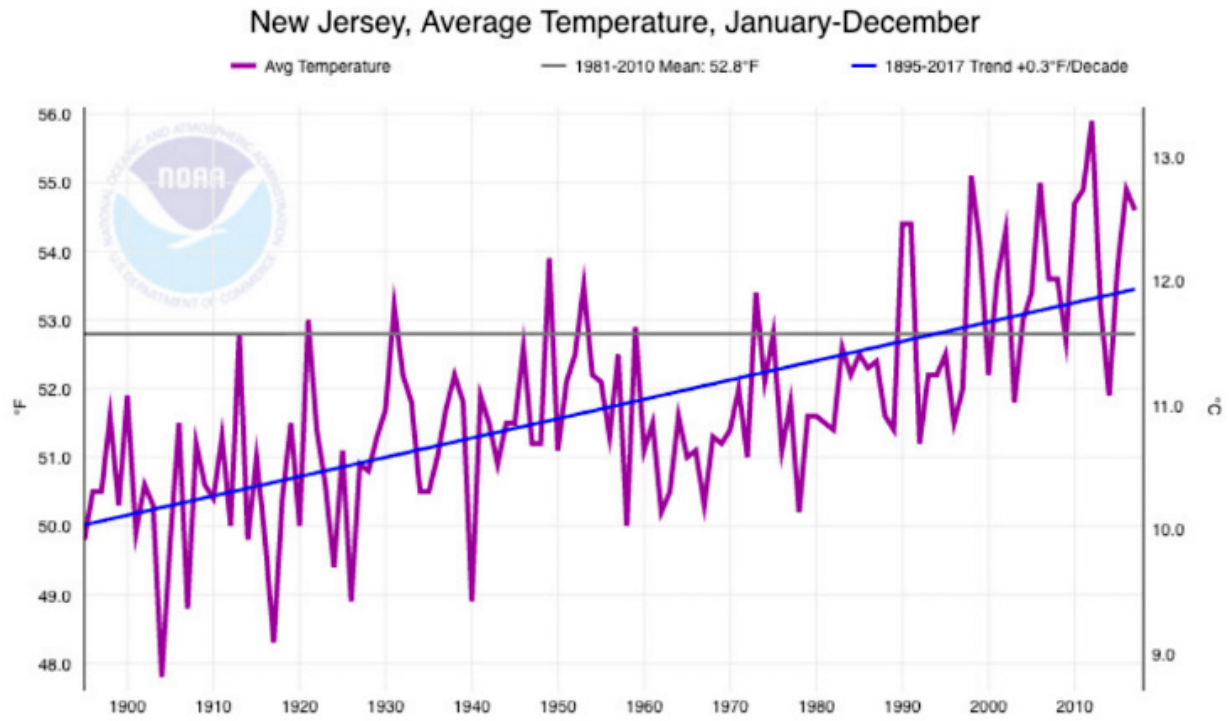


Figure 34. Average annual statewide temperature for New Jersey between 1895 and 2019. (Climate of New Jersey, 2019)

Although New Jersey is one of the smallest states in the country with a land area of 7,836 square miles, it has five distinct climate regions known as the North, Central, Southwest, Pine Barrens and Coastal. The geology, distance from the Atlantic Ocean and prevailing atmospheric flow patterns, produce distinct variations in the daily weather between each of the regions (Climate of New Jersey, 2019).

Climate Change as a DCA

"New Jersey is warming faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014) during the same time period. The rate of warming in New Jersey has increased since 1970. Utilizing data from the New Jersey State Climatologist through the end of 2019, several trends were observed: the ten warmest calendar years on record have occurred since 1990 while the ten coldest years all occurred before 1940; the warmest year on record occurred in 2012 when the average annual temperature was 4.1° F (2.3° C) above the long-term average (1895 – 2019) and 3.0° F (1.7° C) above the 30-year normal; the four warmest winters on record have occurred since 1998, and the eight warmest summers have occurred since 1999." (NJ Climate Science Report, 2020)

Figure 34 shows the average statewide temperature over the last 120 years, dating back to 1895, illustrating this upward trend in New Jersey's temperature. (Source: Office of the New Jersey State Climatologist with data from NOAA - National Centers for Environmental Information (2019).)

Warmer temperatures can lead to decreased soil moisture even without an associated decrease in precipitation. This can temporarily affect a tree's ability to meet water demands (Butler-Leopold, et. al. 2019). The inability to meet water demands can stress a tree's system, making the tree more susceptible to pest and disease issues, among other things.

In New Jersey, the amount and frequency of precipitation varies over short and long periods of time. While average annual precipitation totals show a slight increase, climate change is expected to exacerbate the intensity of rainfall events and extend the duration of drier periods. (NJDEP 2020)

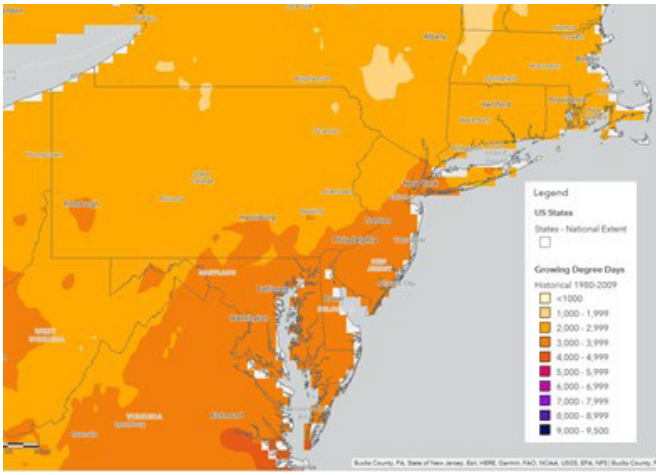


Figure 35. Historical Growing Degree Days for 1980-2009. (Matthews et al. 2019)

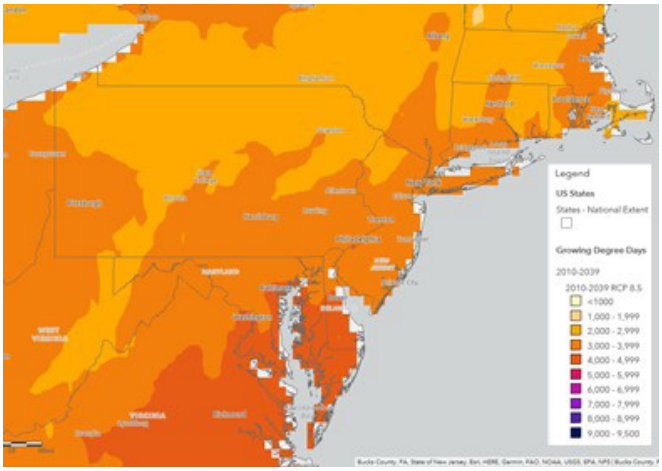


Figure 36. Projected Growing Degree Days for 2010-2039 with a high greenhouse emissions scenario. (Matthews et al. 2019)

Such warmer and wetter conditions can lead to an increase of growing degree days. Growing degree days (GDDs) are the number of days occurring above a pre-defined temperature threshold. Because they are plant or pest specific, calculating the annual GDDs in New Jersey is difficult. However, GDDs are still a very important factor to consider as they are used to measure heat accumulation and can be helpful in predicting biological phenomenon such as insect emergence, tree phenology and crop maturity. GDDs can impact the emergence time of insect pests, allowing pests that could only develop at more southern latitude states to now emerge in New Jersey or allow more or larger generations of insect pests to emerge per year. **Figure 35** depicts historic GDDs for the mid-Atlantic region from 1980 to 2009; while **Figure 36** is a projection of GDDs from 2010 to 2039. Note the increase of annual GDDs northward from **Figure 35** to **Figure 36**.

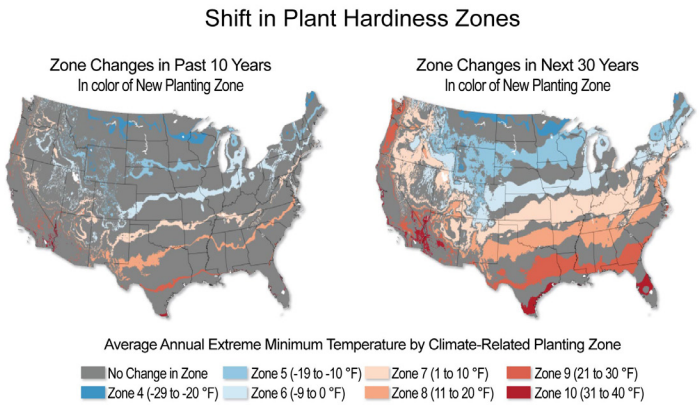


Figure 37. Change in plant hardiness zones in the past 10 years (left) and projected change in the next 30 years (right). (National Climate Assessment, NOAA 2014)

Warmer winters with a greater number of GDDs can also affect plant hardiness and the tree species that grow at a given latitude. Tree phenology, the timing of when trees break and set bud, can also be strongly impacted by changes in GDDs, giving certain tree species or trees of the same species from a more southerly provenance advantages over others.

Figure 37 illustrates shifts in plant hardiness zones across the United States within the last ten years, as well as for the projected change in hardiness zones over the next 30 years. As you can see, temperature zones have and continue to shift northward; this means that tree species more adapted to cooler temperatures in the northern portion of the state, such as those associated with northern hardwood forests, could be outcompeted by more southerly adapted species or generalist tree species. These species could also slowly begin to shift or migrate northward out of the hardiness zone if they do not adapt fast enough.

Climate Change Assessment of NJ Forests

Current land use trajectories that have given rise to expansion of northern hardwood species are anticipated to increase forest stress under a warmer climate. Similarly, increasing forest occupancy, i.e. increasing forest basal area, as a result of land use patterns will increasingly stress New Jersey's forests. This trend is anticipated to collide with the anticipated expansion of SPB, amplifying beetle outbreaks that will likely cause massive carbon emissions following forest mortality. Forest water use (evapotranspiration) is expected to increase, a consequence of mesophication, in addition to increased forest occupancy and increasing temperatures. Differences in how individual tree species grow, survive and reproduce over time (life history processes) will be key in determining the response of each species to the effects of warming temperatures. Predictions about the changes to the forest must simultaneously consider both individual species response and that of the overall plant community as well. Life history processes such as flowering, pollination, photosynthetic dynamics, seed production, seed dispersal, germination, establishment, shade tolerance and response to competition are all species-specific. Climatic controls on these processes vary at a fine scale; a species that can leaf-out early and extend its growing season might be a better competitor with warmer springs, but sensitivity to late-season frost may make this behavior a liability compared to a more conservative or frost-hardy neighbor (Hufkens, et al. 2012).

The USDA Forest Service Climate Change Tree Atlas has attempted to provide species-level predictions for tree species habitat suitability changes expected from different climate change scenarios (Prasad, et al. 2007-ongoing). Refined over the last 13 years using more than 80,000 continuous forest inventory plots (FIA), the Tree Atlas provides reliability estimates and expected ranges under climate change scenarios for roughly 125 tree species in eastern North America.

The Tree Atlas uses grid-based measurements of multiple variables of climate, elevation, daylength, soil taxonomy and soil properties to develop a relationship between these terms and a tree species across the landscape. To make forecasts on future climate, expected climatic changes are used to re-run the model, showing the re-arrangement of climatic suitability across the landscape.

New Jersey's current species palette is diverse but is dominated by two major forest type groups: the oak-hickory group and southern pine forest (Loblolly-Shortleaf Pine Group) (Crocker, Barnett, et al. 2017). The state's most abundant and

voluminous tree species, pitch pine, dominates the latter, comprising ¾ of the basal area in the southern pine forest type-group (Crocker and Nelson, 2018). The oak-hickory type-group is of more mixed composition; Red maple, white oak, yellow-poplar, chestnut oak, northern red oak, scarlet oak, sweetgum and black oak collectively occupy 63% of its basal area. Similar to these data from FIA, the Tree Atlas model data for current composition **(Figure 39)** ranks red maple, pitch pine, white oak, white ash, black cherry, black oak, sweetgum, blackgum and northern red oak as having the highest importance value (importance value is a measure of how dominant a tree species is in a given area).

Predictions from the Tree Atlas based on climate variables describe a significant southern shift to the state's forest composition **(Figures 38 and 39)**. Taking the average of the three high-emission scenarios used in development of the Tree Atlas, sweetgum, pitch pine, red maple and white oak remain some of the state's most important species. However, above all these is Loblolly pine whose ascendance is accompanied by post oak, winged elm, water oak and black hickory. Red maple, while still abundant and important, is expected to be less so in the future. Some of the state's relatively minor species, like persimmon, shortleaf pine and blackjack oak, are expected to become more abundant. (**Figure 40**)

Some native tree species have expanded their range despite climate predictions. This can be explained by land use histories. Contrary to the upslope migration of montane species predicted by climate change, Foster and D'Amato (2015) demonstrated that red spruce is instead migrating down-slope. Though its lower-elevational boundary has likely been moving upslope because of climate warming, land use legacies of harvesting spruce and ignoring hardwoods have left sufficient habitat for red spruce

Today's New Jersey Forests: Species "Importance Values"

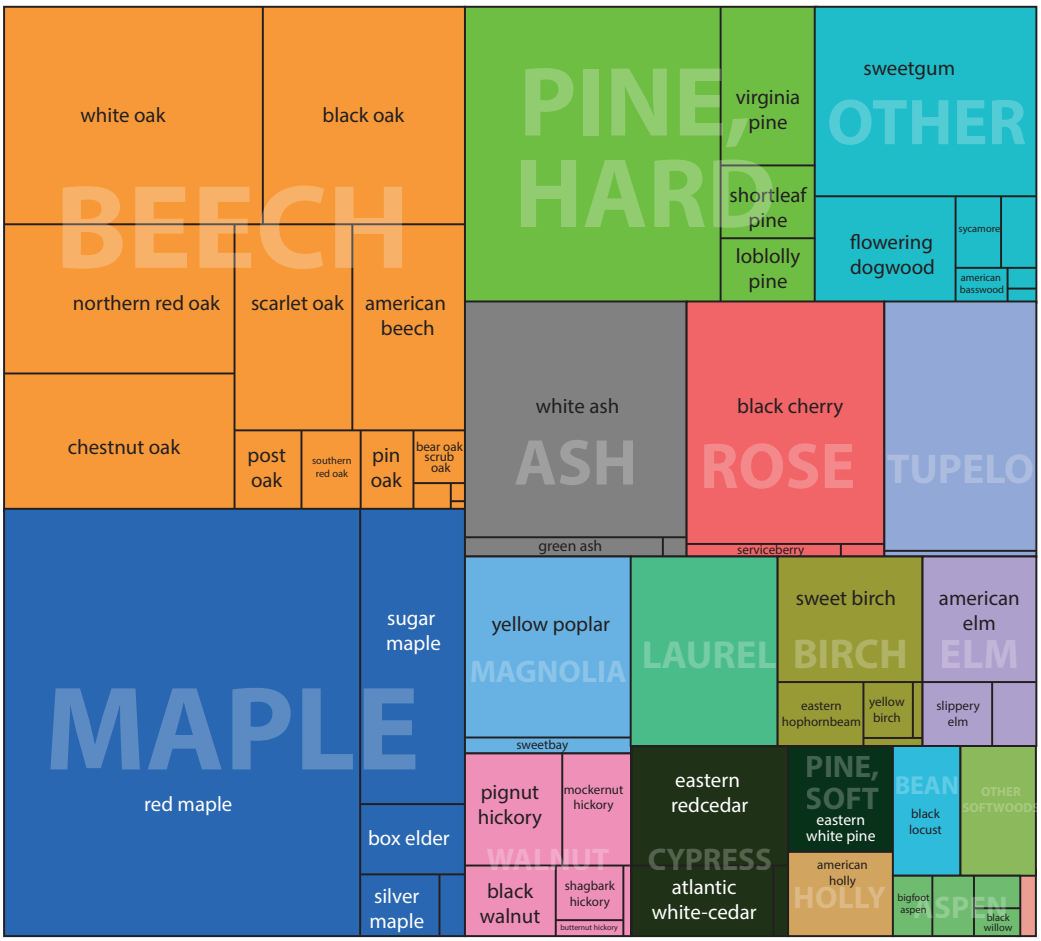


Figure 38. and Figure 39. The two figures here are derived from species importance values used in the USDA Forest Service Climate Change Tree Atlas in forecasting expansions and contractions of a tree species range using broad climate change projections. The colors indicate trees belonging to a particular species group, while the size of the boxes correspond to the relative tree species importance (i.e, a larger box would be tied to a species more likely to expand its range). Figure 38 depicts the estimated tree species importance values at present, while Figure 39 depicts the estimated tree species importance values in the year 2100.

to return to its lower-elevation climatic boundary. In the short-term (<400 years for a forest) for a landscape long dominated by humans, direct actions through land use have had a greater impact than indirect, long-term pressures.

Patterns in forest composition in New Jersey are clearly driven, in large part, by the same land use history of human use, particularly through European settlement. Across the northeast and lake states, forest age-class distribution shows remarkably similar patterns as a result of simultaneous farmland abandonment (Oswalt, et al. 2019). Social-economic changes from early in the 20th century gave rise to much of the forest we have today, the result of technological improvements in farming and changes in type and location of resource exploitation. In New Jersey, the transition towards fossil fuels and the relaxation of pressure on the state's forests for fuelwood allowed the state to retain extensive forest cover despite its high population density. This transition also resulted in reduced forest productivity which leads to or has led to dense forests and a shift in carbon pools.

Wildfire and Climate Change

New Jersey is at the highest risk from wildfires in spring (March through May) when vegetation is at its driest but can also experience fires in the summer and fall or in any month of the year. How climate change will impact wildfires in New Jersey forests is uncertain based on existing literature and models, which there are few that focus on New Jersey specific conditions. Climate change is expected to cause increased temperatures and changes in extreme precipitation events and drought that make it uncertain when a drought, or drought-like conditions may occur. Wildfire seasons could be lengthened, and the frequency of large fires increased from the warmer springs and longer summer dry periods that are expected with climate change due to these conditions causing drier

Future New Jersey Forests Under Climate Change: Species "Importance Values"

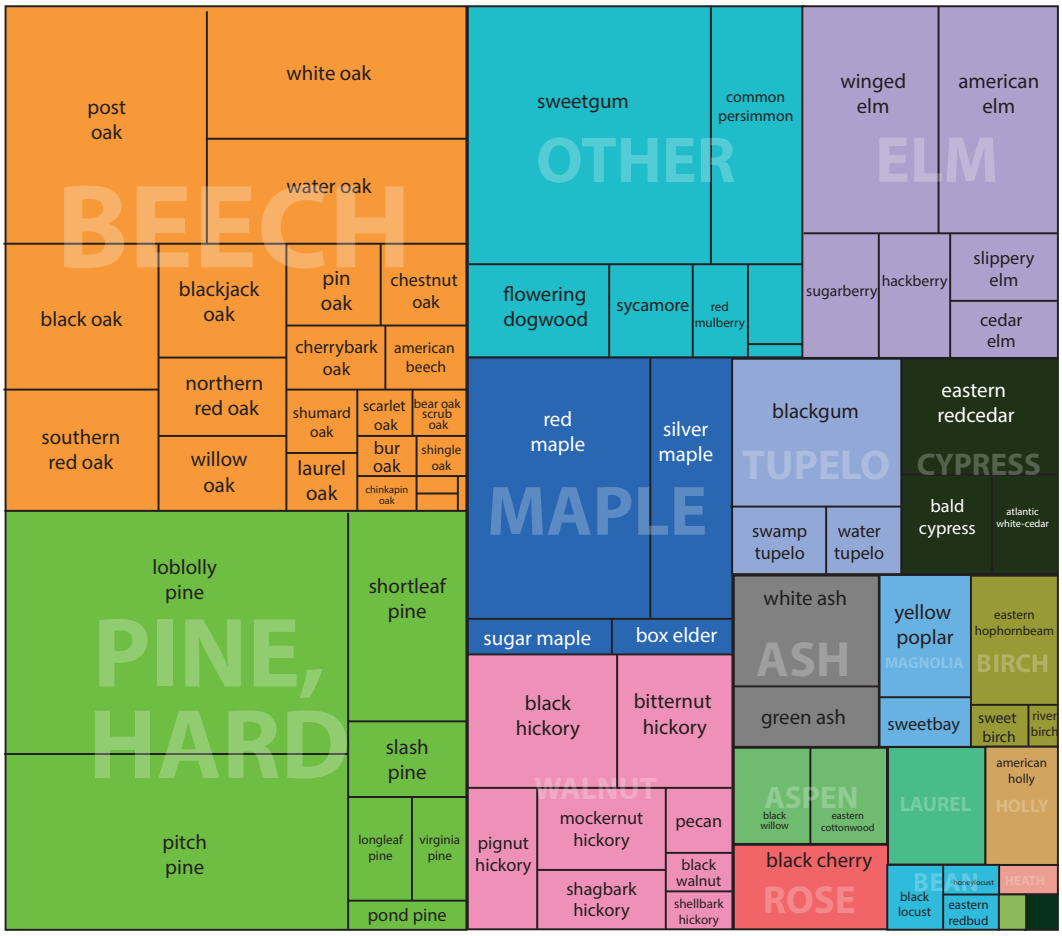


Figure 39.

soils and vegetation (Nolte et al. 2018). Climate change will affect patterns of wildfire disturbance in numerous ways including from higher temperatures and extended dry periods, however the specific effects on eastern forests complicated and are likely to differ not only geographically, but by forest community and over time. The climate can also directly affect the frequency, size and severity of fires, as well as indirectly affect fire regimes via influences on vegetation structure and composition (Sommers et al., 2011).

Some national and global studies suggest that conditions favorable for wildfire will increase due to climate change, but few studies have specifically looked at wildfire risk in the Mid-Atlantic region. One of the more complete sources of information on this topic is the USDA's Climate Vulnerability Assessment for Mid-Atlantic States.

If warmer temperatures and greater amounts of evapotranspiration exceed the amount of modest projected precipitation increases, conditions supporting wildfire may become more frequent (Drever et al., 2009; Guyette et al., 2014). This may be particularly important during the early springand drier conditions are more favorable for wildfire (Heilman et al., 2015). In addition to the direct effects of temperature and precipitation, increases in fuel loading from pest-induced mortality or blowdown events could increase fire risk, but the relationship between these factors can be complex (Hicke et al., 2012; Sommers et al., 2011). It has also been suggested that fire can promote invasive plant species, which may increase the flammability of an area and thus the frequency, intensity or length of the fire season (Brooks and Lusk, 2008). Conversely, prescribed fire can also be used as a tool for controlling invasive plant species.

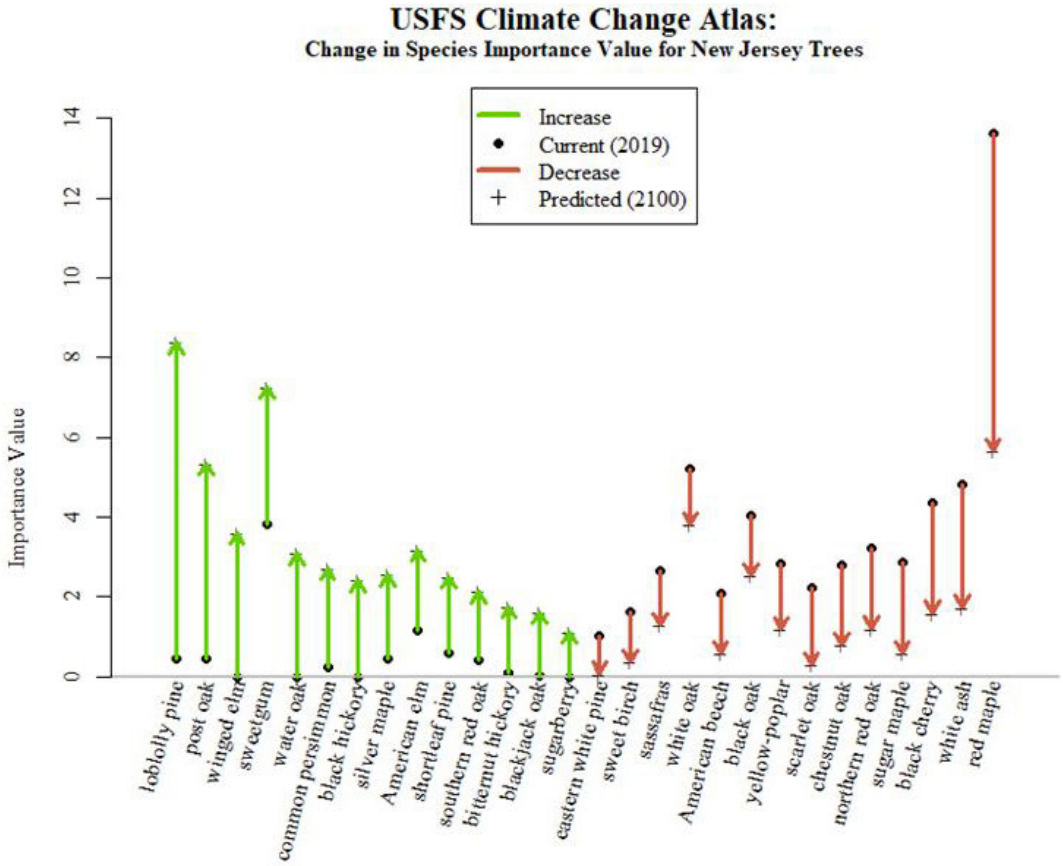


Figure 40. Change in "Importance Value" for selected species in New Jersey. Species with a higher importance value are more abundant in forestland and are expected to be more suited to climatic growing conditions in the years indicated. Green arrows represent increases in importance values, while red arrows represent decreases in importance values from 2019 to 2100. (Data from USFS Climate Change Tree Atlas)

The timing of activities including timber removal, prescribed fire and recreation may need to be shifted as temperatures and precipitation patterns change as well (Butler-Leopold et al. 2018). These climatic changes can especially lead to forest management activity sites remaining wetter for longer periods of time throughout the year, as well as reducing the time period for operating on frozen ground. The seasonality of increased precipitation and warmer temperatures could produce different fire effects based on the severity of the fire, eg, a 'hot' summer fire will create different fire effects on regeneration than a 'hot' fall fire. Also, the phenology of the forest interacts with the severity of the fire and precipitation and climate could shift seasonally. (La Puma et al., 2013)

Plants/Plant Communities and Climate Change

The effects of climate change are a large concern, not only for trees, but for many of the native plants that are found within New Jersey forests. A variety of long-term datasets compiled for dates of first flowering, leaf emergence and local temperature trends provides great insight as to the effects of climate change on plants.

One New York study conducted in Ulster County analyzed local temperature data and flowering dates of native plant species from the late 1800s and early 1900s and determined that most spring blooming herbaceous plants were flowering approximately three to five days earlier per year following a trend in mean temperature increase (Cook et al. 2008). This study also concluded that a 1.9 day/decade change in overall spring flowering dates had occurred (Cook et al. 2008).

A similar dataset from Washington D.C. was compiled with more than 100 species of woody and herbaceous plants. This study concluded that between 1970 and 1999, approximately 85% of those species had incurred flowering dates an average of 5.6 days earlier and many species had flowered more than 10 days earlier (Abu-Asab et al. 2001). Another study done in Massachusetts indicated that after record breaking spring temperatures in 2010 and 2012, flowering dates for 27 different plant species were the earliest recorded (Ellwood et al. 2013). In this 2010 study, the average flowering time was nearly three weeks earlier than that recorded in 1852 and the average spring temperature during 2010 was double that of 1852 (Ellwood et al. 2013). Some individual plant species from the same study were recorded flowering nearly six weeks before historical records from the 1850's as well. Multiple studies have even concluded that for every 2°F increase in average temperature, the period of flowering will become nearly 4 days earlier (Primack et al. 2004; Ellwood et al. 2013). Leaf emergence seems to be advancing at an alarming rate as well and shows a strong relationship with maximum daytime temperatures recorded in spring and late winter (Piao et al. 2015).

	Chance SLR Exceeds	2030	2050	2070 Emissions			2100 Emissions			2150 Emissions		
				Low	Mod.	High	Low	Mod.	High	Low	Mod.	High
Low End	*> 95% chance*	*0.3*	*0.7*	*0.9*	*1.0*	*1.1*	*1.0*	*1.3*	*1.5*	*1.3*	*2.1*	*2.9*
Likely Range	*> 83% chance*	*0.5*	*0.9*	*1.3*	*1.4*	*1.5*	*1.7*	*2.0*	*2.3*	*2.4*	*3.1*	*3.8*
	~ 50 % chance	*0.8*	*1.4*	*1.9*	*2.2*	*2.4*	*2.8*	*3.3*	*3.9*	*4.2*	*5.2*	*6.2*
	< 17% chance	*1.1*	*2.1*	*2.7*	*3.1*	*3.5*	*3.9*	*5.1*	*6.3*	*6.3*	*8.3*	*10.3*
High End	*< 5% chance*	*1.3*	*2.6*	*3.2*	*3.8*	*4.4*	*5.0*	*6.9*	*8.8*	*8.0*	*13.8*	*19.6*

*2010 (2001-2019 average) Observed = 0.2 ft

Notes: All values are 19-year means and are measured with respect to a 1991-2009 baseline. Projections are 19-year averages based on Kopp et al. (2014), Rasmussen et al. (2018), and Bamber et al. (2019). Moderate (Mod.) emissions are interpolated between the high and low emissions scenarios. Rows correspond to different projection probabilities. For example, the 'Likely Range' rows correspond to at least a 2-in-3 (66-100% chance) chance of sea-level rise from the relevant projections considered, consistent with the terms used by the Intergovernmental Panel on Climate Change (Mastrandrea et al. 2010). Note alternative methods may yield higher or lower estimates of the chances of low-end and high-end outcomes.

Figure 41. Sea-level Rise Projections (Ft. above year 2000 average sea-level) for New Jersey from 2030 to 2150 under low, moderate and high emissions scenarios. The likely range represents the range of levels between which there is 66% chance that SLR will occur (Kopp et al. 2019).

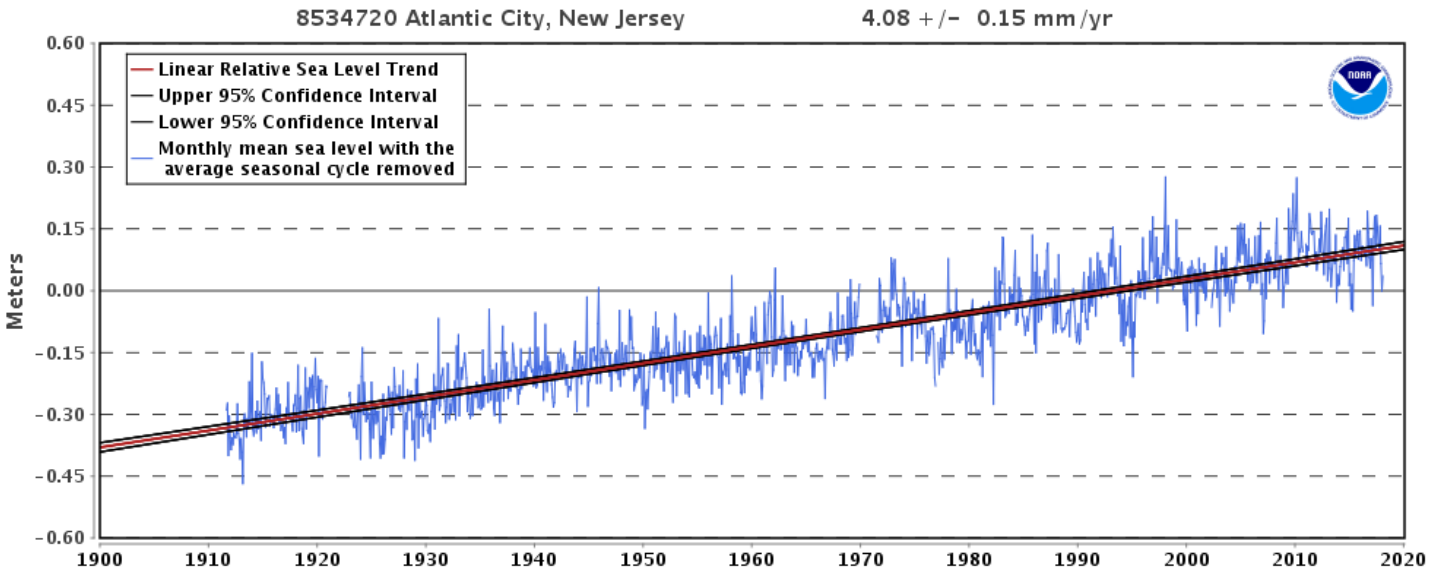


Figure 42. Historic monthly mean sea level at Atlantic City, NJ recorded between 1911 and 2019. Image courtesy of NOAA.

Sea-Level Rise

The rate of sea-level rise in the Northeastern United States has been higher than the global rate over the last several decades and is expected to continue to be amplified. As a coastal state, New Jersey is especially vulnerable to the impacts of sea-level rise. Rising sea level can result in direct loss of land area in the barrier islands and other coastal locations. In addition, low lying portions of the state can become much more vulnerable to flooding, amplified storm surge, and saltwater intrusion, ultimately causing impacts further inland. **(Appendix C)**

In New Jersey, sea-levels at Atlantic City, Cape May, and Sandy Hook have risen at a rate of approximately 0.16 in/yr (4 mm/yr) since the beginning of the 20th century (Kopp 2013, NOAA 2019). Pre-anthropogenic sea-level rise in New Jersey was approximately 0.08 in/yr (2 mm/yr) (Stanley et al. 2004, Miller et al. 2009). This suggests that anthropogenic factors have contributed to a doubling of the historic rate of rise. There is uncertainty surrounding exactly why the rates in the Northeastern United States and New Jersey are greater, but it may be in part due to changes in the Gulf Stream (Sweet et al. 2017b), localized subsidence and continued geologic influences as solid Earth slowly adjusts to the loss of the North American ice sheet at the end of the last ice age (Kopp et al. 2019).

The sea-level rise values in **Figure 41** represent projections made by the STAP to the year 2150 (Kopp et al. 2019). The projections through 2050 do not project to low, moderate, or high projections because differences in sea-level rise projections between emissions scenarios are minor in the first half of the century where low emissions projections for 2050 are about 0.1 ft lower than high emissions projections. The likely range of sea-level rise under moderate emissions is 2.0 – 5.1 ft. by 2100.

Increasing rates of sea-level rise are also expected. By 2050, the local rate of sea-level rise will likely increase from the current rate of approximately 0.2 in/yr to 0.5 in/yr (5.1 – 13 mm/yr) (Kopp et al. 2019). Under the moderate emission scenario, the likely range of increased rates of rise are between 0.2 to 0.8 in/yr (5.1 – 20 mm/yr) over 2060 to 2100.

Forest Area Affected by Storms

The Sea, Lake and Overland Surges from Hurricanes model (SLOSH), is a numerical model used by the National Weather Service to compute storm surge. Storm surge is defined as the abnormal rise of water generated by a storm, over and above the predicted astronomical tides. Flooding from storm surge depends on many factors, such as the track, intensity, size and forward speed of a hurricane and the characteristics of the coastline where the hurricane comes ashore or passes nearby.

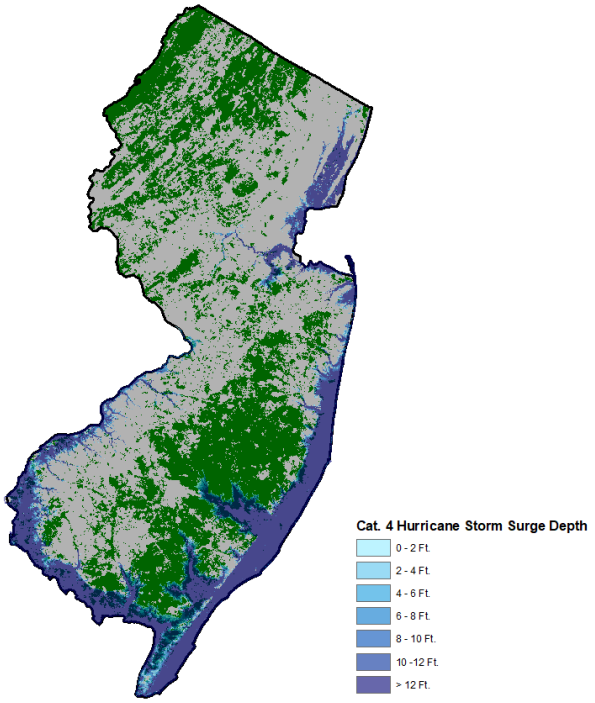


Figure 43. Spatial representation of category 4 hurricane storm surge depths and forests of New Jersey. (NJDEP, 2020)

For planning purposes, the National Hurricane Center uses a representative sample of hypothetical storms to estimate the near worst-case scenario of flooding for each hurricane category (NOAA). The frequency of severe storms is expected to increase as the New Jersey climate becomes warmer and wetter. Therefore, the consideration of the impacts of storm surges are a necessity. This helps to assess potential storm impacts such as forest loss due to saltwater intrusion and informs decision-making processes.

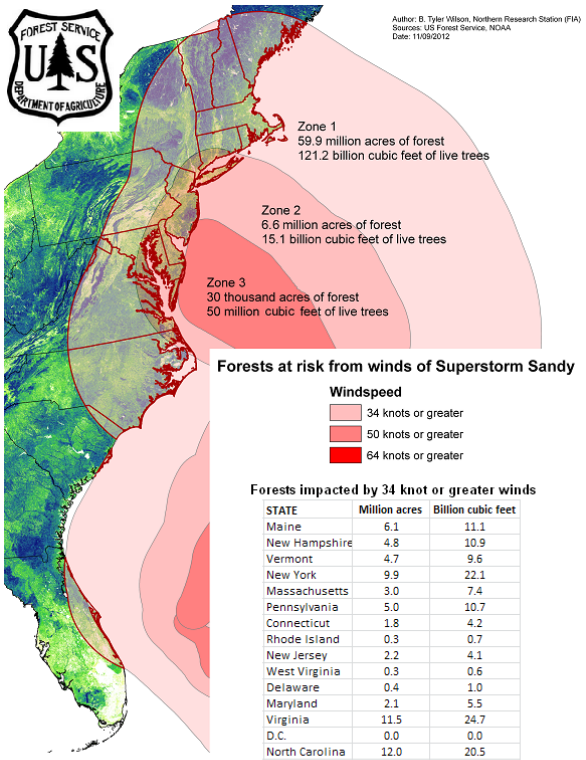
Figure 43 illustrates the effects of a category 4 hurricane storm surge for New Jersey using the SLOSH model over the state's forested areas.

New Jersey has experienced a significant amount of heavy rainfall events, especially over the past two decades, with these events occurring more than twice as often in recent years than during the past century (NJDEP Climate Change, 2019). Rainfall events and overall storm surges associated with Superstorm Sandy in 2012 inundated more than 400,000 acres of uplands and wetlands across the state (Lathrop, Bognar & Hasse 2016). Portions of New Jersey impacted by winds of 34 knots or greater included approximately 2.2 million acres of forest or 4.1 billion cubic feet of trees (Wilson, USDA Forest Service Northern Research Station, 2012). The forecasted impacts from Superstorm Sandy for the eastern seaboard are depicted in **Figure 44**.

Climate Change - A Threat to AWC

Some predictions for forest composition under a changing climate are more certain. Atlantic-white cedar (AWC), long a high-value species throughout its range, will suffer disproportionately (compared to other native New Jersey species) due to rising seas. AWC typically occurs within one hundred miles of the Atlantic coast, from Maine to Mississippi. It competes well against other trees in wetlands, which are often the lowest-elevation features on the landscape. Further, it is completely intolerant of saltwater inundation, although it does have a capacity to re-establish on salted sites if enough salt is leached from the soil (Little 1950).

In New Jersey, AWC mainly grows in wetlands with muck soils in the outer coastal plain. Persistent inundation from direct sea level rise may not functionally eliminate cedar from a site, yet periodic



Forests impacted by 34 knot or greater winds

STATE	Million acres	Billion cubic feet
Maine	6.1	11.1
New Hampshire	4.8	10.9
Vermont	4.7	9.6
New York	9.9	22.1
Massachusetts	3.0	7.4
Pennsylvania	5.0	10.7
Connecticut	1.8	4.2
Rhode Island	0.3	0.7
New Jersey	2.2	4.1
West Virginia	0.3	0.6
Delaware	0.4	1.0
Maryland	2.1	5.5
Virginia	11.5	24.7
D.C.	0.0	0.0
North Carolina	12.0	20.5
South Carolina	0.7	1.1
Florida	1.8	2.1
TOTAL	66.5	136.3

Figure 44. Forest at risk from 3 different windspeeds generated by Superstorm Sandy in 2012. Wilson, USDA Forest Service Northern Research Station, 2012.

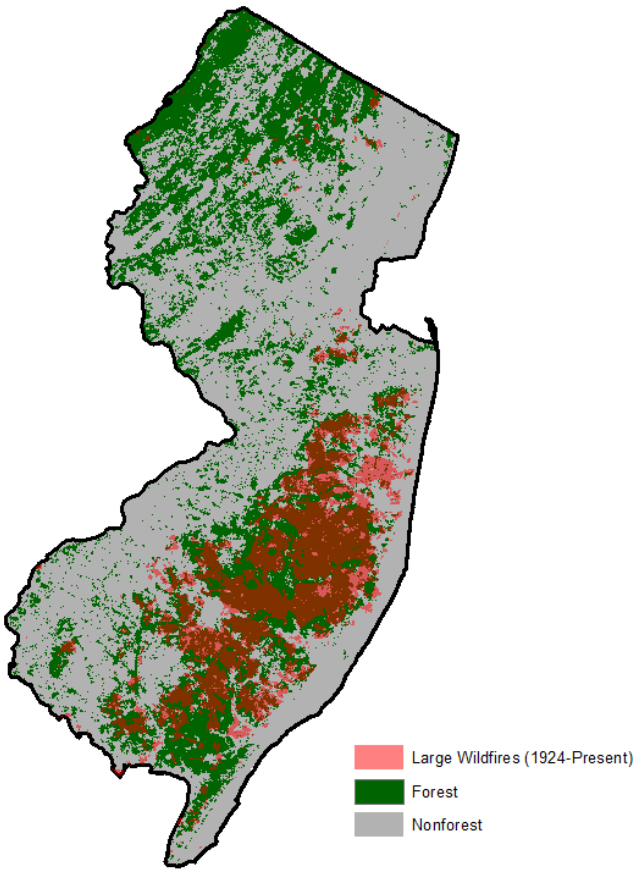


Figure 45. Spatial distribution of large wildfires from 1924-present for New Jersey. (NJDEP 2020)

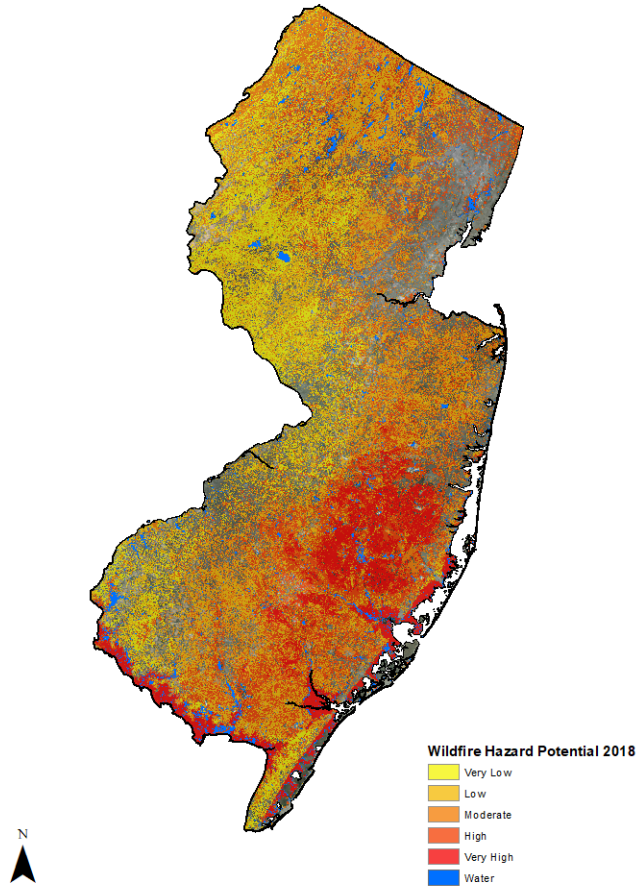


Figure 46. New Jersey wildfire hazard potential for 2018. (NJDEP)

and unpredictable incursions from salty storm surges are sufficient to kill a forest. Hence, loss of areal extent of this globally-rare species is expected with rising seas.

Cedar swamps dying and becoming colonized by marsh species are not a new phenomenon, in fact losses to saltwater have been noted for this species since the 1850s, then attributed to coastal subsidence (Cook 1857). The immense decay resistance of this species has left evidence of the longer-term impacts of rising seas by way of buried cedar stumps well into coastal marshes and shallow bays. These examples show that AWC forests have been retreating with rising seas throughout the Holocene epoch. For AWC forests to maintain their presence across the landscape despite losses on the coast, the conditions that created the establishment of those forests must also be maintained or created.

The current diminished extent compared to historical levels of this species (Sheffield, et al., 1998; Mylecraine and Zimmermann, 2003) makes the threat from sea level rise that much more pressing, as AWC will likely find difficulty in establishing itself in new sites to replace those lost from increased salinity in coastal areas. In forested wetlands that no longer have an AWC component, disturbance such as fire, flooding and wind events tend not to create conditions conducive to AWC repopulation.

Wildfire as a DCA

In the United States today, wildfire seasons are approximately 78 days longer than they were in the 1970s and since 2000 at least ten states have had their largest fires on record. In 2019 alone, there were more than 46,000 fires in the United States. The increase of development near forest boundaries (creation of Wildland Urban Interface, WUI) has also driven up the costs associated with wildfires, as more than 46 million homes and more than 70,000 communities are at risk to wildfire in the United States. Meanwhile, the USDA Forest Service and its partners suppress more than 98% of wildfires upon

initial attack *(https://www.usda.gov/topics/disaster/wildland-fire).* Wildfire frequency and severity shape the landscape often by impacting forest resources for many years after fires have occurred. Most of the wildfires in New Jersey occur from the central to southern portion of the state, many of these occurring within the Pinelands region. **Figure 45** illustrates the spatial distribution of large wildfires from 1924 to present and the forested areas that are primarily affected.

Wildfire hazard is the difficulty in controlling potential wildfire or a physical situation (fuels, weather and topography) with potential for causing harm or damage as a result of wildland fire (Scott and Reinhardt, 2001). The wildland fuels of New Jersey have been ranked by the wildfire hazard potential they pose and are presented in **Figure 46**. The 2007 statewide Land Cover/Land Type dataset (NJDEP) was used as the base map, with each cover type ranked from very low to very high wildfire hazard potential. Take note that the central to southern portion of the state is highlighted with a majority of the very high wildfire hazard potential; this correlates with the same region of the state where most of the large wildfires occur.

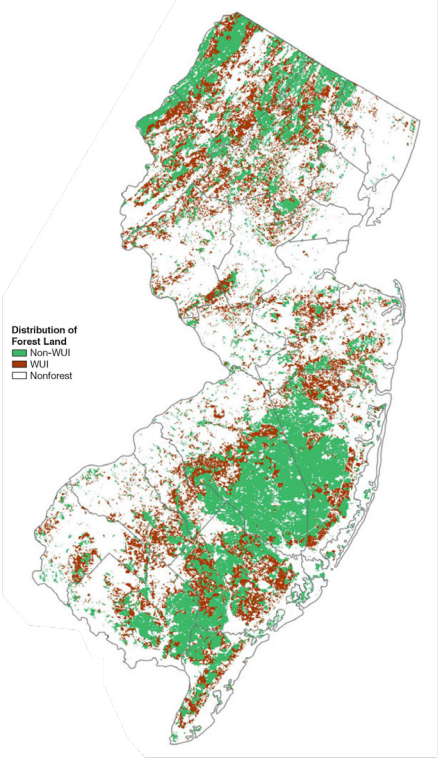


Figure 47. Forestland by WUI status in New Jersey (2010 census restricted to 2011 NLCD forest). (Riemann, 2014)

Wildland Urban Interface

As mentioned within the fragmentation section of this assessment, WUI is described as the zone where human development meets or intermingles with undeveloped wildland vegetation. An analysis conducted by the USDA Forest Service found that 46% of New Jersey's total forested area falls within this zone **(Figure 47)**. The amount of forestland with enough housing density to qualify as WUI has slowly but steadily increased over at least the last 30 years.

In 1990, approximately 42% of New Jersey's forestland was within WUI, in 2000 this increased to 45% and in 2010 forestland within WUI was nearly 46% (Crocker et al., 2017). Further analyses of WUI and land ownership by Riemann et al.

> "County and local government had the lowest proportion of their forestland in non-WUI conditions and nearly 80% of all forestland within WUI in New Jersey is privately owned (2019)."

showed that most of the forestland remaining in non-WUI in 2010 was state owned (54%) and federally owned. County and local government had the lowest proportion of their forestland in non-WUI conditions and nearly 80% of all forestland within WUI in New Jersey is privately owned (2019). Although wildfire can act as a DCA under certain conditions, it can also be beneficial ecologically for a range of plants, wildlife, forest soils and nutrient cycling.

Down Woody Materials

Down woody materials (DWMs) in the form of fallen trees and shed branches, fulfill a critical ecological niche in the forests of New Jersey. These materials provide valuable wildlife habitat, structural diversity and continue to provide carbon storage within their biomass. DWM can also contribute to wildfire hazard, serving as woody fuel along the surface of the ground. The fuel loading of DWM can be

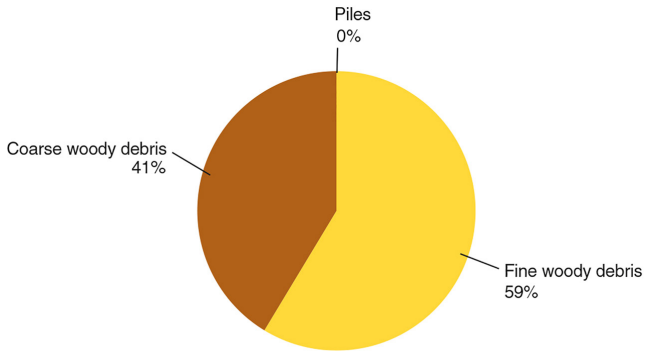


Figure 48. Proportion of DWM biomass on New Jersey forestland by dead wood component for 2006 to 2010. (Crocker et al., 2017)

considered a forest health hazard in times of drought or in isolated stands with excessive tree mortality (Crocker et al. 2017). DWM includes fine woody debris (FWD) with diameters less than three inches, coarse woody debris (CWD) with diameters of three inches or greater and residue piles (FIA Field Measure Manual). FWD includes downed dead branches, twigs and small tree or shrub boles that are not attached to a living or standing dead source.

FWD can also be connected to a downed dead tree bole or downed dead shrub or twigs from various shrubs and vines. To be considered FWD, material must be no higher than six feet above the ground (FIA Field Measure Manual). CWD includes downed dead tree and shrub boles, large limbs and other woody pieces that are severed from their original source of growth and remain on the ground. CWD also includes dead trees (either self-supported by roots, severed from roots or uprooted) that are leaning > 45 degrees from vertical (FIA Field Measure Manual). In New Jersey from 2006 to 2010, most of the DWM was FWD at nearly 60%, while CWD represented approximately 40% **(Figure 48)**.

CWD was also highest on privately owned forestland, while state and local forestland was the next highest (Crocker et al., 2017).

Biotic Damage Causing Agents

In addition to considering several abiotic Damage Causing Agents, the NJ Forest Services' Forest Health Program is responsible for monitoring and surveying a range of biotic DCAs that have the potential to cause harm to the state's forest resources as well.

The NJ Forest Service initiates both aerial and ground surveys for DCAs during certain times of the year including those for gypsy moth, SPB, bacterial leaf scorch, as well as various other native and non-native insects and diseases. Evaluating and monitoring urban tree health conditions are also a very important part of New Jersey's overall forest health initiatives.

Many of the DCAs referenced in this section are referred to as traditional forest issues, however these DCAs also manifest in urban and community forests and even begin as DCAs in these areas. Different concerns and pathways for handling certain DCAs in an urban setting as opposed to a traditional forest setting may also call for different targeted responses or approaches. A list of DCAs, corresponding survey techniques and frequency of survey and monitoring that the NJ Forest Service currently utilizes can be found in **Appendix E**. Additional information is provided in the strategies section under National Priority 2.

Gypsy Moth (*Lymantria dispar*)

The gypsy moth is native to Europe and first arrived in the United States in Massachusetts during 1869. This moth is a significant pest since its caterpillar has a voracious appetite for more than 300 species of trees and shrubs throughout New Jersey, posing a great danger to our forests. The caterpillars defoliate trees and can eventually kill host trees or leave them vulnerable to diseases and other pests. The gypsy moth prefers approximately 150 primary hosts (USDA APHIS).

In New Jersey, gypsy moth is primarily recognized for the damage it causes to oak species. Two of the main forest type-groups impacted by gypsy moth include the oak/hickory forest type-group and the oak/pine forest type-group. In New Jersey, these groups cover approximately 842,984 acres of forestland and 190,085 acres of forestland respectively (FIA, 2018). 24 total forest types across New Jersey are contained within these two-forest type-groups alone.

Gypsy moth can be identified by visible egg masses that are covered with buff or yellowish hair, averaging

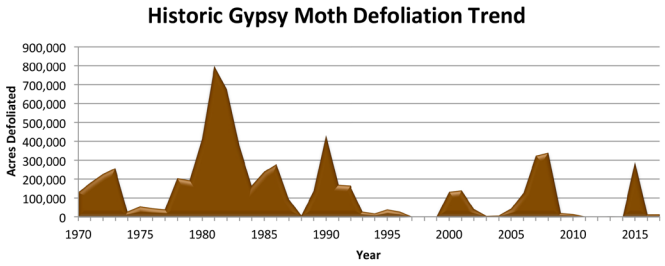


Figure 49. Historic gypsy moth defoliation trends for New Jersey. (NJDEP, 2019)

about 1.5 inches long and about 0.75 inches wide. Newly hatched caterpillars are black and hairy, while later stages of the larvae develop a mottled yellow to gray pattern with tufts of bristle-like hairs and a distinctive color pattern of five pairs of blue dots followed by six pairs of red dots along their backs. Adult moths differ between males and females. Male moths are brown with a darker brown pattern on their wings and have a 1.5-inch wingspan. Females are slightly larger, with a two-inch wingspan and are nearly white with dark saw-toothed patterns on their wings (USDA APHIS).

The first defoliations linked to this insect in New Jersey were identified as early as 1919 with sporadic pockets of activity continually occurring through the early 1930's. Subsequently, many forested areas around the state have been subjected to repeat defoliations. As a result, cycles of tree mortality have congruently occurred.

Initially, suppression of the moth in New Jersey focused on eradicating the insect, but soon the program shifted to a model that focused on attempting to limit defoliation and tree mortality in high-use recreational and residential areas only. This is the suppression program model that the NJ Forest Service currently uses. Biocontrol agents were also introduced to limit gypsy moth populations. These included a fungal pathogen, *Entomophaga maimaiga* and a virus, *nucleopolyhedrosis* virus (NPV). According to aerial survey detection data from both the NJ Forest Service and the NJ Department of Agriculture, conducted from June and early July each year, gypsy moth defoliation has remained low since 2015 **(Figure 49)**. These aerial detection results also provide a basis for where to conduct egg mass surveys for the following fall.

Since more than half of New Jersey's forested area is covered by forest types containing oak species, it is of little surprise that insects and pathogens affecting oak species have been on the rise over the last decade. New Jersey forests are also gradually aging, with little recruitment of younger trees. Compounding this situation, oak seedlings are a preferred species of browse for white-tailed deer, making the re-establishment of oak species difficult within forest understories. These are some of the factors contributing to the percent projected basal area loss of tree species due to gypsy moth damage and oak decline that can be seen geographically across the state as illustrated in **Figure 50**.

Gouty Oak Gall *(Callirhytis quercus punctata)*

Gouty oak gall wasps are tiny wasps that cause the formation of galls on twigs and stems of trees as a part of the wasp's lifecycle. In the spring, the female wasp lays its eggs within expanding plant tissue. The tree reacts to the chemicals from the wasp and forms the gall around the eggs. The gall grows only briefly and then stops to confine the larvae within. The gall is solid and woody with multiple larval chambers in the center. The inner gall tissue nourishes the wasp

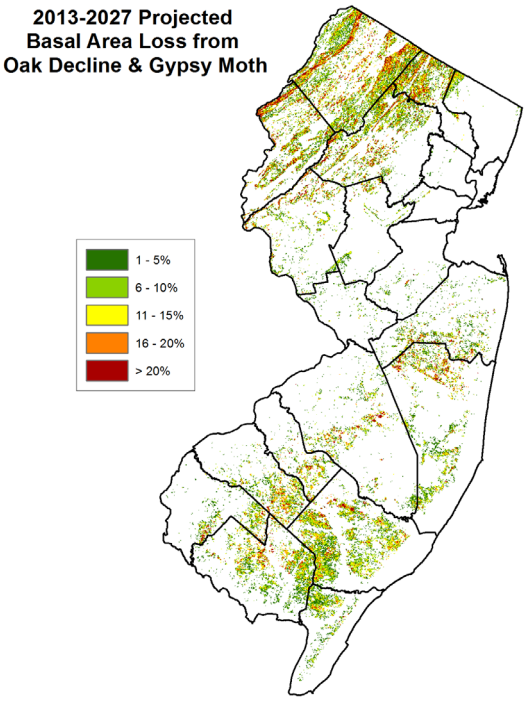


Figure 50. Projected percent basal area loss of tree species from oak decline and gypsy moth from 2013 to 2027. (USDA)

larvae, where they develop within the gall until they emerge within two years or later.

Species of scarlet oak, northern red oak, pin oak, chestnut oak and black oak are most generally affected by gouty oak gall. These species are also found within the two main forest type-groups mentioned above, the oak/hickory type-group and the oak/pine type-group. When galls heavily infest atree, their weight may cause the branches to droop and possibly die. A heavily infested tree is also more susceptible to storm related damages. Overall, tree mortality due to gouty oak gall is widespread on state, private and federal lands. Tree damages on the other hand are most notable for campground areas, causing hazardous conditions to recreationalists.

Gouty oak gall damage historically has only been an aesthetic problem that can be remedied by selective pruning. However, in 2006, southern New Jersey experienced heavy gouty oak gall infestations that caused significant decline and mortality of trees over nearly 20,000 acres. Gouty oak gall often occurs in regions affected by other DCAs such as gypsy moth and orangestriped oakworm (*Anisota senatoria*). This causes a synergism of damage caused by these biotic DCAs.

Asian Longhorned Beetle (*Anoplophora glabripennis)*

The Asian Longhorned Beetle (ALB) is native to Asia and was introduced to North America via wood packing material from China. This invasive species was first discovered in 1996 in Brooklyn, NY. ALB appeared in New Jersey for the first time in 2002, specifically in Jersey City, but has since been eradicated.

The preferred host trees of ALB are maple but they will also attack willow, poplar, horsechestnut, buckeye, sycamore, mimosa, birch and several others. Maple trees comprise over an estimated 30% of the street tree population in New Jersey. There are eight maple forest types within New Jersey alone that comprise approximately 317,034 acres of forestland across the state. A severe infestation could jeopardize nearly half of the trees that line our streets and highways. Additionally, ALB could severely impact the non-urban forests of the Pinelands, Highlands, outer coastal plain and other areas where host species are a major part of the ecosystem.

ALB larvae tunnel into the host tree, damaging the vascular system and overall structural stability of the tree, ultimately causing mortality. Larvae mature into adults in the tree's heartwood and eventually tunnel out. A tree infested with ALB will have perfectly round exit holes in the bark about the width of a pencil. The beetles also leave behind frass, a mixture of sawdust and waste. The branches of an infested tree may also exhibit yellowing leaves and dying limbs. ALB adults can be seen outside of the host tree from May to October.

Emerald Ash Borer *(Agrilus planipennis)*

The emerald ash borer (EAB), native to Asia, was introduced in North America in the 1990s and was first reported causing widespread decline and mortality in trees of the ash genus (*Fraxinus*) in Detroit, MI in 2002. It has been subsequently reported in 33 other states and two Canadian provinces.

The spread of EAB spatially is primarily due to the transportation of infested ash nursery stock and forest products such as firewood and unprocessed logs (USDA Forest Service, 2002). EAB was first discovered in Somerset County, New Jersey in 2014 and has since spread to multiple counties across the state **(Figure 51)**. EAB is of special concern since resulting dead ash trees could be a potential falling hazard for the public.

In New Jersey the three major species of ash found (and affected by EAB) throughout the state, as indicated by FIA, are white ash (*F. americana*), green ash (*F. pennsylvanica*) and black ash (*F. nigra*). FIA estimates that of the 253,291,219 total growing stock trees five inches in DBH or greater in New Jersey, nearly 8,467,543 of these or 3.34%, are ash (FIA 2018).

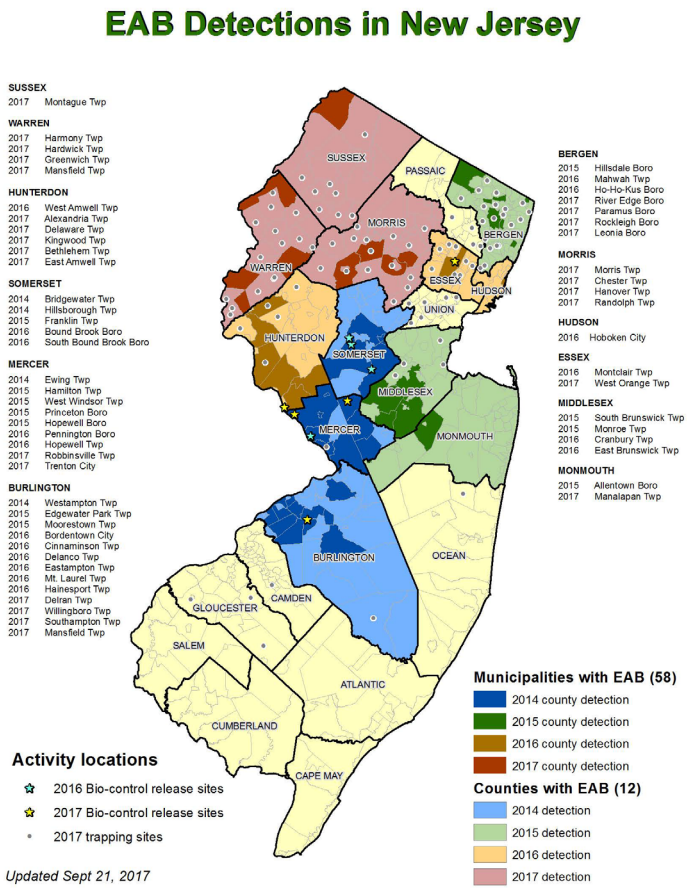


Figure 51. EAB detections in New Jersey by county and municipality. (NJDEPt. of Agriculture, 2018)

Adult EAB beetles are less than a penny in size with metallic emerald green wing covers and a reddish copper abdomen. Adult EAB feed on ash foliage for a few weeks and have an overall life cycle of one year. Peak EAB activity occurs between mid-June and early July with most activity occurring throughout the day. Eggs of EAB are deposited individually in bark crevices or under bark flaps along trunks or branches. After seven to 10 days the larva hatch and chew through the bark into the phloem and cambial layers of the tree where they feed and overwinter. Pupation occurs in late April or May. The EAB adults then exit the tree and form a characteristic D-shaped exit hole approximately three to four millimeters in diameter (USDA Forest Service, 2002).

EAB is responsible for killing and heavily infesting hundreds of millions of trees in urban and rural forested environments. However, in North America EAB has only attacked ash species and appears to prefer green ash and black ash over white ash and blue ash (*F. quadrangulata)*. Even with this preference all North American species of ash are at risk to EAB damage. Symptoms appearing on ash trees from an EAB infestation include wilting foliage, dead branches and an increasingly thin crown (USDA Forest Service 2002).

Southern Pine Beetle *(Dendroctonus frontalis)*

In December 2001, it was thought that the first occurrence of SPB was discovered and reported in New Jersey. However, through much research, historic records were found indicating that a previous SPB event did occur in 1939. No other information as to the location, population and duration of this event has been found.

SPB is the most destructive forest insect pest in the southern and southeastern United States. Since the migration of SPB northward to southern New

> “Characteristics of stands with the greatest risk of attack include biologically mature to overmature, high density, drought stressed and/or storm damaged stands.”

Jersey, it has attacked all pine species growing in the Pinelands region. These species include pitch pine, Virginia pine, shortleaf pine, loblolly pine, white pine and red pine. The loblolly/shortleaf pine forest type-group is most impacted by SPB. This forest type-group contains four forest types and is comprised of approximately 471,294 acres of forestland in New Jersey (FIA 2018). In addition, nearly 65% of these southern-pine forests consist of high-density pine stands (Crocker et al., 2017).

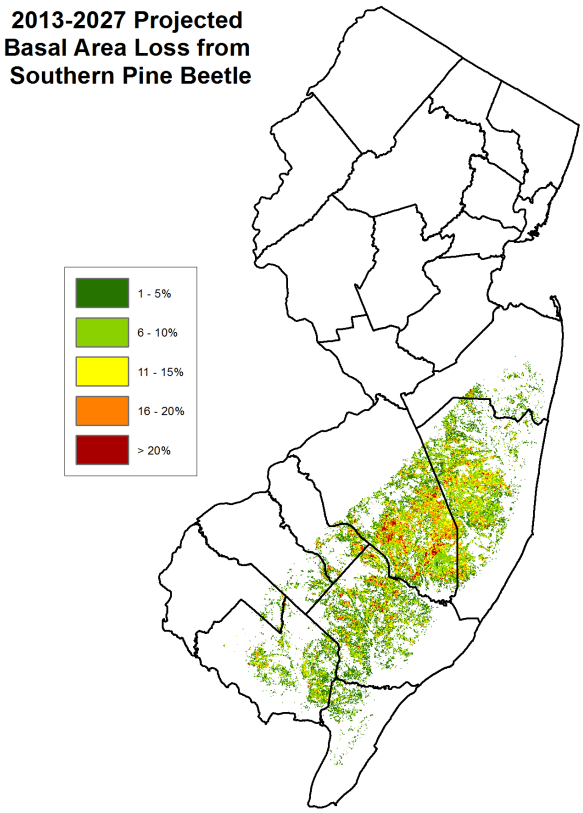


Figure 52. Percent projected loss of basal area of all pine tree species from SPB across New Jersey for 2013 to 2027. (USDA)

SPB infestations occur in pure pine stands, pine-hardwood, hardwood-pine, pitch pine lowlands and pine mixed AWC swamps. Ornamental plantings of Norway spruce have also been infested by SPB. These infestations by SPB across the region have consistently been linked to areas of a significantly high-density of pine, as well as slow individual tree growth rates and older forests (Coulson & Klepzig, 2011). Characteristics of stands with the greatest risk of attack include biologically mature to overmature, high density, drought stressed and/or storm damaged stands. However, even healthy stands can be susceptible to a mass attack if the conditions are right. In 2013, SPB affected nearly 3,630 acres, while approximately 2,016 acres were impacted in 2014.

SPB lives within the inner bark of pine trees where they feed on phloem tissue and construct winding S-shaped or serpentine galleries. These galleries created by adult beetles and offspring can girdle a tree. Not only do the galleries affect a tree's capability of transporting water and nutrients, but the blue-stain fungi that is introduced by the insect can colonize xylem tissue and block water flow throughout the tree as well. This damage to trees caused by SPB activity is considered direct mortality. Females within the tree also emit a pheromone which attracts both males and females to the host tree. This, in addition to the odors associated with the pine resin excreted as a result of beetle attack, attracts even more SPB to the affected tree. Depending on the time of year, number of SPB attacking, presence of blue-stain fungi and environmental factors, mortality may become noticeable within a few weeks to four months after an attack.

The needles of newly infested trees will begin to turn yellow and progress to red. This range of needle discoloration will also indicate the direction the infestation is spreading. Fresh pitch tubes, reddish and yellowish-white in color, also help determine the direction of spread. Eventually the trees will turn brown and lose their needles.

SPB presence in states north of New Jersey, including New York, Connecticut and Massachusetts has indicated the insects' ability to survive more northern climates. Although the northern half of New Jersey is not dominated with hard yellow pines, there are areas of red pine and white pine plantations that are at risk for future SPB infestation as well.

Figure 52 shows the potential percent loss of basal area of all pine tree species due to SPB damage geographically across the state for 2013 to 2027. Issues associated with climate change will most likely lead to continued infestations, northern migration of SPB and the shifting of forest types. This could reduce habitat favorable of pine dependent wildlife species, increase wildfire risk, cause loss of forest revenue and increase costs of hazard tree removal in recreational areas or around structures. Depending on infestation outbreaks throughout subsequent years, mortality by SPB has the real potential of devastating the forests of the Pinelands region.

Climate Change and SPB

SPB behavior in New Jersey represents an early example of the current impacts of climate change. SPB has long been present in pine forests along New Jersey's Delaware Bay shore, but its role was silviculturally insignificant, killing isolated unhealthy trees.

Starting in the early 2000's New Jersey began to experience spot outbreaks of the beetle that progressively moved northward, especially along the coast. Rising winter minimum temperatures are thought to be responsible for this northward movement (Tran, et al. 2007). The insect is killed when cold winter temperatures drop below 3.2°F (Ungerer, Ayres and Lombardero 1999), but the frequency of such overnight lows has already declined as a result of climate change.

Indeed, in 2014 SPB was discovered on New York's Long Island, where it had never been seen before (NYSDEC 2018). Forest susceptibility aside, climate warming alone is predicted to be enough to seriously amplify the impact of SPB on New Jersey's pine forests (FHTET 2019).

Hemlock Woolly Adelgid *(Adelges tsugae)*

Hemlock woolly adelgid (HWA) is an invasive insect native to Asia that attacks eastern hemlock *(Tsuga canadensis)* and Carolina hemlock *(Tsuga caroliniana).* FIA estimates that out of more than 851,592,944 total live trees of one inch DBH or greater on forestland in New Jersey, nearly 3,848,227 of these trees or 0.45%, are eastern hemlock (FIA, 2018).

In 1951, HWA was first reported on the eastern portion of the United States in the state of Virginia. Since that time infestations of these pests have occurred throughout northern New Jersey's eastern hemlock forests, causing significant mortality to eastern hemlock trees. Not only have these pests caused extensive damage, but other stressors to eastern hemlock such as drought, hemlock elongate scale *(Fiorinia externa Ferris)* and borers have accelerated the rate and extent of hemlock mortality throughout the state (Mayer and Scudder, 2008).

HWA is a small (1/16th inch long) aphid-like insect with reddish-brown to purplish-black coloring. As HWA matures it produces a white wool-like wax for protection and the protection of its eggs, from natural predators. HWA is dormant during the summer months and begins to feed at the base of eastern hemlock needles when cooler temperatures arrive, typically October through the winter. After repeated infestations, thinning of tree crowns leads to tree decline and ultimately to mortality (USDA Forest Service, 2005).

Nearly all eastern hemlock populations within the state of New Jersey have been infested with HWA to some extent. This is one of the main reasons why the loss of hemlock as an FIA forest type has occurred, in addition to its negative net growth rates and peaked rate of mortality in 2013 at approximately 4.6 % since its initial rise in 1987 (FIA 2018; Crocker et al. 2017).

Bacterial Leaf Scorch *(Xylella fastidiosa)*

Bacterial leaf scorch (BLS), caused by the bacterium *Xylella fastidiosa*, clogs the xylem tissue within a tree and causes the leaves to scorch, leading to branch dieback. BLS is believed to be spread by xylem feeding insects such as leafhoppers, treehoppers and spittle bugs. These insects pick up the BLS bacteria by feeding on the xylem fluid of an infected plant and then inject the bacteria into the healthy plant leaves while they feed.

BLS is most common in the red oak subgenus, but has also been detected in maples, sweet gum, elms and other hardwood species in other states. In New Jersey, BLS symptoms within oak trees are only visible for a few weeks in mid-summer and early fall (August to September). Although many of the symptomatic leaves remain on the tree until normal leaf fall, some will fall to the ground early, a good indication it is infected with BLS.

Symptoms of BLS can also be very similar to those caused by drought stress and normal autumn changes. In leaves affected by BLS, characteristic features include outer edges turning brown with the discoloration moving toward the center of the leaf in an irregular pattern. Perhaps the most visible distinguishing characteristic of BLS is the

"water-soaked" appearance, sometimes a red band and sometimes a yellow halo at the transitional area between the browning portion and the healthy green portion of the leaf.

BLS may affect only one area of the tree before spreading or can exhibit symptoms throughout the crown of the tree. A tree can also harbor a BLS infection, yet refoliate for several years later, but eventually the stress of the disease and the resulting branch dieback will leave the tree highly susceptible to other pests and pathogens and ultimate mortality. BLS is most common among six different forest types in New Jersey which include species such as northern red oak, pin oak and black oak. These six forest types make up nearly 469,566 acres of forestland across the state.

Oak Wilt *(Bretziella fagacearum formerly Ceratocystis fagacearum)*

Oak wilt is caused by the fungus, *Bretziella fagacearum*, which ultimately cuts off the transportation of water and nutrients throughout the tree. The main period of infection is in the spring, when new vessel wood is being formed. The fungus is spread through a variety of insects that feed on tree bark and sap, as well as through root grafting.

Most new tree infections occur when the fungus moves from an infected tree to a nearby healthy tree through connected root systems in a process called local spread. The roots of trees in oak species groups commonly graft to roots of other trees in the same group, forming a continuous underground network. When one tree in a group becomes infected and dies, the fungus spreads through the connected root systems, killing more trees and creating an infection center.

The fungus can also survive up to seven years within soil. The red oak subgenus is most affected by this disease, causing trees to die within weeks. Species of the white oak subgenus can be infected, however are not as susceptible and may survive for at least a few years later. Overall, the oak/hickory and oak/pine forest type-groups are the most impacted by oak wilt. As mentioned earlier, these two forest type-groups comprise approximately 842,984 acres and 190,085 acres of forestland, respectively.

Symptoms of oak wilt are similar to that of BLS with scorched leaves occurring throughout the crown of the tree, however oak wilt will cause trees to lose both scorched and green leaves in July rather than later in the summer. Oak wilt is usually identified in red oaks by rapid leaf discoloration and wilting. Often the initial symptom is a subtle off-green color shift that may be visible in the upper portion of the tree crown. Shortly after this initial color shift, the leaves begin to wilt from the top of the crown downward.

Fungal mats which also develop under the bark of the tree can usually be detected by a "sweet" smell accompanied by cracking bark. With oak wilt, infected trees will die much faster than BLS, usually within weeks or months of initial infection. Oak decline on the other hand, is a slow-acting decline of oak trees due to a variety of factors such as climate, site quality and advancing tree age. There is no single cause responsible for oak decline.

Although oak wilt has not been confirmed by detection within New Jersey, it is a serious disease that can have significant impacts on several species of oak trees and a significant portion of forestland throughout the state. With confirmed infections of oak wilt in species of oak trees located nearby within New York's Brooklyn and Long Island, continued monitoring for this disease is a key to good forest health for New Jersey trees and forests.

Beech Bark Disease *(Neonectria)*

Beech Bark Disease (BBD) is caused by the beech scale insect (*Cryptococcus fagisuga*) which attacks American beech trees (*Fagus grandifolia*) creating a fungal entryway for three different species of *Neonectria* fungus. Two of the *Neonectria* fungi are non-native (*Nectria coccinea var. faginata* and *N. ochroleuca*) and one is native (*N. galligena)*. The non-native fungus *N. coccinea var. faginata* is the species most commonly found to be associated with BBD. The fungus ultimately causes cankers that girdle and kill the infected tree. American beech trees occur primarily in the northern portion of the state of New Jersey and along the Delaware River corridor. FIA estimates that of the 851,592,944 total live trees of one inch DBH or greater on forestland in New

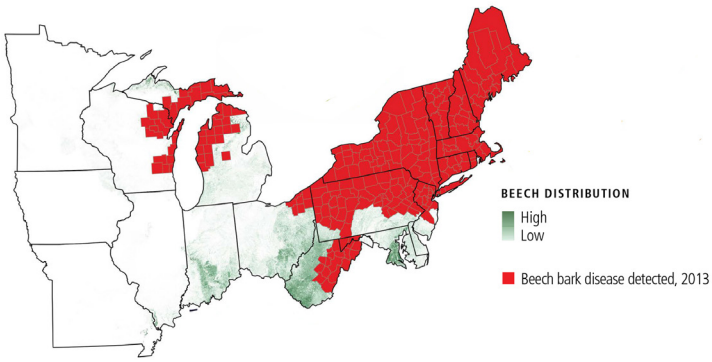


Figure 53. Spatial distribution of American Beech and detection of beech bark disease in 2013. (Forest Futures)

Jersey, approximately 11,999,555 of these trees or 1.41%, are American beech (2018). Symptoms of BBD include patches of the white waxy scale insect on the bark and trunk of the tree, as well as bright red fruiting bodies. Trees infected with BBD develop thin crowns with yellowing leaves, cracking bark, cankers and trunk deformities.

In several northern New Jersey counties, beech trees have been found infested and infected by both the beech scale insect and the *Neonectria* fungus (**Figure 53**). Currently, BBD has not been found in the central portion of the state. The scale insect has also not been found in the southern portion of the state, however small populations of the scale insect have been found in counties located within central New Jersey (2014 NJ Forest Health Highlights, NJDEP).

Beech Leaf Disease

Beech leaf disease (BLD) was first discovered in North America in Ohio in 2012 and has since been found in New York, Pennsylvania and Ontario. Although the exact cause of BLD is still unknown, it is thought to be associated with the anguinid nematode, *Litylenchus crenatae mccannii*, which is believed to be native to Japan. Understory beech are the most susceptible to the disease, where symptoms can rapidly change from early to late stages and mortality occurring soon after infection.

In larger, more mature trees, the disease progresses more slowly – showing symptoms in lower branches first and slowly working its way up the crown. The symptoms of beech leaf disease include a distinct discoloration in the leaf tissue that occurs in a striping pattern, either between the leaf veins or

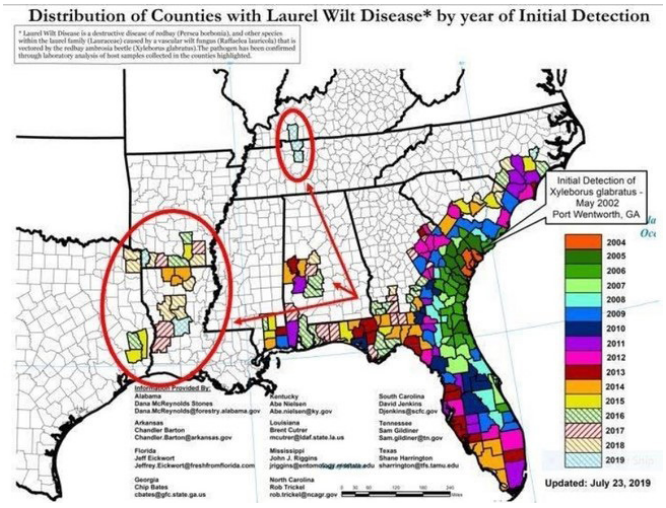


Figure 54. Laurel Wilt Disease distribution by year. (Kendra et al 2013)

along the leaf veins, more clearly visible when the affected leaf is held up to light. This discoloration eventually causes leaf necrosis and defoliation.

Symptoms of BLD also progress through buds and as affected buds are aborted, no new leaves are produced, with branch dieback and tree mortality eventually occurring. BLD can affect more than 90% of beech, including American and ornamental (European and Oriental) beech trees, within a detected area and appears to be spreading to new areas every year. BLD has the potential to further devastate American beech forests that have already been impacted by beech bark disease.

Laurel Wilt Disease *(Raffaelea lauricola)*

Laurel wilt disease (LWD) was first detected in Georgia in 2002 and has expanded throughout the southeast much faster than predicted (Kendra et al. 2013) (**Figure 54**). Laurel wilt disease (LWD) is caused by the non-native fungus, *Raffaelea lauricola* and is transmitted by the exotic redbay ambrosia beetle (*Xyleborus glabratus*) that affects plants in the Lauraceae family, mainly redbay (*Persea borbonia*) and sassafras (*Sassafras albidum*). Female beetles, the sex that transmits the fungi, can reproduce in the absence of males. Additionally, these beetles do not target weak or stressed trees, but can colonize healthy, live trees.

The beetle introduces the fungus into its galleries, where the fungus proliferates and serves as food for the beetles. Infested trees respond to this intrusion by

blocking water transport, which causes systemic wilt and ultimately death. Internal symptoms of disease include dark brownish/black staining around beetle entry holes and galleries and discolored sapwood with blue/gray streaking.

External symptoms in red bay trees include foliar wilt, beginning in terminal leaves in the crown and moving downward, leaves turning from dull green to purple, then copper brown and trees retaining dead leaves for up to a year. In contrast, sassafras trees defoliate rapidly as trees wilt and die. In the south, laurel wilt on sassafras was also found to often be geographically isolated from othersymptomatic hosts and could occur independently of its proximity to other infected hosts. LWD does not appear to be as aggressive in sassafras as it is in redbay but is still highly susceptible to the disease.

LWD has decimated redbay populations in the southeast, eliminating them from their native maritime and coastal plain forests. In NJ, the species at greatest risk are sassafras and spicebush (*Lindera benzoin*).

Fungicides and insecticides have been looked at as a short-term option for management, but are expensive and must be implemented prior to infection, because the beetle's galleries are mostly located in the heartwood of trees, where pesticides cannot reach.

Sweetgum Inscriber

In 2013, an unknown bark beetle, Acanthotomicus sp., also called the sweetgum inscriber, was identified as causing rapid and widespread mortality in American sweetgum (*Liquidambar styraciflua*) in Shanghai, China. American sweetgum is commonly grown and planted in China as a landscape and ornamental tree where the sweetgum inscriber has been said to have a 100% lethality rate.

While not much is currently known about *Acanthotomicus sp.*, it is thought to be morphologically similar to *Ips spp.*, another type of bark beetle. It has the potential to have up to three generations per year and all life stages of the beetle are associated with the phloem of the tree (EPPO, 2020).

Most infested trees did not display any signs of stress prior to attack. Signs of infestation include presence of small exit holes (about 1mm in size), as well as dead leaves that are retained on the tree until winter (EPPO, 2020). All of this indicates a significant ecological impact, should the sweetgum inscriber be introduced to North America and to New Jersey where 3.65% of live trees greater than 1 inch at DBH are sweetgum (FIA 2018). (Gao et al 2017)

Beech Leaf-Mining Weevil

The beech leaf-mining weevil (*Orchestes fagi*) is a European native that feeds on all species of beech, as well as *Rubus spp.*, *Prunus spp.* and *Malus spp.* It was first identified in North America in Nova Scotia in 2011, feeding on American beech (*Fagus americana)*. While adult BLMW have the ability to feed on multiple plant species, beech trees are required for female oviposition and larval feeding.

Females oviposit on young leaves at the time of budburst, laying eggs on the midrib of beech leaves. As larvae hatch, they create tunnels from the midrib to leaf tips, eating within the leaf and then create mines within the leaf where they can pupate. Adults eat holes in leaves and are not restricted to beech leaves as a food source. BLMW overwinter under tree bark and can cause tree mortality after several successive defoliations on a given tree.

In North America, BLMW has only been identified impacting American Beech to date but has the potential to negatively affect other species as well. In areas where beech leaf-mining weevil are present in Nova Scotia, there has been an increase in beech mortality from 18% to 88% in one year. (Canadian Forest Service, 2016) Biocontrol agents from Europe are being tested for release in North America to help control BLMW populations.

Spotted Lanternfly *(Lycorma deliculata)*

The spotted lanternfly (SLF) is a leaf hopper insect native to Asia that was accidentally introduced into Berks County, Pennsylvania in 2014. This insect has the potential to detrimentally impact more than 70 different plant species including agricultural crops such as fruit trees, grapes and hops. The non-native

invasive tree species commonly known as tree of heaven (*Ailanthus altissima*) plays a role within the SLF lifecycle, in particular with the feeding and reproduction by adult SLF. Yet, little is definitively known regarding the specifics of this interaction. FIA estimates that of 851,592,944 total live trees of one-inch DBH or greater on forestland in New Jersey, approximately 3,068,439 of these or 0.36%, are Ailanthus or tree of heaven. (FIA 2018)

Immature SLF are black with white spots and long mouthparts; they later develop large red patches as they further grow toward the adult stage. Adult SLF are colorful with black heads, gray forewings with black spots and reticulated wing tips, with bright red hindwings. Adults are approximately one inch in length and a half-inch wide and are generally present from mid-July through the fall or winter.

SLF feed on the phloem of young stems using their sucking mouthparts and excrete large quantities of honeydew onto surrounding plants. This honeydew facilitates the growth of a sooty mold that further weakens plants by decreasing photosynthesis and tree vigor, as well as through the attraction of other insects including hornets, ants and bees to feed.

Adult SLF mate and lay eggs from mid-July through the fall. Egg masses are laid on smooth surfaces such as bark, stone, outdoor furniture, vehicles and other structures. They have a grey, mud-like appearance and eggs remain in this stage throughout the winter, making them very easy to accidentally transport. Immature SLF then emerge from egg masses in the spring, typically about mid-May for New Jersey.

Since its initial introduction to Pennsylvania in 2014, SLF has spread to a total of 13 Pennsylvania counties. There, it has already negatively affected many plants including cultivated grapes in vineyards, apple orchards and landscape plants. In 2018, SLF spread to New Jersey, effectively placing three counties under quarantine–Warren, Mercer and Hunterdon. Currently in New Jersey, SLF has also been found in Somerset, Burlington, Camden, Gloucester, Salem and Cape May counties.

Verticillium Wilt *(Verticillium dahlia)*

The fungus that causes verticillium wilt (*Verticillium dahlia*) is of primary concern in urban forest settings. Verticillium wilt affects more than 300 plant species, including 80 species of trees. Commonly affected tree species include maple, magnolia and redbud, with conifers being unaffected by the fungus. The verticillium fungus lives in soil and can be spread via flowing water, wind, by tools or via transplanted plants that have become exposed to the fungus. When the fungus enters a tree's root system, it blocks water from circulating throughout the tree and produces toxins that result in the characteristic wilting symptoms.

The leaves of an infected tree will show symptoms of the fungus, including yellowing around the edges in mid-summer. Often only one side of the tree will exhibit symptoms of wilting and if an infected branch is cut, it will show discoloration in streaks, bands or flecks. The branch discoloration is bright green in maples and magnolias and dark brown in most other species.

Sudden oak death *(Phytophthora ramorum)*

Sudden oak death (SOD) is a disease caused by the pathogen *Phytophthora ramorum* and was first reported in central coastal California in 1995 (USDA Forest Service, 2002). This species of fungi infects trees through the soil, on stems or on leaves and can travel by wind or rain to its next host. SOD specifically targets species of oak, with mortality occurring within the first few months or even years within infection. The oak/hickory and oak/pine forest type-groups in New Jersey are the most at risk to SOD and comprise approximately 842,984 acres and 190,085 acres of forestland, respectively.

The effects of SOD include the formation of cankers along tree stems, the deterioration of crowns and the wilting of leaves. This pathogen essentially girdles the tree, preventing the transport of nutrients and water and ultimately leads to tree mortality.

California nurseries with contaminated stock or the potential for contamination were quarantined in 2003 so as not to distribute infected material to other parts of the country. However, prior to

quarantine in 2003, plant material was shipped to New Jersey garden centers and nurseries. The NJ Forest Service received grants to perform surveys and to collect and test samples at the recipient nursery properties and nearby streams. Surveys were completed from 2004-2008; all samples tested negative for SOD.

Thousand Cankers Disease
(Geosmithia morbida)

Thousand Cankers Disease (TCD) is a progressive disease complex that kills various species of walnut, particularly black walnut (*Juglans nigra)*. FIA estimates that of 851,592,944 total live trees of one-inch DBH or greater on forestland in New Jersey, approximately 4,445,534 trees or 0.52%, are black walnut. The TCD, disease-causing fungus (*Geosmithia morbida*) is transmitted into the phloem of the tree by the walnut twig beetle (*Pityophthorus juglandis*) as it constructs its galleries in the tree. Small cankers, no larger than the size of a quarter, develop around the galleries as a result of the fungus. Multiple cankers then coalesce, eventually girdling a branch, stem or trunk of a black walnut tree. The fungus causing TCD is native to the western United States yet does not pose a threat to the walnut species native to that range. However, black walnut trees planted in these western states (in addition to mid-west states) as ornamental or landscape trees were later discovered to be susceptible to the fungus. In 2010, TCD was confirmed in Tennessee, the first detection east of the 100th meridian, within the native range of black walnut trees.

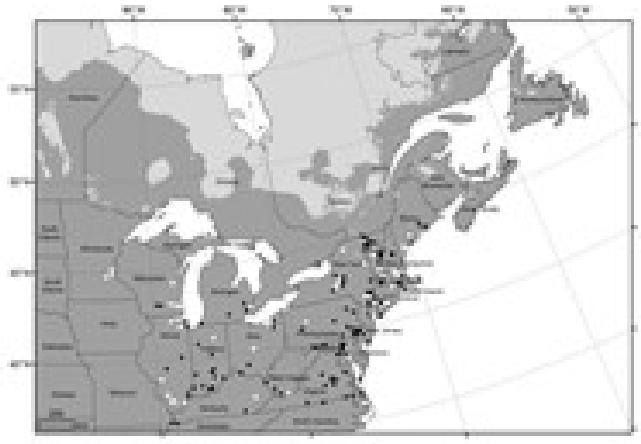


Figure 55. Circles indicate where researchers have detected Amynthas. Dark grey shading indicates the potential range of Amynthas, based on climate. (blog.uvm.edu)

Major symptoms of TCD include yellowing of foliage and thinning of tree crowns followed by branch mortality, cankers on the branches and boles and evidence of small bark beetles. While TCD has not yet been detected in New Jersey, it was confirmed in Virginia and Pennsylvania in 2011 and in Maryland in 2013. Due to the detrimental effects of TCD to black walnut trees and the close proximity of detections in neighboring states, early detection of TCD is a top priority within New Jersey.

Jumping Worms *(Amynthas spp.)*

Jumping worms, native to east Asia, arrived in North America in the late 19th century, most likely via imported plant material or through horticultural and agricultural products (*dnt.wi.gov*). These earthworms in the *Megascolecidae* family, were first detected in Wisconsin in 2013 and have been reported in 37 other states since (*blog.uvm.edu*). **Figure 55** illustrates this spatial distribution of jumping worm detections. *Although most worms are non-native, the* Amynthas *species of worms are of concern for a variety of reasons:*

- **Grow more rapidly**, feed more aggressively and reproduce more quickly than other species of worms;
- **Able to reproduce parthenogenically**, are asexual – females can lay viable eggs in the absence of a male;
- **Feed** closer to the surface of the soil layer, feed on the leaf layer and upper soil levels. Their castings are dry and granular and lack the nutritional composition needed for plants to germinate. This also leads to soil erosion and soil compaction in impacted areas;
- **Negatively affect forest regeneration** and understory vegetation because of the alterations to the soil composition; and
- **Have small dirt colored cocoons** about the size of a mustard seed making it easy to accidentally transport the worms in potted plants, on shoes, tools and tire treads.

There are many species of Amynthas, but the most common species found in North America are the *Amynthas agrestis*, *Amynthas tokioensis* and *M. higendorfi*. *Amynthas* are characterized by their snake-like movements when disturbed and by

the oily sheen on their skin and a flat, smooth, complete clitellum (band around the body of the worm). They may also drop their tail as a defense mechanism. Adult worms are most commonly present from late July to November. While *Amynthas* cocoons are viable for at least two years and are present year-round.

The distribution of *Amynthas* worms is not well documented in New Jersey but they are presumed to be widespread. The impact of *Amynthas* worms on forest regeneration and understory growth is also not well documented yet is presumed to be significant. Therefore, the NJ Invasive Species Strike Team has added *Amynthas* to the 2018 Invasive Species List. The current status of *Amynthas* is listed as High Risk, with "0" detections, a NJ Invasive Species Strike Team status of "Target," and with an early detection/rapid response action code of "1". It is believed that these worms arrived from Japan through cherry blossoms sent from Japan to Washington DC in 1912 (*blog.uvm.edu*.).

White-tailed deer *(Odocoileus virginianus)*
High densities of white-tailed deer pose a significant threat to forest health and plant regeneration throughout New Jersey. Herbivory coupled with wildfire exclusion, forestland conversion, forest fragmentation and invasive plant invasion, are all contributing DCAs with the ability to limit forest regeneration potential. Overabundant deer and

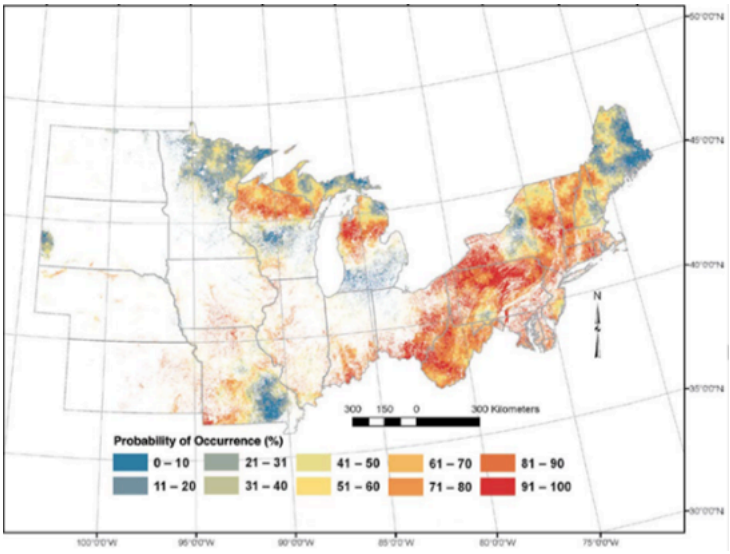


Figure 56. Probability of occurrence of ungulate browse across northeastern states. (McWilliams et al., 2018)

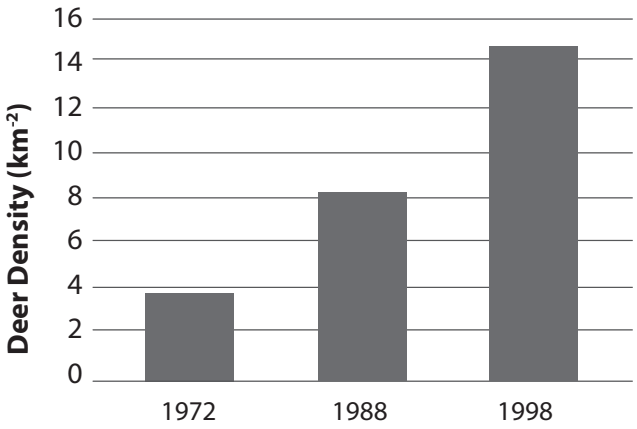


Figure 57. Changes in deer population density in New Jersey, 1972-1998. (Adapted from NJDEP, 1999; and SC and FoHVOS, 2014)

deer browse are specifically mentioned as threats in the Piedmont and parts of the Skylands Regions. (SWAP 2018)

Deer selectively browse tree seedlings and other plants and over time these damages can severely impact the structure and species composition of New Jersey's forests as well as rare species populations and other factors. Deer may also strongly reduce tree recruitment, as well as reduce understory cover across large spatial scales.

White-tailed deer, when unchecked, can also change habitats at a landscape scale and eliminate habitats on which rare wildlife depend by causing a lack of structural diversity. Because of this, natural resource managers have also identified the need to address deer populations alongside the lack of sunlight and invasive plants. (SWAP 2018) The higher the density or local deer population, the more prevalent these detrimental effects become. An approximately 70% probability of occurrence for moderate or high levels of ungulate browse is a useful minimum for describing areas where forest managers need to consider local browse pressure on management activities (McWilliams et al., 2018; **Figure 56**).

Overall, the mid-Atlantic region demonstrates the highest probability of browse occurrence, with New Jersey characterized with moderate and high browse levels as defined by the McWilliams study (2018). Deer densities in New Jersey have been on the rise over the last 50 years (**Figure 57**). This further correlates with an increase in browse probability. As

deer populations increase, so too do their impacts on forest regeneration, structure and composition.

Forest type-groups are impacted differently by the effects of deer browse due in part to variations in tree species biology and life history. For instance, the oak/hickory and maple/beech/birch forest type-groups are under more browse pressure than most other forest type-groups. The proportion of forest land with moderate or high browse impacts for other forest type-groups ranged from 32 to 57%, further supporting the notion that ungulate-compatible silviculture, such as prescribed fire, control of competing vegetation and fencing, has become a major thrust for managers in the Midwest and Northeast (McWilliams et al., 2018).

Although oak species can be quite responsive to forest management, they also tend to be highly palatable to deer. Preference by deer can lead to reduced regeneration success of these species. These browse effects can also alter successional pathways, reducing the amount of understory vegetative biodiversity and ultimately creating a more homogeneous understory. Deer are also responsible for altering forest regeneration potential of specific species such as oaks, hickories and hemlock, especially within the mid-Atlantic states (McWilliams et al., 2018).

A New Jersey study centered around the Piedmont by Kelly showed that significant changes in tree species composition were observed in relation to deer browse preferences, especially in the large seedling and sapling layers of which exhibited the greatest decline (2019). Sites with higher estimated deer populations showed conspicuously lower sapling densities (Kelly, 2019).

This study also showed declines in native herbaceous plants in conjunction with impacts to trees. The cover of exotic shrubs, lianas and herbs also increased, resulting in a major shift in species composition away from mostly native species cover, to mostly exotic shrub and liana cover (Kelly, 2019). Excessive deer browse can also create a favorable environment for invasive plants to germinate and out-compete native species; selective browse on native species allow non-native plants to become established and thrive. (NJ SWAP, 2008) White-tailed deer, when unchecked, can change habitats at a landscape scale and eliminate habitats on which rare wildlife depend. (SWAP 2018)

Invasive Plant Species

An invasive species is a native or non-native plant or organism introduced into a new environment, causing harm. Non-native plant species in particular pose a significant risk to forest ecosystems when they become invasive. These species affect forest ecosystems through direct competition for resources, alteration of fire or hydrologic conditions, disruption of natural succession and pollination and other cascading influences (Frelich et al., 2012; Tu et al., 2001).

Invasive plant species can be introduced into native ecosystems by the transport of seed on vehicles or equipment, on the soles of shoes, in manure from domestic or wild animals or via dissemination by wind and water. Major shipments from international origins are often the source of new exotic species as well, including Amur honeysuckle *(Lonicera maackii)* and reed canarygrass (*Phalaris arundinacea*).

The Snyder and Kaufman (2004) report on nonindigenous plant species in New Jersey provides an excellent background on the number and origin of nonindigenous plant species throughout the state, discusses problems caused by harmful invasive plant species, describes state and federal programs associated with these topics and examines methods of control and prevention. Fact sheets on 27 of the most problematic invasive plant species were developed from this report to help guide management and control initiatives across the state.

The USDA Forest Service, FIA program has monitored 25 invasive plant species in the eastern United States since 2007 (Kurtz, 2013). The density of invasive plant species was found to be highest in the Piedmont region stretching from western Maryland to eastern New York, where five to seven invasive plant species were found in most of the NFI plots. As part of the FIA program protocol, approximately 39 regional invasive plant species are

Name	Occurrences	Percentage of plots
Multiflora rose	24	36.9
Japanese honeysuckle	18	27.7
Japanese barberry	16	24.6
Garlic mustard	14	21.5
Nonnative bush honeysuckles	13	20.0
Nepalese browntop	12	18.5
Oriental bittersweet	11	16.9
Autumn-olive	9	13.8
European privet	6	9.2
Norway maple	3	4.6
Black locust	3	4.6
Canada thistle	2	3.1
Common reed	2	3.1
Spotted knapweed	1	1.5
Dames rocket	1	1.5
Ailanthus	1	1.5

Table 6. Invasive plant species detected by FIA monitoring of invasive plots within New Jersey. (Crocker et al., 2013)

monitored for within plots across the state of New Jersey (Crocker et al., 2017).

Of these 39 monitored invasive plant species, the 2013 inventory revealed the presence of approximately 16 different species. Overall, nearly half (46%) of all New Jersey plots contained these invasive plant species. The detailed results of these observed occurrences are visible within **Table 6** (Crocker et al., 2017). In New Jersey, most of these invasive plant species are located within the northern portion of the state. While statewide eradication of invasive plant species is impossible, site specific removal and restoration is possible and is occurring throughout New Jersey. Therefore, controlling invasive plant species to the point where trees can become established and understanding these thresholds is important.

Another study using FIA data found more invasive plant species and in greater abundance, within fragmented forest landscapes, including areas of the Mid-Atlantic region (Iannone et al., 2015). Glossy buckthorn, bush honeysuckle, autumn olive, crown vetch, Japanese knotweed, Japanese stiltgrass, garlic mustard, ailanthus, mile-a-minute and multiflora rose are among the most problematic invasive plant species within the Mid-Atlantic region (Grafton, 2003).

Non-native invasive plant species are a major threat to many forested communities across the eastern United States. Many invasive plant species can establish rapidly after a disturbance and are able to outcompete native vegetation for growing space, water, nutrients and light (Brown and Peet, 2003; Dukes et al., 2009). Climatic factors that could influence the ability of a species to invade include warmer temperatures, earlier springs and reduced snowpack (Hellmann et al., 2008; Ryan and Vose, 2012). Evidence indicates that increases in temperature, longer growing seasons and more frequent disturbances will lead to increases in many invasive plant species (Butler-Leopold et. al. 2018).

The control of invasive species, particularly plants, is a major focus for the health of New Jersey forests. The lack of forest stewardship, in particular, can

lead to significant ecological damage. More than one thousand non-native invasive plant species have become established within New Jersey. Some of these species are very harmful and can crowd out native plant species, altering the structure of natural plant communities, disrupting ecosystem functions and degrading recreational opportunities. Invasive plant species predominately occur in highly disturbed areas and can adapt to various ecological conditions quickly.

Mortality

An increase in dead trees is a normal sign for a maturing forest and can even be important for biodiversity and in providing structure for wildlife habitat. However, mortality should be closely monitored in New Jersey because of the relative homogeneity of the forest statewide in terms of forest composition (type-groups) and age class distribution within the state. Coupled with these factors, DCAs including insects and pathogens could lead to widespread and rapid changes that would be detrimental to biodiversity, social and economic values of the resource. The average annual tree mortality (in volume) on New Jersey timberland for FIA inventories from 1999 to 2015 is summarized within **Figure 58**.

Since most of New Jersey's forests are classified as timberland, these estimates can be used to gain insight into patterns on forested lands statewide. Mortality appears to be on the steady rise for both hardwood and softwood species of trees since 1999. However, the number of standing dead trees per acre on timberland has fluctuated since 1999, with a general rise since 2011 (**Figure 59**).

Further, as depicted in **Figure 60**, a distribution of tree mortality from 1999 to 2015 by cause of death is visible (FIA). This indicates that tree mortality related to insect damage has experienced a sharp rise since 2010, with more than 5% of standing dead trees on timberland in 2015 due to insect damage (FIA). Concurrently, tree mortality related to disease has only gradually increased across the same time period with less than 1% of standing dead trees on timberland in 2015 due to disease (FIA).

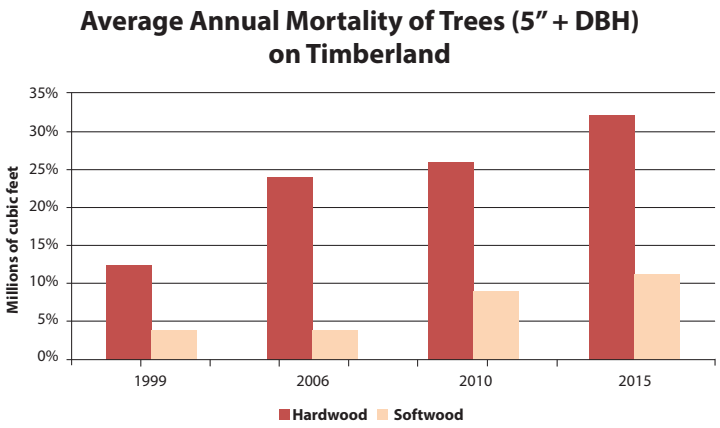


Figure 58. Average annual mortality of trees in volume on timberland in New Jersey by hardwood and softwood species from 1999 to 2015. (FIA)

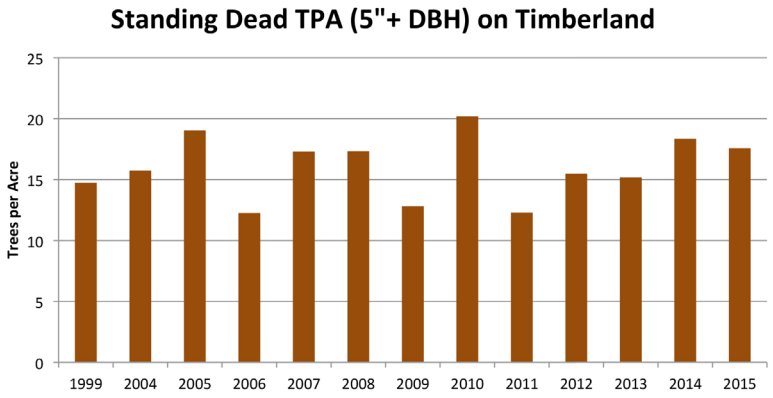


Figure 59. Standing Dead Trees per acre on Timberland in New Jersey from 1999 to 2015. (FIA)

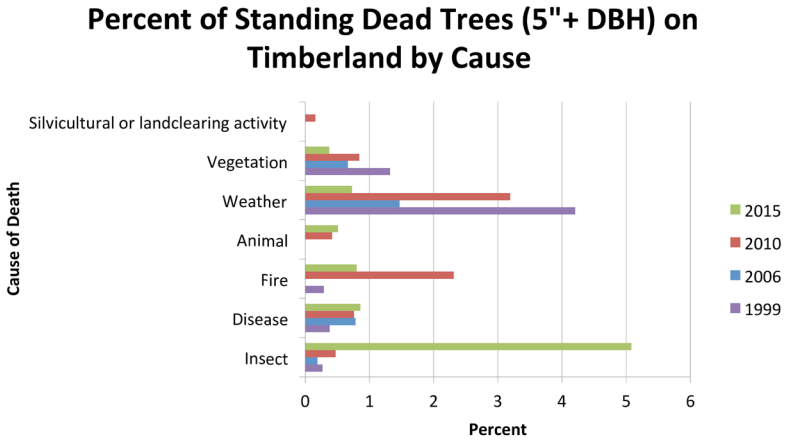


Figure 60. Percent of standing dead trees on timberland by cause of death in New Jersey from 1999 to 2015. (FIA)

CRITERION 4.

CONSERVATION AND MAINTENANCE OF SOIL AND WATER RESOURCES

Soil Quality on Forest Land

Forest contributions to maintaining soil and water quality are an important benefit of both urban and rural forest environments. Trees, shrubs and ground cover help to stabilize soil and transform nutrients. A primary sustainable forest management goal is maintaining soil and hydrologic function (Montreal Process Criterion #4) so that forest productivity (rate of biomass production per unit time and area) is not impaired. However, the relationship between the measures of soil and hydrologic function and forest productivity must be validated with long-term trials so that water quality standards and Best Management Practices (BMPs) can be modified and adapted as needed (Burger et al., 2010). Watersheds with higher forest cover also provide greater amounts of high-quality water for multiple uses. It is important that riparian areas remain forested to serve as natural buffers that filter pollutants and sediments that would otherwise enter streams and other water bodies.

To better understand soil and hydrologic functions in New Jersey, physiographic provinces should first be discussed. New Jersey has four physiographic provinces (shown in **Figure 61**) which are described in the following sections.

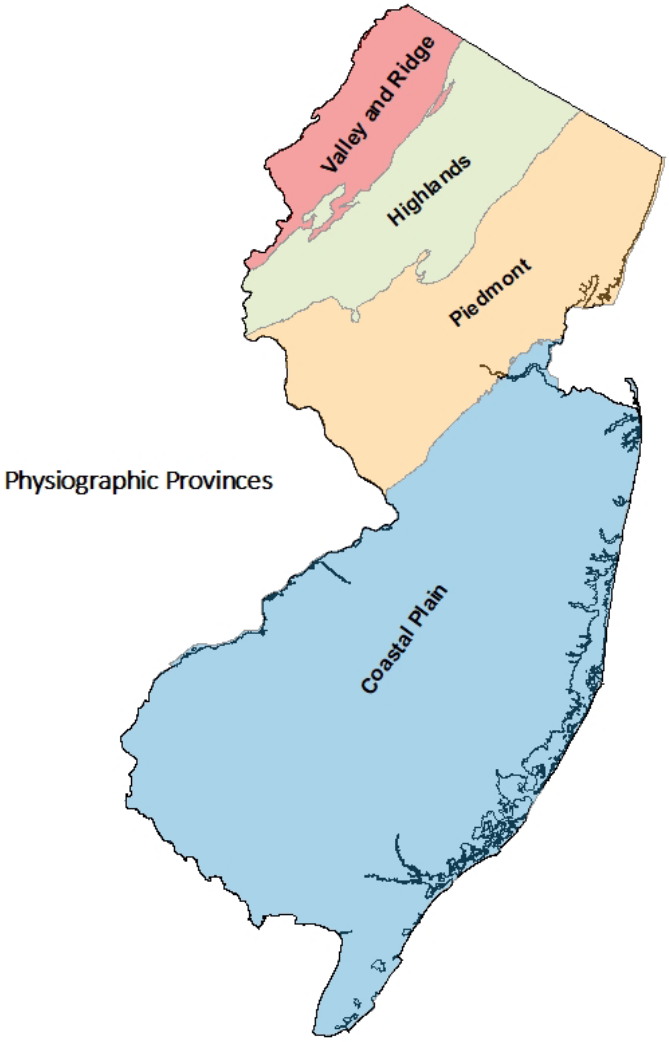


Figure 61. Physiographic provinces of New Jersey. (NJFS, 2019)

Valley and Ridge: Located in the northwestern corner of New Jersey and characterized by steep-sided, linear ridges and broad valleys, underlain by folded and faulted Paleozoic sedimentary rocks of Cambrian to Middle Devonian age (540 to 374 million years old), this province covers approximately 536 square miles and occupies a major portion of Sussex and Warren Counties. Carbonate bedrock including dolomite, limestone, marble and shale characterize the Kittatinny Ridge and Valley. This province comprises nearly 8.5% of the area of New Jersey and is home to about 5% of the state's population. Hardwood swamps, sugar maple-mixed hardwoods, northern mixed oaks, ridgetop pitch-pine scrub oak and hemlock/hardwood forests are common forest type-groups found within this province. (NJDEP, NJGS, 2003)

Highlands: Located east of the Valley and Ridge province, this region spans multiple states (PA, NJ, NY, CT) and consists primarily of metamorphic crystalline rocks dominated by gneiss on ridges, erodible sedimentary sandstone and dolomite and shale in valleys. The Wisconsin glacier extended across the northern half of this region. The Highlands lie in the southeastern portions of Sussex and Warren Counties not included within the Valley and Ridge province, as well as major portions of Hunterdon, Morris and Passaic Counties. This province even extends into portions of Bergen and Somerset Counties. The Highlands occupies approximately 980 square miles within New Jersey. In general, the Highlands province is composed of rugged topography with discontinuous rounded ridges and deep narrow valleys. This province comprises nearly 12% of the area of New Jersey and is also home to about 5% of the state's population. Hardwood swamps, sugar maple-mixed hardwoods, northern mixed oaks, ridgetop pitch-pine scrub oak and hemlock/hardwood forests are common forest type-groups in this province. (NJDEP, NJGS, 2003)

Piedmont: This province covers Essex, Hudson and Union counties in its entirety, as well as portions of Bergen, Hunterdon, Somerset, Mercer, Middlesex, Morris and Passaic counties. The Piedmont consists of slightly folded and faulted sedimentary rocks of the Triassic and Jurassic age (20 to 140 million years old) as well as Paleozoic sedimentary rocks (along northeastern edge). This primarily low rolling plain is divided up by a series of higher igneous rock (lava flows and diabase intrusive rock) ridges and covers approximately 1,600 square miles. The Piedmont comprises 20% of the area of New Jersey and is home to nearly 60% of the state's population. Hardwood swamps, sugar maple-mixed hardwoods, northern mixed oaks and hemlock/hardwood forests are common forest type-groups within this province. (NJDEP, NJGS, 2003)

Coastal Plain: The Coastal Plain is the largest province in New Jersey at roughly 4,667 square miles. The Coastal Plain covers Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Monmouth, Ocean and Salem counties in their entirety, as well as portions of Mercer and Middlesex counties. Unconsolidated layers of silt, sand and clays were deposited during the upper Lower Cretaceous to Miocene periods (90 to 10 million years old). The Coastal Plain can be further described by formation as either the Inner or Outer Coastal Plain. The Inner Coastal Plain composes approximately 14.3% of the area of New Jersey and is home to 14% of the state's population. The Outer Coastal Plain on the other hand, composes about 45.2% of the area of New Jersey and is home to about 16% of the state's population. AWC, pine plains, red maple-sweet gum, pitch pine lowlands, hardwood swamps, upland pine and oak and southern mixed-oak forests are the common forest type-groups found. (NJDEP, NJGS, 2003)

Soil Productivity and Soil Quality

Soil productivity is generally defined as a soil's ability to produce biomass or some harvestable crop. If not modified, soil has a natural or inherent productive potential based on its genesis and setting in the landscape. Some soils are naturally more productive than others, but not necessarily more valuable in terms of the role they play in their natural setting. This difference in soil productivity is reflected in a measure of forest "site index" or volume produced after a given amount of time (Burger et al., 2010). Site index is a very important indicator used to determine overall site productivity and is commonly used in forest management decision-making processes. Site index is a species-specific measure of actual or potential forest productivity, expressed in terms of the average height of trees included in a specified stand component at a specified index or base age (Helms, 1998).

Soil quality has been defined as a soil's ability to provide services important to people. This measure is useful in determining the extent to which a managed soil is improved or

Soil Quality Indicator	Minnesota	Missouri	New Hampshire	New Jersey	New York	Ohio	Pennsylvania	Rhode Island	Vermont	West Virginia	Wisconsin
At 0- to 10-cm depth (percent)											
Phosphorus[a] < 15 mg/kg	44	88	77	100	76	88	80	50	89	96	49
Phosphorus[b] < 10 mg/kg	13	88	NA[c]	NA	50	100	NA	NA	NA	NA	22
Exchange aluminum > 100 mg/kg	24	20	85	50	67	35	85	100	63	58	32
Exchange calcium < 100 mg/kg	1	9	35	63	20	5	43	0	40	14	8
Exchange potassium < 100 mg/kg	48	49	74	88	64	49	72	0	90	54	74
Exchange magnesium < 50 mg/kg	11	14	65	88	42	19	70	0	63	31	26
Organic carbon < 1 percent	3	4	0	0	1	0	5	0	3	0	4
Total nitrogen < 0.1 percent	13	11	3	50	4	2	4	0	10	17	21
Water pH less than 4.0	2	0	18	50	33	2	30	0	23	10	5
At 10- to 20-cm depth (percent)											
Phosphorus[a] < 15 mg/kg	52	90	86	80	83	90	81	100	86	90	56
Phosphorus[c] < 10 mg/kg	64	80	NA	NA	0	100	100	NA	NA	NA	71
Exchange aluminum > 100 mg/kg	28	28	67	38	64	49	89	100	67	65	36
Exchange calcium < 100 mg/kg	3	24	70	88	42	28	61	50	50	29	17
Exchange potassium < 100 mg/kg	77	74	100	88	86	78	93	100	100	67	90
Exchange magnesium < 50 mg/kg	31	22	94	88	59	39	84	50	83	47	48
Organic carbon < 1 percent	31	40	3	13	4	38	22	0	0	10	27
Total nitrogen < 0.1 percent	54	55	21	88	13	47	35	0	17	53	55
Water pH < 4.0	2	0	6	25	13	0	8	0	10	2	1

Figure 62. Percentage of forest inventory plots, 2000 to 2005, in the North that were reported to have suboptimal soil conditions. (Shifley et al., 2016)

degraded from its natural state or some other selected reference condition. Soil is complex; it has many physical, chemical and biological properties that define its natural state and determine its rate of productivity. Disturbances or management inputs can usually change multiple soil properties at once (Burger et al., 2010).

According to FIA data (2000-2005) as illustrated in **Figure 62**, the percentage of plots within New Jersey that were reported to have suboptimal soil conditions for water PH at 0-10 cm (0-4 inch) depth, which is a soil quality indicator, was approximately 50%. At a depth of 10-20 cm (4-8 inch), approximately 25% of the plots reported having a water PH of less than 4.0. The percentage of plots that were reported to have suboptimal soil conditions for the soil quality indicator of exchange aluminum greater than 100mg/kg at 0-10 cm (0-4 inch) depth was approximately 50%. Whereas the exchange aluminum greater than 100mg/kg at 10-20 cm (4-8 inch) depth was about 38%. Similarly, for the soil quality indicator of exchange calcium less than 100mg/kg at 0-10 cm (0-4 inch) depth, the percentage of plots with these suboptimal soil conditions was approximately 63% and for 10-20 cm (4-8 inch) depth it was approximately 88%. (Shifley et al., 2016)

Soil quality and stability is important for all tree species regardless of whether they are under stress from DCAs. For example, a change in fire regime through land use changes as well as other anthropogenic factors can affect soil in many ways. Repeated fires can cause significant impacts on the amounts of organic matter, in addition to various soil properties. For instance, if a severe wildfire occurs, soil organic matter can be rapidly released/ reduced.

Other indicators used to measure soil quality, productivity and potential issues include soil density and soil compaction. Bulk density is a way to measure the weight of soil in a given volume (including dry solids, water and pore space). However, bulk density is also an indicator of soil compaction and soil health, specifically affecting filtration, root depth/restrictions, water capacity, nutrient availability, soil porosity and microorganism activity through soil moisture. When soil is no longer able to allow for the natural movement of water or act structurally supportive, nutrients are lost, water movement becomes unpredictable and the water quality within larger watersheds becomes unreliable. Bulk density measurements for specific soil types can serve as indicators of soil compaction. For instance, soils with higher bulk density values tend to indicate compaction, however sandier soils generally have a higher bulk density than fine silts and clays. These values can also be used to determine rooting depth, tree growth, erosion/runoff potential and waterlogged soil.

Water Quality and Forest Land

Watershed protection is vital to any ecosystem, as watersheds provide valuable ecosystem services such as clean drinking water through water filtration, the reduction of flooding and erosion, sustaining of stream temperatures and flow, watershed stability and resilience, aquatic habitat and recreation (Barnes et al., 2009).

Forests in riparian areas slow the flow of surface water movement into bodies of water, regulate temperature and provide valuable food and habitat for wildlife. Management of riparian forests influences the quantity and quality of water in their adjacent waterways. Therefore, following BMPs is important in maintaining the integrity of forests, streams, lakes and ground-water.

Forests are important in regulating ground-water flow and quality as well. In general, forest cover is often positively correlated with clean drinking water and outdoor recreational opportunities. The health of riparian forest, individual trees and riparian-associated plants is also important in determining the stabilization of stream banks (USFS et al., 2003). Urban tree plantings are an important component of water filtration properties as well. In fact, managing stormwater through the use of green infrastructure, species selection and planting locations, can help communities address flooding and stormwater runoff issues while helping to maintain green space.

Forested wetlands are found throughout New Jersey and are considered one of the state's most vital resources and productive ecosystems. They provide many benefits including flood storage capacity, flood velocity reduction, ground-water recharge opportunities, nutrient and sediment control, wildlife habitat, recreational opportunities and timber supply. Wetlands occur in depressions adjacent to rivers, lakes, streams and coastal waters or in isolated areas disconnected from open waterways . They are frequently transition areas between a well-drained upland and open waters. Many wetlands develop in distinct depressions or basins that can be readily observed. While others may occur in almost imperceptible shallow depressions that cover many acres. They also may be associated with ground-water seeps. Water and hydrology are dominant factors in determining the nature of soil development, as well as the types of plant and animal communities living in the soil and on the surface of wetlands. Hydrology can also create severe physiological constraints for many plants and animals that are not adapted for those conditions and can be extremely conducive for those that are adapted for life in water or in saturated soil.

"Management of riparian forests influences the quantity and quality of water in their adjacent waterways."

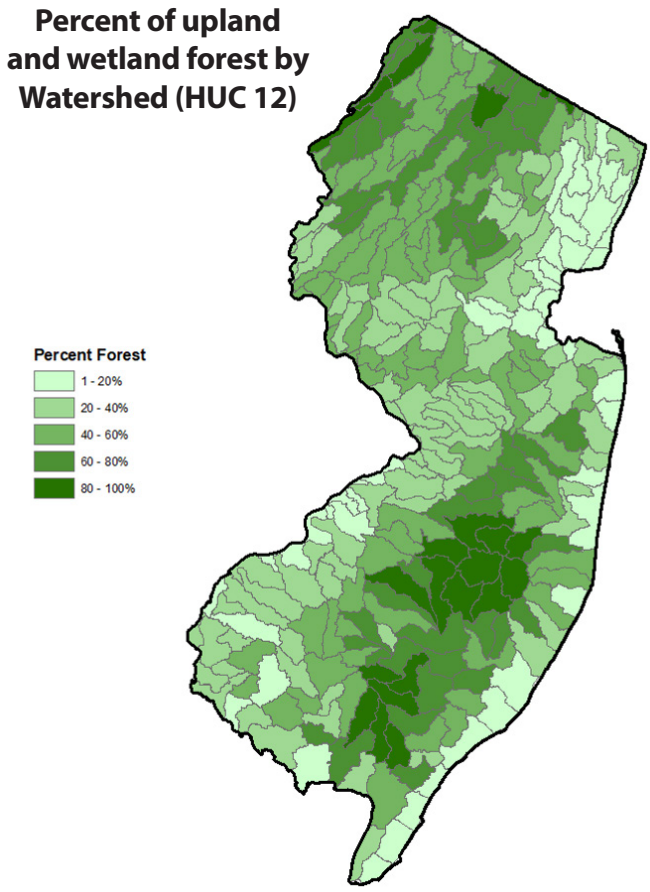


Figure 63. Percent of upland and wetland forest by watershed in New Jersey. (NJFS, 2019)

Forested Riparian Area

The total extent of naturally covered riparian areas in New Jersey is approximately 697,064 acres. This equates to nearly 13% of the total area of New Jersey's riparian areas being naturally covered. These riparian areas, as described by the National Land Cover Database (NLCD) include the following land-cover classes: open water, perennial ice/ snow, deciduous forest, evergreen forest, mixed forest, shrub/scrub, grassland/herbaceous, woody wetlands and emergent herbaceous wetlands (MRLC, 2016). **Figure 63** illustrates the percent upland and wetland forests by HUC12 watersheds located throughout New Jersey, demonstrating where forested areas influence water movement or infiltration and help to regulate runoff, flooding or stormwater issues.

Healthy vegetation adjacent to surface waters such as forested riparian areas are essential for maintaining bank stability and water quality. These are also vital forms of flood control and unless properly controlled, development within flood hazard areas can exacerbate the intensity and frequency of flooding by reducing flood storage, increasing stormwater runoff and obstructing the movement of floodwaters. In addition, structures that are improperly built in flood hazard areas are subject to flood damage and threaten the health, safety and welfare of those who use them.

The NJ Flood Hazard Control Act (FHACA) was developed as a means to regulate flood hazard areas; control stream encroachments; coordinate effectively the development, dissemination and use of information on floods and flood damages that may be available; authorize the delegation of certain administrative and enforcement functions to county governing bodies; and integrate the flood control activities of the municipal, county, state and federal governments (N.J.S.A. 58:16A-50b). The indiscriminate disturbance of wetland vegetation can destabilize channels, leading to increased erosion and sedimentation that exacerbate the intensity and frequency of flooding.

The loss of vegetation adjacent to surface waters reduces filtration of stormwater runoff and thus degrades the quality of these waters. The FHACA Regulations (N.J.A.C. 7:13 –1 et seq.) therefore incorporates stringent standards for development in flood hazard areas and areas adjacent to surface waters. These regulations provide a means to mitigate the adverse impacts to flooding and the environment that can be caused by such development. Further, under FHACA a water that is subject to the FHACA rules is called a regulated water. Under N.J.A.C. 7:13-2.2, all surface waters in New Jersey are regulated with four exceptions – manmade canals, coastal wetlands, certain segments of water that have a drainage area of less than 50 acres and water-filled depressions created in dry land (Technical Manual FHACA, 2018).

Impervious Surface

Impervious surface impedes precipitation infiltration to ground-water; increases the amount of runoff; impacts ground-water recharge, frequency and magnitude of flooding, as well as pollutant levels; and degrades biological activity. Impervious surface in New Jersey is clustered primarily around urban areas and averages approximately 20% of land area by municipality. **Figure 64** illustrates the spatial distribution of the percentage of impervious surface across the state of New Jersey from 1995 to 2012 (Lathrop, Bognar & Hasse 2016). In New Jersey, the total impervious footprint was 515,106 acres as of 2012 or about 805 square miles of concrete and asphalt (Lathrop et al., 2016). This represents 1,285 acres of impervious surface increase per year from 2007 to 2012—however this is a decline from the previous time period (Lathrop, Bognar & Hasse 2016). This means that from 2007 to 2012 there was one acre of impervious surface for every 3.8 acres of development, while on average, newly developed land is 26.5% impervious surface (Lathrop, Bognar & Hasse 2016). Across the state there were also approximately 1,783 acres of stormwater basins added, for a total of 15,209 acres from 2007 to 2012 (Lathrop, Bognar & Hasse 2016). Impervious surfaces not only alter hydrology but can adversely impact wildlife migration patterns (Nowak and Greenfield, 2009).

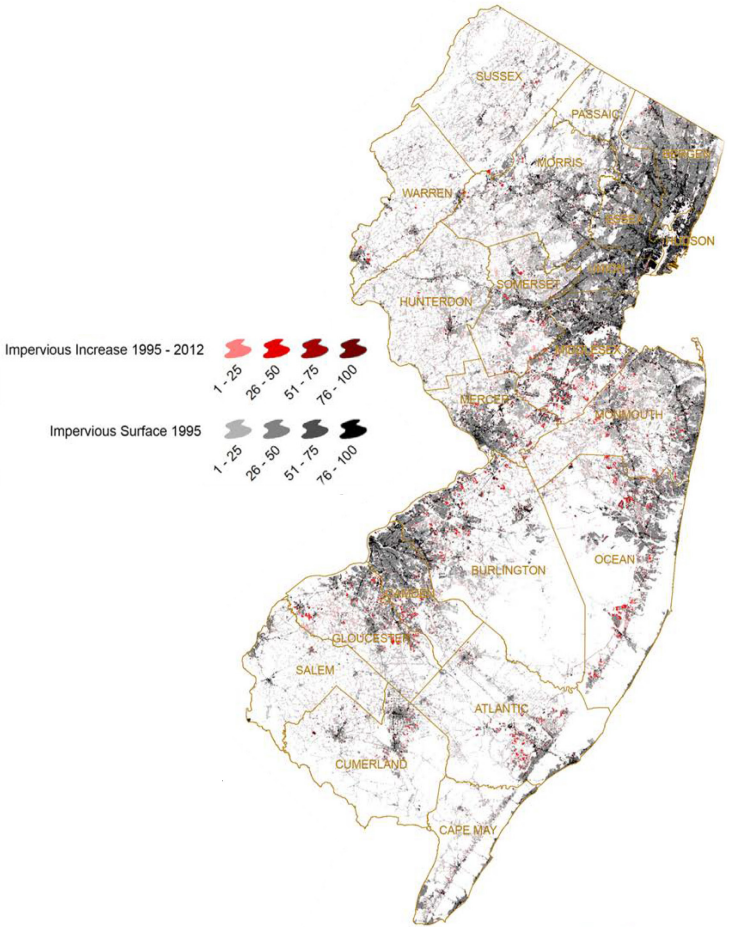


Figure 64. Spatial distribution of the percentage of impervious surface cover for New Jersey from 1995 to 2012. (Lathrop, Bognar and Hasse 2016)

Water quality is greatly affected by land use patterns, including the amount of impervious surface across the state (Chescheir et al., 1990; Evans et al., 1989; Skaggs et al., 1980; Treece, 1994). Drainage water from undisturbed forested watersheds carries a lower nutrient load than drainage water from developed soils. The development of organic soils results in large increases in the phosphorus (P) content of drainage water if fertilizer P is added, because the soil does not bind P, as in mineral soils. Nitrogen (N) also increases, but not nearly to the extent noted for P. Restoration of wetland conditions in peatlands formerly drained for agriculture would likely reduce nutrient export and improve water quality as well.

Water Monitoring

In 2014, New Jersey's targeted monitoring results, as reported to the Environmental Protection Agency (EPA) by the state, concluded that 97% or 19,078 miles of the total miles of rivers and streams in the state (19,705 miles) were assessed for water quality. Of those assessed waters, nearly 1,316 miles of rivers and streams were characterized as "good waters"—met all the uses for which they were assessed. Also, in 2014 nearly 4,084 miles of rivers and streams were considered "previously impaired waters now attaining all uses"—a waterbody (or cause) that was once impaired is considered to be attaining water quality standards if it meets all uses. "Impaired" rivers and streams are those where any one of the waterway's uses is not met.

In New Jersey this included approximately 17,762 miles, with 1,695 miles having a completed TMDL (total maximum daily load) and 16,067 miles with a TMDL needed (69 miles of which a new TMDL has been completed). The TMDL is a

calculation of the maximum amount of a pollutant allowed to enter a waterbody so it will continue to meet water quality standards. Calculating TDMLs also helps to determine a target for the reduction of a pollutant and load reductions that are necessary to the source of the pollutant (EPA, 2018).

The 2014 monitoring results also included 47,109 acres of New Jersey's lakes, reservoirs and ponds which comprises nearly 65% of the 72,590 acres of the total area of water bodies located within New Jersey. Of these assessed waters, approximately 2,698 acres were considered "good waters" while 44,411 acres were considered "impaired". Of those total assessed lakes, reservoirs and ponds, 4,540 acres were "previously impaired waters now attaining all uses". Of these impaired waters, 4,952 acres of TMDLs were completed and 39,459 acres of TMDLs are needed, with new TMDLs completed on 68.5 acres. In addition, approximately 86% of bays and estuaries were assessed (650 square miles of 760 total square miles) for New Jersey.

Figure 65. Delaware River Basin. (Delaware River Basin Commission, 2019)

Of those assessed, 50 square miles were considered "good waters" and 600 square miles were considered "impaired". "Previously impaired waters now attaining all uses" comprised approximately 23 square miles. There were approximately 15 square miles of impaired bays and estuaries that had a completed TMDL, with 585 square miles where TMDLs are needed. The protection of watersheds through proper forest management is important to better protect key regions throughout the state of New Jersey. These key regions include the Highlands, Pinelands and Delaware River Basin. These regions provide clean drinking water, water filtration and temperature regulation, in addition to flood control across the state.

Water Protection Regions

Delaware River Basin

Along the northwestern boundary of New Jersey, following along the Delaware River, is the Delaware River Basin (**Figure 65**). Currently, this segment is part of the Delaware River Basin Commission's (DRBC) Special Protection Waters program. This is possibly the longest stretch of river in the nation under an anti-degradation policy. According to the DRBC website:

"The words watershed and basin are essentially synonymous, although, technically, a basin is a large watershed made up of smaller sub-watersheds. A watershed can be simply described as the area of land draining to a particular stream. When it rains, the rain will run-off the land into that local waterway, which then makes its way into larger bodies of water. The body of water and the surrounding land both make up the watershed. All of the watersheds that eventually drain to the Delaware River make up the Delaware River Basin.

There are 10 main sub-watersheds of the Delaware River Basin. The basin also includes portions of five physiographic regions: the Appalachian Plateau; Ridge and Valley; New England; Piedmont; and the Atlantic Coastal Plain.

The Delaware River Basin includes four states, 42 counties and 838 municipalities. In all, it contains 13,539 square miles, including the 782 square-mile Delaware Bay.

It drains parts of:

- Pennsylvania (6,422 square miles or 50.3 percent of the basin's total land area)
- New Jersey (2,969 square miles, or 23.3%)
- New York (2,362 square miles, 18.5%)
- Delaware (1,004 square miles, 7.9%)

Just over 13 million people (about four percent of the nation's population) rely on the waters of the Delaware River Basin for drinking, agricultural, and industrial use, but the watershed drains only four-tenths of one percent of the total continental U.S. land area. The 13.3 million figure includes about 5 million people in New York City and northern New Jersey who live outside the basin. New York City gets roughly half its water supply from three large reservoirs located on tributaries to the Delaware." (DRBC 2020)

Highlands Region

The Highlands region (**Figure 66**) makes up more than 859,358 acres (approximately 1,343 square miles) and is located in the northern portion of the state. This region contains 88 municipalities within seven counties, providing drinking water for more than five million residents of New Jersey. Consequently, the Highlands Act (P.L. 2004, c.120) was passed in 2004 to protect this sensitive area, water quality being one of the priorities. The Highlands Regional Master Plan (RMP) adopted in 2008, provides guidance for implementation of the Act. There is more than approximately 415,000 acres contained within the Preservation Area and approximately 445,000 acres within the Planning Area of the RMP (NJ Highlands Council website, 2019). This area of national significance was identified as a critical watershed for nearby metropolitan areas. In 2004 the Highlands Conservation Act recognized the importance of the water, forest, agricultural, wildlife, recreational and cultural resources within the region. Therefore, more than $9.25 million in federal funding for land protection in the Highlands region has been appropriated by Congress to date. Related collaborative conservation efforts, like the work of the Appalachian Trail Conservancy, have protected thousands of acres in each state throughout the region, including portions of the Appalachian Trail (Multi-State Priority Areas in the Northeast and Midwest, 2016). This work continues to provide crucial landscape-scale linkages between federal, state and private forest lands that were already protected (Multi-State Priority Areas in the Northeast and Midwest, 2016).

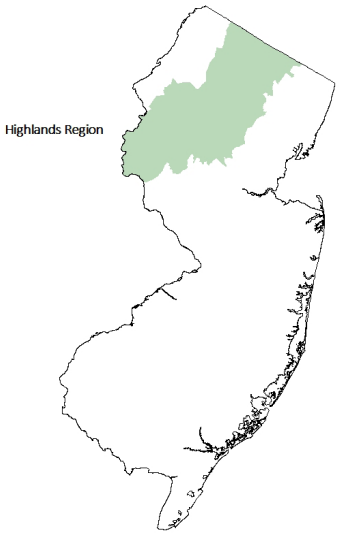


Figure 66. Highlands region of New Jersey. (NJFS, 2020)

Pinelands Region

The Pinelands region is located within the southern portion of the state of New Jersey (**Figure 67**). Underneath much of the Pinelands region is the Kirkwood-Cohansey Aquifer, an important drinking-water source for much of southern New Jersey. The shallow water table across the region lies just beneath the surface in most areas. This provides wetlands, lakes, streams and rivers located within southern New Jersey the capacity to seep or flow into the aquifer. Miles of rivers course through the scenic Pinelands region, most of which also feed the productive bays of southern New Jersey. These major watercourses include the Mullica, Great Egg Harbor, Maurice and Toms Rivers. The Great Egg River and Maurice River are designated wild and scenic rivers, while the Mullica River traverses through the Pinelands Preservation Area. In this area a majority of the lakes are man-made rather than natural phenomena and have generally been created through the damming of streams and other wetlands in the distant past. The best-known lakes in this

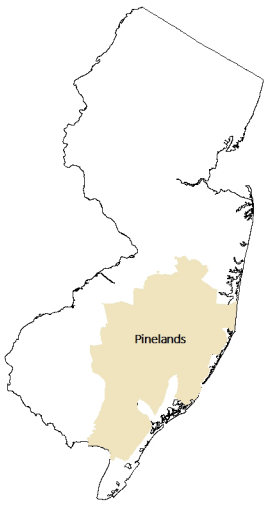


Figure 67. Pinelands region of New Jersey. (NJFS, 2020)

region are Lake Lenape, Harrisville Pond and Lake Oswego (NJ Pinelands Commission website, 2019).

Forests with Known Water Filtration Qualities

Forested wetlands provide many functions and services within larger local watersheds, dependent on size, type and location of the wetland within a watershed. Collectively, wetlands provide many watershed benefits, including pollutant removal, flood storage, wildlife habitat, ground-water recharge and erosion control. While watersheds and wetlands are interconnected systems, their management is often segregated along regulatory and jurisdictional boundaries (Cappiella et al., 2006). Forest types that are best known for effective water filtration qualities or capacity, are often referred to as swamps or wooded wetlands—where trees are the dominant plants. These types of forested wetlands only occur within palustrine and estuarine wetland ecosystems. These wetland forest types are characteristically described by having an overstory of tall trees, understory of small trees and shrubs and an herbaceous ground layer. Within New Jersey there are four common types of forested wetlands: hardwood swamps, pine/hardwood swamps, eastern hemlock wetland ravines and AWC swamps.

> "These riparian areas have been shown to be very valuable for the removal of nonpoint-source pollution from drainage water. Several researchers have measured >90% reductions in sediment and nitrate concentrations in water flowing through the riparian areas."

These forested wetlands or riparian areas that border uplands are important for nitrogen processing and retention of large sediment particles. Fine particles associated with high concentrations of phosphorus are retained in downstream wetlands where flow rates are slowed and where surface water passes through plant litter (Whigham et al., 1988). Studies have found that a watershed can be maintained at least 65% upland and wetland forest forest cover and less than 10% impervious surface. (Booth, 2000).

Wetlands and Watersheds

There are numerous factors that influence the wetness of an area including precipitation, stratigraphy, topography, soil permeability and plant cover. In general, all wetlands have at least a seasonal abundance of water. This water may come from seasonal fluctuation in ground-water level, direct precipitation, overbank flooding, surface water runoff from rain and/or snow melt or from tidal flooding. The duration and frequency of inundation and soil saturation may vary from permanent flooding or saturation, to irregular flooding or saturation. Wetlands are often defined by and possess the following three essential characteristics: wetland hydrology, wetland vegetation and hydric soils.

Wetland hydrology is often the least exact and most difficult to establish in the field, of the three technical criteria for wetland identification. This difficulty is largely due to annual, seasonal and daily fluctuations. Hydrographs for forested wetlands show greater delay between storm events and peak flows due to the remoteness of their headwaters. Forested wetlands are also hydrologically open and dependent, to a degree, on floodwaters for the delivery of nutrient laden silts affecting their fertility.

Due to the nature of wetlands and watersheds and their interconnected systems, proper forest management prescriptions can help improve the overall health and vigor of our natural filtration tools, as well as other ecosystem services. Issues such as fragmentation, urbanization and changes in land ownership need checks and balances.

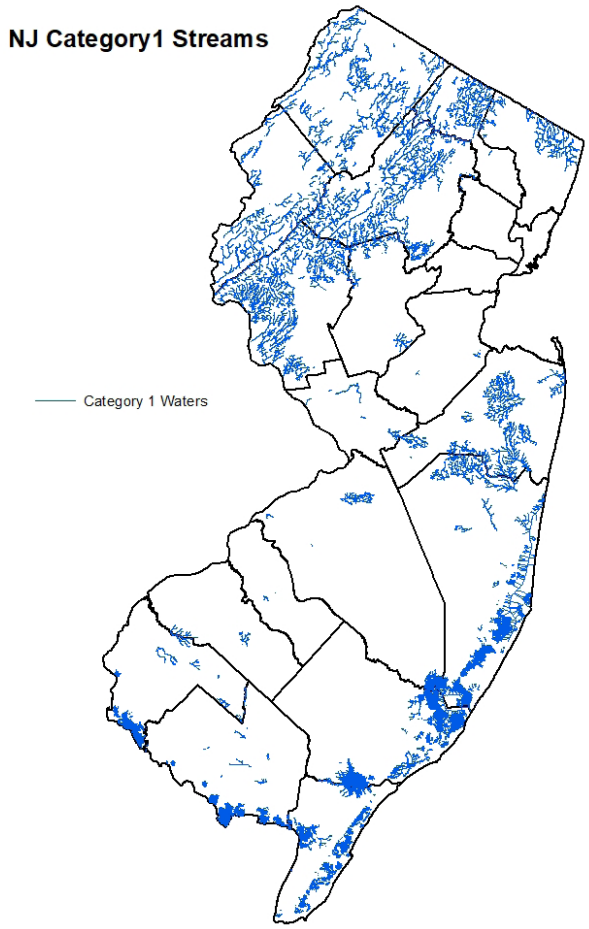


Figure 68. New Jersey Category 1 Streams. (NJDEP, 2019)

Acknowledgment of these issues also helps contribute to our understanding for the need and the importance of keeping undeveloped land forested, especially wetlands, as well as overall watersheds.

Category 1 Streams

Water resources are key to the productivity and health of many forest processes and include the physical features, habitat and organisms of wetland areas, lakes and streams. Maintaining water quality in forested watershed processes is key in sustaining ecological integrity of the environment. The state of New Jersey made water resources a priority due to the systems that depend upon a clean and plentiful supply. Category 1 streams (**Figure 68**) were therefore designated for the protection of water at key sources. Category 1 waters are explicitly defined by the existing New Jersey Surface Water Quality Standards (N.J. A. C. 7:9B, 2019) as:

"…those waters designated in the tables in N.J.A.C. 7:9B-1.15(c) through (i), for purposes of implementing the antidegradation policies set forth at N.J.A.C. 7:9B1.5(d), for protection from measurable changes in water quality based on exceptional ecological significance, exceptional recreational significance, exceptional water supply significance or exceptional fisheries resource(s) to protect their aesthetic value (color, clarity, scenic setting) and ecological integrity (habitat, water quality and biological functions)."

Additionally, realizing water as essential for all species of life throughout the state, rules and regulations were enacted to regulate activities within wetland and flood hazard areas. Everything from drinking water, wildlife (aquatic and terrestrial) and recreational activities such as fishing and swimming, depend on a clean and abundant water supply (USDA Forest Service et al., 2003). In addition to regulatory protections, the state of New Jersey also maintains a manual of Best Management Practices (BMPs) that inform practitioners as to the techniques and methods that can be employed to protect our water resources. BMP applications that are well-planned and carefully executed often result in only short-term changes to stream water characteristics while avoiding long-term changes to stream characteristics such as sediment, flow and temperature that can alter a stream's ecosystem and inhabitants (Stuart and Edwards, 2006).

These practices embrace the application of responsible forest management by completing silvicultural prescriptions through implementation guidelines, leaving undeveloped land as forests with minimal adverse impact during forest operations. BMPs are specifically designed to minimize soil erosion, protect water quality by preventing non-point source pollution, enhance fish and wildlife habitat and improve recreational opportunities (NJDEP, Forest Service, 1995).

In March of 2019, NJDEP Water Resource Management proposed to upgrade 749 miles of waters to Category 1 stream status. These proposed amendments were adopted and became effective on April 6, 2020.

CRITERION 5.

MAINTENANCE OF FOREST CONTRIBUTION TO GLOBAL CARBON CYCLES

Forest and Tree Carbon

The global carbon cycle is responsible for the storage, flow or flux and transformation of carbon compounds that are central to life and the regulation of the earth's climate.

Climate Change and Sources of Greenhouse Gases in New Jersey

"Emissions of GHGs [Green House Gases] are documented in the New Jersey Statewide Greenhouse Gas Inventory Report, prepared every two years pursuant to the mandate of the GWRA [Global Warming Response Act]. The most recent report estimated emissions for 2016 and developed projections for 2017 and 2018.
Net emissions for 2018 were estimated to be 97.0 million metric tons (MMT) of carbon dioxide equivalent (CO2e).
Transportation dominated the state's emissions profile at 40.6 MMT CO2e, which is 42% of the net total. Electric generation, residential, commercial and the industrial sectors rounded out the top five. Combined, these categories added 90.5 MMT CO2e to the atmosphere, or 93% of the state's total net emissions."
(NJDEP GWRA 80x50, 2020)

> "Forests are the largest terrestrial carbon sink on earth."

A carbon sink is "a compartment within the earth's system that acquires carbon from the atmosphere and stores it for a specified period of time" (USGCRP, 2018), and forests are the largest terrestrial carbon sink on earth (Oswalt et al., 2019). The measurement of total carbon and its allocation among various tree components including saplings, tree boles and tree limbs, helps to further our understanding of the distribution of forest resources and their availability for different uses such as carbon sequestration and wildlife habitat (Crocker et al., 2017). Understanding where, how much, and at what rate carbon is stored in forests is vital for evaluating the effects of forest management on the global climate.

Forest Carbon Pools

Carbon pools are reservoirs of carbon that have the capacity to both take in and release carbon (FAO of the United Nations, 2019). There are five very broad global carbon pools which encompass a variety of complex systems. Each of these pools exchanges carbon with one another, known as carbon flux, comprising what is known as the global carbon cycle (University of New Hampshire GLOBE Carbon Cycle, 2015).

Presented here are Forest Inventory Analysis (FIA) data from the USDA Forest Service describing the five forest carbon pools for New Jersey in 2018 as defined by Smith and Heath (2008). The National Forest Inventory (NFI) inputs to the United States forest carbon stock and stock-change estimates are a compilation of FIA forest inventories collected over an interval of more than 30 years. The NFIs include field plot measurements, but also rely on ancillary data such as remote sensing and official census area quantities to estimate forest area or to improve precision (Smith, Heath and Hoover, 2013; Smith et al., 2013)

Since NFIs are not consistent between nations and usually are not specifically or originally intended for estimation of carbon, harmonization of how these data are utilized and presented is necessary. For the purpose of greenhouse gas inventories (GHGIs), harmonizing either forest inventories or carbon factors ensures consistent carbon estimates under potentially different systems of forest inventory.

Harmonized reporting can be challenging for a variety of reasons; including that many nation's national forest

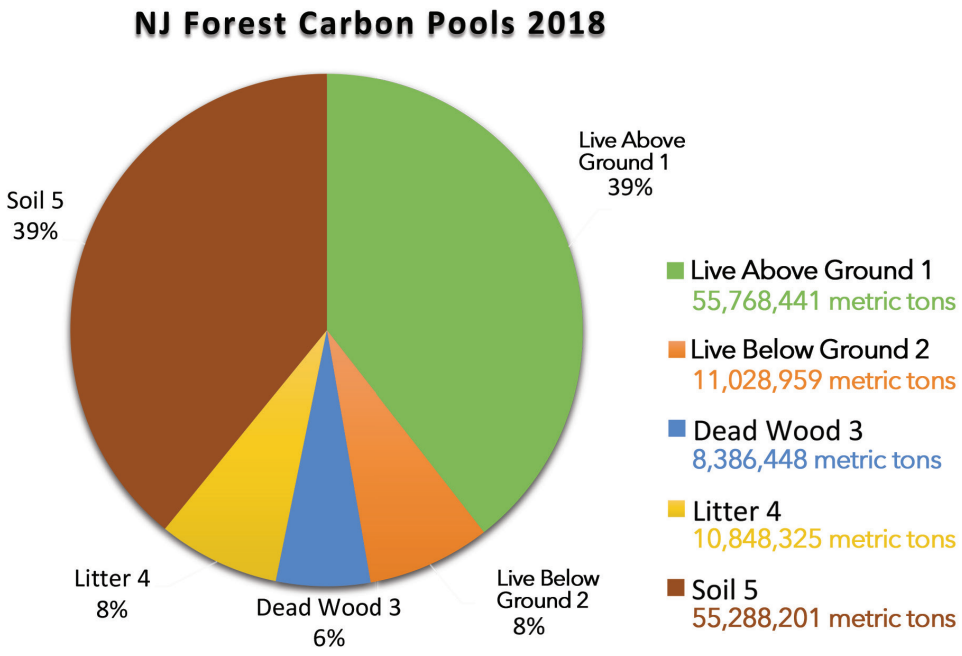


Figure 69. Forest carbon pools by percentage for New Jersey in 2018. (FIA)

inventories were originally developed for purposes that did not include carbon monitoring. (Smith, Heath and Hoover, 2013). Each pool is expressed as a carbon density (tonnes per hectare or Mg per hectare) for the forested conditions in FIA inventory plots, These plot-level carbon-from-inventory conversions are then compiled as the forest carbon stock and stock-change estimates reported annually in the United States National GHGIs (Smith, Heath and Hoover, 2013; Smith et al., 2013).

The five FIA carbon pools for New Jersey are (1) live aboveground, (2) live belowground, (3) dead wood, (4) litter and (5) soil organic carbon. Overall, the forests of New Jersey store an estimated 141,320,375 metric tons of carbon across the five pools. Pool 1, live tree aboveground biomass, includes all live trees 2.5 cm in DBH (at 1.37 m above the forest floor) and larger. The aboveground tree biomass portion includes stems, stumps, branches, bark, seeds and foliage (Smith, Heath and Hoover, 2013). In New Jersey, this carbon pool is one of the largest (almost equal to the soil organic carbon pool) and contains more than 55,768,441 metric tons of carbon (FIA, 2018). Pool 2, live tree belowground biomass, includes all coarse living roots greater than 2mm in diameter (Smith, Heath and Hoover, 2013). This carbon pool makes up approximately 11,028,959 metric tons of carbon in New Jersey (FIA, 2018). Pool 3, dead wood, includes all non-living woody material lying on the ground and having a diameter greater than 7.5 cm at transect intersection, as well as stumps, both above and belowground (Smith, Heath and Hoover, 2013).

In New Jersey this carbon pool contains nearly 8,386,448 metric tons of carbon (FIA, 2018). Pool (4), litter or forest floor, includes litter, fulvic and humic layers and all non-living woody biomass with a diameter less than 7.5 cm at transect intersection, lying on the ground (Smith, Heath and Hoover, 2013). This carbon pool contains more than 10,848,325 metric tons of carbon in New Jersey (FIA, 2018). Pool 5, soil organic carbon, includes all organic material, including fine roots in the soil to a depth of 1 m but excludes the coarse roots of the belowground pool (Smith, Heath and Hoover, 2013). In New Jersey, this is also one of the largest carbon pools with more than 55,288,201 metric tons of carbon (FIA, 2018). **Figure 69** illustrates this forest carbon pool breakdown for the state of New Jersey by percentage (FIA, 2018).

In New Jersey, privately owned forests store approximately 49% of the state's total forest carbon

pool, with public forests storing nearly the same at approximately 51%. Of New Jersey's total forest carbon pool, nearly 30% is owned solely by the state. Counties within New Jersey accounting for the largest amounts of forest carbon storage include Burlington (located in the southern portion of the state) and Sussex (located in the northern portion of the state). Oak/hickory forests store the most carbon, more than 43% of the state's total forest carbon. The loblolly/shortleaf pine forest type-group, which includes the pitch pine forest type, accounts for the second largest amount of the state's total forest carbon storage with slightly more than 20% (FIA, 2018).

Although pitch pine is reported as the most numerous tree species in the state, they store less carbon than the oak/hickory forest type-group. This difference could be related to specific tree morphology, with trees in the oak/hickory forest type-group being larger and taller on average than those found in the pitch pine forest type. This could also be attributed to the fact that the oak/hickory forest type-group covers the largest proportion of the state's forested area.

> "Although pitch pine is reported as the most numerous tree species in the state, the majority of New Jersey's forest carbon storage falls within the oak/hickory forest type-group."

Carbon Sequestration and Carbon Flux

New Jersey's net emissions for 2018 were estimated to be 97.0 million metric tons (MMT) of carbon dioxide equivalent (CO2e) and natural lands, which includes forest, wetland, agricultural lands, sequester the equivalent of approximately 8.1 MMT of carbon dioxide annually, nearly 8% of the overall greenhouse gas emissions of the state (see **Figure 70**). Maintaining these carbon sinks are vital to the state's long-term greenhouse gas reduction strategy.

Forests are a key component of the carbon cycle, not only as existing stocks of sequestered carbon, but through continual removal and storage of carbon from the atmosphere. Terrestrial carbon sequestration is a process that involves the capture of carbon dioxide from the air by plants through photosynthesis, and storage of that carbon in woody biomass and in plant derived soil organic carbon (USDOE, 2010).

Forests in a natural setting are a major component of carbon sequestration in New Jersey, however, trees in the urban and community forest setting also contribute significantly to the sequestration of atmospheric carbon. A recent study by Nowak and Greenfield that evaluates urban areas not typically captured by USDA Forest Service, FIA until very recently (urban FIA data for NJ not available at the time of this writing) estimates 178.7 million trees located within urban areas throughout New Jersey. These trees store approximately 29.6 million tons (26.9 million metric tons) of carbon (Nowak and Greenfield, 2018).

While the loss of urban forests could diminish annual carbon sequestration rates and carbon storage values through lower biomass accumulation within trees (Nowak and Greenfield, 2018), the planting and proper maintenance of trees within communities and especially around buildings, to provide shade or block prevailing winds can moderate temperatures and reduce energy demands and related greenhouse gas emissions as well (NAASF, 2008). These urban and community forest trees also provide co-benefits such as improving air and water quality, mitigating rainfall runoff and flooding, enhancing human health and social well-being and lowering noise impacts (Nowak and Greenfield, 2018). These benefits are important for both individual residents and communities throughout New Jersey. Urban forests in New Jersey annually sequester about 1.13 million tons (1.03 million metric tons) of carbon alone and remove more than 22,000 tons (19,958 metric tons) of air pollution (Nowak and Greenfield, 2018). Air pollution removals include ozone, nitrogen dioxide, sulfur dioxide and particulate matter less than 2.5 microns (Nowak and Greenfield, 2018).

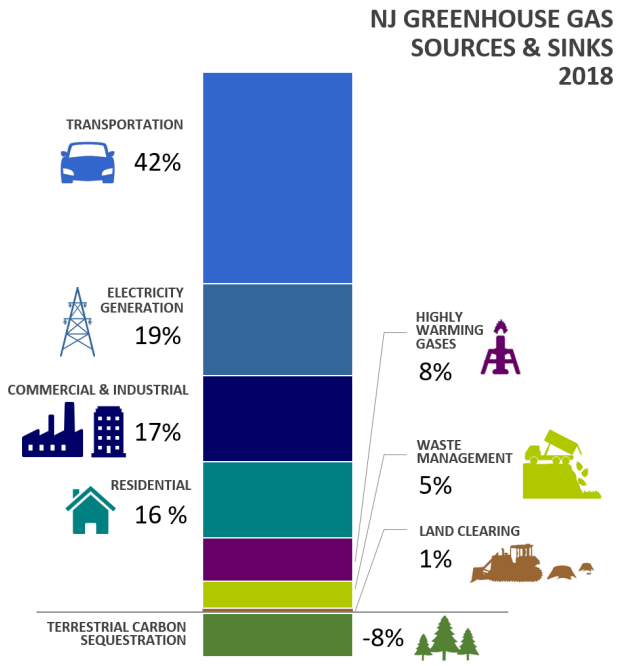


Figure 70. New Jersey's greenhouse gas sources and sinks. (RGGI Scoping Document, 2018)

Land use changes due to social, demographic and economic trends on the global scale are projected to contribute between 11 billion and 110 billion metric tons of carbon to the atmosphere by 2050. Current assessments suggest that improved forest management practices, as well as reforestation and other improvements in ecosystem and natural resources management, are helping the nation decrease its carbon emissions (USGCRP, 2018).

> "NJDEP's 2018 Greenhouse Gas Inventory concludes that the state of New Jersey land sector, which includes forest and associated land cover, sequesters the equivalent of approximately 8.1 million metric tons of carbon dioxide, which is nearly 8% of the overall greenhouse gas emissions of the entire state of New Jersey."

Biomass

Forest biomass is an estimate of the mass (or in this case weight) of biological components in the forest. Biomass is important for assessing forest carbon stocks as well as for providing insights into forest ecosystem productivity. New Jersey forest land supports an estimated 119 million dry tons (108 million metric tons) of aboveground live tree biomass, held almost equally between public and private landowners (FIA, 2018). Estimates of forest tree biomass are related to carbon in that roughly half of the mass of tree biomass is carbon. Therefore, the estimate of tree biomass presented here roughly correlates with the aboveground live carbon pool presented previously. Understanding forest biomass is important in understanding opportunities and implications of varied land uses. The distribution of biomass across the landscape is uneven, with the highest concentrations in the northern half of the state, primarily within the Highlands Region.

Two-thirds of statewide biomass is contained in the stems of growing-stock trees; 19% is in growing-stock stumps, tops and limbs; 6% is in saplings; and 8% is in non-growing-stock trees (Crocker et al., 2017). The forest type-group containing the largest amount of live tree aboveground biomass is oak/hickory, with more than 65 million dry tons or 59 million dry metric tons. The loblolly/shortleaf pine forest type-group is the next largest at approximately 18 million dry tons or 16 million dry metric tons.

The northern United States in particular contains a significant amount of (tree or forest) biomass with more than approximately 8.8 billion dry tons, which has increased more than 19% over the last ten years (Oswalt et al., 2019).

CRITERION 6.

MAINTENANCE AND ENHANCEMENT OF LONG-TERM MULTIPLE SOCIOECONOMIC BENEFITS TO MEET THE NEEDS OF SOCIETIES

Forest Products: Production, Consumption and Economic Contributions

The harvesting and processing of a variety of forest products, including timber, produces a stream of income shared by forest landowners, managers, loggers, truckers, processors and forest product markets alike. It is vital to know not only the species but amounts and locations of trees being harvested to better understand how our forests are being managed and how to better, more sustainably manage New Jersey's forest resources overall.

Wood volume can be measured in several different units using a variety of metrics depending on the products associated with that volume. However, the three most common units used to express wood volume in New Jersey include cubic feet, cords and board feet; all of which will be referenced throughout this section. Sawtimber, measured almost exclusively in board feet, is typically processed into a form of dimensional lumber. Whereas roundwood, typically measured in cords, cubic feet or by weight can be used in a variety of products. These roundwood products range from lower quality sawn lumber, to pulp, paper and firewood. There are exceptions to this however, such as AWC, which tends to be sold in cords in New Jersey but is used for a variety of valuable products.

In 2010, New Jersey sawmills processed more than 5.7 million board feet (941,000 cubic feet), nearly all of which originated from forest land within the state (Crocker et al., 2017). About 1.1 million cubic feet of industrial roundwood was harvested, including roundwood that was harvested in New Jersey but was exported to primary wood-processing mills in other states (Crocker et al., 2017). More than 86% of the industrial roundwood harvested in New Jersey was processed by sawmills and the remainder was processed by pulp and composite panel mills, illustrated in **Figure 71** (Crocker et al., 2017).

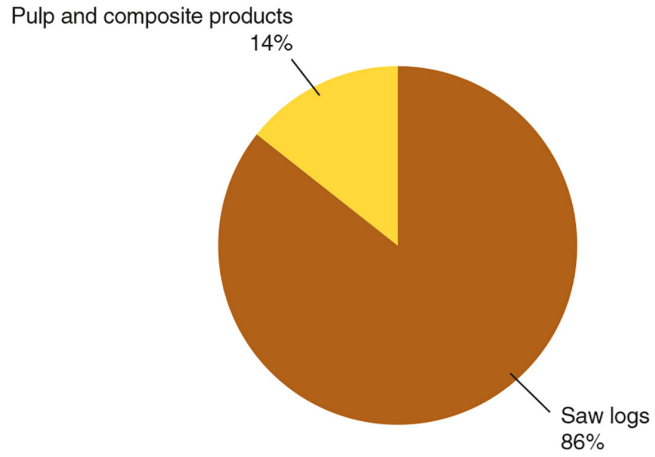


Figure 71. Industrial roundwood production by product in 2010 for New Jersey. (Crocker et al., 2017)

All the timber harvested in New Jersey for pulp and composite panel production was exported to mills in other states (Crocker et al., 2017). The species composition of harvested industrial roundwood within the state included sweetgum, which accounted for more than 40% (454,000 cubic feet), as well as three other major groups of species including the red oaks, white oaks and pines (Crocker et al., 2017). **Figure 72** illustrates the distribution of industrial roundwood harvested by major species.

The processing of industrial roundwood by New Jersey's primary wood-using mills generated approximately 15,200 green tons of wood and bark residues (Crocker et al, 2017). More than 95% of these mill residues were used for mulch while the remaining residues were used for pulp, residential

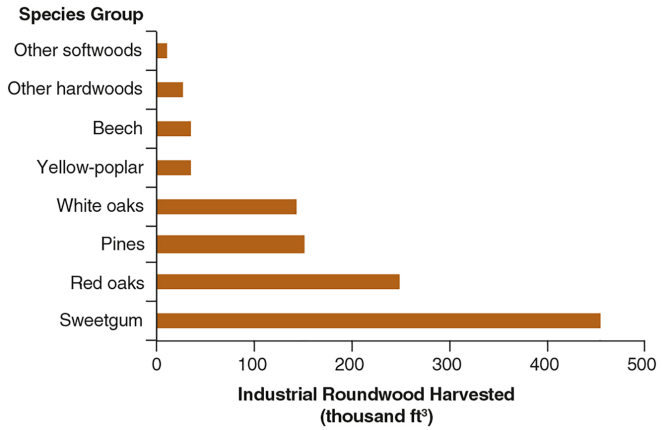


Figure 72. Industrial roundwood harvested by species group in 2010. (Crocker et al., 2017)

fuelwood, animal bedding and other miscellaneous uses and products (Crocker et al., 2017). Less than 1% of mill residues were waste or were not used for any other products.

One of the most important considerations for the future of the primary wood-products industry in New Jersey is the ability to retain industrial roundwood processing facilities. The number of wood-processing mills has steadily been declining, making it harder for landowners to find markets for the timber harvested from sustainable management activities (Crocker et al., 2017). In New Jersey, there are only 20 active sawmills located throughout the state. Each of these sawmills is surveyed annually (as of 2018) via the Timber Products Output (TPO) survey conducted by the USDA Forest Service, FIA program. These surveys are used to estimate the uses of industrial and non-industrial roundwood as well as the volume received, processed and species utilized throughout the state.

Several factors have led to negative impacts on the regional forest products industry from global economics, to changing cultural values and changing forest management policies and priorities. It is essential to convey the importance that forest resources have in the supplying of raw materials for the utilization and consumption of an ever-demanding population. Simultaneously, it is important to balance this priority with responsible and sustainable harvesting levels as well as economically feasible investment of forest resource planning.

According to FIA, the average annual harvest removals of merchantable bole volume of sawtimber trees on timberland within New Jersey has fluctuated from 2014 to 2018. However, it averaged approximately 2.8 million cubic feet over those five years. Virtually all harvest removals of merchantable bole volume of sawtimber trees on timberland has occurred on private lands according to FIA for 2009 to 2017 (**Figure 73**). These removals specifically occur within the oak/hickory and maple/beech/birch forest type-groups (FIA, 2015). The overall trend in 2015 was a decrease in all harvest removals across all ownerships within New Jersey (FIA).

In 2012, more than 20.2 million cubic feet was harvested across all ownerships, to a mere 995,963 cubic feet in 2017. As shown in **Figure 74** for private lands, a shift in markets from sawtimber to roundwood products also tends to occur from year to year (NJDEP, Forest Service).

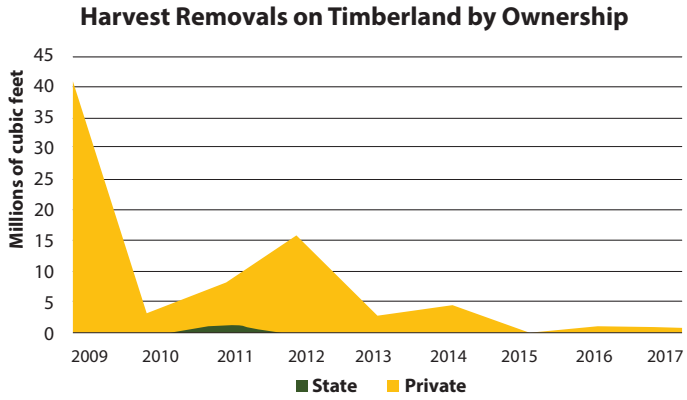


Figure 73. Average annual harvest removal volume of state and private ownership on timberland in New Jersey, 2009 to 2017. (FIA, 2018)

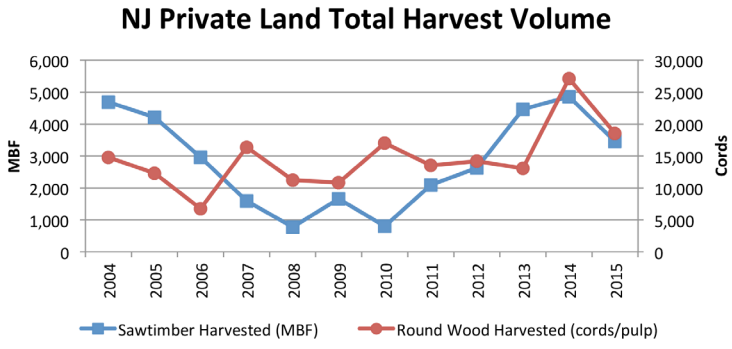


Figure 74. Total harvest volume of sawtimber and roundwood on private land in New Jersey from 2004 to 2015. (NJFS)

In more recent times, carbon stored in forests has become a commodity, taking on a monetary value through the California greenhouse gas regulatory process. This, along with carbon storage increases in the aboveground portion of live trees one inch in DBH or larger for New Jersey from 2007 to 2015 (FIA, 2015), illustrated in **Figure 75**, indicates new opportunities for other economic contributions of forests. However, prices per ton of carbon sequestered in this new market can fluctuate widely, from that in California to worldwide (Kossoy et al., 2015; The Climate Group, 2013).

The Christmas tree industry is an integral part of the New Jersey local economy as well. According to the 2012 USDA Census of Agriculture, approximately 809 Christmas tree farms 4,611 acres in New Jersey and a total of 68,471 Christmas trees were harvested from approximately 690 farms (AC-12-A-30). The total market value of cut Christmas tree sales on those 690 farms in 2012 was estimated to be approximately $1,814,000 (AC-12-A-51).

Another important industry, the maple syrup industry, is a small but well recognized portion of the New Jersey forestry economy. The 2012 survey by the USDA Census of Agriculture indicated approximately 33 maple syrup farms in New Jersey (down from 40 farms in 2007) with roughly 2,685 taps producing 406 gallons of maple syrup (down from 522 gallons in 2007) (AC-12-A-30). The total market value of maple syrup produced in 2012 on the 33 farms was estimated at $17,000 (AC-12-A-51). In a 2017 survey by the USDA Census of Agriculture indicated approximately 57 maple syrup farms in New Jersey with roughly 8,806 taps producing 1,722 gallons of maple syrup, total dollar value not reported.

Another major component of New Jersey's forest based economy is urban and community forestry. In 2018, the Arbor Day Foundation listed 166 Tree City USA communities in New Jersey. Tree City USA communities are a component of the New Jersey Urban and Community Forestry Program (NJUCF) and are important as they encourage proper maintenance and planting of trees, are required to spend at least $2 per capita on urban forestry and provide Arbor Day celebrations for all of the participating communities (Arbor Day Foundation, 2020). In fact, more than 48% of the population in New Jersey lives in a Tree City USA community.

A study conducted by Grabosky et al. 2012, concluded that more than $1.7 billion in sales were generated for the urban forestry sector. Urban and community forestry related activities and training programs alone provided a source of economic income to the state totaling more than $72 million in 2012 (Grabosky et al.). The No Net Loss (NNL) Reforestation Act of 1993 (N.J.S.A. 13:1L-14.1 et. seq.) has also promoted positive forestry practices, in addition to various environmental, social and economic benefits in New Jersey. The NNL program in 2011 alone generated approximately $71,299,439 (Grabosky et al., 2012).

According to the USDA National Agricultural Statistics Service, urban tree sales in New Jersey exceeded $69.7 million in 2014. Roadside vegetation management expenditures (NJ Department of Transportation, NJ Turnpike Authority, County and Municipal governments) totaled more than $15 million dollars in 2012, whereas electric companies alone spent more than $77 million in vegetation management (Grabosky et al., 2012).

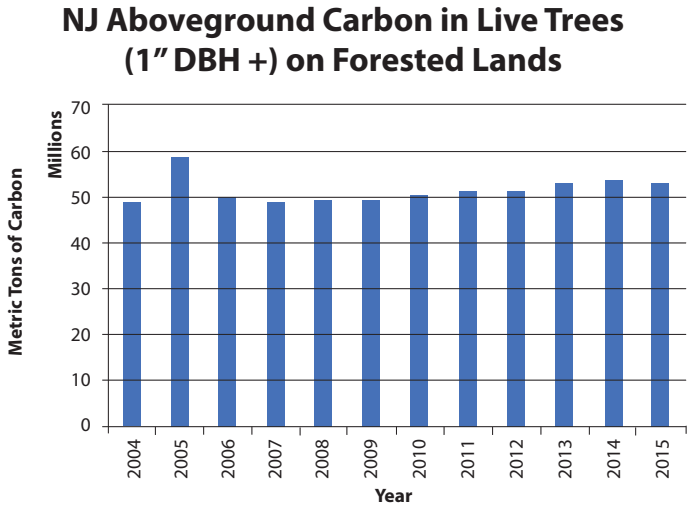


Figure 75. Aboveground carbon in live trees one inch in DBH and larger on forestland within New Jersey from 2004 to 2015. (FIA)

The urban forestry sector also generates a significant contribution to the New Jersey economy through employment. A study conducted by Grabosky et al. reports that approximately 12,182 people worked directly for the urban forestry sector in 2012, with an additional 5,226 jobs created in other industries as a result of this economic activity (17,408 jobs in total). These urban forestry jobs generated more than $676 million in annual wages (Grabosky et al., 2012).

Woodland owners with five acres or more of forest land or land capable of being forest can voluntarily enroll in the New Jersey Forest Stewardship Program (FSP) and/or the New Jersey Farmland Assessment (FLA) Program to pursue active forest management. Participation in either program can qualify forest owners for significant benefits from cost-sharing to reduced property taxes for these properties.

These two programs promote both responsible and sustainable forest management practices on private lands, increasing the ecological and economic value of private property throughout the state. The NJ Forest Service requests an accomplishment report from consultant foresters twice a year regarding these programs (N.J.A.C. 7:3-3.6). Each report requires information on the amount of wood removed and that removed wood to be classified in the form of sawtimber and roundwood (cordage) by species or forest type. The products removed correspond to forest management prescriptions performed including forest stand improvement, regeneration–natural or artificial, insect or disease suppression, invasive species control, prescribed burning, storm damage and wildlife habitat enhancement. The number, type of stewardship plan and acreage in which these activities are carried out is also recorded in the report.

The compilation of these reports for the NJFS 2015 Semiannual Accomplishment Report indicated that forest stand improvement was implemented across approximately 12,691 acres by participating private woodland owners. Additionally, 1,960 acres received natural or artificial regeneration and approximately 260 acres underwent reforestation/afforestation activities.

In the private lands forestry sector, there are currently 55 approved consulting foresters in New Jersey. The amount of staff each of these consultants employs varies from consultant to consultant. Some operate independently, while others have supportive clerical or administrative staff and/or two to four additional foresters working for them. Consulting foresters charge up to $1,000 per management plan depending on the size and type of property. The cost of signing the annual application or Woodland Data Form (WD-1) for reduced property taxes ranges from $0 to more than $240.00. With more than 5,800 landowners applying by August 1st of each year and hundreds of management plans being prepared annually, this is a significant income generator for the private forestry sector. Consulting foresters reported that approximately 18,585 cords and 3.5 million board feet were harvested from properties participating in Forest Stewardship or FLA.

Currently, a private forest landowner in New Jersey might only receive $1-$2 per ton of biomass chips harvested or approximately $10-$15 per cord of firewood. These values are derived from direct contact with consulting foresters, landowners and in some cases the Pennsylvania, Maryland or New York timber marketing bulletins. The United States Energy Information Administration estimates that in 2015, New Jersey residents spent approximately $38.9 million in the consumption of approximately 478,000 cords of firewood.

Employment related to forests is an important social value. According to 2015 U.S. Bureau of Economic Analysis data, the forestry and logging industries have employed approximately 418 people in New Jersey with wages totaling $562,000. The NJ Forest Service alone employs 31 full-time employees, 17 of which are foresters. The state of New Jersey also employs approximately 1,062 seasonal forest fire fighters statewide with salaries ranging from $9-$25 per hour depending on skill set and position (NJFFS, 2018). Through forest related employment, the ability to achieve forest management objectives can be conducted while enhancing wildlife habitat and maintaining forest health (USDA Forest Service et al., 2003).

The utilization of forest products provides the foundation for many rural economies and the stability of communities as well. Although the wood products and paper manufacturing industries (including primary and secondary processors) in New Jersey are relatively small, approximately 9,659 people were employed in 2013, with an average annual payroll of $485.8 million (US Census Bureau, 2015; Crocker et al., 2017).

Wood product manufacturing industries alone in New Jersey employed about 2,811 people with wages totaling $98 million in 2015 (U.S. Bureau of Economic Analysis). Wood product businesses manufacture lumber, plywood, veneer, wood containers, flooring and prefabricated wood buildings; all of which include sawing, planing, shaping, laminating or assembling wood products from logs (U.S. Bureau of Economic Analysis, 2015).

Furniture and related product manufacturing industries employed approximately 6,008 people within New Jersey in 2015 with a total payroll of more than $267 million (U.S. Bureau of Economic Analysis, 2015). Furniture and related businesses manufacture products such as, but not limited to, mattresses, window blinds, cabinets and fixtures; most of which include the process of cutting, bending, molding, laminating and assembling of wood products (U.S. Bureau of Economic Analysis, 2015).

Paper manufacturing industries within New Jersey employed nearly 10,194 people with wages totaling more than $859 million in 2015 (U.S. Bureau of Economic Analysis). Businesses such as these make pulp, paper or converted paper products which includes the process of separating cellulose fibers from other impurities in wood or used paper, matting fibers into a sheet, as well as various cutting and shaping techniques for coating and laminating (U.S. Bureau of Economic Analysis, 2015).

The flow of raw materials regarding these primary and secondary wood processors frequently travel across state and regional boundaries. For example, New Jersey sawlogs or pulpwood chips may be transported to another state for primary processing and later returned back to New Jersey as lumber or pulp for finishing and secondary processing into cabinets, furniture or paper goods. Consequentially, wood processing and the economy it creates is not limited by state boundaries. In fact, New Jersey hardwood logs provided through forest management activities commonly find their way to overseas markets to serve as veneer logs to European, Asian or Mediterranean markets.

The most recent and detailed analysis conducted (2020) using 2017 USDA Forest Service FIA data, shows that the forest products industry in New Jersey has a direct employment to almost 19,000 people leading to $6.7 billion in sales or output. Labor income totaled nearly $1.6 billion and value-added was approximately $1.9 billion for the state. Total contributions within the New Jersey forest industry overall include more than 42,000 jobs, $3.2 billion in labor income, $4.5 billion in value-added and $10.9 billion in sales or output.

Other interesting take-aways from this recent analysis include secondary paperboard and other paper products having the highest number of direct jobs (9,756), value-added ($1.3 billion) and direct output ($5.0 billion), with the next closest industry group being wood furniture. In addition, more than 7% of New Jersey's 257,000 direct manufacturing jobs in 2017 were from the forest products industry; this equates to 1 out of every 14 manufacturing jobs (Forest Products Industries Economic Contributions: New Jersey, 2020).

Outdoor Recreational Facilities and Participation

Outdoor recreation has been a major cultural part of New Jersey's heritage for decades. In a time when society is actively promoting outdoor activity for health and well-being, in addition to many other benefits, the demands for a quality outdoor recreational experience have also increased (USFS et al., 2003).

New Jersey has more than 1.5 million acres of preserved public open space representing nearly 34% of the land area of the state. Open space

preservation is a tool of the state's smart growth policy that provides many amenities including recreation, water resource protection, biodiversity, agriculture and tourism. The state's 239 coastal communities, 42% of all New Jersey municipalities, provide a plethora of water associated park and recreation opportunities. New Jersey's 127 miles of Atlantic coastline together with the Barnegat, Delaware and Raritan Bays contain estuaries, rivers, beaches and wetlands that also provide abundant opportunities for recreation and tourism (SCORP, 2018). In addition, the state's greenways not only offer close to home recreational activities, but they can also be an economical and efficient way to preserve public open space throughout New Jersey (SCORP, 2018).

Land preservation and recreation comprise only one of the cornerstones of New Jersey's smart growth policy. Overall, the smart growth policy includes ten major objectives for communities throughout the state to achieve: (1) mixed land uses; (2) taking advantage of existing community assets; (3) creating a range of housing opportunities and choices; (4) fostering walkable neighborhoods; (5) promoting distinctive and attractive communities with a strong sense of place; (6) preserving open space such as farmland and critical environmental areas; (7) strengthening and encouraging growth in existing communities; (8) providing a variety of transportation choices; (9) making development decisions not only predictable but fair and cost-effective; and (10) encouraging citizen and stakeholder participation in development decisions. Representative of these objectives, New Jersey voters have authorized Green Acres funding by approving thirteen bond referendums. This represents a combined $3.3 billion public investment in open space preservation and recreation by the state since 1961. Beginning in July 2015, 4% of the revenue derived from the Corporate Business Tax Act (CBT) (C.54:10A-1 et seq.), was dedicated to Green Acres, Blues Acres and Farmland Preservation programs as well as historic preservation under the New Jersey Open Space Preservation Funding Amendment (NJDEP 2018). In 2019, the CBT dedication for these programs increased to 6% which will generate an estimated $117 million annually (NJDEP 2018). Residents of New Jersey have continually expressed their support for the state to carry out a comprehensive open space and recreation program (SCORP, 2018). There is no stronger testament of this support than residents consistently voting for open space and recreation referendums not only at the state level, but also at the localized district level. In addition to state funding, 236 municipalities and 21 counties in New Jersey assess a tax for land preservation, park and recreation projects and historic preservation which generated $292.8 million in 2017 (NJDEP 2018). These combined efforts also help to sustain New Jersey's almost $40 billion tourism industry. New Jersey is a clear national leader in open space preservation.

Approximately 257,134 acres of public park land is owned by county and municipal governments within the state, while non-profit conservation organizations have preserved approximately 68,660 acres of land. Within the state of New Jersey, the National Park Service and the US Fish and Wildlife Service manage about 115,100 acres (SCORP, 2018). Of the more than 1.5 million acres in preserved open space in New Jersey, about 801,000 acres is under the jurisdiction of the NJDEP. Parcels are designated as state parks, forests, natural areas, recreational areas, historic sites, burial grounds, state marinas, reservoirs, conservation easements and miscellaneous areas.

NJDEP has the stewardship responsibility of 40 state parks with nearly 134,697 total acres and 11 state forests with approximately 257,737 total acres. The largest state park is Wawayanda State Park with 35,658 acres located in the north central portion of New Jersey. While the largest state forest is Wharton State Forest at nearly 124,128 acres located within the Pinelands region in the southern portion of the State. The NJDEP also has three recreational areas and 43 designated natural areas (NJDEP, Semi-Annual Acreage Report, July 2019) and is responsible for more than 1,600 structures, nearly 1,300 overnight facilities, approximately 1,070 miles of trails (485 total trails), 57 historic sites, 17 dams, four reservoirs, four marinas and three golf courses across our parks and forests.

Waywayanda State Park. Photo by: J. Douglas, NJDEP

Wharton State Forest . Photo by: J. Douglas, NJDEP

The NJDEP has manages 121 WMAs totaling more than 349,000 acres (Annual Report, 2016). Recreational activities on these state lands include boating, camping, fishing, hunting, archery, shotgun ranges, wildlife viewing, photography, hiking, horseback riding and field trials (dog training). These areas also provide for the conservation of wildlife biodiversity. Many of these areas are adjacent to designated parks and forests where management activities have been planned to work in tandem with each other. More recently, landscape and regional planning is taking place in the northern Pinelands Region where both public and private landowners are working towards regional goals including the preservation, protection and enhancement of the natural and cultural resources of this area.

The New Jersey Trails Plan Update, prepared in 2009, revises the 1996 Trails Plan through a comprehensive analysis of trail needs, desires, topics and issues from the standpoint of trail users and trail providers within the state. Some of the recommendations included in the trails plan update include having trails accessible for all, developing community connections, opportunities for trail maintenance and operations, funding for trails, developing trail advocates and the trail experience, providing trail information through communication and promotion and updating the trails planning and development process.

The New Jersey Department of Transportation's (NJDOT) Scenic Byways Program is an example of the relationship between transportation, open space and recreation. The eight Scenic Byways in New Jersey highlight transportation corridors that have scenic, natural, recreational, cultural, historic or archaeological significance. NJDOT also updated and has been implementing the New Jersey Bicycle and Pedestrian Master Plan since 2016 which carries out some of the goals and objectives outlined within the New Jersey Trails Plan Update.

NJDOT also published several bicycle tour guides that are available online, including the 238-mile-High Point to Cape May bike route and the East Coast Greenway Multi Use Trail Guide. One significant recreational opportunity currently being planned within the state includes the Cross-Camden County Trail. This planned trail will cover approximately 33 miles, beginning at the Delaware River Waterfront in Camden and ending in Winslow Township. The state's Regional Plan Association has also proposed the development of an integrated regional trail network of nearly 1,650 miles in the New Jersey, New York and Connecticut tristate region. The plan calls for five trail systems in New Jersey totaling nearly 420 miles. Three of these trails—the Morris Canal Greenway, East Coast Greenway and Henry Hudson Trail already exist and would see additional trail mileage and improvements made. The remaining two, the Jersey Shore Trail and the Shore to Somerset Connector would require further planning and work to make them available for public use (SCORP, 2018).

In New Jersey between fiscal years 2013 and 2017, more than 83 million people visited state parks and nearly 5 million recreation visits to National Park Service sites within New Jersey were reported, an increase of 3% from 2016. According to the 2018 SCORP, state park attendance alone from July 1, 2016 to June 30, 2017 was more than 17.1 million. Local New Jersey parks also experienced heavy public use. For example, in 2016, the Monmouth County Park System had more than 6.5 million park visits. In New Jersey, the Outdoor Industry Association reports that 46% of state residents participate in outdoor recreation each year. In addition, funding requests made to the NJDEP's Recreational Trails Program also show continued funding demand and interest in trails (**Table 7**). In 2015 and 2017 alone, Green Acres awarded a total of $72.8 million in grant and loan funding for park and recreation projects to local governments and conservation organizations.

In addition, New Jersey has funded more than 237 parks and recreation projects with $61 million from the Land and Water Conservation Fund. In 2016 alone, the NJDEP's Office of Natural Resource Restoration (ONRR) awarded more than $53 million in grants to improve public access and to restore wetlands to reconnect the public to urban waterways. From this grant money, 12 projects were funded, including $17.9 million for the City of Newark's Riverfront Park, $13.2 million for the Borough of Carteret's marina, a 1.4-mile walkway along the Arthur Kill and $5 million for the construction of a boathouse with a boat launch and dock as an extension to Newark's Riverfront Park. Overall, nearly $4.5 billion in local tax dollars is used for land preservation, in addition to park and recreation facilities. (SCORP, 2018)

Green Acres Recreation Facility Requests 2015-2017

Recreation Facility	Requests
Field Sports	74
Pathways	65
Court Sports	40
Playground	46
Waterfront	36
Picnic	26
Swimming	25

Recreation Trail Grant Requests 2012-2016

Year	Applications	Funding Request
2012	151	$3,305,195
2013	103	$3,047,068
2014/2015	205	$4,888,354
2016	97	$2,050,363

Table 7. Green Acres recreation facility requests for 2015 to 2017 and recreational trail grant requests for 2012 to 2016. (SCORP 2018)

Outdoor recreation and open space in New Jersey have had a significant positive economic impact. The 2014-2015 National Association of State Park Directors Report documented that the recreational revenue sources for New Jersey totaled more than $11.4 million which includes entrance fees, camping fees, cabins/cottages, group facilities and concessions along with other resources (2016).

The 2011 National Survey of Fishing, Hunting and Wildlife Associated Recreation also estimates expenditures at more than $2.2 billion for fishing, hunting and wildlife viewing within the state of New Jersey with more than 2 million participants. Fish and wildlife are a major capital asset that must be properly managed and protected throughout the state with open space preservation as one of the potential avenues for doing so. In New Jersey, the Outdoor Industry Association's 2017 Outdoor Recreation Economy report showed that consumers spend nearly $18.9 billion annually, support 143,000 jobs and contribute to $5.9 billion in salaries because of outdoor recreation. According to the report, tourism spending in New Jersey was $38.2 billion in 2016 and supported 321,000 jobs. In Cape May County, there was nearly $6.27 billion in tourism expenditures that supported more than 26,000 jobs, while nature-based tourism alone created more than 6,000 full time jobs, expanded the tourism season beyond the summer and generated more than $600 million in expenditures in 2016 (SCORP, 2018).

The value our parks, forests and WMAs, is both environmental and economic. The acquisition and preservation of New Jersey's open space serves to protect the natural resources for not only public enjoyment but for ecological integrity as well. Acquisition and preservation of open space is therefore of high priority, as shown over the last decade, where New Jersey residents consistently and overwhelmingly voted yes to bond issues regarding public land acquisitions.

Investments in Forest Health, Management, Research and Wood Processing

Investments in forest health monitoring are necessary to build new knowledge by utilizing research and development that further improves silvicultural activities necessary to protect, enhance and conserve our forest resources (USFS et al., 2003). These types of investments reflect a commitment to the short and long-term health of New Jersey forests and the importance of research and partnerships in doing so. These investments also include academic, intergovernmental and non-governmental partnerships with research institutions that are conducting research or developing technology that is relevant and beneficial to New Jersey's forest resources. Additional investments include grants that state programs award to local governments and non-government entities and pass through funding, as well as grants awarded to the state for development of projects to facilitate forest health, management and forest products marketing and utilization or wood processing.

Regional Economic Analysis Project: IMPLAN data

The NJ Forest Service has taken part in a landscape-scale restoration (LSR) grant awarded by the USDA Forest Service. The grant titled Economic Contributions of the Forest Products Industries in the 20 Northeastern States is a regional/state economic analysis project that provides the ability to contract a private consulting company to facilitate discussion among the participating states in an already awarded Regional Economic Analysis Project grant. The Regional Economic Analysis Project is a multi-state project to collect and analyze data to quantify the economic role of forest products industries. The purpose of consulting an economist is to translate the data received through the grant agreement (Impact Analysis for Planning or IMPLAN data, an economic input-output model) into a more accessible format for the NJ Forest Service and other participating states. This will allow the NJ Forest Service to develop tools for displays, planning and independent analyses. This cooperative effort will lead to improved understanding of New Jersey forest market dynamics and trends, in addition to current forest conditions and statewide environmental concerns.

No Markets, No Management Grant

Maintaining forests as forests and sustainable forest management are largely possible in the United States via strong local markets for forest products. The No Markets, No Management LSR grant project aims to help maintain viable, healthy, functioning, forests and markets for the products they produce by supporting the entire value chain through outreach, education and technical assistance to forest landowners, loggers and wood manufacturers. This 13-state project focuses work on three major themes of the Eastern Area – (1) keeping forests as forests, (2) supporting active sustainable management and (3) maintaining, expanding or developing forest products industries and markets. In addition to New Jersey, participating states include Connecticut, Illinois, Indiana, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New York, Ohio, Vermont and Wisconsin. The three themes, which are the focus of this grant, are among the top ten identified in state forest action plans throughout the Eastern Area and recently as a focal area by the Midwestern Governor's Association. Over the two-year grant project, participating states will deliver 41 workshops and produce 6 publications, reaching more than 1,500 landowners, loggers and forest products industry workers.

Northeast-Midwest State Forester Alliance (NMSFA)

The purpose of the NMSFA (formerly NAASF) is to support states in their efforts to achieve joint forest management, conservation and protection goals. The NMSFA facilitates regional discussions, meetings and conferences, along with providing landscape level grants for states within the Northeast region of the USDA Forest Service. Discussions and related regional efforts include forest health, invasive insects and pests, wildland firefighting, urban forestry and BMPs. The states making up this alliance are Maine, New Hampshire, Vermont, Massachusetts, New Jersey, New York, Connecticut, Rhode Island, Pennsylvania, Delaware, West Virginia, Maryland, Ohio, Michigan, District of Columbia, Indiana, Wisconsin, Minnesota, Missouri, Iowa and Illinois.

The NMSFA has established eight committees comprised of experts from state forestry agencies, the USDA Forest Service and other federal and non-governmental partners to address a range of forestry and related issues. These committees are: Cooperative Forest Management, Forest Fire Supervisors, Forest Health, Forest Legacy, Forest Resource Planning, Forest Markets and Utilization, Public Land Management and Urban and Community Forestry.

National Association of State Foresters (NASF)

The NASF is a non-profit organization established in 1920 composed of the directors of forestry agencies throughout the United States. Members of this association manage and protect state and private forests across the country. Committee members from the NMSFA report on issues and share developments with all NASF members. The overlap of the NMSFA and the NASF is imperative in bridging the gap of common issues that link states, professional foresters and land managers together. Both organizations also provide needed support for development of comprehensive SFAPs.

USDA Forest Service: FIA Program Joint Venture Agreement

The NJ Forest Service has an agreement with the USDA Forest Service, FIA Program to support and enhance current FIA data synthesis and analytical science delivery. The main objective of this agreement is to build a community of domain experts and software developers to support the development of open source software tools for the various users of FIA data, NJ Forest Service Users' Group. This effort includes contributors from across the country. These new tools for evaluating, reporting and distributing forest inventory data are created with the assistance of the NJ Forest Service Users' Group. NJ Forest Service efforts under this agreement improve upon the overall understanding of the state's and the nation's forest resource dynamics and trends, in addition to current forest conditions and statewide and nationwide environmental concerns.

Forest, Landscape and Agriculture Pest Roundtable (FLAPR)

The FLAPR was first developed out of the necessity to collaborate on EAB pest management decisions and advice, as well as to consolidate and disburse information and resources relevant to EAB within New Jersey. A New Jersey Forest Health Advisory Council (established by state legislation) will both fill the role of this roundtable and expand upon it, once populated. The Council's role will include collaborative management, treatment and discussion related to forest DCAs. Having this council will also provide the opportunity to better coordinate with various agencies and interest groups to address forest health issues that threaten trees and forests across New Jersey.

New Jersey Forestry Association (NJFA)

The NJFA was organized in 1975 and incorporated in 1983 to promote forestry and forest management on public and privately-owned woodlands throughout New Jersey. The NJFA is dedicated to the wise-use and management of the state's forest land resource in a manner which will provide many products and services for the benefit of all New Jersey's citizens, now and for future generations. These include economic and environmental benefits such as wood products, wildlife habitat, recreational opportunities, watershed protection, air purification, soil stabilization, temperature amelioration, windbreaks, urban buffers and landscape beautification. The NJFA works with the NJ Forest Service to provide cost-share opportunities for forest stewardship plan preparation and to provide education and outreach opportunities such as New Jersey FLA/forest stewardship forums, the Woodland Stewards program and the Backyard Forestry in 90 minutes program.

NJ Shade Tree Federation (NJSTF)

The NJSTF is a non-profit organization with more than 1,600 members representing individuals, groups, businesses and agencies entrusted with the selection, planting and care of trees. Partnering with NJUCF, the NJSTF offers an annual educational conference which brings together more than 600 individuals from over 200 municipalities and counties throughout the state of New Jersey to receive education on the care and maintenance of shade trees. This annual conference also provides excellent networking opportunities for attendees to share information and is a great community event for members of local shade tree commissions and professionals in the tree care industry. Educational opportunities provided at the annual NJSTF conference may include recommendations of tree planting based on tree form and proper planting techniques to ensure tree survival and valuable tree-related resource information available online for association members.

North Atlantic Fire Exchange (NAFSE)

The NAFSE was developed as a center for fire science information and discussion between fire scientists. The main topics of research discussion are the balance between public safety, economics and responsible sustainable management of ecosystems. As New Jersey experiences steady increases in population density, the risk for wildfires and proximity to homes also increases. The NJ Forest Service and NJ Forest Fire Service, through NAFSE, have had the opportunity to share information and facilitate discussions, along with the USDA Forest Service, on techniques, stakeholder engagement and the newest research regarding fire management, mitigation, urban encroachment and the culture of fire science. Fire science and technology has advanced greatly since New Jersey completed its last SFAP in 2010, with the advent of new ventures and partnerships.

CRITERION 7.

LEGAL, INSTITUTIONAL AND ECONOMIC FRAMEWORK FOR FOREST CONSERVATION AND SUSTAINABLE MANAGEMENT

Legislation, Process and Policies, in New Jersey for Forest Conservation and Sustainable Management

Federal Legislation

Farm Bill

There have been 18 Farm Bills since the 1930s with the most recent being the 2018 Farm Bill (officially known as the Agriculture Improvement Act of 2018, P.L. 115-334). The Farm Bill governs an array of programs including agriculture, nutrition, crop insurance and energy amongst others. With respect to forestry in New Jersey, the Farm Bill provides funding to help support various programs under the New Jersey Statutory Authority Title 13 – Conservation and Development. Title II – Conservation and Title VIII- Forestry, in the Farm Bill address the federal Environmental Quality Incentives Program (EQIP) and Conservation Stewardship Program (CSP) funding, providing support for forest management programs run by the USDA Forest Service. The 2018 Farm Bill directly speaks to landscape cross-boundary forest restoration efforts, a strategy that the NJ Forest Service discussed in the 2010 NJ SFAP and is currently implementing. This strategy also continues under the 2020 NJ SFAP.

Additional titles under the Farm Bill address energy research and development, both in traditional forest products and in community wood energy programs that aim to facilitate the use of wood energy systems in public buildings. Forest resource monitoring in the FIA program and research and development are of great interest to the NJ Forest Service and its landscape level planning. Watershed protection and flood prevention activities are also included in the 2018 Farm Bill. The NJ Forest Service is currently undertaking all of these activities and initiatives through the NJ SFAP and landscape-level forest management. The Farm Bill also establishes requirements that must be met for an Urban Forestry Coordinator and a Volunteer Coordinator to allow the state to be eligible for federal funding.

Forest Legacy Program (FLP)

The FLP is a partnership between the USDA Forest Service and state agencies to identify and help conserve environmentally important forests from conversion to non-forest uses. Nationally, the main tool used for protecting these important forests is conservation easements. However, fee-simple purchases are permitted which are the main tool utilized by the NJ Green Acres Program for Forest Legacy. The Federal government may fund up to 75% of program costs, with at least 25% coming from private, state or local sources. *(https://www.fs.usda.gov/managing-land/private-land/forest-legacy)*

This nationally competitive program is achieving success. The FLP is currently implemented in 55 States and Territories and 1 more in the planning stages. From its inception in 1990 to 2020, more than 2.8 million acres of working forests across these 55 States and Territories. *(https://www.fs.usda.gov/managing-land/private-land/forest-legacy)*

New Jersey is part of the 20-state FLP region under the USDA Forest Service's Eastern Area State and Private Forestry Program (R9), that serves the 20 Midwestern and Northeastern states plus the District of Columbia. Since New Jersey's start in the program in 1995, more than 7,000

acres with the FLP have been preserved through grants totaling $17,239,477. All preserved tracts are monitored and managed by either the NJDEP Division of Parks and Forestry or NJDEP Division of Fish & Wildlife. New Jersey's Commissioner of Environmental Protection, and his or her delegates, oversees the state-side of the program and oversees the program's acquisition of land in cooperation with the Green Acres program.

Federal Section 404 Program/Clean Water Act

In 1994, New Jersey assumed the Federal Section 404 Program, the second state in the country to do so. This permitting program regulates dredging and discharge into waters and wetlands under the Clean Water Act. A state may take over the Section 404 Program when it incorporates all the federal law's requirements and receives United States EPA approval (SCORP, 2018). This type of program is important to the conservation and protection of New Jersey's waters.

Due to public concerns regarding endangered species, a Memorandum of Understanding (MOU) was signed by New Jersey, the U.S. Fish and Wildlife Service and the EPA to set forth what actions New Jersey would take regarding endangered species, to ensure the utmost protection of listed species (Section 404 requires a state implementing the federal permitting program to protect federally listed endangered species and their critical habit). This MOU states that when the state of New Jersey and the U.S. Fish and Wildlife Service cannot agree on permitting actions moving forward with regard to an endangered or listed species, the case will go to the EPA for review. *(https://www.epa.gov/wetlands/new-jerseys-clean-water-act-ss404-permit-program)*

State Legislation and Policies

New Jersey Statutory Authority-Title 13 Conservation and Development – Parks and Reservations

Originally created by P.L. 1915, c. 241, as the Department and Board of Conservation and Development later became designated after a series of statutes and reorganizations as the NJDEP Division of Parks, Forestry and Recreation established in the Department of Conservation and Economic Development by P.L. 1966, c. 54. The agency continued in the Department of Environmental Protection by P.L. 1970, c.33 and later re-designated to what the agency is now named the NJDEP Division of Parks and Forestry by P.L. 1971, c. 133

Title 13 Chapter 1L, Acquisition, Construction and Management of State Parks and Forests is known as the State Park and Forestry Resources Act (P.L.1983, c. 324). The purpose of this act is to update the statutes under whose authority the state's parks and forests are regulated. The act consolidated 56 separate sections of existing law into a concise law that provides for the acquisition, planning, design, development and operation and maintenance of the State Parks and Forests. Sections 13:1L -13 through 17 contain the foundation of the Forest Management Program, the tree seed and seedling trees program, the forest protection sections of the "No Net Loss Act" and the "NJ Shade Tree and Community Forestry Assistance Act," and define the roles and responsibilities of the New Jersey State Forester.

Farmland Assessment (FLA)

(As it pertains to Woodland Assessment)

The New Jersey Farmland Assessment Act of 1964 was amended in 1986, requiring woodland owners to develop and implement a state-approved forest management plan to qualify for reduced property taxation. Under the amended act, woodland owners must fulfill special requirements concerning property used exclusively and actively devoted for the production and sale of forest products, excluding Christmas and nursery trees.

Eligible landowners must have at least five acres dedicated to active agricultural or woodland devotion. Woodlands of equal or lesser acreage to an owner's primary farm operation are considered supportive and subordinate. Therefore, these owners are exempt from filing a management plan and the WD-1 form, a document used to inform the NJDEP and the local tax assessor of the forestry activities performed during the pre-tax year. More information and details regarding the individual sections of the FLA Act can be found on the NJ Forest Service website.

Preserve New Jersey Act

In 2014, voters approved a dedicated portion of the Corporate Business Tax (CBT) for preservation efforts. Preservation funding consists of 71% of the overall 4% of collected tax for fiscal year 2019, increasing to 78% of the overall 6% of collected tax for fiscal year 2020 and thereafter. Annual amounts will vary based on tax collections (SCORP, 2018).

No Net Loss Reforestation Act (NNL)

New Jersey state entities are required to replant trees when trees are removed during development projects involving a half-acre or more. The framework of the NNL Reforestation Act is summarized hereafter:

The New Jersey NNL Compensatory Reforestation Act, N.J.S.A. 13:1L-14.1 et. seq., "the Act" (**Appendix A)** of the act, requires that a state entity submit a compensatory reforestation plan to the NJ Forest Service, for each project that results in the deforestation of a half-acre (0.5 acre or 21,780 square feet) or more on land the state entity owns or maintains. The compensatory reforestation plan shall have a goal of no net loss of existing forested area. Each plan is subject to review and comment by the NJ Community Forestry Council prior to approval by the NJ Forest Service. The law requires that the state entity obtain NJ Forest Service approval of the compensatory reforestation plan prior to commencing the project.

No Net Loss Inspection at the Round Valley Recreation Area. Photo by: J. Douglas, NJDEP

The purpose of this act is to advise other state entities by determining the amount of deforestation and the appropriate management, compensation and plan oversite by the NJ Forest Service. More information and details regarding the individual sections of the NNL Reforestation Act can be found on the NJ Forest Service website.

Forest Stewardship Program (FSP)

The USDA Forest Service and the National Association of State Foresters (NASF) initiated the FSP in 1990. Congress included the FSP in the 1990 Farm Bill and authorized it again in 2002. In New Jersey, the Program is administered through the NJ State Forest Stewardship Coordinating Committee comprised of representatives from federal, state and private natural resource agencies and organizations.

This program offers technical and financial assistance to private woodland owners. In addition, it helps landowners develop a management plan for wood products, as well as wildlife, forest restoration, forest health, invasive species control and water quality. The program targets private woodland owners, farmers, wildlife enthusiasts, watershed associations, hunting clubs, scouting organizations, private schools, private organizations and individuals.

Among the many benefits of participation in this program are the availability of both technical and financial management assistance, environmentally responsible management of New Jersey's forest resources, active involvement in forest management, public recognition as a steward of the land and the personal satisfaction of managing forest resources for present and future generations.

The NJ Forest Service and USDA Forest Service previously provided passthrough funding via the annual Forest Stewardship Grant to the NJFA for the cost-share of Forest Stewardship Plans. Woodland owners were refunded up to 75% of the cost for a new or revised plan needed to meet the criteria necessary to participate in the state's previous FSP. Landowners are asked to maintain cost-share funded practices for 10 years. In addition, the 10-year forest stewardship management plan must be implemented to the best of the landowner's ability.

Due to the popularity of the program and limited funding, a waiting list was developed. As a result, cost-share applications were stopped in 2016 when the list became three years old. Currently, the last round of payments is being distributed. The New Jersey Forest Stewardship Law was enacted in January of 2010; regulations to implement the provisions of this law were adopted on December 18, 2017 (N.J.A.C. 7:3). Adoption of N.J.A.C. 7:3-6 specifically addresses the Forest Stewardship Advisory Committee, governing establishment of its membership, responsibilities and operation. The committee's role is to advise the NJ Forest Service on issues related to forest stewardship and related matters.

NJ Urban and Community Forestry

The Urban and Community Forestry (UCF) Program was authorized by the Cooperative Forestry Assistance Act of 1978 (PL95-313) and revised by the 1990 Farm Bill (PL 101-624) to promote natural resource management in populated areas and improve quality of life. UCF goals of awareness, outreach and environmental equity, partnerships and comprehensive natural resource management focus on achieving healthy sustainable forests, sustainable economic development and information management.

Every community can benefit from UCF management. The amount, type and administration of an UCF program will depend on community size, tree budget and goals of community leaders. Under state law that established the NJUCF Program (P.L.1996, c. 135), any of the 565 municipalities and 21 counties can ask for assistance in dealing with their urban and community forest. Federal funds to address these needs have been important to the overall success of New Jersey's UCF effort.

New Jersey has one of the most proactive and innovative state UCF programs in the county due in part to continued federal funding, which supplements state funding. Funding is used to provide grants, training and technical assistance to municipalities and counties to manage and expand their urban and community forests. The NJUCF Program continues to seek leading edge opportunities and innovative initiatives to build a sustainable statewide effort to manage local publicly owned trees and forest. Through the use of federal and state funding, the goal of having a statewide community forestry initiative is ensuing. Without this funding, programs that assist residents to recognize the environmental benefits derived from New Jersey's urban and community tress would be non-existent.

Green Acres Program

The Green Acres Program was created in 1961 to meet New Jersey's growing recreation and conservation needs. Together with public and private partners, Green Acres has protected more than half a million acres of open space and has provided hundreds of outdoor recreational facilities in communities around the state. Land can be purchased in fee-simple or by conservation easement from willing owners and must be managed to protect in perpetuity valuable forest lands from conversion to non-forest uses. Historically, lands acquired were added to State Parks, Forests and WMAs. The NJ Green Acres program serves as the state's point of contact and manager for the FLP.

State implementation of the FLP is outlined in the state's AON. The AON is an implementation plan, now fully incorporated into the assessment and

strategies outlined in this SFAP. It defines the threats to a state's forests, identifies important private forest lands, articulates the public benefits provided by these forests and identifies areas of focus for the program. In the AON, a state delineates specific Forest Legacy Areas. More information about these delineations can be found in **Appendix C.**

In 1978, the Urban Aid funding category within the Green Acres Program was created. This category provides grants and zero percent and low interest loans to legislatively designated urban aid communities for open space and recreation projects. Since its inception, the Green Acres Program has provided more than $430 million in Urban Aid funding. Between 2015 and 2017, the Green Acres Program awarded a total of $83.5 million in Urban Aid for densely and highly populated community projects (SCORP, 2018).

In addition, the Garden State Preservation Trust Act (P.L. 1999, c.152) specifies that a percentage of Green Acres State Land Acquisition funding be used to purchase properties in counties with a population density of 1,000 people per square mile or more (SCORP, 2018).

Highlands Water Protection and Planning Act (HWPPA)

In 2004, the New Jersey HWPPA (N.J.S.A. 13:20-1 et seq.) was passed in recognition of the importance of the region's water supply and diverse natural resources. In 2008, the Highlands Council adopted the Highlands RMP which was developed to protect the region's natural, historic, agricultural and recreational resources while also accommodating appropriate economic development. The Highlands Region of New Jersey comprises less than 15% of the state but is the source of water for more than 300 municipalities that are home to 5.4 million people or 70% of the state's population. The HWPPA defines two areas of importance, the Preservation area and the Planning area. (RMP 2008) While the Planning Area does not receive the same level of protections that the Preservation Area receives, it is still a critical part of the Highlands Region. Municipalities that conform to the Regional Master Plan adopt local land use ordinances which implement the resource protection standards of the RMP and Highlands Act into their local regulations.

The HWPPA program regulates "major Highlands development." The purpose of the HWPPA is to protect the exceptional natural resources of the Highlands, including surface and ground-waters, clean air, contiguous forest lands, wetlands, pristine watersheds, habitat for fauna and flora, sites of historic significance and recreational opportunities for the citizens of the state. A Highlands Preservation Area Approval (permit) is required for major Highlands development (SCORP, 2018).

Pinelands Protection Act

The federal National Parks and Recreation Act of 1978 (Public Law 95-625) created the Pinelands National Reserve. The subsequent establishment of the New Jersey Pinelands Commission in 1979 and the state Pinelands Protection Act (P.L. 1979, c. 111) has resulted in the preservation and growth management of this 1.1 million acre region of New Jersey. The Pinelands area comprises pine-oak forests, AWC swamps and extensive surface and ground-water resources of high quality. These unique systems and resources provide a habitat for a wide diversity of rare, threatened and endangered plant and animal species.

The Pinelands also contain many other significant and unique natural, ecological, agricultural, scenic, cultural and recreational resources. The Pinelands Protection Act recognizes the need to protect such valuable areas of the state and its resources from the pressures for residential, commercial and industrial development. The protection afforded under this act requires the coordinated efforts of all relevant municipal, county, state and federal agencies. To that end, a joint agreement between the NJ Forest Service and the New Jersey Pinelands Commission was developed to streamline the Forest Stewardship review and approval process for public non-state-owned forestry applications.

Water Supply Management Act N.J.S.A. 58:1A-13 and the NJ Water Supply Plan

This Act recognizes the importance of water supply, especially in communities that do not have a steady supply of water or have a combined sewershed overflow (CSO). The Act highlights the importance of areas like the Pinelands and Highlands Regions as well as subsequent rules and regulations for these areas. This Act requires a water supply plan to be developed and implemented. The NJ Water Supply Plan (2017-2022) outlines key findings and analyses conducted regarding peak flow, water availability, watershed management areas and per capita measures.

Title 13 Chapter 9 State Forest Fire Service – Forest Fire Prevention and Control Act

Under the general powers of the General Forest Fire Act, the NJDEP may:

- Determine wildfire hazards.
- Remove or cause to be removed brush, undergrowth or other material which contributes to wildfire hazards.
- Maintain or cause to be maintained fire breaks.
- Set backfires, plow lands, close roads and make regulations for burning brush.
- Summon any male person between the ages of eighteen and fifty, who may be within the jurisdiction of the state, to assist in extinguishing fires.
- Require the use of property needed for extinguishing fires.
- Issue permits.
- Collect extinguishment cost and fines for violations.
- Control and direct all persons and apparatus engaged in extinguishing wildfires.
- Have the right of entry upon lands to inspect and ascertain compliance and extinguish wildfires.
- Investigate fires to determine cause.
- Close the woods to all unauthorized persons in an emergency.
- Arrest without warrant anyone violating the Forest Fire Laws.

Fines, Penalties and Assessments:

- The Forest Fire Service may assess and collect amounts equal to the cost of extinguishment or a lesser amount as determined by mitigating circumstances.
- For a non-willful violation of Forest Fire Law the Service may assess a fine up to $5,000.
- For a willful violation of Forest Fire Law the Service may assess a fine up to $100,000.

New Jersey Fire Law Forbids:

- Setting fire to any forest, brush or grass land or tidal marsh except as exempted.
- Setting fire to brush, litter or debris without the written permission of a firewarden.
- Having any fire by which property may be endangered without maintaining a careful and competent watch.
- Interfering with a firewarden or his/her crew in carrying out their duties.
- Refusing assistance or the use of property to a firewarden engaged in firefighting operations.
- Mutilation or destruction to any state forest fire sign.
- Maintaining a hazard that will contribute to the origin and spread of a wildfire.
- Discharging an incendiary device, operating hazardous equipment or throwing/dropping incendiary objects.

Exceptions:

- An owner may set a backfire on his own property for its protection, provided it does not escape to the property of another.
- A written permit is necessary for any fire in any municipality for which firewardens have been appointed.
- Open burning is regulated by the Department of Environmental Protection, Air & Environmental Quality Enforcement Section. This program is administered by the Forest Fire Service statewide through use of a permit system.
- Permits issued by the Forest Fire Service do not supersede restrictions by local agencies or the Air & Environmental Quality Enforcement Section.

State Hazard Mitigation Plan

The federal "Stafford Act" requires states to prepare and implement disaster preparedness plans for mitigation, warning, emergency operations, rehabilitation and recovery. The State Firewarden is appointed by the Governor's Office as a member of the State Hazard Mitigation Team regarding natural disasters in a partnership with other relevant state agencies. The NJ State Hazard Mitigation Plan (NJ-SHMP) was submitted by the State Police Office of Emergency Management (OEM) and has been approved by the Governor and the Federal Emergency Management Agency (FEMA). This document requires the county governments to develop all-risk disaster plans for integration into the NJ-SHMP and lists the goal of having a community wildfire protection plan (CWPP) for every municipality within the state.

Prescribed Burn Act

In August 2018, the Prescribed Burn Act (P.L.2018, c.107) was signed into law preserving landowners' rights to prescribed burns, strengthening protections for practitioners and expanding acceptable uses for prescribed burning rather than for hazard reduction only. The act recognizes that prescribed burning not only reduces hazardous accumulations of wildland fire fuels but can be beneficial for site preparations (both for artificial and natural regeneration), for improving upon wildlife habitat, controlling insects and disease and perpetuating fire dependent ecosystems. The act also outlines potential fees for NJ Forest Fire Service personnel conducting burns for landowners, as well as a prescribed burn plans for starting, executing and controlling a prescribed burn (including fire, smoke and ash) before burning occurs.

NJ Forest Service Nursery Rules and Regulations (N.J.A.C. 7:3 -2)

Amendments to the state's regulations in Subchapter 2. Forestation Program 7:3-2.1 are being finalized. Under the existing rules, the NJ Forest Service Nursery is restricted from shipping seedlings out of state, to limit spread of nonnative species. The amendments would allow the NJ Forest Service Nursery to sell and ship excess inventory out of state rather than plow them under.

Office of Natural Resource Restoration (ONRR)

The ONRR has the primary responsibility within the NJDEP for responding to discharges and other sources of pollution that trigger the NJDEP's obligations as the trustee for all of New Jersey's natural resources for the benefit of all of its citizens, now and in the future. This effort includes working with the persons responsible for conducting the remediation to return such natural resources to their pre-discharge quality, quantity, function and value and to implement restoration projects to compensate New Jersey citizens for the lost interim value or for the permanent loss of their natural resources.

Natural Resource Damages (NRD)

In 2017, an amendment (Paragraph 9 of Section II of Article VIII) was made to the New Jersey Constitution directing the NJDEP as to how to invest the natural resource monetary damages collected for restoration projects. Collected natural resource damages are successfully used to repair, restore or replace damaged or lost natural resources or the permanent protection of natural resources

currently on the landscape. Natural resource damages funding is currently being used for a number of state forestry initiatives that enhance water quality through forest management, including restoration of AWC, a tree breeding program for eastern hemlock and density management objectives.

Forest Health Advisory Council (P.L. 2007, c.44)

The purpose of establishing this council is to study and track the spread of forest health issues such as EAB and SLF and to evaluate forest susceptibility and pest impact on the state's forest resources. The council will make recommendations on prevention, treatments and controls, in addition to conducting research and seeking advice and resources from state and federal sources. Public outreach and education on issues of forest health will also be conducted. The council has not yet been appointed however, it is a goal of the NJ Forest Service to bring discussion on this council to the forefront and push forward with the council's establishment.

Wetlands Act

New Jersey has passed laws and regulations specifically designed to protect coastal wetlands which includes the Wetlands Act of 1970. The New Jersey Wetlands Act of 1970 addresses the protection and regulation of coastal tidal wetlands within the state. Under the act, all coastal wetlands that have been mapped by the NJ DEP are subject to regulation. New Jersey continues to share permitting authority with United States Army Corps of Engineers for coastal wetlands (SCORP 2018 & Yepsen et al 2019).

Coastal Area Facility Review Act (CAFRA)

The purpose of CAFRA is to protect the coastal environment while accommodating compatible land use development. A CAFRA Permit is required for most types of large-scale development in the approximately 1,370 square mile CAFRA area. This area comprises portions of Atlantic, Burlington, Cape May, Cumberland, Middlesex, Monmouth, Ocean and Salem counties. The CAFRA area ranges in width from a few thousand feet to 16.5 miles inland. In 1993, CAFRA was amended to require that developments be subject to a tiered system dependent upon the proximity of that development to the mean high-water line of tidal waters, a beach or dune. These amendments brought more development under CAFRA jurisdiction, particularly sensitive areas along tidal waterways (SCORP, 2018).

Freshwater Wetlands Protection Act (FWPA)

This NJ SFAP updates the state Wetlands Program Plan as it pertains to forestry and contains a review of the FWPA, as well as information on other regulatory programs affecting wetlands and an outline of some of New Jersey's wetlands conservation strategies. This wetlands plan update was prepared in consultation with the NJDEP, NJDEP Division of Land Resource Protection, Coastal Management Office and NJDEP Division of Fish & Wildlife. The NJDEP Division of Land Resource Protection is responsible for the administration of the FWPA, Wetlands Act of 1970 and other land use regulatory programs. (Yepsen et al 2019) The FWPA was enacted on July 1, 1987 and became effective over a period of two years. The act sought to close the gaps in the federal wetlands regulatory program. This was accomplished by taking jurisdiction over all activities in freshwater wetlands, providing protection for areas adjacent to wetlands through regulation as transition areas and regulating activities in state open waters such as lakes and ponds. The FWPA requires permit authorization by the NJDEP for every regulated activity. Water Quality Certification is also required where a discharge of dredged or fill material is proposed (SCORP, 2018).

The FWPA regulates the following activities in wetlands:

- the removal, excavation, disturbance or dredging of soil, sand, gravel or aggregate material of any kind;
- the drainage or disturbance of the water level or water table;
- the driving of pilings;
- the placing of obstructions; and
- the destruction of plant life which would alter the character of a freshwater wetlands, including the cutting of trees.

In addition, the FWPA regulates the following activities in transition areas (upland areas adjacent to wetlands) which currently receive no protection under federal law:

- removal, excavation or disturbance of the soil;
- dumping or filling with any materials;
- erection of structures, except for temporary structures;
- placement of pavement; and
- destruction of vegetation which would alter the existing vegetation community.

The discharge of dredged or filled materials into state open waters is also regulated under the FWPA (SCORP, 2018).

Specific forestry activities have been granted a conditional exemption from these requirements to obtain a wetlands permit. However, to qualify for the forestry exemption a proposed forest management harvest within a wetland or its regulated upland transition area must be detailed in a forest management plan following BMPs approved by the State Forester. To administer the forestry exemption, the NJDEP's Division of Land Resource Protection works in cooperation with the NJ Forest Service. The NJ Forest Service will assist anyone proposing a forest practice in a regulated wetland or buffer area to obtain an approved forest management plan prior to conducting the work.

Flood Hazard Area Control Act (FHACA)

This act empowers the state to control development within flood hazard areas to reduce flood damage and to protect the environmental attributes of floodplains. A Flood Hazard Area Permit is required for the construction, installation or alteration of any structure or permanent fill along, in or across the channel or floodplain of any stream. A permit is also required for any alteration of a stream and for most impacts to a riparian zone, defined as the land and vegetation within and adjacent to a regulated water (SCORP, 2018). Permit-by-rule 26 (N.J.A.C. 7:13-7.26) authorizes the forest management activities provided they are conducted in accordance with a forest management plan that has been approved by the New Jersey State Forester or designee before the activities are undertaken. Such forest management activities may include harvesting of trees, fencing, construction of roads for forestry access and stream crossings. Clearcutting is not permitted in these areas unless it is part of a silvicultural treatment for one of the noted forest management activities.

Surface Water Quality Standards

The NJDEP governs matters of policy with respect to the protection and enhancement of surface water resources, class definitions and quality criteria, use designation and quality criteria for the mainstream of the Delaware River including the Delaware Bay, the classification of surface waters of the state, procedures for establishing water quality based effluent limitations, modification of water quality-based effluent limitations, procedures for reclassifying specific segments for less restrictive uses and procedures for reclassifying specific segments for more restrictive uses pursuant to N.J.S.A. 13:1D-1 et seq., the New Jersey Water Pollution Control Act (N.J.S.A. 58:10A-1 et seq.) and the Water Quality Planning Act (N.J.S.A. 58:11A-1 et seq).

Natural Areas and Natural Areas System Acts

These statutes (N.J.S.A. 13:1B-15.4 et seq.; N.J.S.A. 13:1B-15.12a et seq.), dated 1961 and 1975, respectively, and subsequently developed rules at N.J.A.C. 7:5A, establish and guide the management of the State's Natural Areas System. Natural Areas are specially designated portions of state parks, forests, wildlife management areas and NJ Natural Lands Trust preserves that are guided by rules that prioritize natural resource preservation and management over recreation.

The Natural Areas Program is administered by the Office of Natural Lands Management (ONLM) within the NJ Forest Service, and is one of the oldest and most comprehensive programs of its kind in the United States. The System currently consists of 44 designated Natural Areas encompassing almost 40,000 acres.

Management and use of System lands is guided by the Natural Areas Council, an advisory board to the Commissioner of DEP. Natural Areas support a rich biodiversity including Atlantic white cedar and Eastern hemlock forests, globally rare Pine Plains shrublands, and some of the State's hot spots for rare plant species.

Recording data from fuel transects in Wharton State Forest. Photo by: J. Douglas, NJDEP

Endangered Plant Species List Act

This act, and subsequently promulgated rules at N.J.A.C. 13:1B-15.151 et seq., mandates the creation of an official codified list of State Endangered plant species as necessary to incorporate the preservation of New Jersey' biodiversity into government planning functions.

Endangered species is defined as any native plant species whose survival in the State or the nation is in jeopardy, including, but not limited to, plant species designated as listed, proposed, or under review by the federal government as endangered or threatened throughout its range in the United States pursuant to the Endangered Species Act of 1973, any additional species known or believed to be rare throughout its worldwide range, and any species having five or fewer extant populations within the State. The current Endangered list includes 356 species.

Additionally, rules at N.J.A.C. 7:5C specify that the DEP will maintain a list of Plant Species of Concern for the purpose of monitoring the status of the State's flora and to serve as a working list for transition of species to and from the Endangered species list.

The list of Plant Species of Concern, although not codified in the rules, consists of approximately 456 species whose populations are monitored by the Natural Heritage Program. This program is administered by the Office of Natural Lands Management (ONLM) within the NJ Forest Service.

Guiding Principles: Framework

The management of forest resources in New Jersey are coordinated under a common framework. This framework encompasses systems for evaluating and monitoring forest resources across the state in both traditional and non-traditional forested settings, expanding the scope of forest resource management through innovative research and new technologies, utilizing an inclusive stakeholder process and an effective implementation policy. This framework serves to manage the state's forests and trees through recognition of an "all trees" philosophy, in perpetuity.

Montreal Process

The internationally recognized Montreal Process outlines metrics for tracking sustainable forest management; organizations such as the Sustainable Forest Initiative (SFI) and the Forest Stewardship Council (FSC) use such measures and tracking systems for landowners organizations and governments participating in their certification processes. The Montreal Process is made up of seven criteria and 54 indicators and serves as the basic framework for the NJ SFAP and natural resource stewardship plans.

An international, inter-governmental working group was formed in 1994 to help respond to the pressing need for sustainable forest management. The NJ Forest Service monitors the internationally agreed-upon criteria and indicators for the conservation and sustainable management of temperate and boreal forests as an integral part of the agency's planning process at multiple scales.

Monitoring

Forest conditions are monitored through time across the state of New Jersey using forest inventories (on the ground measurements) occurring at various scales on the landscape. In order to monitor changing forest conditions and trends, a series of permanent plots have been established by the USDA Forest Service, FIA program at a scale that is useful for the purposes of serving the "nation's forest census." The NJ Forest Service has partnered with FIA to enhance this data collection process to better serve the state and it's citizens. Under this system, data is collected every five years for the entire state on a rolling schedule and the number of plots established and measured in New Jersey is intensified to double the national scale. This data is available for public use through publications, online tools and direct download.

Monitoring forest conditions is currently an integral part of the NJ Forest Service state lands management planning process. It is essential for keeping track of the criteria and indicators for forest sustainability outlined within the Montreal Process and identified in the NJ SFAP. State-owned forested lands are also measured using a system of non-permanent plots at a "parcel level" scale. This data is appropriate for making management decisions and for use in simulation models. In addition, state-owned forested lands are also inventoried at the operational level in order to quantify how forest conditions will be and have been altered through forest management activities. These inventories assess individual site conditions.

Remote sensing tools provide many opportunities to capture information that would otherwise be difficult or cost prohibitive to capture via direct measurement on the ground. Many of these tools can either provide useful information on their own or provide a valuable supplement to ground collected information. Utilizing this information, it is possible to determine how forest conditions are changing and how various selective pressures influence the structure of the forest resource. Monitoring rare species in the forests of New Jersey can explain a great deal about the overall health of an ecosystem, its functions and services and habitat suitability. Tools used to evaluate or monitor the presence of rare plant species include on-the-ground surveys, in addition to extensive data analysis techniques which would be conducted under the supervision of the New Jersey ONLM.

The monitoring of forest growth, pests and diseases, as well as rare species and overall wildlife is the mission of the NJDEP internal work group. This group is comprised of members from several different divisions and agencies (discussed in further detail below). This internal work group draws on the collective expertise and experience to gain a better understanding of the overall health of an ecosystem, its functions and services and habitat suitability.

Stakeholder Process

A formal comprehensive 14-step stakeholder process was established in 2014 for the development of natural resource stewardship plans for New Jersey State Parks, State Forests, and Wildlife Management Areas. This process governs all aspects of plan development from inventory of the parcel to the engagement of external stakeholders providing management prescription input.

Natural resource stewardship plans are parcel level plans developed and based on the forest trends and conditions laid out within this document. Across all programs it is the goal of the NJ Forest Service to continue a transparent and inclusive approach to the management of the natural resource by including federal, private, state government and non-government organizations in the stakeholder process.

NJDEP, Natural and Historic Resources, Land Management Review (LMR) Policy

The NJDEP manages more than 900,000 acres of public lands and waters, including State Parks and Forests, Recreation Areas, Historic Sites, Wildlife Management Areas and Natural Areas. These lands and waters are subject to multiple stresses, including demands of recreational users and increase in natural disasters and climate change impacts. It is NJDEP's responsibility to be good stewards of these resources that are held for the public trust in perpetuity.

As "property managers" certain activities conducted on NJDEP managed lands and waters are reviewed under the Land Management Review policy. This review is to avoid and/or minimize adverse impacts to water resources, rare biodiversity, forest resources and cultural resources. When adverse impacts cannot be avoided, they are to be minimized and mitigated and compensating measures are to be considered and recommended.

The Land Management Review process for certain activities is conducted by the subject matter experts from the following programs: the NJDEP Division of Fish & Wildlife's Endangered and Non-game Species Program and Bureau of Freshwater Fisheries (BFF); NJDEP Division of Parks and Forestry's Office of Natural Land Management, NJ Forest Service, NJ State Park Service, NJ Forest Fire Service and Historic Preservation Office. The same reviewing programs are also the internal working group for the natural resource stewardship plans developed by the NJ Forest Service as described within the previous section.

Wildfire Protection Planning

The NJ Forest Fire Service is working to expand wildfire protection planning through a $79,000 FEMA grant. This Pre-Disaster Mitigation Grant (PDMG) was obtained through the NJ State Police, OEM. The grant funds five tasks towards wildfire protection goals to improve plan development and GIS data collection. A "Wildland Hazard Fuel Ranking" map was created for the state, as well as individual county map templates to provide map products to share with other planning agencies. Historic fire records and prescribed burning project maps were digitized to add as data layers during planning as well.

Field crews collected structural assessments on homes within selected communities and provided education on Firewise principles to the homeowners. The collected data and map products developed are used by fire suppression forces, in Firewise community planning and in CWPPs. The minimum requirements for a CWPP as described in the Healthy Forests Reforestation Act (HFRA) are:

- **Collaboration:** A CWPP must be collaboratively developed by local and state government representatives, in consultation with federal agencies and other interested parties.
- **Prioritized Fuel Reduction:** A CWPP must identify and prioritize areas for hazardous fuel reduction treatments and recommend the types and methods of treatment that will protect one or more at-risk communities and essential infrastructure.

- **Treatment of Structural Ignitability:** A CWPP must recommend measures that homeowners and communities can take to reduce the ignitability of structures throughout the area addressed by the plan. The HFRA requires that three entities must mutually agree to the final contents of a CWPP,
    - The applicable local government (i.e., counties or cities);
    - The local fire department(s); and
    - The state entity responsible for forest management.

Interagency Firefighter Mobilization

The NJ Forest Fire Service recently marked their thirty-fourth season (2019) in which personnel have been deployed for interagency assignments. The Resource Ordering Status System (ROSS) dispatching system is used to complete the travel information for mobilized resources as well as creating crew rosters. NJ Forest Fire Service personnel participate in Type I Incident Management Teams from the Northern Rockies and the Great Basin.

NJ Shade Tree & Community Forestry Assistance Act (N.J.A.C. 13:1L-17.1 et. seq.)

In response to municipalities and counties disbanding their Shade Tree Commissions in the late 1990's due to fear of litigation as a result of hazardous tree situations, the New Jersey Shade Tree and Community Forestry Assistance Act (Shade Tree Act) was passed on December 5, 1996. By providing liability protection to participating municipalities and counties, the Shade Tree Act has ensured that Shade Tree Commissions and other local shade tree management programs are in place to provide more livable communities through the care and management of trees throughout New Jersey. New Jersey is the only state to have such legislation in support of its' UCF program.

The NJ Shade Tree and Community Forestry Assistance Act provides for the following:

Liability Protection – The Shade Tree Act provides the necessary basis for local governments to reduce or eliminate liability associated with local tree care programs and shade tree commissions. The Shade Tree Act enables a community to address tree related liability if they satisfy the four accreditation requirements of the act. This includes writing a state approved community forestry management plan and participating in the state's Training Skills and Accreditation program.

NJ Community Forestry Council – The Council is comprised of 20 volunteers representing many aspects of UCF in New Jersey including arborists, urban foresters, tree growers, municipal/county governments, shade tree commission volunteers, electric companies, university forestry programs and tree related non-profits. The Council meets six times annually and acts as an advisory body to the New Jersey State Forester on community forestry issues.

Grants – The Green Communities Grant has been used to help a municipality or county hire a forestry consultant to assist them in writing a community forestry management plan. Once this step has been accomplished, a Stewardship Grant is offered to communities who maintain accreditation status under the Shade Tree Act to implement goals and objectives directly from their community forestry management plan. The Treasure our Trees license plate, also established under the Shade Tree Act, helps fund these grants. Grants are also funded in part by the NNL Reforestation Grant.

The Shade Tree Act has been and continues to be a cornerstone of the NJUCF program. It provides the guiding principles for cooperation between the NJUCF program and the municipal and county representatives and residents that it serves. An important goal for the future of the NJUCF program is an update to the NJUCF Program Guidelines. This update will be structured and informed by the Shade Tree Act, with the goal of helping New Jersey's residents more fully benefit from its' provisions.

NJ Shade Tree & Community Forestry Assistance Act: *https://www.state.nj.us/dep/parksandforests/forest/community/pdf_files/CF_Assistance_Act.pdf*

NJ Urban & Community Forestry Program Guidelines: *https://www.state.nj.us/dep/parksandforests/forest/community/pdf_files/community_forestry_management_plan_guidelines.pdf*

Dedicated License Plate - Treasure Our Trees

Proceeds from the state's Treasure Our Trees license plate fund, funds tree planting projects in communities across New Jersey. These plates are available for both passenger and commercial vehicles. The one-time fee and yearly renewal fees are tax deductible. This attractive plate features the New Jersey state tree, the northern red oak and the New Jersey state memorial tree, the white flowering dogwood. The purchase of the Treasure Our Trees license plate helps fund the NJUCF program as well. In 2018, allocated money from these funds contributed to the payment of the USDA Forest Service, Urban FIA (UFIA) program.

"The Urban FIA program fuses the infrastructure of the traditional, rural-focused FIA program with the urban inventory expertise provided by i-Tree. New Urban FIA methods and protocols are used to produce estimates of the quantity, health, composition and benefits of urban trees and forests. The Urban FIA program complements existing regional and local efforts to provide a cohesive picture of urban forest conditions in the U.S." *(https://www.fs.fed.us/research/urban/fia.php)*

Global Warming Solution Fund and the Regional Greenhouse Gas Initiative (RGGI)

RGGI is the first mandatory multi-state market-based program in the United States to reduce greenhouse gas emissions. RGGI is a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, Vermont and New Jersey to cap and reduce carbon dioxide emissions from the power sector. In 2008, New Jersey enacted the Global Warming Solutions Fund Act, P.L. 2007, c. 340. This act enabled the state to participate in a carbon dioxide emissions trading program and established the Global Warming Solutions Fund. This is a special, non-lapsing fund credited with moneys received from greenhouse gas emissions allowance trading programs. Following a departure from the program beginning in 2012, New Jersey Governor Murphy issued Executive Order No. 7 in 2018 which directed the Commissioner of NJDEP and the President of the New Jersey Board of Public Utilities (BPU) to return the state to full participation in the RGGI program. In June of 2019, the NJDEP adopted rules to codify the mechanics of New Jersey's participation in RGGI's carbon dioxide allowance auctions and funding rules to establish the framework, including the guidelines and the priority ranking system required by N.J.S.A. 26:2C-52, that the Economic Development Authority (EDA), the BPU and the NJDEP will use to select eligible programs and projects to receive funding from the proceeds of the RGGI auctions.

RGGI is composed of individual carbon dioxide Budget Trading Programs in each of the ten participating states which are implemented through state regulations, based on a RGGI Model Rule and are linked through carbon dioxide allowance reciprocity. Taken together, the ten individual state programs function as a single regional compliance market for carbon emissions from electric generating utilities (RGGI, Inc 2020). Following a comprehensive 2012 Program Review, the RGGI states implemented a new 2014 RGGI cap of 91 million short tons. The RGGI carbon dioxide cap then declines 2.5 percent each year from 2015

to 2020 and 3 percent annually from the 2020 baseline from 2020 to 2030. The RGGI carbon dioxide cap represents a regional budget for carbon dioxide emissions from the power sector. The Global Warming Solutions Fund Act requires New Jersey to engage in projects or programs that ensure reductions in GHG emissions and energy use, with increases in carbon sequestration and the provision of co-benefits, with measurable results to ensure that these benefits are actualized. In addition, the Act also divides the auction funding to develop, monitor and implement this goal. Auction funding is divided as follows: 60% to EDA, 20% to BPU and 20% to the NJDEP. Of the 20% allocated to NJDEP, 10% is to support local government efforts to reduce GHG emissions and 10% is to enhance stewardship and restoration of forests and tidal marshes (carbon sequestration benefits).

Strategies by National Priorities

The strategies section of the NJ SFAP 2020 is designed to inform, understand and advise forest management prescriptions to improve the overall health of New Jersey's tree and forest resources in a sustainable fashion. The strategies are also designed to allow the reader to understand how global, national, regional, state and local levels of management are connected and scalable. Three national priorities frame the strategies section:

National Priority 1

Conserve and Manage Working Forest Landscapes for Multiple Values and Uses

National Priority 2

Protect Forests from Threats

National Priority 3

Enhance Public Benefits from Trees and Forests

Even though strategies are outlined within this document under one particular priority, they are often relevant to two or all three priorities. This overlap is due, in large part, to the multitude of benefits forests and trees provide. To better understand this, a National Priority Matrix **(USDA Forest Service Matrix)** can be found at the end of the appendices. The strategies discussed in this section represent pathways to solving some very complex issues that have many potential solutions. These broad strategies will serve to steer the management of forest and tree resources through the next decade. Ultimately, they will be implemented at finer scales with the guidance of a large community of forestry professionals. This approach applies the "think globally, act locally" initiative to New Jersey's forest resources. More importantly, these strategies address the NJ Forest Service's mission across New Jersey. The strategies are data driven and make use of the best science available at the time of the drafting of this document. There are still some gaps, however, that need to be filled. We hope to fill them as this plan is implemented over the next ten years. The NJ SFAP represents a living document, meant to be flexible as the state's environmental conditions and human values change.

NATIONAL PRIORITY 1:
CONSERVE AND MANAGE WORKING FOREST LANDSCAPES FOR MULTIPLE VALUES AND USES

1: FOREST FUNCTION

Age Class Distribution

Forests that are more diverse and resilient are typically those comprised of varying age classes. The age of forests in New Jersey, however, are generally distributed in a "bell-shape" curve centered around the 61-80 year old age class as indicated by FIA data (see the assessment section of this action plan). Therefore, to create a more balanced distribution of age classes in forests throughout the state, management strategies will focus on the regeneration of healthy young forests and creating opportunities for mature forests to grow into well advanced age classes not typically encountered within the northeastern United States since European settlement. It is important to note that terms such as young, middle-aged and mature, when referring to forests, are highly variable depending upon species composition. For example, an 80-year-old average stand age may constitute a mature aspen stand, but this same average stand age would not be considered mature for an oak stand, which is a much longer-lived species.

The terms early successional forest and young forest are often used synonymously, however, it is important to note that these terms refer to separate forest conditions. The term young forest in the context of this plan, refers to the distribution of tree ages in a given forest relative to the life cycle of the species in that forest. Early successional forest refers to forest or stands composed of trees occurring in early seral stages of forest ecosystem development and are often characterized by pioneer species that are able to establish on a site after some type of major disturbance.

An example of different biodiversity in Worthington State Forest. Photo by: J. Douglas, NJDEP

Management strategies focused on creating young forest would involve the establishment from forest stands with age classes centered around the state's most abundant age class (the 61-80-year-old age class). Lands reverting to forest from other uses (i.e. abandoned agricultural lands) will also be considered for this initiative. In addition, young forests may be established using shade tolerant species in the understory of an existing tree canopy (for example eastern hemlock restoration). Young forests may also arise through the reestablishment of less shade tolerant pioneer tree species after a significant disturbance creating early successional habitat (i.e. the regeneration of tulip poplar after an opening in the canopy is created). Uneven-aged management techniques may also be employed to shift established middle-aged forest stands toward age class distributions with a greater number of young trees (where appropriate with species composition conducive to uneven-aged management techniques). Specific young forest types/species experiencing difficulties establishing or where ecosystem functions have been altered in a way that hinders regeneration, may be restored to promote regeneration, establishment and continued development along their respective seral arcs.

An example of forest structure of Atlantic White Cedar. Photo by: J. Douglas, NJDEP

The age of a forest varies as to when it is considered mature. Many factors play into determining forest maturity including forest composition, life history, seral stage, tree age and age distribution among the trees. A functioning mature forest is associated with tree cohorts increasing in vertical structure, recruitment of new trees in younger age classes (i.e. regeneration) and levels of background mortality as older trees die. The presence of snags or dead trees; elements of soil mixing as some larger, older trees or snags fall and litter is deposited on top of these disturbances; structural diversity through the creation of gaps created by tree mortality; and shifts from the proportion of carbon stored in the aboveground pools by the trees to a greater proportion being stored belowground and in the forest soils are all characteristics associated with mature forests. Therefore, mature forests are an important component of New Jersey's overall forest resources.

To promote more mature forests in New Jersey, forest stands need the time to grow with the promotion of a mix of forest ages and species - early, mid and late successional shade tolerant and intolerant species. The first step in promoting the development of mature forests is identifying where these forests are present across the landscape and where they have the potential to exist without possible conflicts. Mature forests or maturing forests where ecosystem functions appear to be largely intact will be identified for conservation and monitoring. Planning horizons for state-owned forest lands will consider potential forest conditions decades into the future and the sustainability of aging forest stands. Functioning forests with the potential to grow into healthy, mature forests will be reserved for a length of time where they will be allowed to continue to grow and mature. Mature forests where ecosystem services have been disrupted (such as invasive species and herbivory), but may be restored will also be identified for restoration through active management. To achieve mature forest characteristics, forest stands should be set aside and actively managed through competition removal and gap openings (individual to groups of trees) in identified stands. A decrease in basal area and trees per acre, as well as increasing age class are both predictors to help measure a maturing forest.

As New Jersey's forests are increasingly populated with shade tolerant species and with a greater percentage of the state's forests falling into the 61 to 80-year-old age range, a better understanding of regeneration presence

"To promote more mature forests in New Jersey, forest stands need the time to grow with the promotion of a mix of forest ages and species - early, mid and late successional shade tolerant and intolerant species."

is needed. Recent studies involving regeneration include direct measurement, re-creation of historic field studies and meta-analyses. These studies are providing greater insights as to forest regeneration in New Jersey, the region and the country. Oak regeneration is an important component of New Jersey forests and is critical to many wildlife species. Species such as red maple, however, are gaining a stronger foot hold, supplanting ecologically important oak species throughout the state. It has become further apparent that species desirability according to deer pressure and presence is dictating what is present across the landscape. Managing these complex components or at least understanding them better, will provide the necessary tools needed to develop an adaptive approach in the promotion of keystone species such as oak.

In understanding the need to increase age-class diversity statewide, it is important that this work is not performed in a vacuum and that consideration is given to the scales of impact that could ensue from implementing these decisions. Increasing communication between local governments and private landowners, as well as collaboration between NJ Forest Service program area professional foresters and land managers help to bring about this understanding and address any potential issues early on. This is exceedingly important as local government officials, private forest owners and others are increasingly concerned about the impacts of certain forest management strategies. Examples of these types of concerns stem from treatments on private lands that can impact public infrastructure and investments, such as increased flooding and road damage, to loss of community appeal to attract homebuyers and business investments. Reverse impacts, wherein communities' impact privately and publicly held forests, have also occurred and should be considered an important component to address. Addressing age-class distribution is a management strategy the NJUCF program will continue to work with local governments on to implement as well.

> "This competition for growing space leads to those surviving trees to become severely stressed trees which are less resilient to wildfire, climate change, insect pests and diseases."

Density Management

Several attributes are often identified as essential when conserving and managing forests as entire ecosystems; these include biodiversity, function and structure (Franklin, et al. 2018). As indicated in the assessment portion of this plan, increasing forest density (trees occupying greater growing space) has become a serious concern statewide for a variety of reasons. Some tree species can survive and thrive even under very resource-limited conditions, while individuals of other species require more resources to survive and never achieve high densities. To communicate effectively about this type of forest density, foresters use the term "Relative Density Index" (RDI), which represents a forest's current proportion of theoretical maximum density, ranging from 0 to 1.

The direct impact of higher relative density on trees is stress. When trees are crammed against each other, their leaves and roots compete for scarce resources, fighting for dominance and survival. This competition is the defining factor for tree growth rates. For the most oppressed trees in an overstocked forest, the result is eventual death. Trees that survive the struggle for resources are not left unharmed, however, as the stress of competition reduces their growth for some time, leaving them more vulnerable to some pest species (Lantschner, Aukema and Corley, 2019).

The forests of New Jersey's Pinelands Region have witnessed a steady increase in RDI over the last century. These forests, adapted to re-sprout and establish new generations of forest after significant fire disturbances, have experienced a lessening in the frequency and extent of fire since the advent of fire suppression policies in the early 1900s. Disturbances associated with harvesting practices also decreased somewhat with the demise of the wood-fueled industries of the Pinelands and rapidly declined with the rise of the environmental movement. These trends have enabled the survival of trees to ages not seen since the time of widespread cutting in the Pinelands in the 1700's. These trends have also caused a parallel increase in RDI. Pitch pine trees of poorer vigor that in previous centuries would have been killed by fire or cut for charcoal are now experiencing stagnated growth, lingering in a low-productivity, high relative-density twilight of poor vigor.

Therefore, the NJ Forest Service is adopting strategies to alleviate issues associated with high density, depending upon the types of forests and the risks associated with these forests. One strategy

identified to address high forest density related issues is silvicultural thinning. Thinning, in this context, refers to the cutting and/or harvesting of living trees to scientifically determined lower targeted densities (i.e. basal area), where a majority of the forest growth during the planning cycle in treated areas will come from existing living trees retained within the forest. This technique contrasts with forest growth coming from the establishment of new trees (regeneration). Results can be achieved through a range of treatments designed to address the specific conditions of forests around the state.

The Pinelands Region of New Jersey is dominated by the extremely flammable pitch pine forest type. As mentioned previously, this species is now growing at densities that create an increased wildfire hazard risk and increased risk of mortality from bark beetles (mainly SPB). New Jersey forests, like many forests in the Northeast and mid-Atlantic, have also become older, with historically high amounts of the forest growing space now occupied. Growing space is almost fully occupied statewide by larger trees with greater shading effects, more fuels and much less break-down of organic material. This competition for growing space leads to those surviving trees to become severely stressed trees which are less resilient to wildfire, climate change, insect pests and diseases. This also leads to potentially massive tree mortality that can threaten ecosystem stability.

The NJ Forest Service is employing both long and short-term density management strategies to mitigate these issues. In the pine forests of southern New Jersey, thinning prescriptions, especially when combined with prescribed burning, can be designed to reduce the chances of wildfires becoming dangerous crown fires. As mentioned previously, forest density can be altered to reduce susceptibility to widespread bark beetle outbreaks as well. Thinning and prescribed burning treatments are also used to restore forest structure and habitat for a variety of rare plants and focal wildlife within these forests. The use of these treatment tools may be able to emulate a disturbance regime more consistent with the natural regime that the region's forests were most adapted to.

There is historic evidence to suggest that natives present prior to European settlement such as the Lenape, were performing dormant-season burns of low-intensity surface fires to suppress woody shrubs and saplings to keep the forest canopy open (Vries, 1853; Lindestrom, 1925; Van der Donck, 1656). Restoring these selective pressures on the forests of southern New Jersey is more consistent with the natural range of variability and may result in a wide variety of benefits, as described above, still considered desirable today.

In addition to the strategies outlined by the NJ Forest Service, the NJ Forest Fire Service has assisted with treatments for military installations across the state. These treatments have included initiating a mechanical hazard mitigation plan focusing on installation boundaries that have the greatest threat of wildfires leaving or coming onto the military installation. The NJ Forest Fire Service is also implementing strategies contained in the National Cohesive Wildland Fire Management Strategy: Northeast Regional Action Plan. These strategies include restoration and maintenance of resilient landscapes through restoration of fire-dependent ecosystems and mitigating hazardous fuels created by an "event", especially through priorities such as communication and collaboration. Density management strategies are also currently being employed as a part of CWPP, which is described in more detail in the "Forest Management Plans" portion of this national priority section. The relationship between forests, wildfire and carbon is quite important for New Jersey in conserving and managing working forests as well as protecting forests from threats.

Thinning can not only reduce tree mortality from drought but may also reduce the chances or severity of drought. Forests of higher densities consume more water through transpiration. Therefore, it is also a strategy of the NJ Forest Service to lower forest densities where appropriate, to alleviate drought stress. Treatments effective in addressing drought stress are those that reduce leaf area available for transpiration. These treatments could include thinning, prescribed burning or a combination of the two. Such treatments may also

alter forest composition to favor forest types that are more efficient with respect to water budgeting (i.e. xerophytic species over mesophytic species).

Thinning is also a means to increase resilience of trees to a variety of Damage Causing Agents (DCAs), reducing the number of trees lost through mortality. As an added benefit, some of these treatments may provide forest products in various forms, such as pellets for biomass or pulp for paper. Density altering treatments designed for fostering resilience to DCAs can take many forms. In combination, these treatments contribute to greater structural and compositional diversity across the landscape to hedge against risk of mass mortality events in tree populations. Density regulating strategies that mitigate wildfire, the impacts of DCAs or foster resilience under pressure from external conditions such as drought or changing climatic conditions, have the added benefit of helping to protect forest carbon pools as well.

Based on its experience and engagements throughout the state, it is the NJ Forest Service's expectation that silvicultural thinning and prescribed burning treatments are appropriate management techniques across forest types within the state of New Jersey. NJ Forest Service encourages private landowners with approved WMPs and/or Forest Stewardship Plans to decrease ladder fuels and lower densities (i.e. basal area) where conditions are appropriate. Cost-share programs for landowners, NGOs and others are available to offset the cost of implementation and plan development for activities like forest density management.

American Forests, a national conservation organization dedicated to advancing the conservation of forests, emphasizes the importance of embracing carbon offense and defense strategies through carbon sequestration, in addition to management which reduces the chances of catastrophic wildfire or widespread forest mortality throughout New Jersey. Many other stakeholders throughout the state also support the importance of protecting and enhancing resilient carbon sinks, making our aboveground carbon resources less susceptible to wildfire and other DCAs and utilizing them for long-lasting carbon sequestering products. These include the NJ Forest Service's long-term strategies to reduce carbon emissions (i.e. wildfire and other DCAs) which include achieving net sequestration while providing co-benefits.

Studies across the forests of Montana, Oregon, California and Arizona determined that thinning treatments and the effects on carbon suggest most of the benefits of increased fire resistance can be achieved with relatively small reductions in current carbon stocks (Stephens et al. 2012). These studies also found that by retaining or growing larger trees, the vulnerability of carbon loss from wildfire was reduced (Stephens et al. 2012). Other studies have continually demonstrated that fuel reduction treatments can reduce carbon losses when treated stands are subsequently burned by wildfire (Finkral and Evans, 2008; North et al., 2009; Hurteau and North, 2010; Zhang et al., 2010). Furthermore, treated stands in many dry forest types within the western United States represent more stable structures for long-term forest carbon sequestration (Hurteau and Brooks 2011).

Active management on publicly held traditional forests for density or other management strategies has not been promoted or enabled by the NJUCF program prior to 2015. In 2018, however, NJUCF received a USDA Forest Service LSR grant which supported the revision of NJUCF guidelines for local government plans for tree and forest management. These revised guidelines will require local governments to identify publicly held traditional forests and plan to begin implementing active stewardship of those lands to allow them to remain as healthy, functional forests into the future. This is one strategy for density management that will continue to be supported by the NJ Forest Service, NJUCF program into the future.

Mesophication

Future climate outlooks expect to favor oak and pine dominated systems as these clades compete better under physiologically droughty conditions. Conversely, northern hardwood communities are those most likely to be

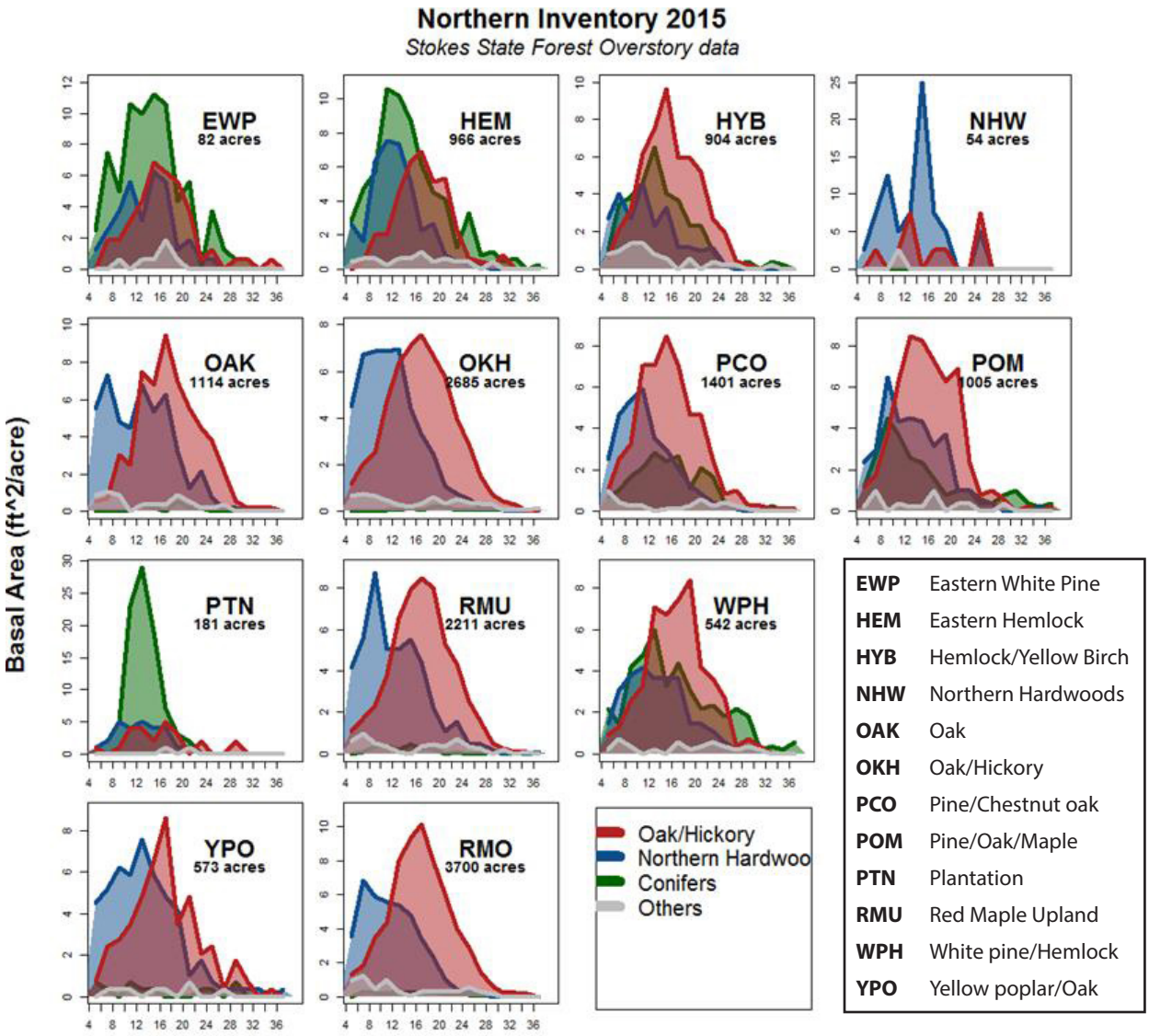


Figure 76: Basal area by diameter for different species functional groups and different forest types in Stokes State Forest. In the most expansive forest types (RMO – Red Maple Oak, OKH - Oak Hickory, RMU – Red Maple Upland) smaller-diameter northern hardwoods are replacing oaks and hickories. Northern hardwoods depicted in blue tend to use more water than the oaks and hickories depicted in red. (NJFS, 2015)

stressed by rising temperatures (Swanston, et al. 2018). Unfortunately, current successional trends in New Jersey are tilting much of the state's oak-hickory forests away from climate-resilient species to more climate-stressed species (**Figure 76**).

Mesic, shade-tolerant generalists, like red maple, are supplanting oaks and hickories (Brose, Dey and Waldrop 2014). The cause for that trend is multifaceted: succession, deer herbivory, competition from invasive species, lack of low-intensity fire, lack of disturbance, low light levels and other factors. However, succession and replacement by shade-tolerant generalists in the absence of fire and disturbance has long been recognized as the eventual fate of eastern oak forests (Lorimer, 1984; Abrams and Downs, 1990).

A growing consensus has affirmed the importance of lower-intensity fire and disturbance in maintaining oak ecosystems on the landscape, yet fire frequency has dropped precipitously for this forest type-group, with alarming implications (Brose, Dey and Waldrop, 2014; Nowacki and Abrams, 2008). The rich biodiversity dependent on mature oak forests faces negative outcomes from habitat transitions

to northern hardwoods. Oak forests are thought to be more resilient to drought stress in the face of change than northern hardwood and maple forests, but it is unclear whether fine-scale processes will mitigate possible mortality from drought (Coble, et al., 2017) or whether droughts in currently oak-dominated systems will be significant enough to cause more than minor compositional changes (Gustafson and Sturtevant, 2013). Current trends away from oak and towards mesic-forest conditions are at odds with the patterns that shaped our forests up until the last century (Lorimer 1984; Nowacki and Abrams, 2008; Thomas-Van Gundy, Nowacki, and Cogbill, 2015; Thompson, et al., 2013).

The diminishment of fire as a component of the entire forest ecosystem of New Jersey and the resulting shift towards less fire-adapted species, foretells of significant stress to our woodlands under climate change. Tree Atlas predictions indicate that the ranges of our current understory and co-dominant forest species, dominated by mesophitic trees (sweet birch, red maple, American beech), are most strongly affected by climate factors (Prasad, et al., 2007-ongoing).

Therefore, strategies to address this trend overlap with those as described in the forest restoration section and included here within the density management section. Specifically, forest restoration efforts that favor the regeneration or composition of more xerophytic species, such as oaks, will be used to address this issue. In addition, density management strategies such as thinning, weeding and/or prescribed burning will also be used in mimicking historic disturbance regimes that mitigate the impacts of forest mesophication.

> "Mesic, shade-tolerant generalists, like red maple, are supplanting oaks and hickories (Brose, Dey and Waldrop 2014). The cause for that trend is multifaceted: succession, deer herbivory, competition from invasive species, lack of low-intensity fire, lack of disturbance, low light levels and other factors."

Watershed at Atsion Lake in Wharton State Forest. Photo by: J. Douglas, NJDEP

To be proactive in accomplishing this type of management, the NJ Forest Service has received NRD funding to do such activities. Resources required to support thinning objectives across the state of New Jersey include funding for the implementation of activities, research and monitoring, as well as the development of forest markets, businesses and products that can be created using low quality hardwood and softwood tree species.

Water Quality – Filtration, Watershed and Sewershed Management

Vegetation plays a key role in the water cycle. Water that reaches the ground is either used by plants, evaporates, makes its way to ground-water and streams through infiltration and runoff; or is stored or channeled through engineered systems, treated or not-treated as is the case in New Jersey's combined sewer overflow (CSO) communities and released back into the state's rivers and streams. In southern New Jersey, evapotranspiration (water turned to vapor either through evaporation or transpired by plants) currently consumes about half of the water budget (Walker, Nicholson and Storck, 2011; Sloto and Buxton, 2005).

It has been hypothesized that plants can make better use of water in a more CO_2-rich atmosphere since they don't have to keep their stomata open

as long to acquire the same amount of CO_2. However, plants do not only keep leaf pores open to accept CO_2, they need to keep their microscopic "windows" open to keep cool without personal air conditioning. Temperature-induced drought stress increases forest water use under a warmer climate so that in a warmer world, forests are expected to be somewhat thirstier (Levesque, et al., 2014).

Global-scale models predict that increases in vegetative water demand will not outstrip "blue water" (siphon water that historically would have become the runoff that fills rivers and streams) in our area due to increased precipitation (Mankin, et al., 2018). However, more local models show modest decreases in blue water for southern New Jersey with expected climate changes, as a result of the increased demand from vegetation (Sun, Caldwell and McNulty, 2015).

Finer-scale processes are also likely to unbalance the water budget to the detriment of "blue water" resources. Forest mesophication is causing a shift away from water-sipping oaks/hickories and towards the water-guzzling northern hardwoods like maple (Caldwell, et al., 2016). A sudden loss of keystone species to emergent pests, like the near eradication of ash by EAB, will cause permanent reductions in water yield due to similar replacement by northern hardwoods (Brantley, et al., 2014; Brantley, Ford and Vose, 2013).

Declines in available "blue water" resulting from the induced climate impacts on forests could have profound effects on the composition of our forested landscape. In the Pinelands Region, plant community composition is strongly related to water table depth (Laidig, Zampella, et al., 2010). Overall, occurrence and individual shape of non-forest habitats is also heavily determined by water table levels (Laidig, 2010). Water table declines are expected to cause shifts in the patterns of plant communities within the Pinelands, with wetland communities disfavored (Lathrop, et al., 2010). Even if subsurface recharge remains in balance under a changing climate, longer periods between rainstorms will still put stress on upland forest communities.

Forest management treatments that reduce stress from competition have the potential to mitigate at least some of these water stress issues. Removal of competition frees up water resources so that remaining plants can use more. It is this mechanism that enables prescribed burning, understory removal or forest thinning to increase the individual water consumption by residual trees (Renninger, et al., 2013; Carter, et al., 1984; Nyland, 2007).

At the stand level, thinning that takes into account the allocation of the site's growing space (in this case, water resources) is effective at defining management options that mitigate climate stress (Magruder, et al., 2013; Jones, Bottero, et al., 2019). Drought resistance and resilience is density-dependent; pine forests managed to leave growing space unoccupied are less vulnerable to drought effects (Bottero, et al., 2017).

> "Forest thinning has the capacity to mitigate the hydrologic impact of climate change. Pressure on the state's forests from population density underscores the importance of keeping forests as forests and maintaining riparian buffers."

Similarly, thinned oak forests have lower mortality as a result of drought (Gavinet, Ourcival and Limousin, 2019). Competition from shrub understories amplifies the stresses caused by forest density (Finley and Zhang, 2019). At the broader level, national scale analysis of watersheds demonstrates that nationwide, as well as statewide for New Jersey, forest thinning has the capacity to mitigate the hydrologic impact of climate change (Sun, Caldwell and McNulty, 2015; Sun, et al., 2016).

Pressure on the state's forests from population density underscores the importance of keeping forests as forests and maintaining riparian buffers. The NJ Forest Service has adopted an integrated approach by providing incentives for private landowners and local governments, in addition to

directly managing forests through public state land use and management policies.

Nationally, the Forest Stewardship Program (FSP) is going through changes regarding how the program is providing technical services to woodland owners and how federal funding is allocated across the priority areas represented in the NJ SFAP. As previously referenced, there are four priorities of concentration in the NJ SFAP and the FSP, fire, water, wildlife and jobs. The FSP is looking for anticipated outcomes for each of these and how they can be integrated.

With the assistance of Farmland Assessment (FLA), private lands forest management assists in "Keeping Forest as Forest and Working Forests Working" (NJ Forest Service, 2010) by providing a mechanism for woodland owners to sustainably manage their property(s) for a variety of goals and objectives, receiving cost-share to prepare a plan and implementing their plan while receiving reduced property taxes. This is an achievement of environmentalism, economics and stewardship.

As referenced in the Category 1 Streams section in Criterion 4 of the Assessment, the NJDEP Division of Water Quality has reclassified approximately 749 river miles to Category 1 status (includes waters due to trout sampling). This is in partial a result of the HUC 14 units these river miles are located within, which have an impervious surface horizon of less than 10%. Certain invertebrates that occur in waters of high quality are also considered among other metrics for classification of Category status (Adopted Amendments: N.J.A.C 7:9B1-4 and 1.15, effective April 6, 2020).

In partial contribution to the reclassification of additional river miles, private lands management programs provide incentives for woodland owners to keep their properties as forests thereby reducing parcelization, fragmentation and land use change resulting in fewer impervious surfaces. Parcelization, fragmentation and land use change would increase one of the metrics that is preferred to be low, impervious surfaces.

> "The Highlands Region is of the utmost importance for safeguarding a critical water supply for a large portion of the state's population. Protection strategies include limiting development and stewarding the region's forests."

As an outcome-based result, private lands management programs and their participants help to Keep Forests as Forests and provide for filtration of water, streambank stabilization, habitat for wildlife, shade for streams and cooler water temperatures for trout and other fish. The NJ Forest Service, USDA Forest Service, other NJDEP agencies and various stakeholders will continue the management of private lands forests for these and other benefits.

Urban and community forests are a critical component for contributions to improved water quality by assisting in creating functional urban systems within a sewershed. These systems absorb rainfall and snow melt, slow stormwater runoff, recharge aquifers, sustain stream flows and filter pollutants. They also help to mitigate the impact to water quality from the approximately 23 billion gallons per year of raw sewage discharged into New Jersey rivers from CSOs.

Clearly New Jersey's water and sewer infrastructure requires significant upgrades statewide, but nowhere is the problem more acute than in those economically distressed communities with antiquated combined-sewer systems, minority populations and low/disproportionately distributed canopy cover.

These environmentally overburdened communities tend to be located in sewersheds where grey infrastructure remedies are difficult and expensive to implement. Therefore, given these statistics within this geographical context, it is imperative to include urban and community forests as working forests for

Sign at Arbor Day demonstrating metrics from urban setting of what a tree can produce in its lifetime.

these communities and to invest in forestry practices addressing water quality not only from up-river highly forested sources, but also in controlling the discharge downstream into the same water supply systems.

There are a variety of multi-state region strategies surrounding watershed and water quality management. Such multi-state region strategies that particularly involve New Jersey include the Highlands Region, Delaware River Watershed, Delmarva Peninsula and the Mid-Atlantic Coastal Plain.

Highlands Region

The Highlands Region, as mentioned in the assessment section of this document, is identified specifically as a Forest Legacy Area as part of New Jersey's former Forest Legacy AON. It remains identified as such in this NJ SFAP as well **(Appendix C)**. The Highlands Region is of the utmost importance for safeguarding a critical water supply for a large portion of the state's population. Protection strategies include limiting development and stewarding the region's forests.

The Highlands RMP outlines requirements and strategies under the Highlands Act, collaboratively developed and implemented by the New Jersey Highlands Council to protect the resources of the New Jersey Highlands. The plan establishes goals to protect, restore and enhance water quality and the protection of agricultural viability, ecosystems, species and communities, as well as scenic and historic resources. Accordingly, a major purpose of the RMP is to "determine the amount and type of human development and activity which the ecosystem of the Highlands Region can sustain" (Section 11.a.[1][a]).

The RMP provides the basis to determine the capacity of the Highlands Region to accommodate appropriate economic growth, while ensuring the sustainability of the resources within the region. The Highlands Council and NJDEP Green Acres Program, overseeing the FLP, identify and advocate for this region through land acquisition as well as proper planning and decision making for the benefit of the public and water quality.

Since this region supplies a vital source of drinking water to millions of New Jersey residents and more than 370 million gallons of water passes through the area daily, forested watershed management adhering to the New Jersey BMPs provides important water filtration through natural processes in this region.

Delaware River Watershed

The Delaware River Watershed is another important multi-state region (including the Delaware River Basin) that has been the subject of a collaborative monitoring and research study by the USDA Forest Service, US Geological Survey and the National Park Service. The Delaware River Watershed is divided into four major regions: upper, central, lower and bay. The Delaware River Watershed provides drinking water for roughly 15 million people, including two of the largest cities in the country not located in New Jersey – New York City, NY and Philadelphia, PA.

An Act was signed into law in December of 2016 called the Delaware River Basin Conservation Act, the goals and priorities of which are similar and align with the SFAP National Priorities. These goals and priorities allow stakeholders and partnerships to conserve and restore fish and wildlife habitat, improve and sustain water quality, upgrade water management, reduce flood damage and enhance recreational opportunities and public access.

Specifically, the US Fish and Wildlife Service offers opportunities to put conservation into action ("Restoring the Delaware River Basin: The Act"). Developing partnerships with the US Fish and Wildlife Service, National Park Service, NJDEP Division of Fish & Wildlife, NGOs and other local governments provides the NJ Forest Service with excellent opportunities to improve the health and vitality of the forested land within these regions.

One such partnership is already underway. The NJ Forest Service, through its NJUCF Program, received a LSR grant from the USDA Forest Service that is focused on three CSO communities in the Delaware River Watershed. The LSR grant entitled "*Storms, Sewers & Social Justice: Increasing Resiliency in 2 Sewersheds of the Delaware River Watershed*", is currently being implemented. The NJUCF Program partners on this project include the New Jersey Tree Foundation, the Rutgers Urban Forestry and Water Resources Programs, the Delaware Valley Regional Planning Commission (DVRPC) and three CSO cities (Trenton, Camden and Gloucester City).

The goals of the LSR grant are to:

1. **Mitigate stormwater** through green infrastructure (planting trees in enhanced tree pits);
2. **Update the community forestry management plans** to work with professional planners and foresters using updated state guidelines that incorporate the USDA Forest Service Sustainable Urban Forest guidelines and include new requirements for green infrastructure and coordination with municipal and county emergency management plans;
3. **Calculate ecosystem services** these practices provide vis-à-vis canopy cover and local urban forest inventories at various scales from local municipalities, to sewersheds and regional watersheds using USDA Forest Service iTree applications;
4. **Provide access to analyses of urban forestry canopy cover** to develop a statewide process to communities and other NJUCF stakeholders with access to analyses of urban forest canopy cover and its functions and values by using remote sensing and USDA Forest Service i-Tree applications; and
5. **Develop and disseminate best practices** via networks, conferences, workshops and webinars best practices to share project challenges and opportunities, enabling development of more rigorous urban forestry plans across New Jersey and the regional watersheds it shares.

Although this project is applied at the local level, the aim is to set the stage for measuring the cumulative impact of these activities across a sewershed or watershed and evaluating the cumulative impact of these strategies for NJUCF. Additionally, development of a connection between urban forestry and the planning sector is critical and, in many cases, lacking. This project engages a new regional planning partner, the DVRPC, which will help integrate forestry into infrastructure as well as municipal and county planning.

The Urban Waters Federal Partnership (UWFP) Delaware River location, which helps communities reconnect with and improve urban waters, is a primary supporter of the LSR grant project mentioned above. The UWFP will work closely with NJUCF to disseminate products and messages derived from this grant to the other regional stakeholders as well as the larger UWFP network (USDA Forest Service, 2016).

Once this project is complete, the NJUCF Program seeks to utilize the model developed from lessons learned, as well as the new urban forest management plan guidelines and processes and apply them to the other 18 CSO communities within the state of New Jersey. This would help to develop and promote the link between healthy urban forests, healthy sewersheds, healthy watersheds and ultimately improved water quality for not just the 1,480,718 people living in New Jersey's CSO communities, but for those dependent on the state's water bodies to provide them with clean drinking water and other enviro-socioeconomic benefits.

Delmarva Peninsula and Mid-Atlantic Coastal Plain

Important issues across the Delmarva Peninsula and Mid-Atlantic Coastal Plain include forest threats such as development and fragmentation, SPB, and other invasive pest and plant species. Maintaining unique forest types and wetlands such as AWC bogs and supporting forest markets to utilize wood from throughout the region are also important strategies for this area.

Delaware, Maryland, New Jersey and Virginia are all states that have identified this region as an important ecosystem deserving multi-state priority. The NJ Forest Service will work in partnership with Delaware, Maryland and Virginia on strategies to address these regional issues.

2: FOREST RESTORATION - SPECIES OF CONCERN

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed (SER International Science and Policy Working Group, 2014). Forest restoration refers to this process in forested ecosystems. In order to achieve recovery of an ecosystem, it is necessary to restore the ecosystem's functionality. The state of New Jersey is engaged in several landscape level forest restoration initiatives, in addition to individual projects designed and implemented on a case-by-case basis. These landscape level initiatives include restoring several essential forest types and ecosystems and are described more fully in the following sections.

Oak Species

Oak species and their related forest types are of special concern in New Jersey. Although oak forest types account for nearly half of the state's total forested cover, these species are facing pressure from competition, changing land use, growing conditions and a variety of DCAs. As outlined in the assessment portion of this plan, these DCAs and growing conditions affecting oak species include herbivory (oak seedlings highly palatable to deer), invasive species competition with regeneration and the effects of insects and diseases on tree condition and tree growth (leading to death). Despite decline, oak species are an important component of the New Jersey ecosystem. Oak species tend to be long-lived, exhibit large tree canopies and provide multiple wildlife benefits such as mast production and habitat for cavity nesters. They also have a great potential to store carbon for very long periods of time and in a stable fashion. Oak species can also better withstand shifts in climate characteristics when compared to other New Jersey natives.

When considering initial planning for oak restoration projects, areas with productive soils and site conditions should be considered first. Different oak species require different soil types. For example, a swamp white oak prefers wetter soils, whereas chestnut oak can be found on well-drained soils or drier sites overall.

Another important indication of sites suitable for oak restoration are places where natural regeneration is already present (advanced regeneration). Sites with regenerating oak provide land managers with the opportunity to use many tools to encourage further growth and to address mesophication.

The use of fencing to prevent deer browse, if present, or girdling competing hardwoods are two examples of management tools that can be used. Tending or forest stand improvement methods in oak stands also create the growing space necessary for advanced regeneration or for oaks already established on the site to prosper.

Another tool utilized to help promote healthy oak stands is prescribed burning where applicable. Prescribed burning is a method used to prepare a stand or woodlot for oak seedlings to regenerate. Fire provides an added benefit by supplying the soil with lost nutrients and ridding the ground of leaf litter and deep duff, better preparing the seedbed for regenerating oaks.

Prescribed burning regimens should be well-thought out and applied carefully, as fire can also impede reproduction and health of oak stands, particularly oak seedlings, under the wrong conditions. Large areas of forestland should be considered for strategies aimed at altering the fire regimen, especially locations where the use of fire can be safely applied without threat to WUI or highly populated areas.

Monitoring the response of individual restoration projects, in addition to overall oak forest types across the state by the NJ Forest Service, academic institutions and other stakeholders and partners is essential. Combating DCAs through suppression and monitoring efforts should also be an applied strategy for the restoration of oak species in New Jersey.

Shortleaf Pine

The NJ Forest Service, in association with a larger 22-state initiative, is working toward the restoration of shortleaf pine trees throughout the state owned forests and is strongly encouraging local and municipal woodlands owners to do the same.

> “As of 2018, shortleaf pine represents approximately 2.4% of the growing stock trees five inches in diameter and greater among the loblolly/shortleaf forest type group in New Jersey.”

“Re-establishing shortleaf pine throughout the Pinelands region will further diversify our forests and help wildlife habitats.” (SLP Brochure, NJFS)

Shortleaf pine occupies a variety of habitats from rocky uplands to moist floodplains. The shortleaf pine tree not only supplies a source of wood pulp, plywood veneer and lumber, but supplies important local ecosystem values for wildlife habitat and improved water quality.

Over the last 30 years, however, shortleaf pine has been significantly impacted (decrease in nearly 50% of its acreage range wide) by pine beetle attacks, land use change, changes in fire regime, disease and other issues in locations where a lack of monitoring and species management occurs. The Shortleaf Pine Initiative (SPI) aims to counter this trend, not only in New Jersey, but across the species’ historic range.

The goal of the NJ Forest Service, in cooperation with the SPI, is to restore this ecologically important tree species to its former position within the New Jersey landscape, to bolster forest health and promote better spaces for wildlife and the surrounding communities. New Jersey has more than 400,000 acres of pine within the Pinelands Region, yet shortleaf pine currently represents about two percent of that population.

The NJ Forest Service aims to increase the presence of shortleaf pine across the state through partnerships with public agencies and residents and by working with woodland owners within the natural region of the species. Landowners will

emphasize management goals and objectives in new or existing forest management plans for improved forest health, diversity and regeneration.

There are several strategies associated with the efforts to restore shortleaf pine throughout the state of New Jersey.

- **Restore populations** is the first strategy of shortleaf pine directly through forest restoration efforts.
- **Establish new stands** to be included on the most appropriate sites;
- **Foster the long-term survival** of shortleaf pine on sites where the species is already doing well;
- **Actively manage** shortleaf pine when selecting retention trees during forestry operations where the species is present but may not be thriving due to competition;
- **Restore the natural fire regime** where practical;
- **Favor shortleaf pine trees** and the conditions most suitable for them to successfully grow across the forest.

The NJ Forest Service Nursery is also growing shortleaf pine seedlings from local, legacy seed sources to support restoration efforts on public and private lands throughout the state.

The NJ Forest Service joined the SPI in 2015. The SPI is comprised of 22 states, federal forestry and wildlife organizations and other partners, including the USDA Forest Service, Private Consulting Foresters, Southern Group of State Foresters, National Wild Turkey Federation, US Fish and Wildlife Service and The Nature Conservancy.

The strategy of the NJ Forest Service is to continue its participation in the SPI. Participation in this initiative allows the NJ Forest Service to receive and share knowledge about the shortleaf pine species, threats, pertinent technology and restoration strategies, as well as providing opportunities to coordinate restoration efforts for shortleaf pine across state boundaries.

Continuing efforts include bolstering inventory and monitoring and analysis, as well as providing outreach to landowners, local governments and other stakeholders that might have an interest in shortleaf pine restoration. Under the SPI, local woodland owners could receive financial assistance through the forthcoming Forest Stewardship Fund and existing Natural Resources Conservation Service (NRCS), EQIP grants to help promote the tree species and to help strengthen and diversify local forests.

The NJ Forest Service has established a target of restoring shortleaf pine to a dominant species in more than 28,000 acres of the state's entire pine component within the next ten years. This will nearly restore the shortleaf pine species to a 1987 FIA baseline of approximately 34,500 acres. This strategy targets all forest lands and lands capable of being forest across all ownerships, public or private, with appropriate conditions for the growth and success of shortleaf pine.

Eastern Hemlock

Widespread overstory mortality of any tree species can increase the effects on water yield, both in magnitude and duration; whether mortality is achieved through insect outbreaks, weather events or tree harvesting. Essentially, a widespread insect outbreak affects hydrology much like extensive land clearing that ignores hydrologic resources and responsible silviculture.

The eastern hemlock species plays such an important role in hydrology that its decline across the northern New Jersey landscape could lead to an overall rise in stream temperatures. Until recently, most eastern hemlock restoration efforts have primarily consisted individual tree treatments for insects and disease.

The NJ Forest Service therefore strategizes to promote the natural regeneration of eastern hemlock through these, in addition to other silvicultural methods, as well as deer control. Positive changes to eastern hemlock can also be achieved through forest management to reduce the risk of insect outbreak, in addition to improving the long-term dependability of watershed services.

> The eastern hemlock species plays such an important role in hydrology that its decline across the northern New Jersey landscape could lead to an overall rise in stream temperatures.

These strategically planned activities protect riparian buffers and ensure their function, while unplanned changes incur severe risks to a vital landscape. Forest management activities have a small direct impact on hydrology, but a large impact by reducing the long-term risk of massive forest changes.

Eastern hemlock trees fulfill an especially important role within the forest ecosystem, primarily for the location which they inhabit. This includes waterways such as streams and rivers, in which the trees provide shade and shelter to support important aquatic life. The eastern hemlock species is also very shade tolerant and trees are able to withstand many years of overstory competition, allowing them to establish a foothold and slowly create a presence within the main canopy.

The loss of eastern hemlock stands across the state up to this point, however, has undoubtedly altered the forest ecosystem. One goal of the NJ Forest Service is to conserve the residual eastern hemlock stands, while propagating HWA resistant trees and beginning to reestablish eastern hemlock throughout its historic range across New Jersey.

Forest stand improvement activities to remove competing vegetation (particularly shade-tolerant hardwoods) are quality management strategies for restoration of the species, in addition to site preparation activities including deer fencing and invasive species control.

The prevention of eastern hemlock loss through mortality and the restoration of eastern hemlock through silvicultural restoration, is merely one strategy, but not the only one that the NJ Forest Service is undertaking in order to protect this species.

Recently, a "bullet-proof" eastern hemlock stand was identified in northern New Jersey on the NJDEP Division of Fish & Wildlife's property. This unique stand of eastern hemlock trees is frequently infested with HWA yet does not seem to succumb to a complete infestation. The University of Rhode Island has conducted studies testing several trees from this eastern hemlock site and the results have shown that these trees have an "induced resistance" to HWA.

There are additional stands throughout the state that have become infested with HWA but do not fully succumb to infestation as well. This group of residual eastern hemlock trees may also have a genetic "resistance" or "tolerance" to HWA. The NJ Forest Service Nursery is currently conducting propagation efforts of these particular "resistant" eastern hemlock trees through various cuttings. Genetic testing strategies will continue to investigate the potential tolerance of eastern hemlock trees to HWA through partnerships with research institutions over the next ten years.

Atlantic White-Cedar

New Jersey AWC swamps are ecologically unique, as well as globally rare and are the characteristic wetland of New Jersey's Pinelands Region. These swamps have long been recognized for their unique attributes.

From native reptiles using AWC swamps in the winter where the steady temperature ground-water protects them from freezing, to the recognizable muck soils that have been laid down since the last ice age, more than 10,000 years, containing massive amounts of carbon. These organic muck soils found in forested swamps of the Pinelands clean the water of the Kirkwood-Cohansey Aquifer as it moves between the ground and streams.

AWC, across its total range, has been vastly reduced from nearly 500,000 acres at the time of European settlement, to about 100,000 acres today from

Maine to Mississippi (Mylecraine, 2003). At one time more than 115,000 acres of AWC existed across the state of New Jersey alone. However, acreage of the AWC forest type has been more recently reduced to about 25,000 acres.

For decades conservationists and preservationists alike have called for the restoration of AWC and the NJDEP is working hard to help put the species back. The NJ Forest Service is dedicated to restoring approximately 10,000 acres of AWC forest statewide within the next ten years.

Funding for AWC restoration strategies on state-owned lands will come from NRD settlements between the state of New Jersey and companies that have polluted ground-water resources. The NJ Forest Service will reinvest in those ground-water resources through the restoration of AWC swamps. Restoration efforts will target locations where current forest species composition predicts the highest likelihood of AWC success. This also includes the following qualifiers: restoration sites are agreed upon between stakeholders, sites contain at least some AWC component and organic soils and sites will be at least a minimum of 20 acres in size. Natural regeneration will be favored in restoration efforts, as it provides the simplest way to start a new generation of AWC.

To achieve a high likelihood of restoration success, work will also be conducted within sites that still have at least a remnant component of AWC from previous harvests to use as seed trees in locations high enough in elevation that they aren't threatened by sea level rise and that connect to larger patches of AWC habitat. AWC restoration efforts are of such significant importance that the governor's office obligated the necessary funds for these restoration efforts as testimony of support.

"Atlantic white cedar restoration efforts are of such significant importance that the governor's office obligated the necessary funds for these restoration efforts as testimony of support."

Atlantic white cedar at Brendan T. Byrne State Forest. Photo by: J. Douglas, NJDEP

As mentioned throughout the strategies section of this NJ SFAP, the NJ Forest Service seeks to and continues to work cooperatively with a host of other public agencies, academic institutions and NGOs to manage and restore forest resources for a wide variety of goals. These forest restoration goals also include the restoration of several rare plant species, in addition to tree species, as per the recommendations from the New Jersey ONLM. The NJ Forest Service has, therefore, consulted and involved these partners in its AWC initiative.

American Chaffseed *(Schwalbea)* Recovery Plan

Several recent developments are expected to contribute to the recovery of American chaffseed *(Schwalbea)* in New Jersey and throughout its range. These include successful greenhouse propagation by placing seed in close proximity to roots of preferred host species *Chrysopsis mariana*; identification of indicators of suitable microhabitats allowing for the assessment and identification of suitable reintroduction sites; successful creation and establishment of experimental outplanting colonies in New Jersey; and discovery of a previously unknown and extensive occurrence in Cape Cod, MA (species' historical northern range limit).

The NJ Forest Service, with the support of the US Fish and Wildlife Service and various stakeholders, plans to continue annual monitoring, habitat management, greenhouse and in situ propagation of American chaffseed, in addition to surveys for *de novo* populations and suitable reintroduction sites, as well as biological research. These actions are part of the NJ Forest Service's five-year recovery plan for American Chaffseed, which is currently under development.

Broom Crowberry Recovery Plan

Despite the threats outlined within the assessment section of this NJ SFAP, there are still potential sites for individuals and populations of broom crowberry to thrive throughout the state. These sites historically consisted of open pine plains and early successional habitats which can still be managed for today via mechanical and prescribed fire methods. Without proper habitat management, broom crowberry is expected to continue its drastic decline. *Managing for a declining broom crowberry population requires the following steps:*

1. **Protect from wildfire** extant populations from intense prescribed burning and wildfires;
2. **Maintain and create early successional habitats** to mechanically manage in and adjacent extant sites and to create new open habitats for colonization and fire-buffering;
3, **Apply prescirbed burning** frequent, low-to-moderate intensity prescribed burning to restore open pine plains that historically supported species and reduce the potential for damaging high intensity fires;
4, **Research** propagation and reintroduction methodology; and
5. **Reintroduce** into known historic, now extirpated sites via out-planting in restored open habitats.

This species is currently on the NJ Forest Service prioritized list of rare plant species for Recovery Plan development.

Pine Barren Gentian Recovery Plan

As mentioned in the assessment section of this document, the Pine Barren gentian is a fall flowering perennial threatened by changes in fire regime, mowing schedules and herbivory. However, the New Jersey ONLM, considers the recovery potential for this species to be high.

Limited management of this species has been shown to increase density, flowering percentage, seed set and population growth rate over successive years. Through habitat management strategies of increasing canopy openness, reintroducing fire and mowing woody shrubs in the dormant season near or within known gentian occurrences, this allows limited seed set from flowering plants to further thrive and increase the population.

This species is currently on the NJ Forest Service prioritized list of rare plant species for Recovery Plan development, and as such, the ONLM has been working jointly with the NJ Forest Service and the Pinelands Preservation Alliance to restore favorable habitat conditions for this species in several locations throughout the state.

Pickering's Morning Glory Recovery Plan

Recent research has led to a better understanding of propagation techniques regarding Pickering's morning glory. Additional research is still needed, however, on the reproduction and methodology leading to the species success across New Jersey public lands.

Currently, seedlings that are properly stratified and planted in the field at test plots on an experimental basis are seeing a 75% success rate. Balanced disturbance appears necessary for the healthy recovery of this species, making recovery potential medium to high. ONLM strategies for the recovery of Pickering's morning glory include more opportunities for identification of populations, increased protection, and annual monitoring of existing populations.

Additionally, habitat enhancement strategies include raking of pine needle/leaf litter and the clearing of successional growth, combined with a properly timed fire regimen to eliminate competing growth and maintain open, sandy habitat that will likely increase populations.

Pickering's morning glory is on the NJ Forest Service prioritized list of rare plant species for Recovery Plan development in cooperation with ONLM, which promotes research studies for reproduction and restoration methodology.

3: FOREST MANAGEMENT PLANS (SCALABLE MANAGEMENT)

Public Lands Management

The NJ Forest Service strives to develop forest stewardship plans in a scalable fashion. This includes data (see **Inventory** within this national priority strategies section and **Data** within the **National Priority 3** strategies section) that can be related at different scales (both temporal and spatial) to allow for meaningful planning and on-the-ground management at various scales as well.

The NJ Forest Service has developed a framework for developing natural resource stewardship plans on public property. The framework consists of utilizing data from different scales in a collaborative 14-step stakeholder process (discussed in further detail within **Criterion 7**, **Guiding Principles: Framework** section of the assessment and within the **Education, Communication and Outreach** section of National Priority 3).

Private lands inspection with NJ Forest Service and a consulting forester in Medford Lakes, NJ. Photo by: J. Douglas, NJDEP

The NJ Forest Service uses FIA data, which is collected at two times the national intensity on a five-year cycle, to track conditions and trends through time for the entire state (and smaller regions of the state when applicable). Discussing trends and conditions in parcel level plans allows the reader/public/stakeholder the ability to incorporate individual management activities into larger overall goals for the entire state on a landscape level.

This framework also provides easily linked criteria and indicators from the Montreal Process to an individual parcel's stewardship plan goals and objectives. In turn, these practices allow for ease in linking priorities set nationally and statewide from this NJ SFAP, into plans being developed at the parcel level (finer scale).

To recommend meaningful practices on-the-ground, the NJ Forest Service uses a scalable, data-driven approach to forest planning. In addition, state forest inventory data collected at the parcel level providing a "snapshot" in time of current forest conditions will also be used to make informed decisions for both the New Jersey landscape and individual parcels.

Both FIA data and state forest inventory data are described and discussed in further detail in the **Inventory** strategies section following. Extensive use of scalable data allows the NJ Forest Service to make forecasts into the future with higher levels of certainty during simulation modelling.

It is a strategy of the NJ Forest Service to provide data-driven stewardship planning that scales not only by land area, but through time. This strategy is essential for the achievement of another closely related strategy, the consideration of potential alternatives in the planning process including a no-action alternative.

The NJ Forest Service considers the potential outcomes in forest stewardship plans for at least 40 years into the future. This is compatible with permitting by the New Jersey Pinelands Commission, even though activities which require Pinelands permits are only valid for ten years.

It is important to use long-term planning horizons, even in an environment with shorter permitting timescales because management activities may not yield the desired results for many years after initial implementation. Thus, documenting the intent of management prescriptions through robust plans is necessary so that management outcomes can be adapted as needed for success across many permitting horizons.

Another strategy that the NJ Forest Service plans to implement into the future is the use of optimization tools to better assess the tradeoffs associated with different management alternatives. These tools can provide insight for potential management outcomes that otherwise may not be apparent.

As the demands on resource managers continue to grow in regard to tradeoffs to consider and effects on natural resources across a broader range of scales both spatial and temporal when making decisions, these tools will be invaluable.

With increasing demands for landscape-level management and the decreasing number of personnel working in conservation for the state of New Jersey, the use of more contracted labor is inevitable. The NJ Forest Service plans to use contracted labor in a strategic fashion to ensure that the integrity and intent of the management of public lands is kept intact.

This strategy involves making use of qualified contractors for the collection of data, project implementation and highly specialized technical input not consistently required to deliver management of the state's forest resources on a continual basis. While NJ Forest Service will use contractors, planning and decision-making will remain the purview of public entities such as the NJ Forest Service under the Commissioner of the NJDEP, the state's official trustee for state-owned lands in New Jersey.

"The NJ Forest Service considers the potential outcomes in forest stewardship plans for at least 40 years into the future."

Private lands – Keeping Forests as Forests and Working Forests Working

The NJ Forest Service manages two regulatory program areas for private lands, the FLA Program and the FSP. Both pertain to the FLA Act of 1964. The Act was amended in 1986, during which time the criteria on which certain woodlands qualify for reduced taxation were redefined (Sheay and West, 1999). The regulations for the FLA Program are under the jurisdiction of the New Jersey Department of Treasury, Division of Taxation (N.J.A.C. 18:15) and the Forest Stewardship regulations are under the NJDEP (N.J.A.C. 7:3-5). As of February 27, 2020, the Division of Taxation regulations only account for WMPs.

FLA provides an opportunity for private landowners to manage their woodlands for the production and sale of forest products, provides guidance (a plan) to avoid excessive and unnecessary cutting (sustainability) and enables participants to receive a preferential tax benefit in the process.

Like the FSP, it also integrates many New Jersey agencies such as the NJ Forest Service, NJ Forest Fire Service, data provided by the ONLM and NJDEP Division of Land Resource Protection. The NJDEP is statutorily required to implement this program and to work with local tax assessors in doing so. Regulations require that NJDEP ensure the properties are inspected every three years. See **Appendix F** for WMP criteria.

Prior to the adoption of New Jersey's Forest Stewardship Program (FSP) Rules on December 18, 2017, the FSP in the state was considered the Federal FSP under the guidance of the USDA Forest Service, Eastern Region, State and Private Forestry, Forest Stewardship Plan. This federal

program included New Jersey specific provisions (i.e. Freshwater wetlands, flood hazard areas and the New Jersey Pinelands Commission).

This is a voluntary program that provides technical services to private woodland owners with over five acres of forest land or land capable of being forest and provides an opportunity for landowners to conserve working forests for water quality, wildlife habitat management, wildfire mitigation and recreational opportunities.

To assist in managing the two private lands programs (FLA Program and FSP), private consulting foresters are hired by private woodland owners. While foresters employed by the state of New Jersey provide technical services to various entities, responsibilities do not entail being service foresters for the preparation of Forest Stewardship Plans or WMPs for private landowners.

Foresters employed by the state as part of the Private Lands Program review, comment and approve these plans; inspect properties; and provide technical services to landowners in or desiring to participate in, these programs.

The NJ Forest Service also administers the New Jersey List of Approved Foresters. This list currently has more than 55 professional foresters who provide services to private woodland owners and other entities that require their professional expertise.

By regulation (N.J.A.C. 7:3-3), these foresters need a minimum of a bachelor's degree from a Society of American Foresters (SAF) accredited institution in forest management or closely related field or a degree from Rutgers–the State University in the forest management option within the natural resource management curriculum awarded no later than 2007, as well as two years of experience.

The services provided by approved foresters include:

- Timber Inventory and Appraisal;
- Forest Management Plan Preparation;
- Reforestation/Tree Planting Assistance;
- Timber Stand Improvement;
- Firewood Marketing and Management;
- Timber Sale Administration—includes marking, selling and supervising sale of timber and other forest products;
- Forest Insect and Disease Control;
- Christmas Tree Management;
- Forest Wildlife Management;
- Forest Taxation and Finance;
- Tree Farm Inspection and Recertification (free of charge);
- Forest Stewardship Plan Preparation; and
- Community Forestry Management Plan Preparation.

Approved foresters are also affiliated members of professional associations such as:

- Association of Consulting Foresters
- Society of American Foresters (SAF)
- New Jersey Licensed Tree Expert (LTE)
- International Society of Arboriculture (ISA)
- Technical Service Provider (TSP) (USDA, NRCS)

Approved foresters prepare plans following one of two sets of criteria, depending on the program the woodland owner wants to participate in. A WMP may be written following criteria from the Division of Taxation (N.J.A.C. 18:15) or a Forest Stewardship Plan following criterion from the NJDEP (N.J.A.C. 7:3-5).

Both types of plans are designed to steward these private forests for a ten-year period. The landowner can participate in the FLA Program with either plan. Alternatively, the landowner may want a plan to better steward their property and not have to apply annually for FLA if they are not interested in a reduction in property taxes. Most are interested, however.

The number of woodland owners new to forestry that participate in managing their woodland continues to increase each year with hundreds of

plans being submitted for review and approval. Many plans also come in as an update for the next ten year plan period or as an amendment due to a change of ownership, goals and/or objectives or a change of acreage.

The strategy of the NJ Forest Service, Private Lands Program is to continue to foster natural resource management for water quality and quantity; mitigate wildfire; create and enhance wildlife habitat; support and create employment opportunities in the private and government forestry sector; and support a web of retail services. The priority of jobs is partially addressed through structured fees for the continued preparation of plans, implementation of stewardship management activities and the purchasing of materials associated with this forest management.

The USDA Forest Service FSP is a federally supported program that New Jersey applies for each year; the USDA Forest Service allocates approximately $130,000 per year to the state for implementation. This funding can be drawn down over five years. The program integrates many NJDEP programs such as ONLM, ENSP, Bureau of Geographic Information Services (BGIS) and NJDEP Division of Land Resource Protection to provide data services necessary for meeting the criteria to prepare a forest stewardship plan and ensuring forests are managed for long-term sustainability. These data services include reports from the Natural Heritage Database for plants, Landscape Project for wildlife and BGIS stream coverage, respectively. See **Appendix F** for Forest Stewardship Plan criteria.

The Stewardship Act of 2010 or the state's FSP is designed to promote the long-term active management of forest lands in order to conserve and enhance the forest resources and ecological services. This program has merged the existing federal FSP with the FLA Program with the potential benefit of achieving preferential tax benefit without the production and sale requirement of forest products.

The "new" state FSP, unlike the requirements set forth for WMPs as part of the state's FLA Program, does not require an income for preferential tax treatment. This difference has necessitated continued training to consultant foresters, landowners, tax assessors, municipal court judges and agencies involved with these two programs.

The training generally encompasses the implementation of prescribed activities that do not generate an income but can be an actual cost for landowners. For example, activities such as invasive plant species removal, wildfire mitigation/brush control, DCA suppression and/or wildlife habitat management. Plans will now need to evaluate activities that were traditionally a cost and that previously did not qualify for FLA, but now do.

> "The role and strategic importance of private forest lands in achieving the desired outcomes of water quality, wildlife habitat and wildfire mitigation, as well as future conditions for the priority forest landscapes and associated areas is critical. There are more than 2,500 Forest Stewardship Plans (195,000 property acres) and 6,000 WMPs (258,000 acres)."

The role of the Forest Stewardship Advisory Committee is to advise NJDEP on issues related to forest stewardship and other related matters. NJDEP's regulations at N.J.A.C. 7:3-6 establish the membership, responsibilities and operation of the committee so that it can provide input and guidance necessary to foster the growth of the state's FSP. One of the committee's roles is to determine what other qualified (degree required) natural resource professionals, other than foresters, can prepare Forest Stewardship Plans.

The role and strategic importance of private forest lands in achieving the desired outcomes of water quality, wildlife habitat and wildfire mitigation, as well as future conditions for the priority forest landscapes and associated areas is critical. There are more than 2,500 Forest Stewardship Plans (195,000 property acres) and 6,000 WMPs (258,000 acres). Nearly all acres in Forest Stewardship Plans are included in WMPs. These properties occur throughout New Jersey and provide connectivity with state and federal lands. This provides the appearance of landscape level stewardship on a state scale. However, there is no general coordination from one landowner to another, despite the fact that these plans follow the same overall program criteria for sustainable forest management.

Outcome Based Forest Stewardship

Example 1: Water Quality

Nationally, the Forest Stewardship Program (FSP) is going through changes regarding how it provides technical services to woodland owners and how the availability of federal funding is allocated across the priority areas represented in the SFAPs. As previously referenced, there are four priorities of concentration in the NJ SFAP and the Forest Stewardship Plans; fire, water, wildlife and jobs. The FSP is looking for anticipated outcomes for each of these and how they are integrated.

With the assistance of Farmland Assessment (FLA), private lands forest management helps in "Keeping Forests as Forests and Working Forests Working" (NJ Forest Service, 2010) by providing a mechanism for woodland owners to sustainably manage their property(s) for a variety of goals and objectives, receive cost-share to prepare a plan and implement their plan while receive reduced property taxes. This is a trifecta achievement of environmentalism, economics and stewardship.

The NJDEP Division of Water Monitoring and Standards recently upgraded several hundred river miles to Category One status. In addition, several streams were reclassified based on trout sampling data (Surface water Quality Standards amendments: N.J.A.C 7:9B-1.15). Category One waters must meet no measurable change in water quality and are subject to a 300-foot riparian zone along the Category One waters and upstream tributaries within the same subwatershed or HUC 14.

In partial contribution to the reclassification of additional river miles, private lands management programs provide incentives for woodland owners to keep their properties as forests, thereby reducing parcelization, fragmentation and land use change. This results in overall fewer impervious surfaces. This is important as rainfall on these impervious surfaces cannot naturally seep into the ground.

As rainfall moves across these impervious surfaces, it carries pollutants and other biological contaminants with it—contaminants that often wind up in nearby streams or other water bodies causing water quality issues. Therefore, keeping forests as forests would increase one of the metrics that is preferred to be low (e.g. impervious surfaces).

As an outcome-based result, private lands management programs and their landowner participation help to Keep Forests as Forests and provide for filtration of water, streambank stabilization, habitat for wildlife, shade for streams and cooler temperatures for trout and other fish.

Example 2: Wildfire

A common practice prescribed by consultant foresters and one most often implemented by woodland owners, is forest stand improvement to thin overstocked stands. Thinning creates more growing space for the residual trees, reduces crown closure and reduces ladder fuels (if thinned from below).

This mitigates the likelihood and/or severity of a wildfire and promotes the conditions necessary to reintroduce fire into a fire dependent ecosystem like the NJ Pine Barrens, in the form of prescribed burning. Prescribe burning further reduces fuel loading, prepares the ground (site preparation) for colonization of native plant species and provides habitat enhancement for wildlife.

Figure 77. Image of thinned vs unthinned mixed pine forest in New Jersey. Photo by: NJ Forest Service

Figure 77 shows the point at which a thinning prescription has temporarily ended and provides an example of how thinning reduces stand density (center to left side of image). The comparison of unthinned, denser forest and the need for thinning is also illustrated (right side of image). The particular thinning prescription visible in **Figure 77** was designed not only to mitigate wildfire potential, but primarily to increase growing capacity and health of the mixed pine species present by reducing competition between trees for greater resilience to SPB attack.

Urban and Community Forestry Plans

One of the three requirements for a local government to obtain and maintain Accreditation with the NJUCF Program is the development and implementation of an approved stewardship plan for trees and forests. The NJ Forest Service, NJUCF Program is currently developing new guidelines for local government stewardship plans for trees and forests through a 2018 LSR grant from the USDA Forest Service. The purpose of revising these guidelines is to bring a scientifically and professionally rigorous process to the local governments invested in managing their trees and forests.

Currently, the Community Forestry Management Plan guidelines and the five year plans developed by local governments in accordance with these guidelines, are more strategic plans or proposed courses of action. This LSR grant project intends to move away from the more strategic model and strives to provide guidelines for comprehensive management plans that include short-term as well as and long-term management goals and specific objectives with a usable timeline by which to establish action items. This allows for the monitoring of activities and actions that work towards the developed goals and objectives, which could be based on measurable urban and community forestry data.

New Community Forestry Management Plan guidelines will also include the development of a standard baseline inventory procedure or "pre-cruise sample," along with the collection of inventory data in each municipality or county. The developed and recommended standard baseline inventory to be conducted will be included with all new and updated NJUCF stewardship plans per the newly developed guidelines. Furthermore, the guidelines will require urban and community forest assessment to value (quantitatively and financially) the ecological services provided by local trees and forests.

The NJUCF Program is working with technical urban forestry and planning experts to ensure that the best urban forestry science and grass roots participatory planning practices are incorporated into the new planning guidelines. Additionally, the NJUCF Program has evaluated the guidelines for both the NJ Forest Service State Lands and Private Lands management plans currently being utilized and is striving to closely align the Community Forestry Stewardship Plan guidelines with these. Preliminary guideline development includes three primary sections: (1) Structure –What do we have?, (2) Function—How is it working? and (3) Management—Is this where we want to be? If yes

Prescribed burn in Wharton State Forest. Photo by: J. Douglas, NJDEP

or no, how do we maintain what we have or how do we get to where we want to be?

The new Community Forestry Management Plan guidelines and therefore plans, will include provisions for "green stormwater infrastructure" (GSI) and stormwater mitigation. These are important provisions, especially in urban CSO communities, to address the toxic effects of overflows. When combined sewer systems overflow due to a heavy rainfall, the local watersheds are polluted not only with stormwater runoff from impervious surfaces, but also with untreated sewage. This is not only a human health hazard but is detrimental to the health of the watersheds.

Separating combined sewer systems by installing a new set of underground stormwater pipes is a costly and lengthy process. Instead, GSI systems, such as enhanced tree beds, rain gardens and similar bio-infiltration techniques can be used to capture rainwater runoff closer to where it falls and allow it to soak directly into the ground, thereby diverting stormwater away from the combined system and reducing overflow and its associated effects.

GSI produces a variety of other important community benefits as well including the enhancement of community greenery, improvement of air quality, amelioration of urban heat island effects and the creation of wildlife habitat islands.

Lastly, the new Community Forestry Management Plan guidelines will require a connection to local, county and state Office of Emergency Management (OEM) plans. This will be done through the integration of urban forest strike team and FEMA vegetative debris management planning into new and revised plans.

Community Wildfire Protection Plans

As the population in New Jersey continues to spread into the wildland or increase the amount of Wildland Urban Interface (WUI), community planning for the protection of both lives and property from wildfire is an unremitting challenge. An effective tool in addressing the challenges of a dynamic WUI in New Jersey is a network of CWPPs. CWPP development in New Jersey focuses on three major goals as identified within the National Cohesive Wildland Fire Management Strategy:

- **Restore and Maintain Resilient Landscapes:** *L*andscapes across all jurisdictions are resilient to fire related disturbances in accordance with management objectives.
- **Fire Adapted Communities:** Human populations and infrastructure can withstand a wildfire without loss of life and property.
- **Wildfire Response:** All jurisdictions participate in making and implementing safe, effective and efficient risk-based wildfire management decisions.

The NJ Forest Fire Service focuses on the Northeast Regional Action Plan option 2A to address these goals:

Regional Option 2A: Focus on promoting and supporting local adaptation activities to be taken by communities such as increasing capacity of volunteer fire departments, passing ordinances, developing Community Wildfire Protection Plans and joining Firewise Communities/USA® or other similar programs.

Through CWPP support for local communities, the NJ Forest Fire Service encourages municipalities and their residents to:

- **Recognize** their responsibility to protect themselves and their property from wildfires.
- **Determine and prioritize** fire protection options available.
- **Implement** the selected methods to reduce their exposure to the threat of wildfire.

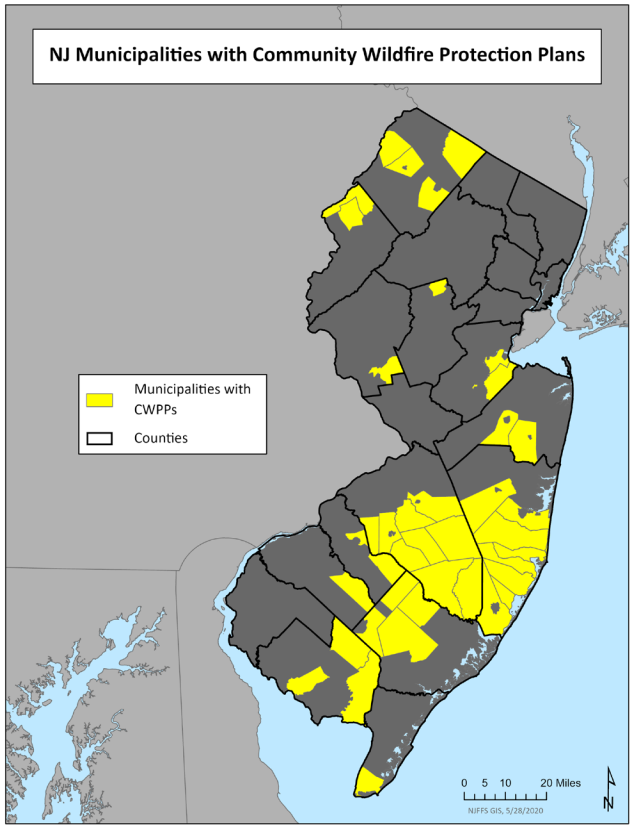


Figure 78. NJ Municipalities with Community Wildfire Protection Plans. (NJFFS, 2020)

The NJ Forest Fire Service offers planning and strategic guidance at the municipal level as prioritization of new and renewal of existing CWPPs continues to be refined. Initial CWPP locations were selected from the New Jersey Pinelands Region utilizing data including wildfire history, hazard mapping and WUI exposure.

Current municipalities enrolled in this program are demonstrated in **Figure 78**. The NJ Forest Fire Service is embracing cutting edge science and technology to model, visualize and interpret wildfire hazard and risk for future use. Through the development of a data assessment and Wildfire Risk Assessment Portal (WRAP), the NJ Forest Fire Service will be able to more efficiently engage with stakeholders to accurately identify and prioritize wildfire mitigation opportunities, as well as those at the community level.

Additionally, the State Hazard Mitigation Plan, required by FEMA under the Stafford Act, directs that a CWPP be developed for all municipalities in the WUI within New Jersey. The Stafford Act requires states to provide all-hazard mitigation planning, including wildfires. In New Jersey these all-hazard plans are focused at the county level.

Fire as a Management Tool

One effect of the Prescribed Burn Act signed into law in 2018 (see **State Legislation and Policies** within **Criterion 7** of the **Assessment** for further details) was to change how prescribed fire could be used as a management tool throughout New Jersey. Prior to this Act, the only legal use for prescribed fire in the state was for fuel hazard reduction. This new Prescribed Burn Act now authorizes prescribed burning for a variety of uses including public safety and wildfire control, as well as for ecological, silvicultural, agricultural and natural resource management purposes.

It is the strategy of the NJ Forest Service to make use of these expanded uses of prescribed fire in conjunction with the NJ Forest Fire Service, particularly for ecological and silvicultural purposes. It is important to note that the NJ Forest Fire Service and NJ Forest Service continue to work closely with the utilization of prescribed burning for public safety and wildfire control, often combining silvicultural and wildfire mitigation/suppression tools and techniques.

Many of the strategies outlined within this NJ SFAP make use of prescribed fire as a management tool. These strategies could include more traditional applications such as wildfire mitigation, but can also include forest restoration, regeneration, invasive species control, establishment of rare plants, creation/maintenance of habitat for rare wildlife species and more. Density management, for example, can be combined with prescribed fire in a variety of ways to achieve a wide range of goals. Likewise, forest restoration for species such as shortleaf pine, mixed oak and even the protection of AWC, could make use of prescribed fire. Prescribed fire could also be used as a tool for strategies to adjust forest age class distribution.

The NJ Forest Service has also worked in cooperation with ONLM and the NJ Forest Fire Service to use fire and silvicultural techniques for rare plant habitat restoration. In addition, the NJ

Forest Service has operated in an advisory capacity for local government entities, the NJDEP Division of Fish & Wildlife and private consultants in cooperation with the NJ Forest Fire Service to support highly integrated forest management and wildfire mitigation plans that support strategic planning across ownerships for both public safety and ecological purposes.

The USDA Forest Service, New Lisbon Research Station, works with the NJ Forest Service and the NJ Forest Fire Service to provide valuable research regarding fire behavior, tree mortality from fire, carbon flux, air pollution and even the responses of tick populations to prescribed burning and silvicultural treatments throughout the New Jersey Pinelands.

One of the strategies of NJDEP is to expand upon these efforts into the future. Expansion could take the form of increased numbers of personnel, funding or equipment, as well as joint venture and collection agreements with academic, federal, NGOs and local government partners.

The NJ Forest Fire Service has also been able to leverage the broader range of landscape level management with passage of the new Prescribed Burn Act. Partnerships with Tall Timbers and the NRCS have enabled the NJ Forest Fire Service to provide assistance to local government, private and NGO land managers to use fire as a management tool as well.

The NJ Forest Service has provided this assistance in a variety of ways including acting in an advisory capacity and providing resources and personnel for training (both as trainers and trainees). It is a strategy of the NJ Forest Service and NJ Forest Fire Service to further expand upon these efforts through continued cooperation, jointly seeking future funding and expanding the number of personnel and resources available for these efforts.

Wildfire Mitigation

The NJ Forest Service and the NJ Forest Fire Service work closely to locate, prioritize and implement fire risk reduction activities across the landscape. The NJ Forest Service FSP and FLA Program promote the reduction of hazardous fuels with private woodland owners. In addition, passing of the recent Prescribed Burn Act has enabled the NJ Forest Service and the NJ Forest Fire Service to work closely with NRCS to provide cost-share opportunities for implementing these hazardous fuel reduction activities.

Since 2014, the NJ Forest Service has conducted 29 silvicultural projects related to fire mitigation strategies totaling approximately 4,000 acres, more than what had been done in the preceding ten years. However, more is needed to solve the excessive density issues that still exist across the state.

The NJ Forest Service recognizes the continued vital need to address these issues and intends to do so through actions discussed within this SFAP. The NJ Forest Service continues to explore various forest management and density reduction projects, including partnering with private enterprise, that may provide opportunities to cost-effectively realize the broader ecological management and fire safety goals.

Strategies specific to fire mitigation and state-owned lands include executing broad-scale forest management that is both cost-effective and respectful of the natural resource concerns behind the original acquisition of these public lands. These include the creation of a "Fuels Crew" in partnership with the NJ Forest Fire Service to conduct fuel reduction work as well as pre/post burn fuel load measurements. In addition, the development of new state term contracts for forest management implementation that can provide a greater range of equipment and options for technique to implement less economically viable projects is also a focus.

One of the strategies for wildfire mitigation includes the ability to secure additional stable sources of funding for continued and improved forest inventory, monitoring and management. This aids the NJ Forest Service in promoting the management of state-owned public forests for ecological services such as watershed protection, wildlife habitat, plant diversity and carbon sequestration. Promotion of these environmental and public benefits through the sharing of scientific data and constructive

Taking inventory of Atlantic white cedar in Wharton State Forest. Photo by: J. Douglas, NJDEP

communication helps to offset negative emotions that often surround traditional forest management activities. This is also an important strategy of the NJ Forest Service over the next ten years.

4: INVENTORY

As stated previously, New Jersey is a relatively small and densely populated state. Despite enormous population pressure, a sizeable portion—roughly 40% of the state is considered forested and approximately half of that forested area is publicly held. However, this pressure is causing rapid changes in the state's forest resources. New Jersey's population is not only dense, but extremely diverse. This highly diversified population means that opinions vary widely and can change often with respect to how, for whom and to what ends that state natural resources should be managed.

Robust inventory and analytical processes are therefore necessary to keep up with these increasing and changing demands. With the rise in the use of internet capable mobile devices, opportunities for data driven outreach are also greater than ever before. This trend is expected to continue far into the future. Therefore, the NJ Forest Service strives to continually maintain and improve how it collects, processes, analyzes and presents data about all tree and forest resources.

Forests cover large expanses and grow over very long periods of time relative to the scales encountered in people's everyday lives. When looking at a large and changing resource, the concept of scale becomes very important. For instance, a half-acre gap created by a storm may look devastating at the scale of one acre, however, in the context of a 60-acre stand of trees or a 20,000-acre forest or even the eastern seaboard, this same disturbance might appear quite different. In order to consider changing forest resources at multiple scales both in size and through time, the NJDEP is continuously refining a system of scalable inventory.

Coarse Scales, Long Time Periods

The USDA Forest Service, FIA program acts as the nation's forest census. One of the prime functions of this program is to gather data through remote sensing and a network of permanent forest inventory plots. It is a strategy of the NJ Forest Service to partner with FIA to collect data on permanent plots throughout the state at a higher intensity and frequency than the national standard.

Rural forests across the state are measured at two times the intensity of the national grid. In addition, the NJ Forest Service partners with FIA to ensure that the entire state is remeasured every five years on a rolling annualized schedule (as opposed to the base program remeasuring each state every seven years for the northern states). It is also a strategy of the NJ Forest Service to partner with FIA as a participant in the UFIA program, collecting plots at a higher frequency and intensity as well (every five years).

In this program, plots are collected from sites that do not meet the traditional FIA definition of forest in urban and community settings. This data will be particularly used to inform strategic planning initiatives for urban and community forest resource planning at the state level.

Future strategies may include intensifying collection further, in order to provide a data stream through time at a finer scale, in addition to integrating a statewide inventory tool for local governments to

communicate their data with the NJUCF Program and with each other. By comparing UFIA data with data collected through local inventories, the NJ Forest Service is able to scale the context of urban and community forest management from the local, to watershed, to state, to regional efforts.

FIA also manages the National Woodland Owner Survey (NWOS), which surveys landowners that own forested properties of ten acres or more across the United States. The NWOS can be used at the national, regional and state level. In addition to data from permanent plots and the NWOS, FIA is also responsible for conducting the Timber Products Output (TPO) survey across the country. The state of New Jersey intends to maintain this partnership, as the data and data products produced from this effort allows for evaluation of landscape level changes through time.

Data collected as a part of this effort are made publicly available in several different formats. These formats include traditional reports, digital products such as story maps and tabling interfaces, as well as raw digital data served in batches through Application Programming Interfaces (APIs) to FIA databases.

> "Roughly 40% of the state is considered forested and approximately half of that forested area is publicly held."

Information gained from these data sources is referenced throughout this SFAP and represents an important, non-traditional means of data gathering related to our state forest resources. FIA data serves to connect our knowledge of the forest resources of New Jersey, to the forests of the country and the globe. Therefore, it serves a valuable role in New Jersey's overall scalable forest data collection and analysis strategy.

In addition to the data products mentioned above, FIA also oversees the development of the i-Tree tool suite in partnership with Davey Tree. These tools distill data from a wide variety of data sources to provide information about urban, community and rural forests at a variety of scales. Part of what makes i-Tree unique is the tools' ability to conduct benefit analyses for ecosystem services that forests and trees provide. Examples of these types of analyses include tree impacts to stormwater across entire watersheds, to looking at the impacts on energy usage of planting a single tree near a specific building.

The NJ Forest Service currently leverages i-Tree to provide data and information to stakeholders and natural resource managers across the state. The Rutgers Urban Forestry Program, in partnership and with the support of the NJUCF Program, provides training and analytical support to a wide range of stakeholders interested in making use of the tool suite. These stakeholders include urban forestry and arboricultural consultants, municipal and county shade tree commission members, public works representatives, Rutgers University urban forestry, landscape architecture and other related program students and many others.

The Rutgers Urban Forestry Program has also partnered with the NJUCF Program on an LSR grant designed specifically to inform the update of the guidelines for Community Forestry Management Plans (discussed in further detail in the previous **Forest Management Plans** section and soon to be called Forest Stewardship Plans). The Rutgers Urban Forestry Program role in this grant and in the guidelines update includes incorporation of the use of the i-Tree suite of tools to help increase understanding of the benefits and values of trees in the urban landscape, as well as to help facilitate the use of this knowledge and understanding to inform management decisions at the municipal and county levels.

The NJ Forest Service plans to continue to support further development of the i-Tree tool suite through partnerships with the USDA Forest Service and academic institutions. This suite of tools provides opportunities to create better data products in addressing overall forest resource management planning for all trees and forests and specific emerging issues such as energy impacts in communities disproportionately impacted by environmental degradation and climate change.

These tools also provide opportunities for data products on the potential impacts from newly arrived insect pests and pathogens and the associated policy implications. Therefore, the state is also interested in creating a range of new data products using i-Tree. Lastly, the NJ Forest Service is incorporating into this NJ SFAP, the strategy of leveraging its partnerships to facilitate training of stakeholders in the use of i-Tree through state outreach programs, in addition to outreach provided by the Rutgers Urban Forestry Program and the USDA Forest Service.

The availability of public data has led to a rise in academic and NGO produced data products that are instrumental in bridging gaps between national, regional, state and local scales. One such project is the NJ Forest Adapt data dashboard produced by Rutgers University in partnership with NJDEP. This dashboard connects a variety of data sources to inform state and local governments, private entities and NGO planners.

The NJ Forest Service has also partnered with Rutgers NJ Forest Adapt to provide information about forest canopy to local governments for urban and community forest resource management through the "municipal shapshots" tool.

The Rutgers Urban Forestry Program is also working with the development team of the NJ Forest Adapt web tool to build from the previous partnership with the NJ Forest Service. This includes informing the team and enabling student research to support the development of additional data for the snapshots derived from i-Tree Landscape to help municipalities prioritize planting goals based on specific criteria. These criteria would include things such as flooding/stormwater management, carbon storage and sequestration and percentage of population below the poverty line.

Another data effort is the NJ Conservation Blueprint created and maintained by Rowan University in partnership with the NJ Conservation Foundation and The Nature Conservancy. This online interactive mapping tool is aimed at the public, as well as conservation professionals from a broad array of fields. The blueprint is not just limited to forest conservation but provides insights into many conservation issues across the state by displaying data in an interactive way that is accessible to those with less technical backgrounds.

Finer Scales, Snapshots in Time and Baseline Data for Future Projections

Another strategy of the NJ Forest Service (implemented since 2014) has been to acquire funding and contract services to attain inventory data of New Jersey's public forested land at an average rate of approximately 40,000 acres per year. The collection of this data is used to inform the public agencies that manage these properties, by providing a "snapshot" of the current forest conditions at a rate of one plot for approximately every 20 acres of forest. This rate can differ based on variability within each forest type of the state-owned parcel.

These inventory plots include nested sub-plots used to gather additional data on forest regeneration, understory vegetation species composition and understory competition. The primary purpose of this data collection effort is to support natural resource stewardship planning on New Jersey state-owned properties.

This inventory is conducted at a much higher intensity and with temporary plots, rather than the permanent FIA inventory described above. This method of data collection provides information at a finer scale (i.e. an individual forest type within a particular forest parcel), as well as a baseline data set that is suitable for simulation models projecting forest conditions into the future under a variety of management scenarios and a no-action alternative. These models are calibrated using data collected through time from the FIA effort and then run using the higher intensity snapshot data, which includes specific radial and height growth information (an additional fine-tuning mechanism of the calibrated models).

Another purpose for data collection of this magnitude is the opportunity to share it with academic institutions, NGOs and other interested parties to further develop research and outreach

opportunities. The NJ Forest Service receives multiple requests each year from academic institutions, graduate students and other government entities for this data which is used for a variety of purposes beyond natural resource stewardship planning.

Several graduate students have produced research papers using this data on topics ranging from forest structure, to disturbance response, impacts of wildfire and more. The NJ Forest Service is also engaged with university partners for use of the data in education programs for students learning silviculture, ecological forest management, ecological modelling, simulation modelling, statistics and machine learning.

Within NJ Forest Service's overall strategy for scalable forest inventory, operational inventory represents the finest scale "traditional" style of inventory taken. These inventories are taken at high intensities to accurately represent forest resources at the individual forest stand level. They are usually designed to provide a snapshot of a specific area with some type of operational objective in mind (i.e. timber harvest, invasive species control, forest regeneration, prescribed burning response and riparian zone restoration).

The data produced by these efforts may or may not be used in simulation modeling based upon the operation objective being evaluated or supported. These inventories are modular by design and are highly flexible to support adaptive management under fluid conditions on the ground.

Botanical Inventories

The management of forest resources has become significantly more complex as our understanding and interest in managing entire ecosystems rather than specific resources has advanced. A basic scientific principal in natural resource management is to establish baseline conditions so that the response to management can be quantitatively and qualitatively determined. However, comprehensive inventories of the flora and the ecological communities that support our flora are not available for most lands in New Jersey, including public lands managed by the DEP.

Arbor Day sawmill demonstration at Rutgers University. Photo by: J. Douglas, NJDEP

The Office of Natural Lands Management (ONLM), Natural Heritage Program, is the lead agency for these elements of biodiversity and for coordinating botanical surveys on state-owned public lands. Data is collected and maintained in the Natural Heritage (or Biotics) Database, the DEP's digital and manual file on occurrences of rare plant species and ecological communities. Most of this information is based on an extensive examination of New Jersey's rich history of botanical exploration followed by almost 40 years of targeted surveys to relocate historical records. To a lesser extent, de novo surveys of suitable habitats for rare plant species is also performed or is obtained from other qualified sources.

The ONLM has developed survey protocols to determine the locations and composition of the rare elements of biodiversity tracked by the Natural Heritage Program (ONLM, 2015). Application of these protocols by qualified botanical and ecological professionals will create a baseline that may be used to determine the biodiversity value or importance of a site, to guide habitat management to preserve or enhance occurrences of these elements, to assess the biodiversity impact of proposals to alter or destroy the habitat supporting these resources, and/or to design mitigation in those instances where avoidance of impacts to species or ecological communities is not possible.

Rare plant species include those species on the List of Endangered Plant Species and Plant Species of Concern *(http://www.nj.gov/dep/parksandforests/natural/heritage/ njplantlist.pdf)*. Natural Heritage Program Rare Plant Species Reporting Forms *(http://www.nj.gov/dep/parksand forests/natural/heritage/textfiles/NHRPSR_Form.docx)* record the existence, status, and location of occurrences of each rare species discovered during the survey.

> "Approximately 87% of the average annual timber volume harvested, is harvested from privately owned forests in New Jersey (FIA 2018)."

Botanical surveys can be conducted at the parcel or priority area level but may frequently be conducted at scales down to portions of individual forest stands covering individual plant populations. This is necessary as some herbaceous plants may cover very small areas with very narrow favored microsite conditions. These surveys represent another useful layer in the overall effort of scalable data collection for the State of New Jersey.

Since 2016, the NJUCF Program has provided 26 grants to accredited local governments to conduct inventories of their urban forests. Additionally, the program has modified its grants process so that only local governments with an inventory can apply for tree planting grants. This promotes the increase in management rigor and assists local governments in understanding how to use their inventory data to make more efficient and effective management decisions. All data collected locally must be shared with the NJUCF Program upon completion of their grant work. The NJUCF Program plans to aggregate these datasets to provide a bottom-up lens from which to examine the courser data coming from the Urban Forest Inventory Analysis (UFIA) effort.

Additionally, the NJUCF Program has begun recording data electronically upon final inspection of tree planting grants. In time, these data can help to inform the distribution of funds for tree planting into the future, while also enabling the ability to analyze past performance of grant recipients. Other uses of this data may prove useful as the mission of all trees and forests management continues.

The current update of the NJUCF guidelines for local government management plans for trees and forests is taking an in depth look at local inventory for both local plan development and to inform future management. Current LSR funding, as discussed previously, is being used to develop a standard baseline inventory procedure or "pre-cruise sample" along with a state standard on the collection of local inventory data based on defined "stands" within the local government jurisdiction. Such stands may include street trees, park tree lawns, traditional forests on public land, municipal or county management zones and urban land use, as defined by the local government in their tree and forest management plan development.

Future Inventory Strategies

Following the 2010 NJ SFAP, in which scalable inventory was identified as an explicit data gap, New Jersey adopted several strategies as outlined above to improve the scalability of forest inventory and to keep forest inventory relevant to land managers and the citizens of the state. It is the intent of the state to continue these efforts into the future. To that end, the NJ Forest Service has identified several key focus areas to improve scalable forest inventory. These include areas of climate impacts, disturbance, ecological integrity and the larger overall role of New Jersey's human population in relation to global natural resource concerns. This also includes eclipsed interests in single resource investments. Strategies to address these key areas in adapting forest inventories are outlined (but not limited to those) below.

Remote sensing data has become cheaper and more accessible than ever before. This trend is expected to continue with the cost of sensors and the means to distribute collected data continuing to fall. Inventory efforts benefit from this trend as the accessibility of this information can help forest managers and inventory specialists gain more information from on-the-ground measurements.

The rise in interest of machine learning, artificial intelligence (AI), spatial statistics and new statistical methods has allowed better interpolation of data into "surfaces" that cover gradients over a large area. One strategy taking advantage of this includes integrating field collected measurements with remote sensing data to create hybridized, modeled "surfaces" available at different scales based upon the data used to create these products. The result would be a system that provides data at multiple scales using remote sensing data, direct measurements and interpolations of either or both depending upon the requirements of the user.

Another strategy of the NJ Forest Service is to recognize that many direct measurements taken in the field will most likely be used, at least in part, as training data for machine learning models. Inventory design will be influenced in ways that emphasize the collection of data that provide adequate training characteristics for machine learning, rather than simply providing data of only features directly measured. This will involve experimentation with different types of sample design and analytical techniques, in addition to different methods of displaying forest resource data.

Expertise from a broader range of disciplines across ownership types will be necessary as the field of conservation expands, the lands where conservation takes place are redefined and the amount of data used in planning expands with it. The processing of very large datasets using systems such as distributed computing networks will also be considered.

5: FOREST PRODUCTS (UTILIZATION & MARKETS)

In the state of New Jersey, the importance of the forest products industry is notable and wide spread. Not only does the harvesting and processing of timber products produce a steady stream of income shared by landowners, managers, loggers, markets, truckers and various processors alike, but it also supports the proper management of the forest resource. The harvesting and processing of forest products also supports carbon sequestration through long-lived forest products, provides a renewable resource for energy alternatives and ensures a steady source of workforce development or "Green Jobs," in both rural and urban areas.

The forest products industry in New Jersey once flourished, producing a variety of products through many different processing methods. Today, the lack of forest product markets in the state has not only increased the difficulty of implementing forest management operations but has greatly encumbered jobs in the industry as well.

Currently, most of the timber extracted from forests within New Jersey comes from privately held land (as indicated within **Criterion 6** of the Assessment section of this document) and is shipped to neighboring states for further processing. The source of timber and where it's processed is important to understand as trends in these areas affect the ability to maintain stewardship practices and a resilient forest.

Niche markets and non-traditional forest products, as described more fully later in this section, may be promising avenues to explore to both support the utilization and marketing (U&M) of New Jersey's forest resources and to provide additional funding to improve the management of New Jersey forests as well. In conjunction with this exploration of these new markets, the state of New Jersey should take advantage of additional opportunities such as regional economic analyses and grant funding.

Analyzing Current Market Conditions

Presently, the NJ Forest Service is participating in a Landscape Scale Restoration (LSR) grant, led by the Michigan Department of Natural Resources, Forest Resources Division. This grant will provide the ability to quantify who, what, where and how forest products are being consumed, harvested or brought through New Jersey and the northeast region of the country. This grant will also assist in the ability to predict or relay market potentials to business owners and New Jersey citizens.

Participation in this LSR grant allows New Jersey to coordinate and compare reports with 20 other northeast and northcentral states involved, to provide an improved assessment of forests and the economies they support. Using FIA data and 2017 Impact Analysis for Planning (IMPLAN) data (an economic input-output model), an analysis was conducted to understand importing and exporting as well as primary and secondary processing that occurs in-state, regionally and comparatively with New Jersey and neighboring states.

The analysis is still currently underway and distribution of this report will be extremely useful to industry professionals when complete. From this analysis, more informed conversations can ensue regarding how the data can be tailored to address issues and trends of importance to more specific professionals.

The Wisconsin Department of Natural Resources is currently leading an additional LSR grant specific to the urban forestry economy. While economic impact studies for individual states or the broader green industry have been conducted, there has not been a standardized and repeatable approach for the economic impact analysis of the urban forest industry.

This LSR urban economy impact project will provide the needed methodology and will allow for future comparisons across states and through time to assess trends in the industry. This will be invaluable as we work to demonstrate the value of the forest products industry and the resource to stakeholders and to foster awareness among the public.

The Wisconsin LSR study is a financial contribution analysis for the 20 states of the USDA Forest Service, Eastern Area to quantify the economic impact of the urban forest industry and the environmental services provided by the urban forest resource in the region. The project will document the importance of urban forestry throughout the region and provide a basis for comparison with other regions and between states. This information is needed to help "tell our story" to policy makers in Washington D.C. and state legislators. It will help us describe why investment in active urban forest management and the environmental services provided by urban trees are important, using values that resonate strongly with lawmakers—jobs and financial contributions.

The resulting economic impact and resource valuation information will influence policies to optimize public benefits from the urban canopy. Additionally, quantifying the economic impact specific to the urban forest industry, as opposed to the broader green industry, will provide a standardized methodology resulting in data that has been long sought after, but difficult to attain. Results from both grants will be imperative to understanding markets for New Jersey and regionwide.

Niche Markets

There are several factors that have contributed to the decline of the forest products industry in New Jersey. Land use trends in the state have changed drastically as the gradual movement from an agricultural-based economy, to an industrial-based economy and finally to a service-based economy have ensued. Management of land no longer directly impacts as large a proportion of the state's population economically as it did historically.

Globalization of markets has also impacted timber markets nationwide, creating stiffer competition in wood processing and manufacturing industries. At the same time, the state has become more densely populated and the regulatory environment in New Jersey has become more stringent with regards to the creation of large production facilities for raw materials that benefit from economies of scale.

Therefore, niche markets are needed now more than ever for market and utilization improvement throughout New Jersey. Strategies used to support and create niche markets, however, must consider the possible negative effects such markets may have on the larger markets, such as sawmills and pulp.

A strategy taken by industry professionals relies on locally grown and sourced material for furniture and cabinetry products tailored to clientele. Forest products such as Christmas trees and maple syrup are examples of niche markets that have withstood the test of market imbalance, with farms and woodlots held by private landowners remaining steady in ownership and production. Integrated wood utilization strategies should harmonize with management and restoration goals, especially within the Pinelands Region of the state where active management is a necessity but does not have strong enough economic drivers for utilization.

Urban wood utilization can also attest to the locally grown and locally sourced markets while assisting local communities in species specific issues. For instance, many towns and counties planted ash *(spp.)* across the state decades before EAB was an issue. Now, local government officials have to make quick decisions regarding the disposition of dead and dying ash trees.

As already discussed within the Assessment section and throughout other strategies, trees are just as important in urban settings as they are in rural settings. Throughout the northeast region, the idea of urban wood utilization is constantly being explored. Urban forest products can be attractive because they pair local sourcing of raw material with places of high population density. Additionally, the utilization of urban and community trees may provide access to wood products from unusual tree species, as many trees in these settings are selected to survive within urban and suburban locales rather than the state's traditional forests. The availability of these species could provide opportunities for entrepreneurs seeking non-conventional or niche markets that may otherwise be unexplored.

Currently, New Jersey is one such state exploring these opportunities as conversation starters for linking forest industry professionals, entrepreneurs and forest managers/planners. An important strategy and a starting point in understanding and engaging individuals from "seed to saw" includes working together through the use of workshops and forums. The utilization of trees grown in urban and community settings provides unique opportunities for engagement with communities that may not otherwise have considered the role of the forest products industry in sustainably managing trees and forests or assisting in the creation of unique and underdeveloped opportunities for workforce development and small business generation.

Non-traditional Forest Products

While smaller niche markets should be considered, so should larger non-traditional forest products. Such unique forest products may include data services, carbon trading and pharmaceutical use. Many large pharmaceutical companies have headquarters established within New Jersey. Therefore, where applicable, links between forest industry professionals and pharmaceutical companies to discuss potential market overlaps with in-state versus out-of-state goods should be considered. Another potential non-traditional forest product is carbon trading.

Some private forest landowners within New Jersey are currently engaged in trading carbon credits and significant interest from state and local governments is also present. This interest stems from the possibility of trading carbon credits to provide additional employment and revenue opportunities throughout the state. However, engaging in carbon credit trading typically requires third-party auditors, such as consulting foresters, willing to be trained and take on additional work. Carbon credit trading should not impede sustainable forest management activities from occurring but provide added benefits of carbon sequestration. This is just one other way to capitalize on the added benefits New Jersey's forest can provide.

As noted previously, strategies for the utilization of wood should be harmonized with management and restoration efforts. Areas within the Pinelands where active management is needed but does not have strong economic drivers for traditional utilization could be targeted focus areas for non-traditional markets.

Data services, such as data mining and data science, are a rapidly growing industry that has exhibited growth while United States manufacturing has slowed. Increasing global interest in data applications further increases the demand for datasets that may be used for a wide range of applications including those which can be utilized as training data for machine learning algorithms. Therefore, much of the data collected for planning and monitoring of forest resources has the potential for monetary value, beyond the values of those originally intended. It is not impossible then, to imagine a time where the value of collected forest data products may very well exceed that of the traditional forest products produced from those same forests.

Data markets include applications such as training machine learning algorithms used in AI applications. For example, data collected from plots on the ground could serve a role in training algorithms to recognize forest attributes from remote sensing data. Training sets produced around forests could also very well have applications beyond forests or natural resources. For instance, a dataset for recognizing errors in tree species identification in forest inventories may also well serve applications in credit card fraud detection or an algorithm that proves useful in classifying forest types from remote sensing information may serve to classify indicators for rare cancer in blood test results. The NJ Forest Service would like to explore the potential for forest data sets in AI markets.

There are many aspects of worldwide data markets still emerging that are worth exploring. Expansion of the video game industry may provide opportunities in marketing forest data and analytical products for the development of realistic 3D environments as well. Smart devices capable of using data for a wide range of applications such as navigation, health, information and recreation could very well use forest data or some offshoot of this data.

These markets may provide another avenue for forest products and could help provide active management to the masses, both small family forests and large public entities. The state of New Jersey would like to further explore these markets throughout this next planning cycle by engaging partners and stakeholders both within and outside of the spheres of traditional forest management.

The NJ Forest Service is also interested in exploring the nature of data markets in terms of added economic potential and hedging against the cyclical nature of many traditional forest product markets (i.e. how cycles surrounding data markets compare with those surrounding more traditional forest products industries which were typically tied to manufacturing and/or building).

Planning for market expansion cannot solely be supported on analysis, non-traditional and niche markets. The ability to implement sustainable forest management practices through proper available equipment is also an important consideration. Placing equipment restrictions where necessary is important in preserving the integrity of the working land. Conversely, restricting equipment by weight when unnecessary will restrict the ability to responsibly support markets in an economical fashion.

NATIONAL PRIORITY 2:
PROTECT FORESTS FROM THREATS

1: RESILIENCY

Climate and Carbon

New Jersey's forests are experiencing stress as a result of climate change, which stress is projected to worsen over the next several decades. By adopting climate resilience strategies, we can better support the long-term health of our forests as they adapt to effects of climate change. While specific adaptation and management techniques will differ across New Jersey's forests, the primary climate change and carbon budget goals for our forests are to diversify forest carbon resources, promote resilient ecosystem function, enhance carbon sequestration, and prevent our forest resources from becoming a net carbon emitter.

What's New in This Planning Horizon

In the last planning horizon (2010 NJ SFAP) the NJ Forest Service and its partners identified strategies that largely focused on location selection for activities to increase the odds of their success in the face of climate change impacts. One such example included choosing sites for AWC restoration that were not likely to be impacted by sea level rise or the storm surge estimated to be associated with hurricanes up to Category Four. This was necessary because of the species' sensitivity to the exposure of saltwater. Such strategies continue to influence decision-making during this planning horizon as well.

During this planning horizon we will focus more on utilizing forest management as a tool to respond to the anthropogenic influences that have played the greater part in influencing forest ecosystem resilience in the last century. Anthropogenic influences are echoed throughout the Strategies section of this SFAP in regard to forest restoration, density, age class distribution, invasive species, herbivory, and more. Another key difference during this planning horizon is an increased understanding, recognition, and use of forest carbon cycles as a means of proactively addressing global climate change.

Carbon

Good Forest Management is Good Carbon Management

Through a balanced forest management approach that considers forest carbon among the myriad benefits and needs of our forests, the NJ Forest Service will best promote the the long-term health of our forests and the natural resources they support while responding to the risks of climate change through the maintenance and expansion one of the state's most critical carbon sinks.

The strategies outlined here emphasize that diversity is key in managing forest carbon to offset increases in global atmospheric carbon. In contrast, a singular focus on maximizing specific carbon pools or sequestration rates, just like maximizing any single forest attribute, increases the likelihood of unintended consequences to other important forest ecosystem functions.

Managing the state's forests for multiple objectives allows for resilience and a well-balanced New Jersey forest. Carbon is sequestered and stored at different rates depending on species, forest type, forest age, and other factors (see **Criterion 5** within the **Assessment** section for more details). Maintaining tree species diversity and ecosystem function across the landscape hedges against drastic, widespread changes in the forest resource, mitigating losses in stored forest carbon. Such changes can be wrought by insects, pathogens, and environmental stressors like drought; working to dampen stress steadies the behavior of forests in the carbon cycle, if lowering the maximum sequestration rate.

Age Diversity

A forest landscape that exhibits a wide range of age classes supports a robust positive carbon balance, in addition to other co-benefits (see **Priority 1** and 2018 NJ SWAP). Different forest types grow at different rates, go through various stages of development, and reach maturity at differing times, driving a diverse range in forest ecosystem carbon behavior.

Forest age interacts with forest type to cause carbon cycling to behave differently in different forests. Older forests generally store more carbon, but a younger forest in a carbon-rich forest type may hold more carbon than an old forest in a carbon-poor forest type. Carbon is partitioned differently between roots and shoots based on forest age, but this also varies depending on the life history strategy of the species in a given forest type.

Old forests tend to store proportionately more carbon in roots and soil, while younger forests store more in living tissue, but the lifespan of different species (and their presence in differing forest types) complicates simple comparisons across type by age. In a given year an older forest pulls less carbon out of the air than a younger forest, but "old" and "young" here refer more to the physiological attributes of the trees and species on a site than they do to a numerical age. Managing for age diversity steadies changes to the carbon pool: some young forests will show a higher rate of sequestration, while some older forests will have steadier already-stored carbon pools.

Age diversity also boosts carbon budget resilience in the face of drastic, landscape level changes. Forests in different stages of growth react differently to disturbance agents, and age diversity within stands allows a forest to continue to take in carbon and turn it to wood. Carbon balance is only maintained in the face of disturbance if forest processes like regeneration continue: if there are no young trees to fill a gap, disturbance causes net carbon loss.

Maintaining the size and growth rate of the aboveground live forest carbon pool sequesters carbon directly from the air efficiently, but all of the aboveground carbon can be a volatile place to store carbon in the face of a wildfire or widespread tree mortality. Soil carbon is more stable than aboveground carbon, but it does not sequester carbon from the air at as high a rate as the live carbon pools, limiting the magnitude of its carbon benefit. By encouraging age-class diversity, fast-growing-but-risky and slow-growing-but-steady carbon pools are represented, providing the stability of a more diverse carbon investment portfolio.

Structural Diversity

Similarly, structural diversity maintains and enhances greater potential for carbon sequestration and increased stability for carbon pools. Forest structure encompasses the ways in which trees are distributed on the landscape, the density of trees in forests, vertical layering of trees, the spatial arrangement of forest stands and trees on the landscape, an incorporation of natural and human made features into the forest, and other explicitly spatial attributes of forests.

Forest structure can play a key role in disturbances when considering things such as wildfire spread and can be important in terms of long-term stability of forest carbon pools as well. Structural diversity allows for a greater range of sizes and proportions of forest carbon pools, as well as a range of sequestration rates. A mixture of forest structures within urban settings can also decrease energy demand as tree placement can impact energy usage from nearby buildings.

Carbon Offense Strategies

There are several strategies for managing forest and tree carbon that either increase the size of the carbon pools, the rate at which carbon is sequestered from the air or influence the rate at which carbon is transferred between pools to enhance long-term carbon storage. Collectively, the NJ Forest Service considers these strategies as "carbon offense" management.

1. Afforestation

Afforestation establishes forests on sites that were previously non-forested. Afforestation expands the overall carbon pools by establishing more forest. For this strategy, abandoned agricultural land and other non-forested land are of primary importance. Locating planting sites to offset deforestation on state-owned properties under New Jersey's NNL laws are also important to afforestation, if less beneficial for overall carbon budgeting.

Establishing forest on abandoned agricultural lands and other non-forested lands has the lowest potential for transferring carbon offsets to other portions of the carbon balance that might undo potential gains. However, establishing new forests on active agricultural lands displaces agricultural production to other locations, indefinitely increasing transportation emissions for those sites.

Afforesting New Jersey's farms would simply squeeze demand for produce and foodstuffs elsewhere, increasing the carbon footprint of agricultural goods. This concept, where an activity's carbon gains are undone by displacement of an existing need, is known as leakage. Afforestation will be used as a carbon-offense strategy where leakage can be minimized.

2. Reforestation

Reforestation establishes young forests which can rapidly sequester carbon from the air. This second strategy will be used to re-establish prior forests or will encourage forest development on sites having problems regenerating naturally. In the short-term, young forests do not store much in the way of stable belowground carbon. However, this strategy is appropriate for regions of the state where the co-benefits of establishing new forest age classes overlap with the need to increase carbon sequestration rates.

This strategy is also appropriate for regions of the state recovering from disturbances, and in locations where natural regeneration has been interrupted. Such interruptions to natural regeneration include excessive deer browse, competition from prolific invasive species, overstory mortality due to introduced pests, storm damage, and other causes.

3. Forest Restoration

Forest restoration is a broad strategy that involves repairing ecosystem function. Restoring forest ecosystem function allows forests to grow and sequester carbon in places where a forest's ability to sequester carbon efficiently or to transfer carbon between pools has been compromised. It is appropriate where ecosystem functions have been interrupted, places that have sustained damage from Damage Causing Agents, or places where an ecologically significant forest type or tree species could be restored.

It is important to note that carbon sequestration is generally not the main objective for many forest restoration projects, but these projects can serve to enhance sequestration rates and alter flux between particular carbon pools. Systems where a high degree of forest productivity is desired tend to be appropriate places for enhanced sequestration. Enhanced sequestration techniques can be coupled with utilization of durable forest products that store carbon for long periods of time for added carbon-removal efficiency as well.

4. Proforestation

Proforestation is the practice of keeping a forest intact into old age to maximize its ecological potential. Given the different models for assessing ecological potential, the focus of this practice centers around the likelihood that the maxima for forest ecosystem biomass versus the maxima for forest tree volume, tree carbon by weight and forest tree growth rates occur at different points in time. Proforestation makes allowances for forest growth unimpacted or minimally directly impacted by active human intervention while ecological processes continue to function properly. This strategy could be appropriate for forests that are expected to remain intact for very long periods of time with minimal interruption of ecological processes, provided ecological processes continue to function properly. If this strategy is implemented, tradeoffs between the impacts to the carbon balance both on and off site need to be evaluated.

5. Urban and Community Forests

Urban and community forests are capable of double-duty to reduce atmospheric carbon: they sequester it directly, but can also avoid emissions through energy savings in the built environment. According to New Jersey's Global Warming Response Act 80x50 Report, "shaded surfaces may be 20-45F cooler than the peak temperatures of unshaded materials (Akbari, 1997). Evapotranspiration, alone or in combination with shading, can help reduce peak summer temperatures by 2-9F (Huang, 1990) (Kurn, 1994)". For these reasons, enhancing urban and community forests is a strong carbon offense strategy.

Evergreen trees planted to block prevailing winter winds (generally from the northwest in New Jersey) keep buildings warmer, avoiding emissions by reducing the need for heating energy. Deciduous trees that provide shade in the summer absorb and reflect much of the sun's energy, keeping buildings, roads and parking lots cooler; in the winter, they let much of the sun's warming light through. Trees of many sorts that shelter HVAC systems help them run more efficiently and last longer. Greater amounts of urban forest canopy help cool the urban heat island effect through transpirative cooling and reflection of solar radiation.

The i-Tree suite of tools can be used to inform specific tree planting locations at the individual property scale. Proper use of tools like i-Tree can help individuals and communities to realize the most benefits of carbon offense strategies by placing new plantings where they will save the most energy. These strategies will be incorporated into the revised guidelines for Community Forestry Management Plans.

6. Nurturing Forests with the NJ Forest Sevice Nursery

The NJ Forest Service Nursery produced approximately 300,000 bareroot trees and shrubs and sold approximately 280,100 of those in 2019. The NJ Forest Service works with more than 5,800 applicants participating in private lands management with WMPs and Forest Stewardship Plans covering more than 250,000 acres. Providing bareroot nursery stock to woodland owners and those seeking to create woodland aids in carbon sequestration on private forestland.

Carbon Defense Strategies

NJ Forest Service uses the term "carbon defense" for strategies that protect the integrity of the existing carbon pool, rather than trying to expand the pool. The existing carbon pool represents years' worth of net ecosystem productivity and dwarfs the size of net annual growth for all but the youngest sites. However, existing carbon pools are subject to losses from catastrophic disturbance and land use conversion. NJ Forest Service also plans to support the role of forests in the carbon cycle through strategies that forestall losses to the existing forest carbon pool.

1. Avoided Emissions

Avoiding emissions by protecting forest carbon pools is a strategy focused on preventing catastrophic carbon loss from forests due to events such as widespread impacts from DCAs. This strategy seeks to lower potential volatility in carbon pools with associated forests, rather than increasing the amount of carbon being directly stored. Activities that help to avoid emissions generally work by lowering forest stress through low-to-moderate-intensity disturbances like thinning and prescribed burning.

Defense strategies that have an upfront carbon cost are appropriate in forests that are under stress. Catastrophic releases of carbon can take place through damaging wildfire, like Californian woodlands over the last decade and Australian wildlands in 2020. Forests at risk of eruptive pest outbreaks are similarly at risk of becoming carbon emitters; as a result of the decade-long Mountain Pine Beetle Outbreak, several western U.S. states have witnessed their forests become net sources of carbon due to the steady decomposition of massive amounts of trees killed by the beetles.

NJFS aims to avoid forests becoming long-term carbon emitters through appropriate stress-reducing forest management treatments, particularly in those places most at risk from loss by pest, disease, or

wildfire. This carbon defense strategy will mainly be used at a large scale in areas of excessive pine forest density in the coastal plain.

2. Avoided Conversion

Keeping forests growing, at any age, maintains the continued existence of a forest carbon pool. In contrast, development that removes forest sacrifices that pool. To protect the existing carbon pool and the potential of the land to continue to sequester carbon, it is imperative to include a defense strategy that aims to avoid forest conversion to nonforest land use.

Avoided conversion strategies are appropriate for forested lands at risk for being developed or converted from a forested to a non-forested condition. In New Jersey this is regularly assumed to be accomplished by direct means, such as legislative protections or public acquisitions.

Alternatively, measures to avoid forest conversion can also include creating incentives that induce private landowners to keep forests as forests. Such incentives leave maintenance and administrative costs to the private landowner but encourage them to manage the forest in a way that is consistent with state and national priorities.

Strategies supporting avoided conversion in New Jersey include the direct purchasing of forested property using the criteria set forth in the Forest Legacy (FL) Area priority designations and creating incentives for landowners to keep forests as forests. The Green Acres Program is responsible for purchasing land for the state of New Jersey. In addition to using state funds for land acquisition, the Green Acres Program utilizes federal funds, such as those provided under Forest Legacy, to acquire forested lands for conservation.

To support avoided conversion on land that stays private, New Jersey also offers tax incentive programs for private landowners to actively manage their forests. These programs include the New Jersey Farmland Assessment (FLA) Program and Forest Stewardship Program (FSP), both of which offer lower property taxes for landowners actively engaged in managing privately held forests.

Overview of Brendon T. Byrne State Forest thinning. Photo by: NJ Forest Service

3. Urban Forest Stewardship

Carbon defense strategies can also be implemented within urban and community forests by working to maintain the health and safety of existing mature trees, thus protecting the existing urban forest carbon pool. The Urban and Community Forestry Program accomplishes this by encouraging municipalities and residents with trees on their private property to care for their trees through drought, by reducing pressure from insects and disease, and by performing structural and maintenance pruning. Such measures ensure that trees can establish quickly, grow to their full potential, and safely provide the maximum amount of ecosystem service benefits throughout their lifetime.

In looking to the future and across scales, urban and community forests may be included in statewide and regional carbon economies by forming local partnerships. UCF will encourage local governments to manage across and above municipal and county lines to maximize local forest, street tree, and park tree survivorship.

Information Strategies

The carbon strategies recommended in this NJ SFAP include taking on a range of actions that offer a diversity of impacts to the state's forested carbon pools, flux and sequestration rates. Promoting diversity to benefit carbon sequestration is highly compatible with many of the state's other objectives

for forest resources, as maximizing one ecosystem variable often comes at the detriment to others. Tracking the tradeoffs among a range of actions can be difficult and confusing, as many data sources appear to conflict with strategies to increase carbon storage, sequestration rates, or flux. Traditional information sources may provide little coordinated indication of what real world tradeoffs might look like from widespread application of these strategies.

A central repository for information related to carbon sequestration strategies and their relationship to ecological, biological, social, cultural, and economic values of the state's forest resources should be created and maintained. This will inform stakeholders about the "state of the forest" and strategies employed to manage forest resources across the state.

A repository would include not only the research used to derive these strategies, but an explanation of how this information is interpreted and how it impacts local decision-making. Outreach from this effort would take on many forms including traditional reporting, collaboration with other agencies and educational institutions, digital media, social media, and forums for experts to exchange information with each other and with stakeholders. Representatives from the U.S. Climate Alliance have expressed interest in these efforts, and collaboration between multiple states and the alliance would be likely.

Existing Policies Addressing Climate and Forest Carbon

As a coastal state with high population density, New Jersey faces many direct threats from climate change. However, these threats are occurring at a scale and magnitude larger than any single state. New Jersey has therefore adopted some multi-state policies and strategies to address climate threats can address on its own.

Regional Greenhouse Gas Initiative (RGGI)

As stated within the Assessment portion of this document (**Criterion 5**), approximately 20% of the proceeds from the auctions associated with RGGI will be allotted to NJDEP, with nearly 10% required to be used to oversee efforts to enhance the stewardship and restoration of the state's forests and tidal marshes, which provide important opportunities to sequester or reduce greenhouse gases. In of the Spring of 2020, the DEP, EDA and BPU collectively released the first RGGI Strategic Funding Plan. This plan governs the investment of NJ's auction proceeds earned during its first three years of participation, from 2020-2022.

The Plan identifies four funding initiatives:

1. *Catalyzing Clean, Equitable Transportation*
2. *Promoting Blue Carbon in Coastal Habitats*
3. *Enhancing Forests and Urban Forests*
4. *Creating a New Jersey Green Bank*

Initiative 3 aligns with the efforts of SFAP by dedicating funding to foresty projects and programs including grant programs and outreach efforts aligned with the Forest Stewardship Plan; stewardship and management of the state's forests; and/or support for the New Jersey Urban & Community Forestry Program.

U.S. Climate Alliance

It is the policy of the state of New Jersey to adhere to the principles upheld under the Paris Agreement in cooperation with a collection of other states (currently a total of 25) as a part of the U.S. Climate Alliance. New Jersey joined the U.S. Climate Alliance in 2018. As a member of the alliance, New Jersey has committed to implement policies that advance the goals of the Paris Agreement; aiming to reduce GHG emissions by at least 26 to 28% below 2005 levels by 2025; track and report progress to the global community in appropriate settings, including when the world convenes to take stock of the Paris Agreement; and accelerate new and existing policies to reduce carbon pollution and promote clean energy deployment at the state and federal level (U.S. Climate Alliance, 2020).

2: DAMAGE CAUSING AGENTS

Forest Health Overview

The Northeast is a hub for invasive plant and animal species introductions and increased international trade has amplified this risk of introduction within New Jersey. New Jersey alone has 14 ports and 56 airports, three of which are major commercial airports (Newark, Trenton and Atlantic City). The port of New York and New Jersey located at Newark/Elizabeth is the largest port on the East Coast and the third largest port in the nation. In 2018 alone, more than four million containers moved through this port (The Port Authority of New York and New Jersey, 2020). Although most invasive introductions are benign, some can and have, caused detrimental ecological impacts.

As the most densely populated state in the nation, New Jersey is also a hub for interstate and international transport via roadways, railways, airways and waterways. Although it is not possible to predict future forest health invasions, early detection and suppression of small populations is critical in reducing the impacts to forest ecosystems. This is done through surveys (aerial, visual and trapping) and by keeping informed of the invasive detections in the Northeast and North America.

However, forest health includes more than just monitoring, detection and DCAs, it also includes metrics such as regeneration success, healthy levels of mortality, species diversity and growth potential. Forest health threats that have persisted for decades or even centuries, have significantly impacted entire species and in some cases, have caused local extirpation. In these situations, species restoration is necessary through artificial or natural regeneration of native New Jersey trees within their respective historic ranges. The four strategies Prevention, Early Detection, Rapid Response and Regeneration an Restoration will serve as a guide in the efforts to maintain and achieve healthy, sustainable forests throughout New Jersey.

Prevention

A certain level of tree mortality is normal within the natural environment; after all trees are living organisms with a limited lifespan. However, forest health becomes a concern when extensive or rapid tree mortality occurs. This unexpected mortality is often attributed with the introduction of a non-native insect or disease of which our native tree species have no natural defenses against and are highly susceptible to or when changes in growing space occur over a relatively short period of time.

Predisposing factors can affect a tree's ability to tolerate inciting and contributing factors making them more susceptible to mortality (**Figure 79**). In simpler terms, healthy trees are more likely to tolerate or survive than unhealthy or stressed trees. *Strategies to promote healthy forests and to prevent outbreak situations can include:*

- **Reduce tree density** for active forest management.
- **Promote tree species** on appropriate sites.
- **Remove infested or stressed trees** that serve as a breeding ground for DCAs.

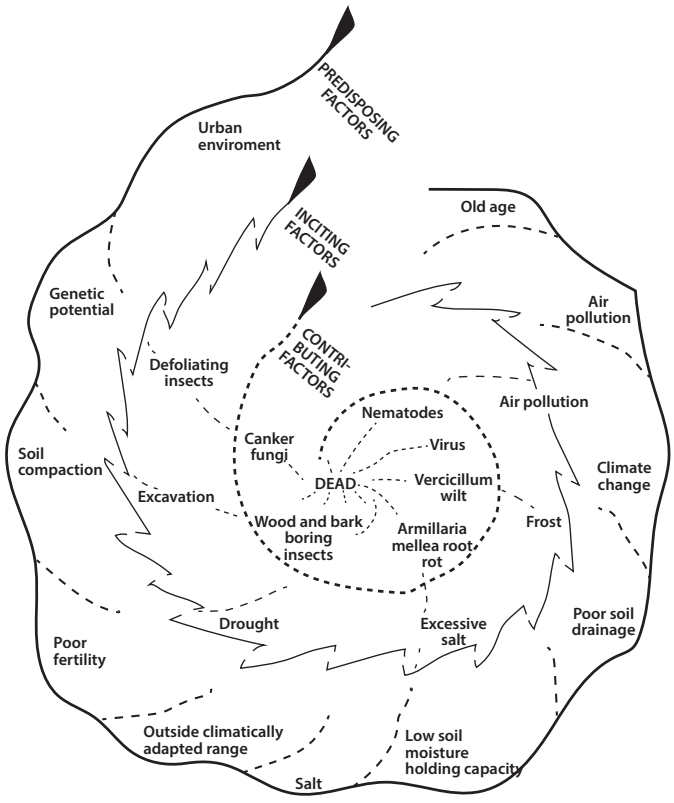


Figure 79. Tree disease risk factors. (Paul Manion)

- **Maintain healthy age class distributions**, as older trees can be less vigorous than younger trees.
- **Diversify genera and species**, as most DCAs are monophagous or have a narrow host range.
- **Prevent invasive species** from being introduced to forested areas through enforcement, outreach or interstate regulations (quarantine zones).

For example, densely stocked pine stands are more susceptible to SPB outbreaks than actively managed pine stands. SPB are naturally attracted to trees under stress and are more successful at infesting them because these trees lack reserves to effectively pitch the beetles out. Healthy trees, however, can more effectively prevent SPB infestation through natural defenses. Therefore, maintaining healthy pine stands can reduce the opportunity for widespread SPB induced morality by minimizing the impacts of predisposing factors.

Sirex woodwasp operates in a similar fashion in that they are most attracted to stressed pine trees. It is only when these DCAs are capable of building their populations up, that they are able to successfully infest healthy pine trees.

Educating land managers, landowners and the general public about prevention is also very important. Many DCAs are moved far distances anthropogenically, whether intentional or unintentional. The "Don't Move Firewood Campaign" uses outreach and education to prevent the spread or introduction of DCAs into new areas by informing people about DCAs that can be easily transported on untreated firewood.

Early Detection, Rapid Response

The NJ Forest Service conducts survey and monitoring efforts on an annual or as needed basis that vary depending on the level of risk and/or proximity of the DEP to the state. See **Appendix E** for the list of DCAs, corresponding survey techniques and frequency of survey and monitoring. Detecting DCAs as early as possible while populations or occurrences are low, increases the chance of containment or eradication. Survey and monitoring techniques include deploying traps, aerial survey and visual survey.

Trapping techniques are typically provided by the USDA Animal and Plant Health Inspection Service (APHIS) or USDA Forest Service, which can include the type of trap, the type of lure used and the timing of trap deployment and service. Often, traps are placed on public lands that are adjacent to known detections or close to major thoroughfares (i.e. highways, railways and waterways) that are connected to areas of known detections.

Aerial surveys of the entire state are done on an annual basis to measure defoliation or tree mortality. Additional flights can take place on an as needed basis, such as those for SPB. These SPB surveys take place on a weekly or bi-weekly schedule during the summer and provide up-to-date information on active locations. These flights are also concentrated in the southern half of the state where SPB populations are currently most active.

Visual surveys are often conducted by on-the-ground observation and can be associated with trap locations, the results of aerial survey or performed during standard field work operations. The NJ Forest Service also relies on the public to report their visual surveys and potential detections of forest health issues. The NJ Forest Service works cooperatively with professional entomologists and pathologists from the USDA Forest Service, NJ Department of Agriculture, Rutgers Diagnostic Labs, Rutgers University, as well as additional institutions and organizations for their expertise in identification of insects and pathogens.

In addition, the New Jersey Invasive Species Strike Team, comprised of a diverse group of stakeholders (government agencies, non-profit conservation groups, consulting foresters and related businesses and private individuals), helps to identify and monitor invasive plants and pests across the state with the use of a database which is integrated into the nationwide Early Detection and Distribution Mapping System (EDDMapS). The New Jersey Invasive Species Council, composed of

various stakeholders appointed by the Governor, is tasked with developing commensurate strategies in combating invasive species, which includes developing an agreed upon list of invasive species for the state. The council also acts as a liaison for regional and national cooperative efforts.

Suppression or eradication efforts are implemented once a specific population threshold is met for a given species. Suppression efforts are more commonly utilized versus eradication efforts. However, historically, the fight against ALB infestation included eradication efforts which were very successful within the state of New Jersey. Suppression efforts will vary depending on the DCA. Currently, suppression efforts for EAB are being implemented on state lands where high-value ash trees are being treated with a chemical trunk injection of Emamectin benzoate on a two to three-year cycle.

Also, during years of high gypsy moth defoliation and gypsy moth egg mass counts a suppression program is implemented using aerial chemical applications of BtK in May to June. This is the time when gypsy moth caterpillars are in the first or second instar. Gypsy moth suppression is done in cooperation with the NJ Department of Agriculture. The NJ Forest Service oversees the gypsy moth suppression program on state-owned lands, while the NJ Department of Agriculture oversees the municipal suppression program. These suppression efforts keep populations low (i.e. gypsy moth, SPB) and protect individual high-value trees (i.e. EAB with ash trees, HWA with hemlock trees) in order to prevent or minimize widespread tree mortality.

Biological controls are a long-term forest health management tool that primarily use insects or fungi to control non-native invasive DCAs. In New Jersey, all biological control programs are administered by the NJ Department of Agriculture, Philip Alampi Beneficial Insect Laboratory in West Trenton. The NJ Forest Service works cooperatively with this lab as it relates to biological controls impacting forest DCAs. Currently biological controls are being released for EAB.

Historically, biological controls have been released for gypsy moth, HWA and eastern hemlock scale. These biological controls have been considered established for those species and are no longer being released. However, there are additional biological controls that are not currently being released in New Jersey but may be in the future. These include the HWA summer predator, silverfly (*Leucopis argenticollis* and *L. piniperdaof*) native to the Pacific Northwest and a tachinid fly *(Cyzenis albicans)* a parasitoid of winter moth that is already well established in New England.

There is also currently pending research on biological controls for SLF, which will hopefully be approved for release in the near future. The NJ Department of Agriculture also releases biological controls for several invasive plant species that impact forests including mile-a-minute (weevil, *Rhinoncomimus latipe*), purple loostrife (leaf eating beetles, *Galerucella spp.*) and Japanese knotweed (sap-sucking psyllid, *Aphalaris itadori*).

As noted previously, outreach is an important tool in the early detection and prevention of the unintentional spread of DCAs as well. In New Jersey, several major DCAs were first reported by non-governmental programs. For example, the Middlesex County ALB infestation was reported by a homeowner who saw an ad about ALB and reported a sighting to the NJ Forest Service. Additionally, the first EAB detection in New Jersey was reported by a landscaping company working in a shopping plaza in Somerset County. There are countless other examples of public reports of DCAs throughout the state, which supports the effectiveness of outreach efforts (some of which are specifically discussed within the **Education, Communication and Outreach** section of the **National Priority 3**).

There are also several other tools and methods that could assist in early detection or monitoring efforts throughout New Jersey that have not yet been utilized but will be considered for future use.

Some of these tools and methods include:

- **Drones** to locate trees in decline.
- **Satellite imagery** to detect areas of leaf color change during the growing season.
- **Sentinel trees** in urban environments as an indicator of potential native invasive DCAs in response to climate change. For example, native insects/disease that cause decline or mortality in urban environments may serve as an indicator of how these native insects/diseases may respond in forested environments with changing climates.
- **Tree-recognition software** (compared to facial-recognition) to identify populations of host trees.

Regeneration and Restoration

Forest regeneration is critical in the establishment of future forests as these are the trees that will make up the next generation. Natural forest regeneration is preferred, but in some instances, areas where natural disturbances are limited human intervention is necessary to support successful regeneration. Some practices might include silvicultural prescriptions such as artificial regeneration, prescribed burning, site preparation, herbicide application and deer fencing. *When DCAs are introduced and established, they impact natural regeneration by:*

- **Reducing the number of parent trees**, such that the distance between them is too great for cross pollination (i.e. butternut).
- **Causing additional stress** that limits natural seed production (i.e. eastern hemlock).
- **Preventing viable seed development** in parent trees (i.e. American chestnut).
- **Changing growing or site conditions** that no longer support seedling establishment (i.e. worms, saltwater intrusion and flooding).
- **Inhibiting seedling establishment** through occupation of growing space and limited sunlight availability by invasive plant species (i.e. Japanese stiltgrass, Japanese barberry and multiflora rose).

Restoration efforts for tree species or genera that have been impacted by invasive DCAs are critical to maintain native New Jersey tree genetics. Fortunately, most DCAs have not been successful in causing extinction of a single tree species or genera. However, there are a few species that are at high-risk of extirpation if no future action is taken. *Several strategies for the restoration of these particularly threatened species include:*

- **Locate New Jersey native parent trees** and confirming their identification.
- **Propagate cuttings** of native parent tree or seeds at the NJ Forest Service Nursery.
- **Create seed bank** of parent tree seed to conserve New Jersey native tree seed.
- **Test for resistance** (if applicable).
- **Establish orchards** from New Jersey native seeds.
- **Out-plant** on state-owned lands and monitoring establishment.
- **Provide seedlings** for public and private land planting.
- **Support natural regeneration** where applicable.

The current species of concern include Eastern hemlock, butternut, American chestnut, American elm, green and white ash, black ash, pumpkin ash, and American beech. Recovery plans and guidelines will be prepared before propagation and out-planting of any State Endangered species. The NJDEP Division of Land Resource Protection will also be consulted to ensure that planned restoration activities do not conflict with existing regulations for State Endangered plant species and Plant Species of Concern. Additional species may be added to this list as DCAs impact others in the future.

Currently, eastern hemlock regeneration and restoration work has been implemented on state NHR lands. One of these areas is located in Stokes State Forest and is composed of an overstory mixed with mature eastern hemlock, hardwoods and pines with minimal eastern hemlock regeneration. This location was selected for eastern hemlock restoration work as discussed in the **Forest Restoration – Species of Concern** strategies section in **National Priority 1**.

Early in 2019, some of the non-hemlock competition was removed from this location and approximately 900 hemlock seedlings were planted. In addition, a deer fence was erected to protect the planted seedlings as well as any natural seedlings that could potentially establish. This site will be monitored annually for regeneration success and overstory hemlock health.

A diverse range of seed from New Jersey native trees should be collected for storage even in the absence of a known DCA. Often, seeds are collected from trees that have already been impacted by DCAs and parent material is limited. Proactive measures to collect seed from optimal parent trees prior to DCA impacts would allow for a more genetically diverse population. For example, there are no known DCAs detected in New Jersey that threaten sweetgum. In fact, sweetgum is so prolific in some sites that it might be hard to imagine this species nearing extirpation.

However, North American sweetgum trees growing in China have been infested and killed by an insect nicknamed the "sweetgum inscriber" a bark beetle in the genus *Acanthotomicus* ("The Potential U.S. Economic Cost of a New Sweetgum-Killing Pest", 2017). Should this insect make its way into the native range of sweetgum, this species could also face near extinction. Therefore, this is the time to seek out optimal parent trees to serve as the seed source for future seed banking should a DCA unexpectedly cause widespread species mortality.

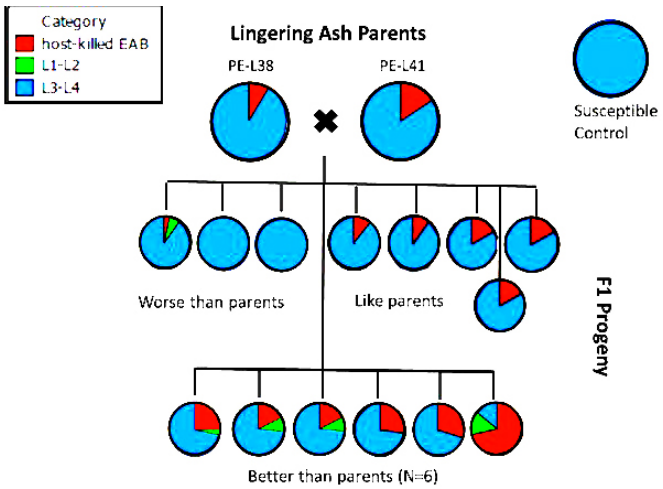


Figure 80. Lingering ash breeding program. (Jennifer Koch, USDA Forest Service)

Because it is very difficult to eradicate an invasive insect or disease, DCA populations continue to persist in the environment. Although suppression and biological control efforts are tools that are effectively used to suppress DCA populations or protect certain trees, tree breeding is another tool that can be used to help establish host trees that are more resilient in the presence of sustained DCA exposure.

In fact, incorporating suppression, biological control and tree breeding concurrently would offer the best opportunity for success. Selecting parent trees most resistant or tolerant to DCAs through breeding programs or genetic crosses creates offspring or progeny that will perform better than the parents, like the parents and worse than the parents.

Continuing the crosses with the best performing offspring will again create offspring that will perform better, like and worse than the parents. These crosses can continue and a portion of the offspring will continue to perform better than the previous generation, with the hope that these best populations will become sustainable and regenerate naturally. This example is demonstrated in **Figure 80 and Figure 81** from USDA Forest Service, Forest Geneticist, Jennifer Koch's work on the lingering ash breeding program.

However, in some cases, there is no level of tolerance or resistance in parent trees that would allow for natural regeneration. In these cases, hybrid

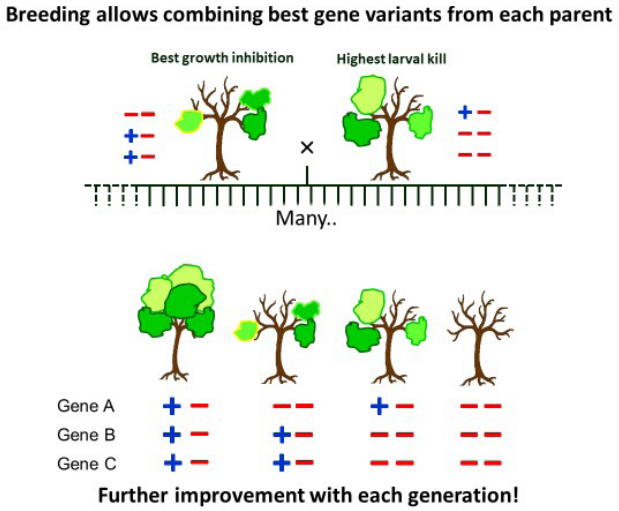


Figure 81. Lingering ash breeding program. (Jennifer Koch, USDA Forest Service)

or transgenic work can provide the additional resistance needed. An example of this is the American chestnut. It has been crossed with the resistant Chinese chestnut to produce a cross that has characteristics of the American chestnut with the blight resistance from the Chinese chestnut.

Additional work is being conducted at the State University of New York – College of Environmental Science and Forestry (SUNY-ESF) involving transgenic chestnuts, where a blight resistant wheat gene is spliced into American chestnut trees. When these transgenic chestnut trees cross with susceptible chestnut trees, a portion of their offspring are resistant to the blight.

Although this work is promising for the future of American chestnut, it is still in the process of FDA approval for release. Similar hybridization naturally occurs with butternut and Japanese heartnut where pure butternut trees are highly susceptible to butternut canker, Japanese heartnut trees are highly resistant to butternut canker and the hybrid of the two are somewhat resistant to butternut canker.

Long-term Monitoring and Trends

To achieve a better understanding of how our forests are changing over time, long-term monitoring is necessary. Often the results of long-term monitoring plots can answer questions as they relate to overall forest health including tracking levels of mortality, growth, species composition, stand age and more. Measuring the health of forests can be difficult without baseline data though. Because it is difficult to predict what host species will be impacted next, it is important to start measuring the forests as early as possible.

The NJ Forest Service, Forest Health Program, works closely with the State Lands Management Program in utilizing the state's forest inventory data as well as FIA data. However, utilizing more local permanent plots for analyzing the changes occurring over time within certain species may require additional data collection. For example, in 2015 the USDA Forest Service and the NJ Forest Health Program established eight permanent plots to measure and evaluate American beech trees in forested areas (**Figure 82**). These plots specifically measured American beech trees, the presence or absence of BBD, level of infestation, canopy density and other forest health related criteria.

Although BBD has not been prevalent within New Jersey in the last few years, the effects on American beech during outbreak years have caused widespread mortality and decline. Residual American beech trees that are present today vary in the level of BBD infection and overall tree health; these trees are being measured on a two to three-year cycle on permanent plots. These plots can also be used in BBD resistance studies, which, as of current have not yet been performed in New Jersey. These plots can also be used to monitor for BLD or other DCAs that would impact American beech.

Developing permanent plots for threatened or at-risk species such as eastern hemlock, ash, pitch pine or oaks can provide the following useful information:

- **Establish a baseline** of forest health data for known stands.
- **Identify stand locations** that include species of concern.
- **Show changes in growth**, decline and mortality over time.
- **Track regeneration success** and/or absence and the ability to track this over time.
- **Follow species range movement,** where certain species perform better or worse, depending on factors such as growing zones, changes in climate and the ability to track this over time.

Impacts of DCAs on tree growth, canopy density, species distribution, regeneration and mortality should be measured on a regular basis to track trends and changes over time. This type of data could be incorporated with state, regional or even national data to track trends over larger and scalable landscapes.

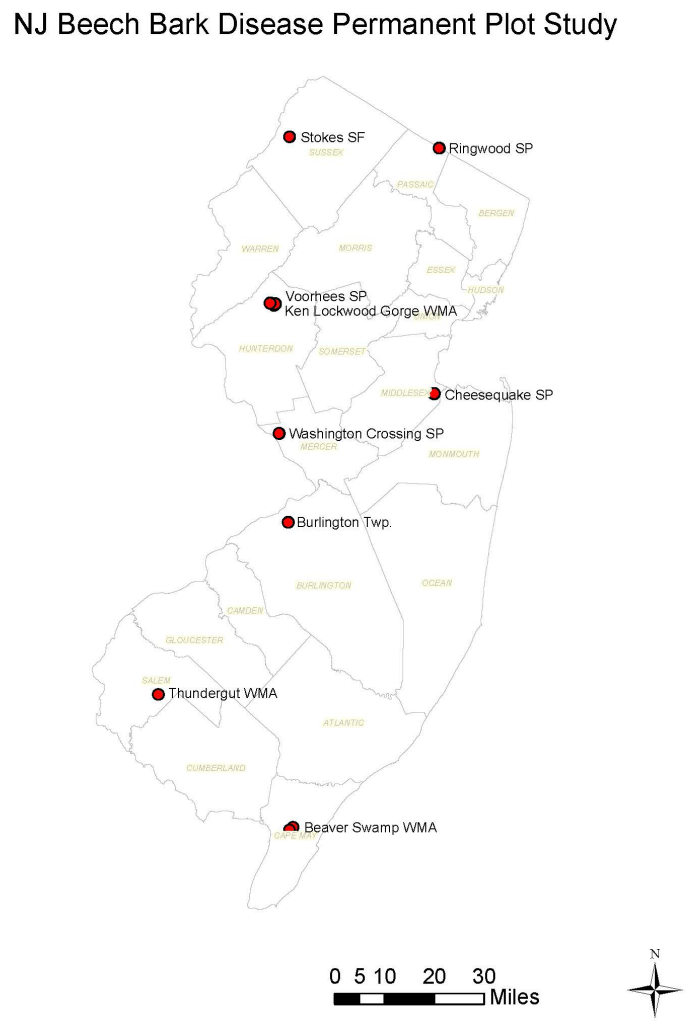


Figure 82. New Jersey permanent plot beech tree disease study. (NJDEP, 2015)

The state of Vermont has been tracking the date of budbreak, the end of growing season and the length of growing season since 1991 (Vermont Department of Forests, Parks and Recreation, 2018). Although it may be too early for making solid conclusions on the impacts that climate change could have on budbreak and length of growing season, this type of data collection could be used to better understand climate impacts on the timing of budbreak or growing season, as well as insect or pathogen emergence.

For example, gypsy moth egg hatch coincidently corresponds to soon after oak leaf-out. This preferentially benefits gypsy moth because the early instar caterpillars prefer the soft, young leaf tissue as a food source. Yet, if for some reason oak leaf-out is delayed or occurs earlier in the season, the young caterpillars will either have no food or there will be an insufficient amount of food for them to eat after they hatch. Many other DCAs also rely on the timing of egg hatch and leaf-out for their success and changes in the timing of even one of these events could benefit one DCA and be a detriment to another.

The growing season length could impact the number of generations a DCA has per year, possibly increasing DCA populations within a single growing season as well. DCAs that were once relatively insignificant could become potential issues if an additional generation was added within a growing season.

Warmer temperatures during the winter followed by a rapid frost can also impact forest health, whereas trees can start to break bud as temperatures warm. These young leaves or flowers are then susceptible to frost damage, which can impact leaf and seed production as well as induce localized leaf, flower or stem mortality. Healthy trees are typically able to withstand frost damage and can recover by growing more leaves. When flowers are damaged, however, plants typically do not produce a second set of flowers. Therefore, seeds or fruit are not produced or are produced to a lesser extent that year (Frost and Winter Injury, 2020).

Native insects and pathogens are exhibiting trends of expanding native ranges as a result of changes in temperature from climate change. The impacts of native DCAs in new geographical areas could cause similar widespread impacts as non-native DCAs. This can be attributed to a host tree's inability to effectively protect itself from the DCA because it has not necessarily evolved the defense mechanisms or native predators do not exist in those climates.

One example is the movement of SPB into more northern states. The natural range of SPB historically occurred in the southern United States and central America. The native range of SPB host trees also occurred throughout the Northeast and Southern United States (Aoki et al., 2018). (**Figures 83& 84**)

As climactic conditions have become more conducive to SPB survivorship, northern states that had not historically experienced SPB outbreaks may anticipate SPB outbreaks into the future. These states, however, are better prepared for SPB since they are aware of the risk it poses and the northward range moving trend. (**Figure 85**)

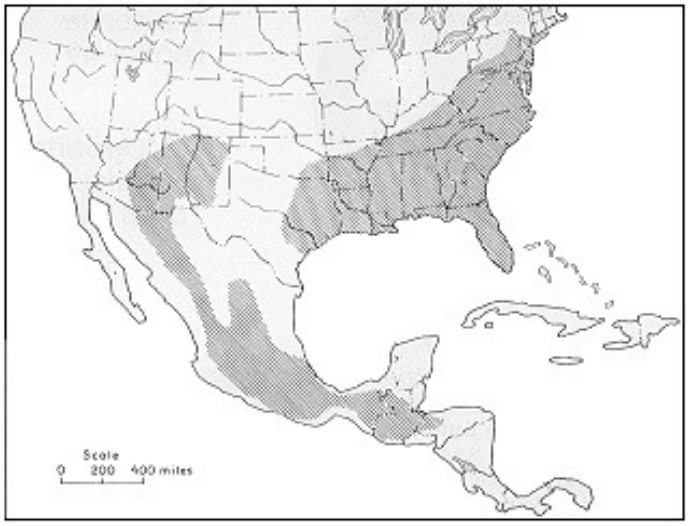


Figure 83. Range of the southern pine beetle in North and Central America. https://www.barkbeetles.org/spb/spbfidl49.htm

Herbivory

As discussed within **Criterion 3** of the **Assessment** section, New Jersey identifies deer browse as a DCA inhibiting successful regeneration of many native species of oaks, hickories and a variety of understory plants.

Strategies for this planning period will focus on deer management programs in conjunction with the NJDEP Division of Fish & Wildlife, as well as with non-profit entities with privately owned lands such as Duke Farms. The primary strategy is to reduce deer populations to appropriate levels for ensuring the successful establishment and regeneration of tree seedlings into the future. Another strategy will include managing deer populations to be more in line with forest ecosystem carrying capacities indicated through the regenerative response of vegetation. For example, further research and development efforts should also continue to build a better understanding of success rates of preventative deer fencing, hunting regulations, regeneration rates by species composition, activity size. Current research ranges from focus on long-term and regional changes in forest understories to deer exclosure experiments.

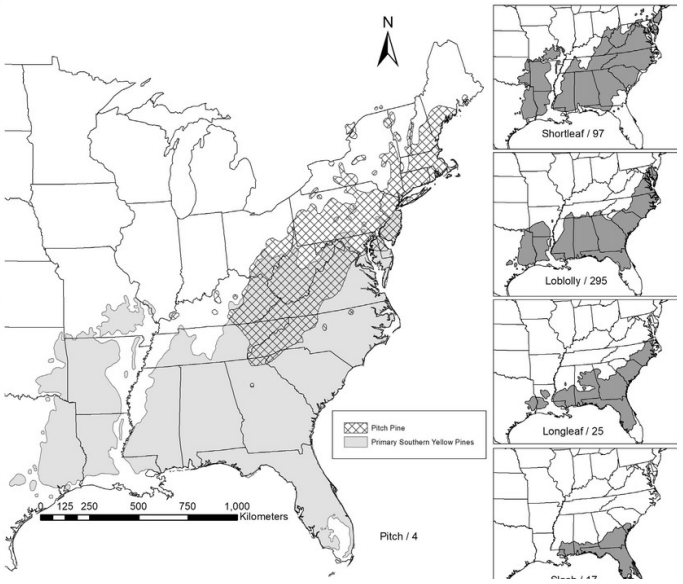


Figure 84. Distributions of SPB host pine species across the eastern U.S. (Aoki et al. 2018)

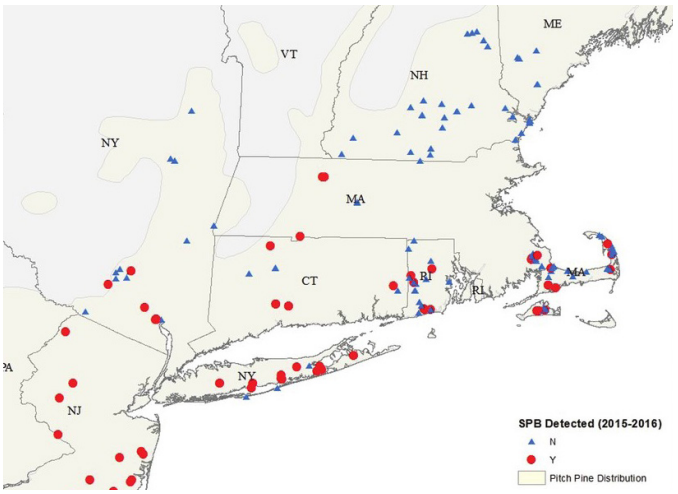


Figure 85. Results from southern pine beetle detection and monitoring traps deployed throughout the northeastern United States in 2015. (Dodds el at. 2018)

Wildfire Suppression

A Snapshot of the NJ Forest Fire Service's Capacity and Resources to Manage Wildland Fire

Through a reliable wildfire detection system and the implementation of hazard fuel reduction treatments, the NJ Forest Fire Service strives to continually reduce the potential for and severity of, wildfires. A network of 21 lookout towers are staffed for quick detection of wildfires, rapid dispatching, careful tracking of resources and communication of critical information. Fires detected when small are generally safer to suppress and could cause less overall damage depending on location.

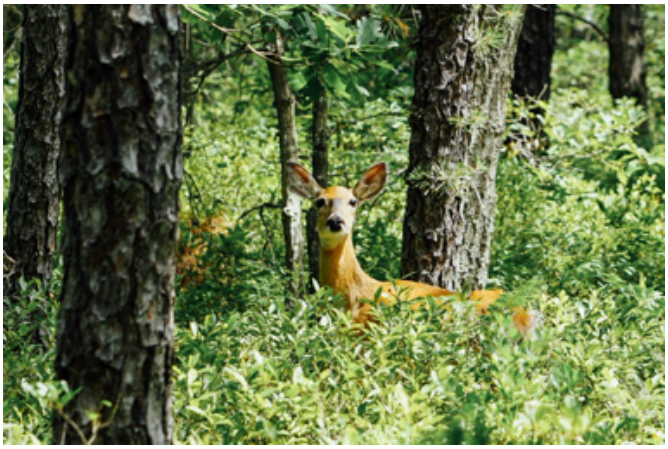
Specialized aviation resources, both fixed-wing and rotor aircraft, aid in wildfire detection and provide for safe and rapid suppression efforts. Specially designed and fabricated vehicles also permit direct and aggressive attack of wildfire. A planned, coordinated and strategic fuels mitigation program supports the reduction of hazards and lessens wildfire related risk as well. This includes the use of prescribed burning, as well as mechanical fuels treatments including mowing and thinning.

Employing well-trained, experienced staff along with a customized fleet, the NJ Forest Fire Service fights wildfires nearly every month of the year. NJ Forest Fire Wardens not only respond to wildfire incidents for initial and extended attack, but also train crew members and volunteers, plan and execute hazard mitigation activities, investigate and prosecute arsonists, maintain forest roads, permit open burns and campfires, deliver educational programs and support other statewide response to natural disasters such as hurricanes and floods.

NJ Forest Fire Service staff benefits from frequent and diverse training opportunities, often crossing boundaries to interface with various types of land management and emergency response professionals. Three divisional maintenance shops are also staffed with full-time mechanics for fabrication and maintenance of the vehicle and equipment fleets. When fire danger is low, fire observers support maintenance shop services and provide building and grounds maintenance.

Preparedness measures build connections to create communities more resilient to wildfire. The NJ Forest Fire Service routinely practices interagency cooperative response during WUI preparedness drills to familiarize all parties with wildland fire protection protocols, resources and needs during a wildfire incident. Various community assistance programs are administered to guide development of CWPPs, offset costs of hazard mitigation and provide wildland firefighting equipment to local fire departments. Outreach and education programs take place throughout the year, with NJ Forest Fire Service representation at events like local fire prevention expos, the NJ Teachers Convention, Firewise Community Open Houses and various NJDEP events.

An example of a wildfire. Photo by: J. Douglas, NJDEP



White tail deer in Bass River State Forest. Photo by: J. Douglas, NJDEP

Rising Demand for Action

To adequately address fire suppression in New Jersey, the NJ Forest Fire Service has identified several needs and strategies. The agency has identified the need to treat approximately 30,000 acres annually with prescribed fire to reduce hazardous fuels. However, based on capacity, the annual average treated acreage falls well short at 15,000 acres per year.

Modern wildland fire managers have a more diversified set of duties and must make tough decisions to allocate preparedness assistance and implement hazard reduction. Heightened land use pressures also broaden the exposure of wildland fuel to human activity and increase ignition potential. Sprawl into the WUI increases the vulnerability of lives, homes, infrastructure and firefighter safety.

3: CLIMATE

Climate change has a direct effect on New Jersey's recreational areas. As strong storms become more frequent, the recreational facilities and trails are more at risk (experienced during 2012 Superstorm Sandy). Statewide nearly 184,000 acres of federal, state and local public open space was inundated by the Superstorm Sandy storm surge.

Approximately 75% of NJDEP park facilities sustained damage from the storm, including serious damage to the two most visited parks in the state park system. It is expected that public parklands and recreational facilities will be subjected to increasing impacts of climate change and sea level rise in the future. Rising temperatures, as well as heat waves and more heavy rain events with stronger storms, including hurricanes and northeasters, are anticipated as a result of climate change. Warming temperatures will also affect water temperature, both freshwater and marine, with impacts to recreational fisheries. Forest management techniques are vital in assisting with shoreline resilience projects and carbon sequestration. (SCORP, 2018)

Blue Acres, Office of Natural Resource Restoration, Bureau of Tidelands Management

The Green Acres, Farmland, Blue Acres and Historic Preservation Bond Act of 2007 authorized approximately $12 million for acquisition of lands in the floodways of the Delaware River, Passaic River or Raritan River and their respective tributaries for recreation and conservation purposes.

An additional $24 million was approved by voters in the Green Acres, Water Supply and Floodplain Protection and Farmland and Historic Preservation Bond Act of 2009. Properties (including structures) that have been damaged by or may be prone to incurring damage caused by storms or storm-related flooding or that may buffer or protect other lands from such damage, are eligible for acquisition. This program provides willing landowners the ability to sell floodplain areas to the state. Green Acres lists the Coastal Plain (flood prone area) as a Forest Legacy (FL) Area, which is already considered a priority for land acquisition under the **Assessment of Need (AON)**.

The purchasing of flood prone and/or coastal areas operates in conjunction with the New Jersey ONRR for restoration efforts in tidelands. RGGI funding provided to NJ Forest Service programs with tidelands projects provides even more opportunity

> Warming temperatures may also affect water temperature, both freshwater and marine, with impacts to recreational fisheries. Forest management techniques are vital in assisting with shoreline resilience projects and carbon sequestration.

for carbon management projects (explained in further detail within the **Resiliency** section of this National Priority). To facilitate our shared goal of managing New Jersey's landscape, the NJ Forest Service assists these sister programs with technical support and other resource needs as appropriate.

Species Proxy

The shift in climate characteristics is present via temperature, precipitation, plant hardiness zones and growing degree days (GDD), especially when determined through various climate prediction models. As discussed within the **Climate Change as a DCA** section of the Assessment **(Criterion 3)**, these changes are inevitable and will cause shifts in both importance values of species as well as species range. This shift, particularly to more southern tree species composition was identified as an important issue to address as a resiliency strategy to climate change.

If tree species cannot adapt fast enough to changing climate conditions, forest and land managers need to consider the integration of proxy species to ensure that forests remain as forests and that essential ecologic and economic functions remain relatively consistent. This includes tree species filling important ecological roles within riparian areas, as wildlife food and mast production, as well as providing biodiversity.

New Jersey residents also depend on a stable economy including the value generated from forest product markets. The strategy of identifying southerly species (or other future-adapted species) that could act as native species proxies for ecologic and economic roles has also been identified as a climate change adaptation and mitigation plan action by the Pennsylvania Department of Conservation and Natural Resources (2018) and several other states across the country. A significant component of this strategy should be comprised of scientific research involving proxy species considerations for potential ecosystem impacts and successes.

4: FRAGMENTATION/HABITAT RESTORATION

Forest conditions throughout New Jersey today starkly differ from those which would have been observed prior to European settlement. Pre-European settlement era woodlands contained substantially greater vegetative biodiversity and age class diversification. This means enormous swaths of pre-settlement forest were comprised of stands of old growth eastern hemlock ravines, early successional habitat, as well as wildfire formed herbaceous meadows (Brose et. al., 2014).

The transformation of New Jersey forests to present-day conditions can principally be attributed to the anthropogenic influences over the last century. Mass deforestation, the regrowth of even-aged stands and development has created a forested landscape that is both fragmented spatially, but homogeneous temporally. Today, approximately 75% of New Jersey forests are between the ages of 40 and 99 years old. Historically, the ecoregion's temporal homogeneity would have been abated by frequently occurring natural disturbance, primarily in the form of fire. As these numbers are averages across the state, the NJ Forest Service will respond to stakeholder requests to provide information to assist in understanding the nuances of this distribution at finer scales.

Development and forest fragmentation have altered the way these disturbances were historically allowed to naturally diversify New Jersey's woodlands. Fire had an especially important role in perpetuating oak and pine stands throughout the state during pre-settlement times (Stambaugh et al., 2018). That process has been almost entirely precluded from woodlands located in close proximity to developed areas. Even wildfires that occur in these locations are extinguished or controlled long before they can have a landscape altering effect.

New Jersey woodlands are least fragmented in the northwestern and southeastern portions of the state—observed by looking at the locations of core forested areas located within **Criterion 1** of the Assessment (i.e. least fragmented/highest spatial integrity index). First farming, then commercial development and housing has increased the effect of forest fragmentation over the past century. However, recent state level protection trends such as the Pinelands and Highlands Acts have helped slow woodland parcelization. In addition, many townships have introduced zoning regulations which disallow development of properties not containing enough acreage. Yet, once productive agricultural and forest lands historically owned by an individual, have been subdivided and sold to multiple owners. *Strategies to balance New Jersey's high population density while maintaining forest integrity include (but are not limited to) the following:*

- **Participation of private landowner** in active forest management.
- **Identification of species** loss and associated habitat.
- **Consideration of habitat fragmentation** in state lands management planning.
- **State acquisition** of core forests.

With 48% of New Jersey forests under private ownership, tax incentive programs and the Stewardship Act have become increasingly important to educate landowners on the importance of and participation in, sustainable, responsible forest management. Landowners with five acres or more of woodlands are an important target demographic for the NJ Forest Service. This is because as New Jersey reaches "build out," these woodlots, along with state lands and NGO properties, will provide a critical network of wildlife habitat connectivity along with areas of conserved core forest.

While management of privately held woodlots is essential, incentive-based programs like FLA are only voluntary to join. The NJ Forest Service, Private Lands Program is responsible for connecting landowners with consulting foresters, as NJ Forest Service overall objectives are guided by the USDA Forest Service national priorities as outlined within the Farm Bill. The Private Lands program has and will continue to provide realistic goals and expectations, minimally burdensome rules where necessary and manageable costs for participation in the FSP.

The Farmland Assessment Program and its more than 6,000 properties represent the most active forest management throughout the state. The steady increase of applications and acreage under management will only help to increase connectivity of forests throughout the state. The recent adoption of the NJ Stewardship Act rules has also increased the demand for active forest management. Without the need for income to receive FLA, the NJ Forest Service is seeing a boost in planting operations from landowners. That, coupled with invasive species management in abandoned farm fields, will further increase the potential for usable habitat and reduce the effects of fragmentation. For example, presence of the SPI in the southern portion of the state, will encourage landowners to increase planting of dwindling pine species.

Natural Resources Conservation Service (NRCS) also works closely with the NJ Forest Service to provide private landowners incentives such as cost-sharing to implement responsible forest management on their property. The focus of these cost-share projects includes keeping forests intact, improving forest stands for biodiversity, promoting the habitat conditions favorable for threatened and endangered species and enhancing carbon sequestration.

As discussed previously, the NJDEP Division of Fish & Wildlife recent CHANJ (Connecting Habitat Across New Jersey) project was developed to identify species and habitat loss. CHANJ is an effort to make New Jersey's landscape more suitable for terrestrial wildlife by identifying key areas and actions needed to preserve and restore habitat connectivity across the state.

This initiative was designed to help:

- *Prioritize land protection*
- *Inform habitat restoration and management*
- *Guide mitigation of barrier effects on wildlife and habitats*

CHANJ offers tools and resources to guide these goals forward in a strategic way. Whether on the local or statewide scale, these tools can help land managers, transportation planners, conservation groups and the general public to visualize their place in New Jersey's habitat connectivity puzzle and to be more proactive and collaborative in their planning efforts.

The ability to predict connectivity-related issues and opportunities can also reduce conflict, while saving time and money. This effort also identifies core and connecting habitats across the state of New Jersey. It is important to note that although there is overlap with the core forests identified using the USDA Forest Service, FIA spatial integrity index, the methodologies used to determine core forests among these two models are different. These differences present potential usefulness for strategic planning opportunities.

The spatial integrity index scores forested areas based on factors such as distance from roads and forest edges and proximity to similar forests. CHANJ uses similar scoring criteria, but also includes areas that could be used to connect contiguous forests through the lens of wildlife biology. Observing where these models overlap and where they don't could be useful in prioritizing where forest restoration may be most effective at connecting forests of highest integrity and wildlife value.

Red-Tailed Hawk in Cheesequake State Park Photo by: J. Douglas, NJDEP

As mentioned previously, forested lands throughout the state are divided nearly evenly among private and public ownership, with the state of New Jersey being the largest single landowner of publicly held forest. It is therefore essential that both public and private lands have cooperative goals to reduce fragmentation and protect habitat corridors essential for wildlife. Through the creation of parcel level natural resource stewardship plans, following the 14-step stewardship process, the NJ Forest Service works closely with experts in the NJDEP Division of Fish & Wildlife to incorporate wildlife habitat needs as a part of a multidisciplinary approach to natural resource management on public property.

Natural resource stewardship planning on state-owned forest land takes into consideration creating habitat corridors as well as benefits for threatened and endangered species and their associated habitat through guided prescribed treatments. The companion document to the SFAP is the State Wildlife Action Plan (SWAP). The SWAP provides all New Jersey land managers with an extensive list of wildlife species important to the state's ecosystem and/or those which provide diversity. These 3,700 species across New Jersey are specifically identified as to the importance of habitat loss, as well as the identification of short- and long-term management changes needed on a landscape level (SWAP, 2018).

> Mass deforestation, the regrowth of even-aged stands and development has created a forested landscape that is both fragmented spatially, but homogeneous temporally. Today, approximately 75% of New Jersey forests are between the ages of 40 and 99 years old. Historically, the ecoregion's temporal homogeneity would have been abated by frequently occurring natural disturbance, primarily in the form of fire. As these numbers are averages across the state, the NJ Forest Service will respond to stakeholder requests to provide information to assist in understanding the nuances of this distribution at finer scales.

Wildlife biologists from the NJDEP Division of Fish & Wildlife are active participants in the natural resource stewardship plan development process for state-owned forests in conjunction with a range of other domain specialists. Forest management activities are developed with regard to the potential adverse impacts to existing species and/or improvements upon habitat of already present species, as well as species potentially present during the planning cycle.

Finally, the acquisition and management of lands (including easements) by the state of New Jersey should continue through the Green Acres Program. However, land acquisitions should be prioritized to increase connectivity and to provide habitat across the state. Certain laws have also encouraged the retention of forest land such as the FHACA, which limits the conversion of forest lands within these areas.

Maintaining Core Forests through Policies

In a state where there are nearly nine million people and approximately two million acres of forest (out of roughly five million acres of total land), pressures of development are a constant concern. The NJ Forest Service has policies, incentive programs and laws to help develop strategies to promote keeping forests as forests and reforestation. The ability to retain forest and tree cover in rural, urban and interface areas will foster strategies such as carbon and forest density. In addition, under the NNL Compensatory Reforestation Act, a state entity must provide a reforestation plan to the NJ Forest Service for approval, for each project not silviculturally related that results in the deforestation of a half-acre or more on land the state entity owns or maintains. The NJ Forest Service reviews these plans and provides quality control inspections for tree survivability. This helps to keep forest cover roughly the same across the state despite the loss of trees.

Forest Legacy

The NJ Green Acres program is charged with land acquisition for the state of New Jersey as well as identifying Forest Legacy Areas. These processes and procedures can be found within the **AON** in **Appendix C** of this NJ SFAP. It is a strategy of the Green Acres program to protect natural resources of the state by working with other state entities to prioritize lands for acquisition.

Prioritization criteria for Green Acres and Forest Legacy are also presented within **Appendix C**. As mentioned previously, New Jersey is closely reaching "build out" and the preservation of land has never been more important. The SCORP explains not only how land is purchased, but also the importance of managing the land for multiple uses including the health and enhancement of the forest. The purchase and management of land is not just for state acquisition; green acres funds have helped local governments expand or create parks and NGOs such as the New Jersey Conservation Foundation (NJCF), to acquire land for conservation purposes.

NATIONAL PRIORITY 3:
ENHANCE PUBLIC BENEFIT FROM TREES AND FORESTS

1: BIODIVERSITY

As mentioned previously, biological diversity is a critical component of a healthy and ecologically productive forest supporting many important ecosystem functions. These principles can be broadly interpreted to support ecosystem function and biodiversity at landscape scales as well. The SWAP identifies management for biodiversity as a key strategy for the stewardship of public and private lands. The conservation of biodiversity is also a major criterion of the Montreal Process for monitoring the success of forest stewardship. As the management of the state's forest resources continues to progress, so too has NJDEP's understanding of biodiversity.

Forest biodiversity is not just the species richness of plant and animal communities, but also the richness of forest mycology, the microbiology, trophic levels, life history and current trajectories of ecological systems, selective pressures, disturbance and ecosystem function. Many of the strategies for forest biodiversity discussed within this section speak to forest structure, continuity, scale, history, composition and disturbance rather than to the manipulation of biodiversity directly. This latter approach often proves difficult to execute and requires direct response from the ecosystems being managed. For instance, managing for mast producing trees can have a profound effect on animal populations that depend on mast for food. It is important to note that many of the strategies mentioned elsewhere within this document collaboratively support biodiversity objectives and the strategies outlined within this section in particular apply to more than a single national priority.

NJDEP recognizes the need to maintain or enhance structural complexity and heterogeneity at the

Commissoner McCabe planting Atlantic White Cedar in Double Trouble State Park. Photo by: NJDEP

landscape level. Strategies such as managing the distribution of forest age classes, the alteration of forest density, fire and other disturbance regimes, forest restoration, forest stewardship, forest connectivity and integrity and several of the strategies related to climate change such as fostering resilient forest carbon pools and sequestration, all impact biodiversity. Therefore, biodiversity is a significant component of many strategies presented within this document.

It is a strategy of NJDEP to utilize and develop tools that maintain and enhance forest heterogeneity and structural complexity. Through retainment of biological legacies persisting after disturbance, the NJ Forest Service applies the understanding of structural complexity and its role in biodiversity as a strategy. Through the use of traditional tools such as transects and plots, along with more modern tools such as LiDAR, new ways of making decisions for retention of live trees, standing dead trees and downed woody material in the field are emerging. Fire and disturbance utilized in conjunction with silvicultural prescriptions can further promote conditions favorable to enhanced biodiversity as

> Forest biodiversity is not just the species richness of plant and animal communities, but also the richness of forest mycology, the microbiology, trophic levels, life history and current trajectories of ecological systems, selective pressures, disturbance and ecosystem function. Many of the strategies for forest biodiversity discussed within this section speak to forest structure, continuity, scale, history, composition and disturbance rather than to the manipulation of biodiversity directly.

well. A variety of these management tools have been discussed in the preceding strategies.

The collection of scalable forest data and the exploration of new planning and analytical techniques (outlined as separate strategies within this document) are also essential for scalable forest resource management—from the landscape level, to microsite conditions. These tools aid in the understanding of the tradeoffs associated with management decisions amongst many competing objectives. It is a strategy of the ONLM to improve the classification of forest and woodland communities by making these methods scalable and compatible with other commonly used systems throughout the nation.

The NJDEP Division of Fish & Wildlife utilizes the concept of umbrella species when making management decisions for wildlife across the state. (Umbrella species are species that serve as indicators of habitat conditions beneficial to a broader range of species and provide data available on the presence of these habitat conditions.) In addition, NJDFW also utilizes the Landscape Project which is an ecosystem-level approach for the long-term protection of imperiled species and their important habitats in New Jersey. It is a strategy of the NJ Forest Service to utilize these information sources to consider forest composition under changing conditions that will also impact biodiversity. These strategies allow forest land managers to make informed decisions as to management impacts at multiple scales and how to plan accordingly. It is a strategy of NJDEP to use scalable data and analytical techniques to support scalable management decisions. Likewise, efforts mentioned in the strategies surrounding forest fragmentation also support the protection, maintenance and enhancement of biodiversity through supporting continuity of habitat.

In addition to the strategies above, the NJ Forest Service plans will engage a wider network of experts in collaborative planning and design of forest resource management across the landscape. To this end, tools that allow for more streamlined communication across disciplines (as described throughout this document) facilitate planning and management with a more comprehensive eye towards biodiversity. Similarly, the proper archiving of site and landscape level history to gain a more comprehensive understanding of the life history of forested ecosystems and to determine criteria for assessing biodiversity, is a strategy not only of the NJ Forest Service, but of several other state agencies, private stakeholders, academic institutions and NGO's.

All these efforts combined, support and utilize natural resource management strategies that influence forest biodiversity through the support of a complex mosaic of forested habitats with mindfulness of continuity through different spatial and temporal scales. The Private Lands Program has and will continue to encourage Forest Stewardship Plan and WMP landowners to management for biodiversity. Species diversification in forest management planning is of the utmost importance and proper education, outreach and review of management plans is essential to this process. Implementing strategies aimed at invasive species management (both plants and animals) as well as regional specific species, also contribute to the integrity of biodiversity across all NJ Forest Service programs. NJUCF also promotes biodiversity through street tree inventory

Brendan T. Byrne Cabin. Photo by: J. Douglas, NJDEP

and plantings, ecosystem services, task forces, partnerships and above all else through the NJ Shade Tree and Community Forestry Assistance Act approved in 1996.

2: RECREATION

NJ's Parks and Outdoor Recreational Facilities

The state of New Jersey is committed to providing recreational opportunities that responsibility connect people with New Jersey's forests and open spaces while striving to minimize any adverse effects to the diverse range of ecosystems found throughout the state. The state is also committed to developing new recreational opportunities within urban areas, the creation of greenways connecting New Jersey communities and enhancing existing recreational resources.

Public recreation spaces are essential components of communities as they provide economic, environmental, health and social benefits. The economic and environmental benefits of recreational areas were previously discussed within the assessment section of this document, while the health and social importance of these areas will be further explored throughout this section.

In recent years, a significant amount of research has been directed at the connection between increased physical and mental health of people of all ages to outdoor recreation. Increased outdoor activity can reduce obesity, enhance immune systems and increase life expectancy. Numerous individual studies show how outdoor exercise, physical activity and even mentally recalling outdoor recreation activities, can have positive effects on depression, stress and self-esteem (California State Parks, 2005).

The social importance of outdoor recreation cannot be understated, especially in urban areas. In urban settings, parks provide identity for citizens and are a major factor in the perception of quality of life for a given community. Park and recreation services are often cited as one of the most important factors in surveys of how livable communities are (National Recreation and Parks Association, *nrpa.org*). These spaces provide a sense of public pride and a shared area for everyone in the community to interact, regardless of income, age, ability or race.

The State can help enhance community building efforts by continuing to support and promote more livable communities through the care and management of trees via the NJUCF Program. This program provides grant opportunities for qualified communities to enhance/create green recreational spaces that will directly benefit their citizens. Additionally, Green Acres will continue to prioritize preserving and creating open spaces in our urban areas and help to develop additional greenways connecting neighboring communities.

Responsible, forward thinking management of our rural, suburban and urban forests are crucial in assuring that recreational opportunities are provided to the public as a whole. To determine future recreational opportunities, as well as efforts to

Mount Tammany Trail in Worthington State Forest. Photo by: J. Douglas, NJDEP

best manage our existing lands, research is required to ensure the needs of the culturally diverse and aging population living within New Jersey are addressed. Recreational stakeholders, government agencies and nonprofit organizations should conduct a statewide study to determine the future management of outdoor recreation in New Jersey that is inclusive of all citizens.

Recreational spaces provide an abundance of environmental benefits, but these spaces have also been highly compromised by various natural resource management issues. Invasive species, wildlife management, water quality concerns, lack of facilities and staffing limitations are some of the problems that all recreational managers must face.

New Jersey state recreation areas have seen a boom in visitation over the years. This increase in visitation has highlighted capacity issues at many state park areas and the need to expand and offer additional areas for the public to enjoy. To date, New Jersey has conserved more than 34% of its land. The NJ Green Acres Program continues to acquire land for recreational open space throughout the state by prioritizing areas that promote connectivity to existing preserved lands, urbanized areas and riparian zones. Green Acres will continue to assess land acquisitions, consider the missions of potential land managers and donate the land to agencies that are best suited with its potential use.

The NJ State Park Service is a state agency which is often the benefactor of lands purchased by NJ Green Acres. The NJ State Park Service mission is to provide recreational opportunities to the public while protecting and preserving the state's natural and historic treasures. Currently, Green Acres funds are available to local governments for stewardship and management efforts, however this funding is not made available to state owned lands. NJ State Parks, Forests and Wildlife Management Areas are struggling to manage the additional acreages of preserved land without supplemental funding for projects and staff. According to the 2018 Annual Report for the NJDEP Division of Parks and Forestry, staffing levels are down more than 26% from 2006, while thousands of acres have been

"To determine future recreational opportunities, as well as efforts to best manage our existing lands, research is required to ensure the needs of the culturally diverse and aging population living within New Jersey are addressed."

added to the Division's landholdings. This has created a major backlog of required maintenance and infrastructure repair, leading to reduced services at various NJ State Parks and Forestry facilities.

However, in 2014 New Jersey residents approved a 14th referendum that permanently dedicates 4% of the State's Corporate Business Tax (CBT) for open space, farmland and historic preservation purposes. It is estimated that approximately $75 million a year will be generated by this dedication. The CBT dedication increased to 6% in FY 2019. This dedication of funds will be used toward enhancements and improvements to infrastructure and stewardship in a variety of NJ State Parks and NJDEP Division of Fish & Wildlife facilities. While these dedicated sources of funding have been an enormous help in moving forward, additional sources of funding will still be required to meet state needs.

Grant opportunities provided by the Recreational Trails Grant Program and funded through the Federal Highway Administration have been a steady source of funding for increasing/improving the state's recreational facilities. This federal program has provided more than $16 million dollars to federal, state, county, local government and non-profit agencies for projects that benefit motorized and non-motorized trail projects. Additionally, potential recreation funding sources could include federal funding such as the Land & Water Conservation Fund (LWCF), Forest Legacy Program and North America Wetlands Conservation Act grants. The state will continue to look for additional opportunities to increase recreational capacity and to

provide recreational opportunities with the continued support from CBT and Green Acres funding.

While there are numerous locations for the public to hike, bike, boat and swim; there are very limited areas for the public to utilize off-road vehicles (ORV). This lack of approved areas has contributed to a larger overall problem of people illegally operating ORVs on public lands, often causing long-term damage to unique ecosystems. Partnering with responsible ORV groups in creating legal and safe opportunities for the public to enjoy this type of recreation is imperative.

> "To date, New Jersey has conserved more than 34% of its land."

One possible strategy may be to establish a single-track trail system for enduros that would include options of utilizing existing fire cuts and roads. This single-track trail system could be maintained under an agreement with the NJDEP and responsible ORV organizations. Dedicated funding is available to help design, construct and maintain motorized vehicle recreational trails through the Federal Highway Administration's Recreational Trails Program.

Invasive species impact New Jersey native flora and fauna and consequently affect the public's ability to access and enjoy public lands. Birdwatching is one recreational activity that is heavily impacted by invasive species. More than 45 million people in the U.S. take part in birdwatching and New Jersey is considered one of the preeminent states for this because of its diverse landscape and location along the Atlantic Flyway. Habitat loss coupled with the introduction of invasive species to New Jersey has transformed native ecosystems to the extent that they is no longer viable for many wildlife species, including birds, which greatly reduces the recreational experience for birdwatchers.

Invasive species, such as EAB, create hazardous areas along trails, campgrounds and picnic areas throughout the state due to dead trees and limbs; aquatic invasive species like hydrilla can severely interfere with water related recreational activities. Collaborative efforts between public agencies, non-profits and conservation foundations on the forefront of these invasive species issues, such as the Invasive Species Strike Team and the Duke Foundation, will help to determine where land managers need to prioritize management.

Water-related recreational opportunities such as swimming, boating and fishing are among the highest demand of activities within New Jersey. In previous years, New Jersey has successfully managed water recreation areas by addressing water quality issues. Some water quality issues are caused by high geese population and invasive species such as water chestnut and hydrilla. In recent years, however, the state has been severely impacted by a high occurrence of Harmful Algae Blooms (HABs) which cause the closure of swimming areas. In 2019 alone there were more than 70 suspected and 39 confirmed HABs within freshwater lakes across New Jersey. This was a significant increase from past years. Research suggests that this natural phenomenon will continue to be an issue within New Jersey. These HABs have significantly affected many New Jersey lake communities and recreational swimming areas, preventing the public from swimming due to the potential for serious health effects on humans and aquatic life. HABs are caused by an excessive amount of nutrients, mainly phosphorus and nitrogen, present within the waterways.

Interpretive signs describing Carbon in High Point State Park. Photo by: NJ Forest Service

The NJDEP dedicated approximately $13.5 million dollars in 2019 for lake management grants, watershed planning grants and funding for projects of major infrastructure upgrades to reduce nutrient loading of New Jersey waterbodies. NJDEP will also be hosting educational summits throughout the state to share information and expertise on how to best manage HABs and to increase communication efforts with local municipalities and the public.

3: EDUCATION, COMMUNICATION AND OUTREACH

Effective management of forest resources involves acute understanding and acknowledgement of peoples' values. To this end, building relationships that facilitate collaboration is essential to being able to meet management goals across the landscape. Stakeholders often have differing and opposing interests. This general realization lead to the NJ Forest Service's development of an in-depth stakeholder process for natural resource stewardship planning. This stakeholder process is explicitly outlined within **Criterion 7** of the **Assessment** portion of this document.

When developing forest stewardship plans or landscape level management strategies, the NJ Forest Service uses the stakeholder process as an engagement tool to bring groups (i.e. NGO's, strike teams, local government and other state/federal agencies) in as the architects to actively participate in the planning process rather than simply taking on the roles of reviewers and commenters. A natural result of this collaborative process includes bringing to light any issues, management techniques and/or unforeseen problems before actual plan development occurs. This provides buy-in for stakeholders and a sense of ownership in a project where strategic decisions are made early on in the process.

The NJ Forest Service will continue to improve upon the stakeholder process and continue to perform a facilitator role to allow stakeholders to express their objectives, ideas and concerns in a safe environment. Many stakeholders, when sitting down to discuss forest management, vary significantly in background and discipline in which they were trained, leading to the potential for open and honest discussion. The NJ Forest Service helps to guide the discussion toward productive levels of engagement. Overcoming "language barriers" through collaboration strengthens forest management in New Jersey holistically.

> "Wildlife Management Areas are struggling to manage the additional acreages of preserved land without supplemental funding for projects and staff. According to the 2018 Annual Report for the Division of Parks and Forestry, staffing levels are down more than 26% from 2006, while thousands of acres have been added to the Division's landholdings."

An important part of this stakeholder process is being transparent to all who hold a stake in the management of New Jersey's trees and forests. Transparency is achieved through stakeholder meetings and discussion of simulated management results during plan development. This helps to define stakeholder roles, improve understanding of practical science behind data-driven decisions and create relationships with stakeholders built on trust. The NJ Forest Service planning system provides a series of checks and balances that remain flexible while plainly presenting trade-offs of actions to be taken. This allows for an environment where more diverse ideas can be generated and/or entertained, producing better results for the forested resource across the landscape.

Inclusion and Relevance

For collaborative conservation efforts in New Jersey to be effective and remain relevant, they must connect with the broader population and not just

with conservation professionals. It is important to recognize how the population is changing and how this affects the perception and use of natural resources. For instance, the sale of hunting licenses has declined in New Jersey since the 1970's (NJDEP Division of Fish & Wildlife, 2019). This may be a result of the increased urbanization of the state. (The population of the U.S. is increasingly living in urban rather than rural areas [US Census Bureau, 2016]).

A recent survey of users of New Jersey WMAs also shows that visitors now come to WMAs for a wide variety of reasons and not primarily for hunting (Tredick et al., 2018). Likewise, the state of New Jersey has seen a decline in the number of sawmills across the state. Agriculture has also become more mechanized, requiring fewer people to work larger areas of land. These factors contribute to a larger proportion of the population no longer working directly with natural resources in a "hands-on" fashion. This loss of direct connection can change the population's perception of and values concerning their natural resources.

The conservation community, therefore, has an obligation to engage the overall population in natural resources and conservation issues in ways that are inclusive and meaningful. Strategies to accomplish this include engagement on issues of managing forests and other natural resources in ways that matter to the larger population, by understanding and communicating the broadening role of conservation professionals and addressing disparities between demographic differences in the community of conservation professionals and the communities whose resources they manage.

> "While there are numerous locations for the public to hike, bike, boat and swim; there are very limited areas for the public to utilize off-road vehicles (ORV). This lack of approved areas has created a larger overall problem of people illegally operating ORVs on public lands, often causing long-term damage to unique ecosystems."

Meaningful engagement of the population in natural resource and conservation issues is a strategy largely addressed in several other strategy sections of this action plan. Examples of this include education programs, digital engagement, professional and community outreach, as well as the robust collaborative stakeholder processes regarding natural resource decision-making.

The second of these strategies is understanding and communicating the broadening role of conservation professionals. While traditional professions associated with conservation–such as foresters, wildlife biologists and conservation officers (to name a few) still make up a portion of the workforce, there are many more professions involved directly or indirectly in conservation issues and activities than one might realize. These professions include data scientists, remote sensing specialists, pilots (both drones and traditional aircraft), engineers, geneticists and biometricians.

The role of professions more traditionally associated with conservation (such as foresters, wildlife biologists and environmental technicians) has expanded as well. Engaging the wider spectrum of professions and the academic institutions that educate them to bring their conservation perspectives and roles to the population is part of this strategy. With the nation's population increasingly coming from urban environments, it makes sense as part of conservation outreach to engage conservation issues through professions more easily recognized in urban populations. This would involve broadening what is considered conservation, increasing opportunities for collaboration across disciplines and expanding stakeholder involvement in the management of their natural resources.

The third of these strategies is to be aware of differences in the values, backgrounds and demographics of conservation professionals and the population whose forest and other natural resources they manage. When conservation professionals differ significantly from the population served, they will have a much harder time remaining relevant and credible to their customers. The population of conservation professionals nationally versus the demographics of the U.S. show several differences (compare datausa 2018 with US Census Bureau 2018). Conservation professionals appear to have less diversity in terms of race and sex. Nationally, the conservation professions are still disproportionately white and male compared to the larger U.S. population. The NJ Forest Service is much closer to the national population in terms of representation of both sexes but follows the national trend in terms of ethnicity. A single entity cannot rectify these differences; acknowledgement of the issue and a concerted effort across multiple entities may ultimately prove successful.

Several strategies NJDEP, its state partners and partners across state lines could undertake to further meaningful dialog with New Jersey's diverse population on conservation issues are outlined later in this section. Examples include digital engagement, which allows people in urban settings (who might not otherwise be able to visit the locations of rural conservation efforts) to experience the decisions and outcomes surrounding rural conservation efforts; community outreach programs in local neighborhoods; working with higher and lower level academic institutions to raise awareness of the broad range of conservation careers available; increasing the availability of scholarships and internships in a wide range of both traditional and non-traditional conservation careers; marketing the importance of conservation to a wider population through a variety of means already mentioned within this document; and various others. In summary, inclusion and relevance will be carefully considered throughout the next decade of forest planning and will be implemented alongside the other strategies presented within this NJ SFAP, most importantly in strategies associated with education, communication and outreach.

Education and Outreach

Among the top priorities of the NJ Forest Service is to educate the public on forestry issues. The NJ Forest Service is fortunate in that it operates a facility explicitly dedicated to forestry education, the Forest Resource Education Center (FREC) located within the Pinelands National Reserve. Recent increases in staffing have enabled the NJ Forest Service to expand, update and prioritize education and outreach efforts at the FREC facility.

Starting in 2020, FREC staff will collaborate with the NJDEP Division of Parks and Forestry to develop an updated interpretive plan. The updated interpretive plan will lay the groundwork for engaging users of the facility in forestry experiences such as hands on and classroom educational programs and tangible interpretive features that advance the mission and bolster public support for the objectives of the NJ Forest Service. The interpretive plan will include current messaging on topics of conservation concern such as active forest management.

Additional staffing of the FREC facilities would allow the NJ Forest Service to become the state manager of Project Learning Tree (PLT), an international award-winning environmental education program. The FREC will host PLT facilitator workshops for formal and non-formal educators to enable them to instill a deeper understanding of forestry topics to students of all ages. New environmental education programs will be developed in correlation with the NJ Department of Education's Learning Standards to ensure the facility is meeting the needs of visiting school districts as well. This would also include reassessment of current lessons and educational programs.

The NJ Forest Service will continue to develop new and innovative partnerships and educational experiences for formal education groups and students ranging from primary school to graduate programs. A concerted effort will be made providing in-service PLT training to university students majoring in education degrees such as those attending Rider University, The College of New Jersey and Georgian Court. By providing young

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teachers with training and resources, it ensures their future students will have the opportunity to learn about forestry and natural resource issues as well.

The NJ Forest Service will obtain the funds needed to cover the administrative and material needs for PLT to be provided at a free or reduced cost for workshops held at universities and within public-school systems. The NJ Forest Service will also continue to partner with universities and colleges to develop an integrated forest ecology curriculum. In addition, the NJ Forest Service will continue to partner with secondary education facilities to develop policies for and create additional internship opportunities for undergraduate and graduate students to help develop foresters of the future.

Since private landowners own approximately 48% of all the forested land in New Jersey, this makes them a key stakeholder in determining how forests are managed. The NJ Forest Service will strive to reach and motivate landowners to apply principles of sustainable forest management through outreach via local governments and through free seminars/ workshops that will provide up-to-date forest management techniques and incentive programs like the NJ Forest Stewardship Program. The Forest Stewardship Program provides technical assistance and funding towards the development of comprehensive forest management plans with the potential for property tax abatement.

The NJ Forest Service, Woodland Stewards Program provides outreach, education and leadership for the care and use of New Jersey forests for ecological, social and economic benefits and values. The NJ Forest Service, Woodland Stewards Program is a growing collaboration of trained volunteers and partners advocating for sustainable forest management throughout the state. These volunteers and partners will connect directly with forest landowners to share information about local and regional forest prescriptions and how their lands can contribute to landscape level goals.

The NJ Forest Service will strive to continue outreach to the general public through multiple additional avenues and approaches including social media. The NJ Forest Service will partner with other agencies to host seminars highlighting forest effects from climate change, deer management and invasive species. The SWAP (2018) supports the need to develop greater understanding of and support for forest management practices through education and outreach, specifically efforts implemented to enhance SGCN habitat and biodiversity. The NJ Forest Service will also help promote and support the NJ Tree Foundation's programs such as "TreeKeepers" and "Right Tree, Right Place, Planted the Right Way" throughout the state as funding and programs are developed. These workshops and seminars provide entities such as local governments, shade tree commissions, landscapers, DPW workers and many others with hands-on and classroom instruction on a variety of topics and forestry practices.

Backyard Forestry in 90 Minutes

"Backyard Forestry (BYF) in 90 minutes" is a monthly event sponsored by the Rutgers Extension, the NJ Forestry Association and the NJ Forest Service FREC for adults to learn about natural resource management. BYF includes topics such as forestry, wildlife management, invasive species management, forest health monitoring and mitigation and wildfire mitigation which are all under the umbrella of forest stewardship.

Topics for 2019 included the emergence of spotted lanternfly, Big tree and Heritage program and

deer management. Larger scale concepts, such as state lands management planning which includes landscape scale management across several regions of the state, has been considered "Big Backyard Forestry." This type of management includes all citizens of the state as participants of the process including the management of state forests, state parks and WMAs for current and future generations to enjoy.

To date, more than 400 people have attended the BYF seminars that occur on the second Thursday of each month. Due to the popularity of the program, as of winter of 2019, BYF in 90 minutes expanded to northern New Jersey at the Frelinghuysen Arboretum. The NJ Forest Service has also partnered with the NJ State Park Service and non-profit agencies to make these free programs available at different facilities located throughout the state.

These programs, in addition to other existing and new programs will be promoted online and through written media and programming at parks and nature centers across the state as well via traditional means of promotion. The NJ Forest Service and NJ State Park Service will partner to develop further public programming with a forest management focus within the 43 state parks, forests and recreational areas.

There are numerous active forest management projects being implemented within these lands; educational programming will assist citizens in better understanding the importance and significance of this work. The NJ State Park Service has dedicated full-time staff, in addition to seasonal staff, to assist in the development and presentation of these programs. Foresters working for the NJ Forest Service can identify high priority topics that necessitate communication and even host some seminars or workshops for environmental educators to learn and develop educational strategies on how to best share this information with the public.

It is imperative that this information be presented to the public in an understandable format and that it does not become lost in technical jargon. In addition, the NJ Forest Service will provide funding for environmental education/interpretation training for the staff of the NJDEP Division of Parks and Forestry to ensure forest issues, management techniques and forest fire subjects are communicated effectively.

Rutgers Urban Forestry Program and PLT

The Rutgers Urban Forestry Program supports NJ Project Learning Tree by providing occasional workshops, in addition to those provided by the state PLT coordinator. Rutgers has partnered with NJ PLT within the past several years to execute numerous PLT Model Program Initiative (MPI) Grants from National PLT to reach additional audiences throughout New Jersey. Most recently these initiatives have included developing a hybrid online workshop model for New Jersey to embrace the National PLT model. This presents an on-line workshop component while still maintaining a connection to the hands-on experience of PLT activities through the traditional workshop model.

In recent years, the Rutgers Urban Forestry Program, in partnership with NJDEP's PLT program, has presented the PLT hybrid model workshops at both the winter and fall Alliance for New Jersey Environmental Education (ANJEE) conferences as well as for the NJFA Woodland Stewards Update. In addition, the Rutgers Urban Forestry Program, with funding from a PLT MPI grant, developed a document titled "NJ PLT Forestry Career Profiles" (accessed with the following link: *https://urbanforestry.rutgers.edu/outreach/docs/NJ-PLT-Forestry-Career-Profiles.pdf).* It is our hope that this document will be used by teachers to raise awareness of the many career opportunities available in forestry in New Jersey.

Woodland Stewards

The NJ Woodland Stewards Program is a four-day workshop sponsored by the New Jersey Forestry Association (NJFA) in partnership with Rutgers New Jersey Agriculture Experiment Station (NJAES), NRCS, NJ Forest Service and NJDEP Division of Fish & Wildlife. The program trains approximately 25 participants each year in topics including forest stewardship (including government

sponsored incentive programs available to forest landowners), silviculture, forest and wildlife ecology and management, tree identification and outreach strategies. The program is targeted to forest landowners throughout New Jersey. The hope of this program is that improving the understanding of forestry will lead to better forest management practices on individual properties and that the attendees will share what they have learned with other landowners and with the general public through volunteerism and outreach.

Firewise

The Firewise program educates communities on taking responsibility for themselves by reducing fire risk within their community. This program also provides grant support for wildfire mitigation projects such as underbrush removal to reduce fire risk on private land. Firewise Communities follow the "Be wise, Be very wise, Be Firewise", a slogan adopted by several states and many communities throughout the country as part of an outreach and awareness effort to educate residents of the benefits of wildfire preparedness.

Wildfire planning and preparedness is at the core of a new national initiative—The Firewise Communities/USA program. This effort, sponsored by the National Wildfire Coordinating Group, is designed to facilitate and provide information and resources to towns, municipalities, developments and communities that need to adopt long-term, proactive solutions to protect homes and natural resources from the risk of wildland fire. In addition to working closely with communities to achieve a few simple steps for enrollment, the NJ Forest Fire Service will also assist communities in obtaining grant funding to implement Firewise concepts, as well as wildfire prevention and education events. Agencies and organizations responsible for wildland fire management agree to reduce the loss of lives, property and damage to natural resources from wildfire by building and maintaining communities that are compatible with their natural surroundings.

There is no single solution, however, to achieving this common goal. Yet, the Firewise Communities/USA concept is most successful because it emphasizes local decision-making and encourages community representatives, including homeowners, to develop local plans. These efforts will continue to evolve as the natural setting and local government officials change. With continued engagement, however, the NJ Forest Fire Service can improve upon these outreach objectives and the goals of communities.

Fuel transects at Wharton State Forest. Photo by: J. Douglas, NJDEP

Rutgers University Forestry Club

In 2019, Rutgers students, with support from the Rutgers Urban Forestry Program organized to form the Rutgers University Forestry Club. Since its inception, the club has hosted speakers from the NJ Forest Service, International Society of Arboriculture (ISA) and SAF and is working to establish annual service projects and links to the forestry and arboricultural community in New Jersey. The club has applied for official recognition through the University and has secured affiliation letters from both the NJ Arborists chapter of the ISA and the NJ Division of the Allegheny SAF. The club looks forward to working with the NJ Forest Service in the future as a resource for service projects, career advice and internship opportunities.

Communication

Communicating the value of New Jersey forests as a natural resource is imperative. The management of this natural resource must be understood by the public for the NJ Forest Service to accomplish the overarching goals that are outlined throughout this Forest Action Plan. Oftentimes, especially in a state as populous as New Jersey, residents believe that many forestry practices are not beneficial. The

goal of the NJ Forest Service Communications Team is to create a suite of content that explains the benefits of forest management tools and techniques. This content will begin to break-down common misconceptions generally held about forestry practices in New Jersey. Through the communications methods explained in the following segments, the residents of New Jersey will learn about the role of the NJ Forest Service and its professional staff in managing the states resources.

Wildfire and Thinning through Research

Research institutions within New Jersey, such as Stockton University, are currently carrying out various silvicultural thinning operations within the Pinelands Region for increased study and monitoring of the benefits of thinning across this fire dependent ecosystem. As tree cutting reduces the number of canopy trees, distance between crowns of trees also increases, in turn reducing the ability of crown fires to move from one tree to another and across a forest (Fule et al. 2001).

The New Jersey Fire Safety Council continues to convey the importance of forest thinning to prevent overcrowding, fuel build-up and weakened trees through excessive competition. The Council also iterates how this will help heal the fire dependent forest ecosystem and create more dynamic wildlife habitat conditions in areas that have needed suppression from wildfire because of the WUI. WUI has significantly increased over the last several years, making the ability to address forest density related issues through prescribed fire management alone extremely difficult.

Forested WUI area is steadily growing, with increases from 42% in 1990 to 46% in 2010, particularly within the Pine Barrens region of southern New Jersey and in the Highlands region of northern New Jersey (Crocker et al., 2017). This has also led to changes in fire regimes and fire suppression in forests has led to increases in forest density (lack of even low intensity killing fires). Multiple studies have found that fire exclusion is either degrading pine barrens ecosystems or causing them to be lost completely (Milne 1985, Bernard and Seischab 1995, Copenheaver et al. 2000, Howard et al. 2011).

Digital Media

Photo/Video Content: The best way for the public to understand what the NJ Forest Service does is for the public to actually see the work in progress. Photo and video content will take viewers through an entire NJ Forest Service project from start to finish, sharing this information as work proceeds. Social media will act as the main outlet for the public to see many of these photos and videos. This content will also be shared through press releases, in public meetings and in print media such as brochures and posters.

Audio Content: The NJ Forest Service will develop a forest health podcast as a long form media outlet that gives more information than a typical video produced by the agency would. A podcast is a digital audio file made available through the Internet for downloading to a computer or mobile device. Typically, podcasts are available as a series with new installments, that interested listeners can subscribe to automatically. The forest health podcast will discuss many of the current forest health issues that New Jersey is facing. Our host will be joined by guests outside of the NJ Forest Service who are the leading experts in the topics covered in each episode.

Video Games: Video games are a mainstream media source in the 21st century. Many video games now gross as much or more than blockbuster films with comparable budgets for their creation. Video games also present unique and growing opportunities to engage large sectors of the population. According to a report from the Electronic Entertainment Association in 2019, more than 65% of American Adults in the U.S. play video games daily and 67% of parents play video games with their children at least once per week.

There are many ways that video games may be used to engage large portions of the population. Games may be directly educational for instance. Microsoft, for example, features *minecraft.edu* as a central repository for modifications (mods) for the popular game, Minecraft, that can be used to teach classroom lessons. Game content, however, does not need to be directly educational to convey lessons regarding our forest resources. Forest management and ecology

A post on NJ State Forests Facebook page.

concepts can be expressed in games that are otherwise "fun to play." Likewise, many games employ or contract ecology experts that advise game designers on realistic environments presenting opportunities for natural resource managers and experts to engage game designers.

The NJ Forest Service has been exploring opportunities to express concepts such as silviculture, forest ecology, wildlife management and wildfire mitigation by using video games. The NJ Forest Service has reached out to partners in the academic and gaming industry to develop several products. These range from video games themselves, to several game mods, forest data products useful for realistic portrayal of forested environments and natural processes, as well as the construction of game worlds that represent actual publicly owned forests with augmented reality tools for enhancing visitor experiences to these actual locations.

Dashboards

Data dashboards or dashboards are a type of Graphical User Interface (GUI) that link to datasets usually stored in databases of some kind. They are interactive and provide a centralized means of accessing data. Dashboards are increasingly being used to convey information even from mainstream media sources. They can take on several forms from interactive tables and charts, to story maps depicting geospatial data with lots of graphics and narrative. It is a strategy of the NJ Forest Service to leverage dashboards in a multitude of ways to convey information to a variety of audiences. Many of the strategies presented within this action plan, along with much of the data presented in the assessment portion of this plan, could be expressed using dashboards.

As mentioned previously, the NJ Forest Service has pursued several strategies to secure scalable data streams form a variety of sources. Therefore, it is only logical to utilize these data streams to produce products such as dashboards. These dashboard products could be used to convey technical aspects of strategies to NJDEP leadership, among domain experts, or to convey the story of the benefits of forest management to the public and/or other important stakeholders. These may also be used in coordinating management efforts across state and institutional lines.

More recently, the NJ Forest Service has worked with partners to develop dashboards such as NJ Forest Adapt with Rutgers University, a number of products created in cooperation with the USDA FS FIA Program, as well as the NJ Conservation Blueprint created by Rowan University, The Nature Conservancy and The NJ Conservation Foundation. The NJ Forest Service also has strategies to produce a number of dashboards tailored to more specific needs.

Social Media

Now that the world has turned to a more digital age, the NJ Forest Service has found that one of the most successful ways to deliver messages to the public is through social media. Much of the photo, video and audio content described above is used within this context. As of February 2020, the NJ Forest Service uses Facebook as its main social media outlet. The NJ Forest Service Facebook page which was first created on April 10, 2012, currently has 37,627 "likes" and 38,788 "followers."

Posts to the NJ Forest Service page are frequently viewed by approximately 20,000 to 30,000 Facebook users and it is not uncommon for a popular post to be viewed more than 100,000 times. In addition, the NJ Forest Service also relays messaging through the Department of Environmental Protection via Facebook (*Facebook.*

com/newjerseydep) and Twitter (*@newjerseydep*) accounts, as well as through the NJ State Park Service's Instagram account (*@newjerseystateparks*).

A summary of the audience and goals/strategies of the content for the NJ Forest Service Facebook page are described below:

Audience: New Jersey residents, residents from surrounding states, outdoor enthusiasts, homeowners, those who live in WUI areas, hikers and parents.

Objectives: To highlight the work of the State Park Service, NJ Forest Service and the NJ Forest Fire Service and how the three agencies collaborate with each other to achieve a common goal. Create content that interests our audience and prompts them to share their experiences through comments and share posts on to their own Facebook feeds. Through posting all original content, page followers will learn more about what each of these agencies' goals are and gain the trust and understanding of the public.

Best Times to Post for Engagement:
- 8:00 a.m.
- 6:10 p.m.

While Facebook is currently the main social media network the NJ Forest Service uses (*facebook.com/NewJerseyForests*), the agency is open to creating additional accounts, especially as times change and new social networking sites come into existence.

Continued Professional Development for Staff

The NJ Forest Service Communication staff would benefit from attending conferences and events hosted by other states and organizations in order to stay up to date with the latest trends. In an ever-changing digital world, especially with social media, it is important to see what is working for other agencies and how the NJ Forest Service can continue to improve communication with all residents of New Jersey.

Rutgers Communication

The Rutgers Urban Forestry Program provides outreach and extension services in forestry throughout the state, while the Director and Outreach Coordinator are often speakers at statewide conferences and trainings. This includes events such as the NJ Shade Tree Federation annual conference, the New Jersey Arborists, Chapter of the ISA (NJAISA) Garden State Tree Conference, the NJ Division of the Allegheny Chapter of the SAF annual Training, the NJ Forestry Annual Meeting and Member Program and Woodland Stewards Program, ANJEE Conferences, NJ Nursery & Landscape Association annual conference, North Jersey Ornamental Horticulture Symposium (NJOHS) Tree Day, NJ Tree Foundation Right Tree, Right Place workshops, as well as providing many specialized presentations to local groups throughout the state each year.

Rutgers Center for Remote Sensing & Spatial Analysis (CRSSA) is supporting the work of the NJ Forest Service through integration of management goals and information priorities in the NJ Forest Adapt tool. Rutgers also supports the continued expansion and improvement of this tool to help facilitate the evolution of NJ Forest Service programs including the update of the NJUCF Guidelines for Community Forestry Management Plans and the implementation of RGGI.

Forest Resource Education Center (FREC)

As noted earlier, the FREC is a central connection point between the NJ Forest Service and the people of New Jersey. The FREC operates a forestry-focused interpretive center on a 1000-acre forested campus within the Pinelands National Reserve shared with the NJ Forest Service Nursery. Each year, the FREC engages more than 1,000 students in forest-focused educational experiences; educational programs are provided at no cost to audiences ranging from kindergarten school groups through adult continuing education.

Natural resource interpretation at the FREC emphasizes the unique qualities of the Pinelands National Reserve and the work of the NJ Forest Service Nursery. Visitors learn about fire ecology in the Pinelands, the process of growing seeds into

trees and about the numerous forest products New Jersey's woodlands can provide. Staff promote the use of forest products through the process of cutting logs into lumber on a portable bandsaw mill located on site, as well as hosting maple sugaring events in late winter. The FREC also maintains nearly 8 miles of non-motorized trails with interpretive waysides for hikers, bikers and horseback riders to experience and appreciate the unique natural and human ecosystems present on-site.

The FREC brings the programs of the NJ Forest Service together with environmental, tree- and wood-focused organizations present at the Fall Forestry Festival every October since 1994. The Fall Forestry Festival 1-day public event has had an attendance of up to nearly 1,000 people. Attendees have the opportunity to interact with professional foresters currently tasked with managing the state's forest resources, make a spinning top with the assistance of woodturners, interact with professional arborists following a tree climbing demo, experience a prescribed fire up-close and personal with the NJ Forest Fire Service and many more forestry related activities and exhibits.

The FREC interpretive center is constructed of laminated timbers with "Autumn Leaves" art-embedded within the hardwood floor; this design has a natural aesthetic that models responsible natural resource stewardship and features endless interpretive opportunities. A 50-seat classroom space with an 80" video conference-enabled monitor is also available for free reservation and is the current meeting place for Backyard Forestry in 90 Minutes. This program (discussed in more detail previously) allows the public to engage in more face-to-face conversations and learn interactively from various natural resource professionals.

Friends groups are NGOs that support the mission and associated activities surrounding a given publicly held park, forest or facility. Friends groups can facilitate access to certain types of resources and reach stakeholders in ways that would be difficult for government entities to do so in a traditional fashion. Friends groups also give members of communities surrounding government-held properties a sense of ownership in local, publicly held properties. It is a goal of the NJ Forest Service, FREC facility to foster a friend's group. This friend's group could help promote volunteering opportunities, facilitate events, provide an extra means of keeping watch on the property and purchase and maintain equipment for maintenance, educational and volunteering events.

The FREC supports public inclusion efforts of the NJ Forest Service by responding to inquiries, creating interesting content for social media and educating residents on the importance of forests. As stated previously within this strategies section, starting in 2020 the FREC will be collaborating with the various NJ Forest Service programs to develop an updated interpretive plan; this will include efforts for communicating program strategies as well.

The FREC leads the Volunteers in Forestry program, matching prospective volunteers with NJ Forest Service staff in relevant programs. The FREC also offers on-site volunteer opportunities including trail maintenance and the harvesting of seedlings with the NJ Forest Service Nursery. The FREC coordinates between program areas of Forest Health and State Lands Management by developing programs that protect forests from threats through insect/disease surveys and conserve and manage forests through forest inventory data collection. The FREC seeks to expand its volunteer staff in these topics of interest, as well as other forestry related initiatives to further the goals of the New Jersey State Forest Action Plan. This requires dedicated staff and financial support, which may require actively seeking grant opportunities and/or additional federal and state funds.

In addition, volunteer recruitment targets colleges and high schools that have service-learning requirements. A stronger partnership with New Jersey schools will prove very beneficial for the outlook of future NJ Forest Service professionals. This also provides a more "real-life" educational experience and adds a more public face to the NJ Forest Service. Other sources of public engagement include connecting to corporations

that support volunteerism in their workforce and strengthening the FREC's partnership with the Rutgers Environmental Stewards and NJ Woodland Stewards programs.

NJ Big and Heritage Trees

The Big Tree Program in New Jersey dates to the 1930s, while the Heritage Tree Conservation and Education Program began in 2017. Prior to 2016, the Big Tree Program was known as the Champion Tree Program because it focused on the largest trees only throughout New Jersey. After 2016, the program was renamed the Big Tree Conservation Program to include all big trees and not just the largest. Trees are classified as Heritage trees when they have a significant historical story associated with them. Not all heritage trees are big or old.

Big and heritage trees are found on both private and public properties across the state. Private landowners complete a right of access agreement to provide necessary permissions for NJ Forest Service staff to measure the tree, list the tree on its official registry and take photographs.

An inventory for all big and heritage trees listed on the official registry for the state of New Jersey was a crucial task recently undertaken, since the last inventory was completed nearly 15 to 20 years prior. This allowed the NJ Forest Service to determine how many big trees had grown, how many had died or fallen, as well as the health of each tree. As a result of the inventory, approximately 100 big and heritage trees were recorded on the official big and heritage tree registry. Currently, there are approximately 400 big and heritage trees on the official registry.

This number has quadrupled since the original inventory conducted approximately four years ago for New Jersey and it continues to grow. The next big and heritage tree inventory is planned to be conducted in 2026 and as such a large undertaking, the help from contracted professional foresters may be required. Nominations for a big or heritage tree by the public can be considered by filling out a nomination form available on the NJ Forest Service website (*https://www.state.nj.us/dep/parksandforests/forest/community/*).

Typically, big tree programs in many other states across the U.S. are managed along with other forestry programs. The NJ Forest Service values it's big and heritage tree program, which continues to advance and expand as necessary.

NJ Big and Heritage Tree Conservation and Education Program has partnered with several organizations throughout the state for the advancement of the program. Some of these include the Willowwood Arboretum, Frelinghuysen Arboretum, Medford Leas Arboretum and the Girl Scouts. Efforts to include the Boy Scouts as a partner organization are also being pursued. By partnering with organizations such as the Girl Scouts and Boy Scouts, the program will receive help in locating and measuring big and heritage trees, while credit towards specific badges and scout projects can be attained. NJ Big and Heritage Tree Conservation and Education Program also closely works with the FREC on presentations, workshops, activities and projects, promoting the program.

Several events are attended by the NJ Big and Heritage Tree Conservation and Education Program staff throughout the year, as it provides a good opportunity to extend outreach and awareness of the importance of the conservation of big and heritage trees. This provides the opportunity to educate the public on necessary maintenance to extend the life of big and heritage trees. Big and heritage trees are New Jersey treasures and mega-resources that greatly contribute to the health of the environment.

Benefits from these trees include:

- **Provide increased environmental benefits** relative to a typically sized tree.
- **Act as windbreaks.**
- **Provide enormous impacts on the conservation of energy** and reduces the heat island effect.
- **Reduce water runoff,** which also prevents flooding and greatly improves the life of streets.

Rutgers Extension

The NJ Forest Service supports the development of the forestry programs at Rutgers University, as the university is working through the 5-year accreditation process through the SAF with the goal of achieving accreditation for programs in Urban Forestry and Natural Resources and Ecosystem Management. The NJ Forest Service provides guest speakers in classes, tours and field trips for students and offers internship opportunities to help with the development of future forestry professionals. Specifically, the NJUCF provides funding for student internships for NJUCF projects through federal pass-through grants.

The Rutgers Urban Forestry Program Outreach Coordinator works in partnership with the NJUCF to review continuing education opportunities for municipal and county representatives participating in the NJUCF accreditation program and provides a list of CEU opportunities on the Rutgers Urban Forestry Program website at: *https://urbanforestry.rutgers.edu/njucfce/continuing-education-opportunities.html.*

In addition, the Rutgers Urban Forestry Program Outreach Coordinator helps to facilitate the NJUCF Core Training program, which is another training requirement of the NJUCF accreditation program established through the NJ Shade Tree & Community Forestry Assistance Act. Core Training is offered at least twice annually, once at Rutgers in the spring and once at the NJ Shade Tree Federation annual conference in the fall. The Rutgers Urban Forestry Program Outreach Coordinator hosts the spring program, is a presenter and coordinates all other presenters for both programs. This work is supported through federal pass-through grants as well.

4: DATA

Data Driven Strategic Planning and Management

As previously stated, New Jersey uses data in decision-making, outreach and is exploring potential markets in data and data services surrounding forest resources. The NJ Forest Service is interested in adopting a comprehensive and highly integrated approach to data and data services. The availability of data, ease of distribution and access to computing power are leading to widespread cultural changes, not just in the conservation community, but in the global population at large. In the wake of such profound cultural shifts, even in the years between the drafting of New Jersey's last state forest action plain in 2010 and now, the call for fundamental shifts in data strategies is moving forward.

Although some of these viewpoints on data have been outlined within other strategy sections, the magnitude of the changes in data use, collection, storage, processing, outreach and implications to the management of natural resources has changed so drastically in the last decade that a section outlining data strategies is required.

Several factors have coincided over the last decade to bring about changes in how data is used and consumed by the masses. Data from a wide range of sources can be combined and effectively analyzed to gain information that would not have otherwise been apparent. Many of these datasets can be very large and/or may not appear to have any pattern to them at first observation. Machine learning techniques (i.e. using algorithms that can learn from large datasets to provide information) have become much more widespread. This was largely publicized when defense contractor, Edward Snowden, leaked information about how the NSA utilized various forms of data in order to draw detailed conclusions about national security threats from U.S. citizens.

Although many of these techniques have been around since before the last decade, the publicity surrounding the uses of "big data," increases in computing power and increases in the amount and

availability of data have led to greater public and professional interest in data. In addition, the rise of professions such as data science, which is not as much centered on a traditional scientific discipline as the use of data to gain knowledge and actionable information. It is a strategy of the NJ Forest Service to invest in projects, technology and personnel that can make use of these techniques to gain knowledge and information from a variety of data sources.

The widespread use of data and data products, coupled with increasing demand, interest, political and economic value necessitate the adoption of strategies regarding ethical use and distribution of these products. It is a strategy of the NJ Forest Service, therefore, to implement open data and open source software licensing where practical. The NJ Forest Service is currently engaged in a Joint Venture Agreement (JVA) with the USDA FS FIA program to develop data tools and products by supporting a community of professionals and enthusiasts through open source project development. The JVA provides opportunities for technology transfer, multi-state and federal support and has built an online community to develop open source software and data products.

The online community consists of professionals and enthusiasts coming from many different backgrounds representing private, public, NGO's and hobbyists. The products produced by this community utilize version control systems to coordinate collaboration. Software products resulting from these efforts are licensed using open source licenses and distributed from public repositories online. It is a strategy of the NJ Forest Service to continue participation in this agreement, as well as build upon it and forge more of these types of agreements and efforts into the future.

However, as previously discussed, making data, data products and software does not necessarily mean making all products free (or no cost). Other strategies related to utilization and marketing within this document outline potential strategies for ethically capturing returns on these data products. Open data and open source strategies strive to make data and source code transparent and available for use. These strategies can include legal implements such as licenses and agreements that clearly define the parameters of use or may also include technical solutions such as making use of web tools, version control, public repositories and Application Program Interfaces (which are a set of routines, protocols and tools for building software applications) to facilitate access to software, data and data products in meaningful ways in a world where users are interested in automating data gathering for analytical and display applications.

Investments in data and data products include making the use of data mining techniques such as web scraping, scalable database administration, distributed computing and the use of skilled employees and contractors to use these tools effectively. Some of these tools, such as cloud computing and fielding connected "Internet of Things" (IoT) devices, will certainly pose ethical challenges to public entities. However, the NJ Forest Service intends to embrace these technologies moving forward collaboratively working with other agencies and stakeholders.

The NJ Forest Service is also interested in working with public, academic, private and NGOs in the field of 3D modelling for a variety of purposes including simulation, visualization and outreach. The NJ Forest Service is also seeking to make use of optimization models in understanding tradeoffs, ecosystem services, function, land management decisions and the relationships between these factors and human values, as discussed previously. The NJ Forest Service is committed to becoming a leader and valuable partner in many fields surrounding data, analytics and ethical use and distribution of data.

5: GAPS

Forest Carbon: The amount of data and information available on forest carbon has increased dramatically since the drafting of New Jersey's last State Forest Action Plan in 2010. However, with new information, new questions have arisen. Although statewide numbers for forest carbon stores are available, estimates for flux and sequestration

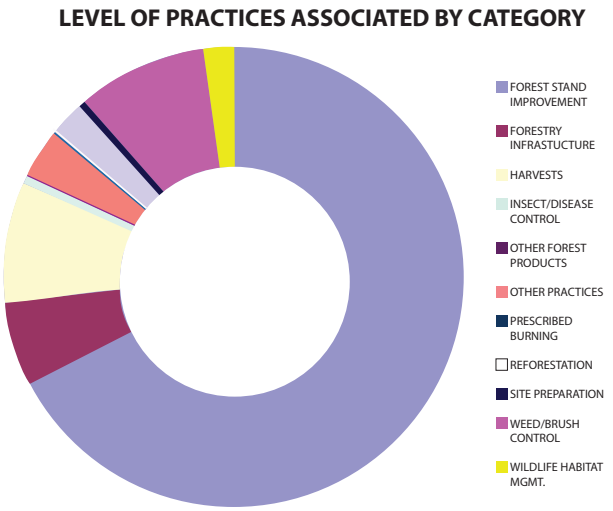

Figure 86. Private Lands, Landowner Level of Practices (Farmland Assessment Database, 2019)

rates present gaps. In this planning cycle, it was possible to make inferences about the state of New Jersey's forest carbon pools and risks to them. It was not possible, however, to make recommendations regarding the allocations to each carbon pool or in analyzing tradeoffs associated with different allocations because sound information at usable scales for carbon flux and sequestration are still largely unavailable.

It is also worth noting that although data on statewide carbon pools and storage have greatly improved, there is still a need to improve the resolution on this data. For instance, the statistical rigor associated with statewide pools quickly falls apart when trying to make comparisons among forest types. Having information on carbon flux and sequestration rates at similar scales would also be extremely useful. Data collected at these scales could provide useful comparisons of the storage and sequestration capabilities, risks and tradeoffs between upland and lowland forests, for example.

This type of information would also be an essential part of determining short-term and long-term risks to carbon pools and sequestration from damage causing agents such as insects, disease and wildfire. Over this coming planning cycle, it is essential to gain more information so that forest carbon allocation can be considered among all of the other factors that make these carbon stores important.

Forest Regeneration: The last State Forest Action Plan (2010) also closed several gaps surrounding forest regeneration with regeneration surveys becoming part of the USDA FS, FIA data collection protocols. This type of data would also be useful at finer scales such as allowing comparisons to be made across forest types or deer management zones. Information and data surrounding invasive species, which often significantly impacts forest regeneration could stand to be improved as well. FIA data on invasive species is available from now defunct "Phase III" plots. The federal list of invasive species, out of necessity to be nationally standardized, does not include several invasive plant species that would be of concern to New Jersey forest resource managers. The state of New Jersey does not have an up to date or officially recognized list, of invasive plant species because the question of what constitutes a species being invasive is also a question of values. These issues also lead to a lack of standardized reporting and data collection protocols at finer scales.

Ecosystem Services: The ecosystem services surrounding forest resources are still often difficult to quantify for meaningful analysis. Efforts to make more information surrounding ecosystem services more available such as improvements to the iTree tool suite and Forests to Faucets have significantly helped, however many gaps still remain. The ecosystem services relating water quality to forest conditions could still use improvement. Data useful for decision-making surrounding water quality include discharge rates and runoff to sewersheds, forest evapotranspiration (ET) and its impacts to water budgets, forest ET related to forest stocking and composition and forest water budgets versus response to disturbance.

Fire: New Jersey has a robust relationship with forest fire researchers and innovators around the world in no small part, through the state's relationship with the USDA FS New Lisbon Field station staff. Yet, gaps surrounding fire and its interaction with forest ecosystems still remains. Information regarding wildfire risk under a variety of conditions would be useful not only for assessing risk to life and property, but to forest resources

such as ecosystem services, productivity and carbon stores. Establishing better data surrounding forest structure and composition, both understory and overstory, combined with fuels would make for more effective simulation and alternative selection during planning.

Data Gaps related to Private Lands Management and Farmland Assessment WD-1 Form Activity Tracking

Each year woodland owners enrolled in the New Jersey Farmland Assessment Program, as it pertains to woodland assessment, need to submit a Farmland Assessment Application Form (FA-1), Woodland Data Form (WD-1) and an Activity Map by August 1 of each year.

The WD-1 Form lists the activities and extent prescribed in the plan that have been or will be implemented of each year. Activities may include forest stand improvement, planting, tree harvesting via silvicultural prescriptions, vine and brush control, prescribed burning and establishment of access roads. These activities are entered into our database and aggregated and queried by municipality, county, region and State. A pie chart **Figure 86,** depictes with a sample set of recorded WD-1 form data.

The data received is understandable but does not always fit specifically into predefined categories due to the amount of activities that can occur, the combination of activities and poor reporting. A partial data gap that was resolved involved the establishment of subcategories or sub-activities. An example of a prescribed and implemented prescription is forest stand improvement with a sub-activity of single-tree selection.

With 55 consultant foresters working with up to 5,900 woodland owners, submitted WD-1 Forms have variations of data reported that require interpretations and judgments on how to nest the activities implemented in a predefined activity or sub-activity. A crosswalk will be prepared to group activities in to-be-determined categories in order to narrow down inconsistencies. NJ Forest Service will coordinate with consultant foresters on categories and subactivities for their perspective input as the foresters and woodland owners are preparing the forms for submittal. This will assist in facilitating a new way of recording activities without being burdensome and capture buy-in to a refined way of data recording and analytics.

Although this data can be queried to the scale of a municipality, a geodatabase will be established to refine scale and spatially track activities with other data layers such as forest types, water and wildlife resources.

Rutgers University

Significant data gaps exist in urban tree growth curves/site indices. Richard Leopold, a PhD student at Rutgers, is currently working to fill this data gap for the 10 most common tree species in the planted landscape. Mr. Leopold is working under Dr. Jason Grabosky, Director of the Rutgers Urban Forestry Program, to complete this research *(https://urbanforestry.rutgers.edu/research/graduate-studies.html).*

"The objective of this study is to analyze the allometric relationship between the diameter at breast height (DBH) and crown volume. The question presented is: Does site type influence this relationship? The species selected for this study are Quercus rubra, Quercus palustris, Acer rubrum, Acer platinoides, Pyrus calleryana, Gleditsia triacanthos, Planatanus X acerifolia, Zelkova seratta, all species of Tilia spp and Fraxinus spp. Four different site types have been identified, lawns, pits, small strips and large strips. Lawns are classified as areas with non-limited root growth in all directions. Pits are growing areas that are limited in root growth in all directions, sidewalk cutouts. Strips are areas with non-limited growth in two directions 180 degrees from one another, areas between the street curb and the sidewalk. Furthermore, strips have been divided into large strips, greater than 4 feet up to 12 feet in the limiting directions and small strips, less than or equal to 4 feet in the limiting direction.

NJ State Forest Action Plan: Spatial Prioritization Survey

Rank Questions on a scale of 1 (least important) to 10 (most important) for program interests.

Rural Priority Areas

1. Please rank the importance of ***Forest Stewardship Planning*** on forestland to your organization.
2. Please rank how important the ***Protection/Enhancement of Threatened & Endangered Species Habitat*** is to your organization.
3. Please rank how important the ***Protection/Enhancement of Potable Water Quality*** is to your organization.
4. Please rank how important the ***Protection/Enhancement/Restoration of sensitive wetlands*** is to your organization.
5. Please rank how important the ***Protection/Resilience of Forests from Damage Causing Agents (i.e. Invasive Plants & Pests, Pathogens & Diseases, and Storm Damage, ash)*** is to your organization.
6. Please rank how important ***Mitigating Forest Fragmentation*** is to your organization.
7. Please rank how important ***Forest Carbon storage, Its Impacts to Global Climate Change, and avoided Carbon Emissions Through Wildfire*** mitigation is to your organization.
8. Please rank how important the ***Protection/Enhancement/Restoration of Ecologically Significant Forest Tree Species (i.e. Atlantic white-cedar, eastern hemlock, oak, shortleaf pine)*** is to your organization.

Urban Priority Areas

1. Please rank how important ***Population in Urban Areas*** is to your program.
2. Please rank how important ***Pollution Impacts to Urban Areas*** is to your program.
3. Please rank how important ***Serving Underserved Communities or Communities Disproportionately Impacted by Environmental Degradation*** is to your program.
4. Please rank how important ***Communities/Counties Involved with Planned Tree-Related Programs or Grants*** is to your program.
5. Please rank how important ***Communities with Significant Trees/Forested Areas or lack thereof*** is to your program.
6. Please rank how important the ***Management and Protection of Wetlands and Community Water Supplies in Urban and Community Forest Settings*** is to your program.
7. Please rank how important the impacts of flooding in communities are to your program.
8. Please rank how important ***Carbon Storage and Decreased Energy Demand Provided by Urban and Community Trees*** is to your program.
9. Please rank how important ***Protection/Resilience of Communities from Invasive Plants & Pests*** is to your program.

Interface Priority Areas

1. Please rank how important ***Wildfire Hazard Within Wildland-Urban Interface Areas*** is to your program.
2. Please rank how important ***Forest Carbon Storage and Avoided Carbon Emissions Through Wildfire*** mitigation is to your program.
3. Please rank how important is the ***Protection/Enhancement of Forest Connecting Patches of Vital, Contiguous Wildlife Habitat*** to your program.
4. Please rank the importance of ***Forest Stewardship Planning Within Interface Areas.***
5. Please rank how important ***the Population within interface areas*** is to your program
6. Please rank how important the ***Protection/Resilience of Forests from Damage Causing Agents (i.e. Invasive Plants & Pests, Pathogens & Diseases, and Storm Damage, ash) Within Interface Areas*** is to your program.
7. Please rank how important the ***Protection/Enhancement of Potable Water Quality*** is to your organization.
8. Please rank how important the ***Protection/Enhancement/Restoration of sensitive wetlands*** is to your organization.
9. Please rank how important the ***Protection/Enhancement of Ecologically Significant Forest Tree Species (i.e. oak) Within Interface Areas*** to your program.

Figure 87. Survey questions provided to Stewardship Committee for Spatial Priority Analysis, February 2020. See end of this section for larger image.

The DBH is measured, recorded and a bright dot placed at the point of measure to provide a known height for image analysis. A high-resolution digital photograph is then taken. The image is then processed using software called ImageJ. This software allows us to scale the pixels of the image to the known height of 4.5 feet based on the location of the dot placed on the tree. The following image measurements are taken, DBH, total tree height, crown height and crown diameter at regular intervals of crown height. Volume of the crown is then calculated by way of analyzing each crown segment as a truncated cone (Cadori et al. 2016, Heger 1965).

Once the crown volumes have been calculated the allometric relationship for each species site combination will be performed. An analysis will be used to determine if there are significant differences in the allometric scaling relationship of DBH and crown volume between the different site types. Understanding how site type influences growth patterns can allow us to better employ the concept of the right tree for the right site. Furthermore, time and money can be saved by predicting multiple measurements while only having to take one measurement."

Spatial Priority Area Analysis

New Jersey's State Forest Action Plan priority areas were designated by examining stakeholder inputs, data surrounding forest conditions and trends, state and federal laws establishing areas of special considerations and forests of the state considered important to the public. As required under the Farm Bill, part of this stakeholder involvement includes the state's Forest Stewardship Coordinating Committee which includes state and federal land management agencies, as well as agencies and non-profits.

To facilitate this process, a survey containing a series of questions was developed based upon the national priorities to guide the selection process of the priority focus areas for implementation of the New Jersey state strategies. These questions included topics such as forest stewardship planning, the protection and enhancement of threatened and endangered species habitat, importance of water quality and restoration of sensitive wetlands, the protection and resilience of forests from DCA's, forest fragmentation mitigation, carbon storage and avoided emissions through wildfire, population, pollution impacts within urban areas, underserved communities or communities disproportionately impacted by environmental degradation, importance of tree related programs and grants, decreased energy demand through urban and community trees, wildfire hazard within WUI areas, importance of connecting patches of wildlife habitat and the protection/enhancement of ecologically significant forest tree species. The topics of focus were then weighted based upon the stakeholders' feedback and used within a GIS analysis to determine the state's priority areas spatially (including regional and multi-state priority areas).

Numerous GIS layers representing the topics surveyed were then used from state and federal sources within the analysis. These layers included NJ Forest Service State Lands Management planning areas and Private Forest Stewardship planning areas, FIA Forest and Non-forest raster data, NJDEP land use/land cover data, NJDEP landscape project 3.3

Layer Description	Threshold	Composite Survey Score
SAP 2019 (June) & SLM Planning Areas	N/A	8.9
FIA Forest & Nonforest	N/A	N/A
NJDEP Land Use/Land Cover	N/A	N/A
NJDEP ENSP Landscape Project 3.3 Data - DEP Toolbar	Skylands & Pinelands, 3-5 (State T, State E, Fed Listed)	9.3
NJDEP ONLM T & E's	N/A	9.3
NJDEP Damage Causing Agent Survey	2010-2019 including only GM, Hemlock, Human-caused Fire, SPB, Tornadoes, Hurricanes, Wildfire	8.1
FIA Invasive Species	Forested Areas of Municipalities within or intersecting the buffer area (6,450') of the points with a frequency of invasive plants of 3+	8.1
FIA Derived Carbon Raster	60+ tons/ac	8.4
Spatial Integrity	7-10 (All High integrity and Core)	7.9
NJDEP Category 1 Waters & Wetlands	300' Buffer	8.8
FIA Species	AWC, All oak, Shortleaf Pine, Hemlock - All 10sqft/ac+	8.4
CHANJ	Core Only Forest	7.9
NJDEP Public Water Supply	300' Buffer, (public community and non-community wells	7.4
NJFFS Wildfire Hazard Potential	5 (Very High)	8.4
US Census Population	2,500 people and Under	N/A

N/A = Not Applicable, for Composite Survey Score this coverage was used to qualify inclusion.

Table 8. Rural Forest Priority Area Inputs and Ranks

data (Skylands and Pinelands regions in particular), NJDEP threatened and endangered plant species tracking data, HUC 14 watershed data, NJDEP damage causing agent survey data, FIA invasive species plot data, USFS carbon raster data, USFS spatial integrity data, NJDEP Category 1 waters and wetlands data, FIA species raster data, NJDEP Connecting Habitat Across New Jersey (CHANJ) data, NJDEP public water supply data, USFS wildfire hazard potential data, US Census Bureau population data, NJDEP hydrography data and NJDEP brownfields data. I-Tree Landscape data for New Jersey municipalities was also used for the GIS analysis and included information for population density, population, carbon removal, poverty, tree cover per capita, total basal area, avoided runoff, total carbon storage and carbon storage per year. All GIS layers were then compiled and weighted accordingly to perform an overlay analysis and only those priority areas for the state of New Jersey with the highest weights were chosen as the final spatial priority areas. Three separate GIS overlay analyses were performed in total with different layers and specialized weighting for Rural, Urban and Interface priority focus areas.

The analysis produced three different priority focal areas for consideration. The NJ Forest Service took this approach because, in trying to represent all trees across the state, the entire state gets painted with a broad brush as a priority. To adequately represent the diverse needs of the state's forest and tree resources, different portions of the state are represented with differing strategic foci. The inputs used to determine these regions are described here.

Rural

Rural forests evaluated in this prioritization lean heavily towards those that meet the traditional USDA Forest Service FIA definition of forest, which is, "Land that has at least 10 percent crown cover by live tally trees of any size or has had at least 10 percent canopy cover of live tally species in the past, based on the presence of stumps, snags or other evidence. To qualify, the area must be at least 1.0 acre in size and 120.0 feet wide. Forest land includes transition zones, such as areas between forest and nonforest lands that meet the minimal tree stocking/cover and forest areas adjacent to urban and built—up lands. Roadside, streamside and shelterbelt strips of trees must have a width of at least 120 feet and continuous length of at least 363 feet to qualify as forest land. Unimproved roads and trails, streams and clearings in forest areas are classified as forest if they are less than 120 feet wide or less than an acre

Layer Description	Threshold	Composite Survey Score
FIA Derived Carbon Raster	54+ tons/ac	5.9
USDA FS Spatial Integrity	4-8 (All Medium Integrity & 7-8 High Integrity)	9.2
FIA Forest & Nonforest	N/A	N/A
NJDEP Category 1 Waters & Wetlands	300' Buffer	8.7
FIA Species	All oak & Shortleaf Pine - All 10sqft/ac+	7.6
NJDEP Damage Causing Agent Survey (without fires)	2010-2019	7.3
NJDEP Land Use/Land Cover	N/A	N/A
FIA Invasive Species	Municipalities within or intersecting the buffer area (6,450') of the points with 1+ frequency of invasive plants	7.3
Population	Urban Clusters or 2,500-50,000 people	4.7
WUI_Interface_and_Intermix_2010 & Wildfire Hazard Poter	All WUI, and where Hazard Potential overlaps with it	7.3
CHANJ	Connecting Only	9.2
NJDEP Public Water Supply	300' Buffer	6.9
SAP 2019 (June) & SLM Planning Areas	N/A	8.3

N/A = Not Applicable, for Composite Survey Score this coverage was used to qualify inclusion.

Table 9. Interface Forest Priority Area Inputs and Ranks

Figure 88. Rural Forest Priority Areas. NJDEP 2020.

Figure 89. Interface Forest Priority Areas. NJDEP 2020.

in size. Tree-covered areas in agricultural production settings, such as fruit orchards or tree—covered areas in urban settings, such as city parks, are not considered forest land." (USDA Forest Service, FIA 2019). A series of 15 different GIS data layers were used to conduct the analysis for the Rural Forest Priority Focal Areas. **Table 8** entitled "Rural Forest Priority Area Inputs and Ranks" provides a description of each of these layers, threshold values for consideration as a priority and the composite score derived from the survey feedback provided by the NJ Forest Stewardship Coordinating Committee.

Interface

Interfaces evaluated in this prioritization may or may not meet the traditional USDA Forest Service FIA forest definition. There are some similarities in the data evaluated for these areas and those in the Rural Forest category with some differences in data layers and notably the thresholds used when considering the values in each layer. As a result, Interface priority areas lean towards transitional regions between Rural forests and more developed landscapes. A series of 13 different GIS data layers were used to conduct the analysis for the Interface Priority Focal Areas. **Table 9** entitled "Interface Priority Area Inputs and Ranks" provides a description of each of these layers, threshold values for consideration as a priority and the composite score derived from the survey feedback provided by the NJ Forest Stewardship Coordinating Committee.

Urban

Urban priority areas include urban and community forests. These priority areas evaluate several distinctly different data layers to better assess the needs of urban and community forest resources. The focus of these priorities is on the interactions between the state's population and it's trees. These priorities emphasize environmental justice in terms of prioritizing communities that are underserved by ecosystem services that forests and trees provide, mitigating climate change impacts upon NJ's population centers and protecting the state's water supplies in populated areas. A series of 13 different GIS data layers were used to conduct the analysis for the Urban Priority Focal Areas.

Much of the Urban prioritization data was tabular, rather than spatial. To represent these data spatially, they had to be joined to existing spatial coverages, such as municipalities that tended to oversimplify the spatial complexity of these data. This presented some special challenges, as priorities could not be reasonably evaluated using spatial overlap. This distribution of this data was examined and evaluated based on where the mean and each quartile for each tabular "layer" fell to derive thresholds. Using the composite survey score based on Forest Stewardship Coordinating Committee feedback, the top 4 scoring data sets were outer joined (joined inclusively) and all subsequent sets were then evaluated based upon their inclusion within the top 4 joined sets (left joined). **Table 10** entitled "Urban Priority Area Inputs and Ranks" provides a description of each of these layers, threshold values for consideration as a priority and the composite score derived from the survey feedback provided by the NJ Forest Stewardship Coordinating Committee.

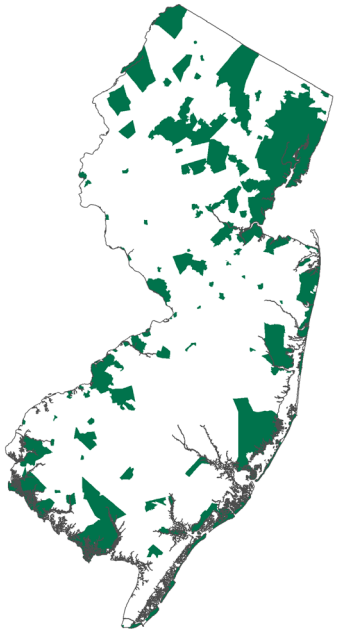

Figure 90. Urban Forest Priority Areas. NJDEP 2020.

Layer Description	Threshold	Composite Survey Score
US Census Bureau Population	Urban Areas & Urban Clusters or 2,500-50,000+ people	4.8
Tree City 1-41+ Years	N/A	4.5
UCF Accredited Municipalities, UCF Approved Municipalities, UCF Inventory Grant Municipalities, UCF Planting Grant Municipalities	N/A	4.5
NJDEP Land Use/Land Cover	N/A	6.8
FIA Derived Carbon Raster	8 tons/ac and under	4.9
Population Density Q4	Quartile 4 (1.49e-3 and up)	4.8
Population Q4	Quartile 4 (18,133 and up)	4.8
iTree Carbon Removal Mean and Under	Mean (1046.88) and under	4.9
Pop. Below Poverty Q4	Quartile 4 (3.80 and up)	7.1
iTree Tree Cover Per Capita Q1Q2 Tab	Quartile 1 & 2 (388.4 and under)	7.1
iTree Total Basal Area SqFt Q4	Quartile 4 (544,763 and up)	6.8
iTree Avoided Runoff Mean & Under	Mean (49,660) and under	5.5
iTree Carbon Tonne Per Year Mean & Above	Mean (2602.5) and up	5
iTree Carbon Storage Q4	Quartile 4 (164,015-1,799,313)	5

N/A = Not Applicable, for Composite Survey Score this coverage was used to qualify inclusion.

Table 10. Urban Forest Priority Area Inputs and Ranks

NJ State Forest Action Plan: Spatial Prioritization Survey

Rank Questions on a scale of 1 (least important) to 10 (most important) for program interests.

Rural Priority Areas

1. Please rank the importance of ***Forest Stewardship Planning*** on forestland to your organization.
2. Please rank how important the ***Protection/Enhancement of Threatened & Endangered Species Habitat*** is to your organization.
3. Please rank how important the ***Protection/Enhancement of Potable Water Quality*** is to your organization.
4. Please rank how important the ***Protection/Enhancement/Restoration of sensitive wetlands*** is to your organization.
5. Please rank how important the ***Protection/Resilience of Forests from Damage Causing Agents (i.e. Invasive Plants & Pests, Pathogens & Diseases, and Storm Damage, ash)*** is to your organization.
6. Please rank how important ***Mitigating Forest Fragmentation*** is to your organization.
7. Please rank how important ***Forest Carbon storage, Its Impacts to Global Climate Change, and avoided Carbon Emissions Through Wildfire*** mitigation is to your organization.
8. Please rank how important the ***Protection/Enhancement/Restoration of Ecologically Significant Forest Tree Species (i.e. Atlantic white-cedar, eastern hemlock, oak, shortleaf pine)*** is to your organization.

Urban Priority Areas

1. Please rank how important ***Population in Urban Areas*** is to your program.
2. Please rank how important ***Pollution Impacts to Urban Areas*** is to your program.
3. Please rank how important ***Serving Underserved Communities or Communities Disproportionately Impacted by Environmental Degradation*** is to your program.
4. Please rank how important ***Communities/Counties Involved with Planned Tree-Related Programs or Grants*** is to your program.
5. Please rank how important ***Communities with Significant Trees/Forested Areas or lack thereof*** is to your program.
6. Please rank how important the ***Management and Protection of Wetlands and Community Water Supplies in Urban and Community Forest Settings*** is to your program.
7. Please rank how important the impacts of flooding in communities are to your program.
8. Please rank how important ***Carbon Storage and Decreased Energy Demand Provided by Urban and Community Trees*** is to your program.
9. Please rank how important ***Protection/Resilience of Communities from Invasive Plants & Pests*** is to your program.

Interface Priority Areas

1. Please rank how important ***Wildfire Hazard Within Wildland-Urban Interface Areas*** is to your program.
2. Please rank how important ***Forest Carbon Storage and Avoided Carbon Emissions Through Wildfire*** mitigation is to your program.
3. Please rank how important is the ***Protection/Enhancement of Forest Connecting Patches of Vital, Contiguous Wildlife Habitat*** to your program.
4. Please rank the importance of ***Forest Stewardship Planning Within Interface Areas***.
5. Please rank how important ***the Population within interface areas*** is to your program
6. Please rank how important the ***Protection/Resilience of Forests from Damage Causing Agents (i.e. Invasive Plants & Pests, Pathogens & Diseases, and Storm Damage, ash) Within Interface Areas*** is to your program.
7. Please rank how important the ***Protection/Enhancement of Potable Water Quality*** is to your organization.
8. Please rank how important the ***Protection/Enhancement/Restoration of sensitive wetlands*** is to your organization.
9. Please rank how important the ***Protection/Enhancement of Ecologically Significant Forest Tree Species (i.e. oak) Within Interface Areas*** to your program.

APPENDIX A:
USNVC GLOBALLY RARE FOREST AND WOODLAND ECOLOGICAL COMMUNITIES

Examples of USNVC Globally Rare Forest and Woodland Ecological Communities in New Jersey tracked by the New Jersey Natural Heritage Program and Rarity Rank Definitions.

Common Name	Scientific Name	Link to USNVC Description	Global Rarity Rank	State Rarity Rank
Northeastern Red-cedar Limestone Glade	*Juniperus virginiana/Bouteloua curtipendula - Carex eburnea* Wooded Grassland	CEGL006047	G1	S1
New Jersey Pitch Pine/ Shrub Oak Barrens	*Pinus rigida/Quercus (marilandica, ilicifolia)/ Pyxidanthera barbulata* Woodland	CEGL006051	G2	S2
Cape May Lowland Swamp Forest	*Acer rubrum - Nyssa sylvatica - Liquidambar styraciflua - Populus heterophylla* Swamp Forest	CEGL006013	G1	S1
Pitch Pine Maritime Dune Woodland	*Pinus rigida/Hudsonia tomentosa* Woodland	CEGL006117	G2G3	S1
Coastal Loblolly Pine Swamp Forest	*Pinus taeda/Morella cerifera/Osmunda regalis var. spectabilis* Swamp Forest	CEGL006137	G3	S1
Northeastern Maritime Forest	*Prunus serotina - Sassafras albidum - Amelanchier canadensis - Quercus velutina/Smilax rotundifolia* Forest	CEGL006145	G2G3	S1S2
New Jersey Pine Plains	*Pinus rigida - Quercus marilandica/Corema conradii* Scrub	CEGL006148	G2	S2
Freshwater Tidal Woodland	*Acer rubrum - Fraxinus pennsylvanica/ Polygonum spp.* Floodplain Forest	CEGL006165	G2	S1S2
Coastal Plain Atlantic White-cedar Swamp Forest	*Chamaecyparis thyoides/Ilex glabra - Rhododendron viscosum* Swamp Forest	CEGL006188	G3	S3
Inland Atlantic White-cedar Swamp Forest	*Chamaecyparis thyoides - (Tsuga canadensis, Betula alleghaniensis)/Clethra alnifolia* Swamp Forest	CEGL006189	G3	S1
Maritime Red-cedar Woodland	*Juniperus virginiana var. virginiana/ Morella pensylvanica* Woodland	CEGL006212	G2	S1
Pine Barrens Streamside Shrub Savanna	*Chamaecyparis thyoides/Gaylussacia dumosa/Andropogon glomeratus var. glomeratus* Swamp Woodland	CEGL006262	G2	S2S3
Pine Barrens Streamside Bog Asphodel Savanna	*Chamaecyparis thyoides/Narthecium americanum - Sarracenia purpurea - Drosera filiformis/Sphagnum pulchrum* Swamp Woodland	CEGL006263	G2	S2
Atlantic White-cedar Bog	*Chamaecyparis thyoides/Chamaedaphne calyculata* Swamp Woodland	CEGL006321	G3	S2S3
Atlantic White-cedar/ Great Laurel Swamp Forest	*Chamaecyparis thyoides/Rhododendron maximum* Swamp Forest	CEGL006355	G2	S1
Pasture Fern	*Juniperus virginiana/Dasiphora fruticosa/ Carex flava - Carex tetanica* Fern	CEGL006357	G1	S1

Common Name	Scientific Name	Link to USNVC Description	Global Rarity Rank	State Rarity Rank
Kittatinny Valley Prairie Fern	*Juniperus virginiana/Betula pumila/Carex sterilis - Oligoneuron rigidum* Fern	CEGL006367	G1	S1
Maritime Holly Forest	*Ilex opaca/Morella pensylvanica* Forest	CEGL006376	G1	S1
Pine Barrens Pine - Oak/ Shrub Oak Woodland	*Pinus rigida - (Pinus echinata) - Quercus stellata/ Quercus (marilandica, ilicifolia)* Woodland	CEGL006383	G2?	S3
Coastal Plain Mesic Pine Barrens	*Pinus rigida/Quercus ilicifolia - Kalmia angustifolia/ Pyxidanthera barbulata* Woodland	CEGL006384	G1	S1
Pitch Pine Subhydric Lowland Swamp Woodland	*Pinus rigida/Gaylussacia baccata - Kalmia angustifolia* Swamp Woodland	CEGL006387	GNR	S3
Pitch Pine/ Reedgrass Savanna	*Pinus rigida/Gaylussacia dumosa / Calamovilfa brevipilis* Swamp Woodland	CEGL006388	G1	S1
Mesic Coastal Plain Oak Forest	*Quercus falcata - Quercus michauxii/Ilex opaca* Forest	CEGL006390	GNR	S2S3
Coastal Plain Calcareous Seepage Swamp Forest	*Acer rubrum - Fraxinus pennsylvanica/Packera aurea - Carex bromoides - Pilea fontana* Swamp Forest	CEGL006413	G2	S1
Mid-Atlantic Terrace Floodplain Forest	*Carya cordiformis - Prunus serotina/ Ageratina altissima* Forest	CEGL006445	G2	S1
Paleodune Sand Barrens	*Pinus (rigida, echinata)/Hudsonia ericoides/ Cladonia spp. Paleodune* Woodland	CEGL006767	G1	S1
Pitch Pine/Sand-myrtle Lowland Subhydric Woodland	*Pinus rigida/Leiophyllum buxifolium Subhydric* Swamp Woodland	CEGL006768	G1	S1
Dwarf Pitch Pine/Reedgrass Hydric Pine Plains	*Pinus rigida/Calamovilfa brevipilis* Wet Scrub	CEGL006769	G1	S1
Sinkhole Pond Floodplain Forest	*Platanus occidentalis - Fraxinus pennsylvanica - Ulmus americana/Cornus sericea* Floodplain Forest	CEGL006901	G1	S1
Pine Barrens Pitch Pine - Hardwood Swamp Forest	*Pinus rigida - Nyssa sylvatica/Clethra alnifolia - Eubotrys racemosa* Forest	CEGL006926	G2G3	S3
Oak/Sand Hickory/Sedge Paleodune Woodland	*Quercus falcata/Carya pallida - Quercus prinoides/ Carex pensylvanica* Woodland	CEGL006954	G1	S1
Coastal Plain Red Maple/ Sedge Swamp Forest	*Acer rubrum - Fraxinus pennsylvanica - Liquidambar styraciflua* Floodplain Forest	CEGL006965	GNR	S1

GLOBAL ELEMENT RANKS

G1 Critically imperiled globally because of extreme rarity (five or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

G2 Imperiled globally because of rarity (six to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single western state, a physiographic region in the East) or because of other factors making it vulnerable to extinction throughout it's range; with the number of occurrences in the range of 21 to 100.

G4 Apparently secure globally; although it may be quite rare in parts of its range, especially at the periphery.

G5 Demonstrably secure globally; although it may be quite rare in parts of its range, especially at the periphery.

GH Of historical occurrence throughout its range i.e., formerly part of the established biota, with the expectation that it may be rediscovered.

GU Possibly in peril range-wide but status uncertain; more information needed.

GX Believed to be extinct throughout range (e.g., passenger pigeon) with virtually no likelihood that it will be rediscovered.

G? Species has not yet been ranked.

GNR Species has not yet been ranked.

STATE ELEMENT RANKS

S1 Critically imperiled in New Jersey because of extreme rarity (five or fewer occurrences or very few remaining individuals or acres). Elements so ranked are often restricted to very specialized conditions or habitats and/or restricted to an extremely small geographical area of the state. Also included are elements which were formerly more abundant, but because of habitat destruction or some other critical factor of its biology, they have been demonstrably reduced in abundance. In essence, these are elements for which, even with intensive searching, sizable additional occurrences are unlikely to be discovered.

S2 Imperiled in New Jersey because of rarity (six to 20 occurrences). Historically many of these elements may have been more frequent but are now known from very few extant occurrences, primarily because of habitat destruction. Diligent searching may yield additional occurrences.

S3 Rare in state with 21 to 100 occurrences (plant species and ecological communities in this category have only 21 to 50 occurrences). Includes elements which are widely distributed in the state but with small populations/acreage or elements with restricted distribution, but locally abundant. Not yet imperiled in state but may soon be if current trends continue. Searching often yields additional occurrences.

S4 Apparently secure in state, with many occurrences.

S5 Demonstrably secure in state and essentially ineradicable under present conditions.

SA Accidental in state, including species (usually birds or butterflies) recorded once or twice or only at very great intervals, hundreds or even thousands of miles outside their usual range; a few of these species may even have bred on the one or two occasions they were recorded; examples include European strays or western birds on the East Coast and vice-versa.

SE Elements that are clearly exotic in New Jersey including those taxa not native to North America (introduced taxa) or taxa deliberately or accidentally introduced into the State from other parts of North America (*adventive taxa*). Taxa ranked SE are not a conservation priority (viable introduced occurrences of G1 or G2 elements may be exceptions).

SH Elements of historical occurrence in New Jersey. Despite some searching of historical occurrences and/or potential habitat, no extant occurrences are known. Since not all of the historical occurrences have been field surveyed and unsearched potential habitat remains, historically ranked

taxa are considered possibly extant and remain a conservation priority for continued field work with the expectation they may be rediscovered.

SP Element has potential to occur in New Jersey, but no occurrences have been reported.

SR Elements reported from New Jersey, but without persuasive documentation which would provide a basis for either accepting or rejecting the report. In some instances, documentation may exist, but as of yet, its source or location has not been determined.

SRF Elements erroneously reported from New Jersey, but this error persists in the literature.

SU Elements believed to be in peril but the degree of rarity uncertain. Also included are rare taxa of uncertain taxonomical standing. More information is needed to resolve rank.

SX Elements that have been determined or are presumed to be extirpated from New Jersey. All historical occurrences have been searched and a reasonable search of potential habitat has been completed. Extirpated taxa are not a current conservation priority.

SXC Elements presumed extirpated from New Jersey, but native populations collected from the wild exist in cultivation.

SZ Not of practical conservation concern in New Jersey, because there are no definable occurrences, although the taxon is native and appears regularly in the state. An SZ rank will generally be used for long distance migrants whose occurrences during their migrations are too irregular (in terms of repeated visitation to the same locations), transitory and dispersed to be reliably identified, mapped and protected. In other words, the migrant regularly passes through the state, but enduring, mappable element occurrences cannot be defined.

Typically, the SZ rank applies to a non-breeding population (N) in the state - for example, birds on migration. An SZ rank may in a few instances also apply to a breeding population (B), for example certain lepidoptera which regularly die out every year with no significant return migration.

Although the SZ rank typically applies to migrants, it should not be used indiscriminately. Just because a species is on migration does not mean it receives an SZ rank. SZ will only apply when the migrants occur in an irregular, transitory and dispersed manner.

B Refers to the breeding population of the element in the state.

N Refers to the non-breeding population of the element in the state.

T Element ranks containing a "T" indicate that the infraspecific taxon is being ranked differently than the full species. For example, *Stachys palustris var. homotricha* is ranked "G5T? SH" meaning the full species is globally secure but the global rarity of the var. homotricha has not been determined; in New Jersey the variety is ranked historic.

Q Elements containing a "Q" in the global portion of its rank indicates that the taxon is of questionable or uncertain taxonomical standing, e.g., some authors regard it as a full species, while others treat it at the subspecific level.

.1 Elements only, ever documented from a single location.

Note: To express uncertainty, the most likely rank is assigned and a question mark added (e.g., G2?). A range is indicated by combining two ranks (e.g., G1G2, S1S.

APPENDIX B:
ENDANGERED PLANTS AND PLANT SPECIES OF CONCERN

Number of the Endangered Plants and Plant Species of Concern (of 821 total) tracked by the Natural Heritage Program that occur in forest and woodland habitats.

Upland or Wetland Forest	Number of rare plant taxa in forest habitats	% of rare plants in forest habitats
Forested wetlands	149	36.2%
Upland forests	206	50.0%
Both Upland and Wetland Forests	57	13.8%
Total Rare Plants in Forest Habitats	**412**	**100.0%**

State and Global Rarity Ranks of Endangered Plants and Plant Species of Concern tracked by the Natural Heritage Program that occur in forest and woodland habitats.

State Rarity Ranking	Number of taxa	% of total in forest and woodland habitat
S1.1	24	5.8%
S1	141	34.2%
S2	123	29.9%
S3	62	15.0%
SH.1	12	2.9%
SH	34	8.3%
SU	7	1.7%
SX.1	6	1.5%
SX	3	0.7%
Total	**412**	**100.0%**

Global Rarity Ranking	Number of taxa	% of total in forest and woodland habitat
G1	3	0.7%
G2	5	1.2%
G3	22	5.3%
G4	103	25.0%
G5	279	67.7%
Total	**412**	**100.0%**

Rare Plants of Wetland and Upland Forest and Woodland Communities in New Jersey.

Common Name	Scientific Name	Fed T&E	State Status E	G Rank	S Rank	Wetland Forest & Woodland	Upland Forest & Woodland
Balsam Fir	Abies balsamea		E	G5	S1	x	
Red Baneberry	Actaea rubra var. rubra			G5T5	S2		X
Climbing Fumitory	Adlumia fungosa			G4	S2		X
Small-flower False Foxglove	Agalinis paupercula var. paupercula			G5T5	S1		X
Yellow Giant-hyssop	Agastache nepetoides			G5	S2	X	X
Purple Giant-hyssop	Agastache scrophulariifolia			G4	S2		X
Small-fruit Grooveburr	Agrimonia microcarpa			G5	S2		X
Low Service-berry	Amelanchier humilis			G5	S1		X
Round-leaf Service-berry	Amelanchier sanguinea var. sanguinea		E	G5T5	S1.1		X
Running Service-berry	Amelanchier stolonifera			G5	S3		x
Fly Poison	Amianthium muscitoxicum			G4G5	S2	X	X
Bog Rosemary	Andromeda polifolia var. glaucophylla		E	G5T5	S1	x	
Elliott's Beardgrass	Andropogon gyrans			G5	S2		X
Long-head Anemone	Anemone cylindrica		E	G5	S1		X
Riverbank Anemone	Anemone virginiana var. alba			G5T4T5	S2		X
Hairy Angelica	Angelica venenosa			G5	S2		X
Canada Pussytoes	Antennaria howellii ssp. canadensis		E	G5T5?	S1		X
Puttyroot	Aplectrum hyemale		E	G5	S1		X
Western Hairy Rockcress	Arabis hirsuta var. pycnocarpa			G5T5	S1		X
Missouri Rock-cress	Arabis missouriensis		E	G5	S1.1		X
Bristly Sarsaparilla	Aralia hispida			G5	S3		x
Dwarf Mistletoe	Arceuthobium pusillum		E	G5	S1	X	
Northern Jack-in-the-pulpit	Arisaema triphyllum subsp. stewardsonii			G5T4T5	S2	x	
Woolly Three-awn Grass	Aristida lanosa		E	G5	S1		X
Wand-like Three-awn Grass	Aristida virgata			G5T4T5	S2	X	
Virginia Snakeroot	Aristolochia serpentaria			G4	S3	X	X
Leopardbane	Arnica acaulis			G4	SX.1		x
Pale Indian Plantain	Arnoglossum atriplicifolium		E	G4G5	S1	X	X

Common Name	Scientific Name	Fed T&E	State Status E	G Rank	S Rank	Wetland Forest & Woodland	Upland Forest & Woodland
Four-leaf Milkweed	Asclepias quadrifolia			G5	S3		x
White Milkweed	Asclepias variegata			G5	S1		X
Whorled Milkweed	Asclepias verticillata			G5	S2		X
Pawpaw	Asimina triloba		E	G5	S3	X	
Bradley's Spleenwort	Asplenium bradleyi		E	G4	S1		X
Mountain Spleenwort	Asplenium montanum			G5	S2		X
Lobed Spleenwort	Asplenium pinnatifidum		E	G4	S1		X
Wall-rue	Asplenium ruta-muraria var. cryptolepis			G5T5	S2		X
Prostrate White Heath Aster	Aster ericoides var. prostratus			G5T4T5Q	S3		X
Willow-leaf Aster	Aster praealtus var. praealtus		E	G5T5?	S1	x	
Crooked-stem Aster	Aster prenanthoides			G4G5	S2	X	
Shining Aster	Aster puniceus var. firmus			G5T5	SX.1	x	
Low Rough Aster	Aster radula		E	G5	S1	X	
Paper Birch	Betula papyrifera var. papyrifera			G5T5	S2		X
Swamp Birch	Betula pumila var. pumila			G5T5?	S2	X	
Lance-leaf Moonwort	Botrychium lanceolatum var. angustisegmentum			G5T4	S2		X
Leathery Grape Fern	Botrychium multifidum		E	G5	S1		X
Blunt-lobe Grape Fern	Botrychium oneidense			G4	S2	X	X
Upland Least Moonwort	Botrychium simplex var. laxifolium			G5TNR	SH		X
Slender Least Moonwort	Botrychium simplex var. tenebrosum			G5T4?Q	S2	x	x
Side-oats Grama Grass	Bouteloua curtipendula var. curtipendula		E	G5T5	S1		X
False Boneset var. eupatorioides	Brickellia eupatorioides		E	G5T5	S1		X
Fringed Brome	Bromus ciliatus var. ciliatus			G5T5	S2	x	
Early Brome	Bromus latiglumis			G5	S2S3	x	
Wild Calla	Calla palustris			G5	S3	X	
Marsh Water-starwort	Callitriche palustris			G5	S2	X	
Austin's Terrestrial Water-starwort	Callitriche terrestris			G5	S3	x	
Occluded Bindweed	Calystegia sepium ssp. erratica		E	G5TNR	SH.1	X	
Erect Bindweed ssp. spithamaea	Calystegia spithamaea		E	G4G5T4T5	S1		X

Common Name	Scientific Name	Fed T&E	State Status E	G Rank	S Rank	Wetland Forest & Woodland	Upland Forest & Woodland
Slender Toothwort	Cardamine angustata			G5	S3		X
Two-leaf Toothwort	Cardamine diphylla			G5	S3		X
Purple Bittercress	Cardamine douglassii			G5	S2	X	
Large Toothwort	Cardamine maxima		E	G5	S1.1	X	
Meadow Cuckoo-flower	Cardamine pratensis var. palustris			G5T5	S3	X	
Round-leaf Bittercress	Cardamine rotundifolia		E	G4	S1	X	
Glomerate Sedge	Carex aggregata			G5	S2		X
White Bear Lake Sedge	Carex albursina			G5	S3		X
Drooping Wood Sedge	Carex arctata		E	G5	S1		X
Bicknell's Sedge	Carex bicknellii var. bicknellii			G5T5	S2		X
Round-spike Brownish Sedge	Carex brunnescens var. sphaerostachya		E	G5T5	S1	X	
Brown Sedge	Carex buxbaumii			G5	S3	X	
Silvery Sedge	Carex canescens var. canescens			G5T5	SU	x	
Carolina Sedge	Carex caroliniana			G5	S3		X
Thin-leaf Sedge	Carex cephaloidea			G5	S2		X
Soft Fox Sedge	Carex conjuncta			G4G5	S3	x	x
Dewey's Sedge	Carex deweyana var. deweyana		E	G5T5	S2		X
Soft-leaf Sedge	Carex disperma			G5	S2	X	
Ebony Sedge	Carex eburnea			G5	S2		X
Florida Sedge	Carex floridana			G5?	S1		x
Handsome Sedge	Carex formosa		E	G4	S1.1	X	X
Cloud Sedge	Carex haydenii		E	G5	S1	X	
Hitchcock's Sedge	Carex hitchcockiana			G5	S3		X
James' Sedge	Carex jamesii		E	G5	S1	X	X
Cypress-swamp Sedge	Carex joorii		E	G4G5	S1.1	X	
Coupled Sedge	Carex laxiculmis var. copulata		E	G5T4	S1		X
Harper's Sedge	Carex leptalea var. harperi			G5T4T5	S3	x	
Fine-nerve Sedge	Carex leptonervia		E	G5	S2		X
Southern Long Sedge	Carex lonchocarpa			G5	S2	x	
Louisiana Sedge	Carex louisianica		E	G5	S1	X	
Hop-like Sedge	Carex lupuliformis		E	G4	S1	X	
Mead's Sedge	Carex meadii		E	G4G5	S1		X
Mitchell's Sedge	Carex mitchelliana			G4	S2	X	
Few-fruit Sedge	Carex oligocarpa		E	G4G5	S1		X

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Peck's White-tinged Sedge	Carex peckii		E	G5	S1		X
Narrow-leaf Sedge	Carex planispicata		E	G4Q	S1		X
Plantain-leaf Sedge	Carex plantaginea		E	G5	S1.1		X
Variable Sedge	Carex polymorpha		E	G3	S1		X
Retrorse Sedge	Carex retrorsa			G5	S2	X	
Large Awl-fruit Sedge	Carex stipata var. maxima		E	G5T5?	S1	X	
Quill Sedge	Carex tenera			G5	S2		X
Tuckerman's Sedge	Carex tuckermanii		E	G4	S1	X	
Cat-tail Sedge	Carex typhina			G5	S3	X	
Willdenow's Sedge	Carex willdenowii var. willdenowii			G5T5	S2		X
Chinquapin	Castanea pumila		E	G5	S1		X
Dwarf Hackberry	Celtis tenuifolia			G5	S2		X
Redbud	Cercis canadensis var. canadensis		E	G5T5	S1		X
Spreading Chervil	Chaerophyllum procumbens var. procumbens			G5T5	S3	X	X
Devil's-bit	Chamaelirium luteum			G5	S3		X
Indian Wood-oats	Chasmanthium latifolium			G5	S1	x	
Hairy Lipfern	Cheilanthes lanosa			G5	S2		X
Maple-leaf Goosefoot	Chenopodium simplex			G5	S2		X
Stanley's Goosefoot	Chenopodium standleyanum			G5	S2		X
Fringetree	Chionanthus virginicus			G5	S3	X	
Slender Wood-reed	Cinna latifolia		E	G5	S1	X	
Tall Thistle	Cirsium altissimum			G5	SX.1		x
Hammond's Yellow Spring Beauty	Claytonia virginica var. hammondiae		E	G5T1	S1.1	X	
Spreading Pogonia	Cleistes divaricata		E	G4	S1	X	
Purple Clematis	Clematis occidentalis var. occidentalis			G5T5	S2		X
Yellow Clintonia	Clintonia borealis			G5	S3	X	
Butterfly-pea	Clitoria mariana		E	G5	S1		X
Long-bract Green Orchid	Coeloglossum viride var. virescens			G5T5	S2		X
Marsh Cinquefoil	Comarum palustre		E	G5	SH	X	
Slender Dayflower	Commelina erecta var. erecta		E	G5T5	SH		X

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Hemlock-parsley	Conioselinum chinense		E	G5	S1	X	
Early Coralroot	Corallorhiza trifida			G5	S1	X	
Broom Crowberry	Corema conradii		E	G4	S3		X
Pale Dogwood	Cornus amomum var. schuetzeana		E	G5T5	S1	X	
Bunchberry	Cornus canadensis			G5	S1	X	X
Pear Hawthorn	Crataegus calpodendron		E	G5	S1	X	X
Fireberry Hawthorn	Crataegus chrysocarpa var. chrysocarpa			G5T5	S1		X
Dodge's Hawthorn	Crataegus dodgei			G4	S1		X
Holmes' Hawthorne	Crataegus holmesiana		E	G5	S1	X	
Scarlet Hawthorn	Crataegus pedicellata			G5	S1		x
Pennsylvania Hawthorn	Crataegus pennsylvanica			G3	S1.1		X
Dotted Hawthorn	Crataegus punctata			G5	S2	X	X
Fleshy Hawthorn	Crataegus succulenta		E	G5	S1		X
Slender Rockbrake	Cryptogramma stelleri		E	G5	SH.1		X
Blue Waxweed	Cuphea viscosissima			G5?	S3		X
Buttonbush Dodder	Cuscuta cephalanthi		E	G5	S1	X	
Hazel Dodder	Cuscuta coryli			G5?	S2		X
Wild Comfrey	Cynoglossum virginianum var. virginianum			G5T5	S2		X
Bristly Flat Sedge	Cyperus hystricinus		E	G4	SH		x
Lancaster Flat Sedge	Cyperus lancastriensis		E	G5	S2		X
Plukenet's Flat Sedge	Cyperus plukenetii		E	G5	SH		x
Rough Flatsedge	Cyperus retrofractus		E	G5	SH		X
Small White Lady's-slipper	Cypripedium candidum		E	G4	S1	X	
Fen Small Yellow Lady's-slipper	Cypripedium parviflorum var. makasin			G5T4T5	S2	X	
Showy Lady's-slipper	Cypripedium reginae		E	G4G5	S1	X	
Lowland Fragile Fern	Cystopteris protrusa			G5	S2	X	X
Robin-run-away	Dalibarda repens		E	G5	SH.1	X	
Toothed Tick-trefoil	Desmodium cuspidatum var. cuspidatum			G5T5?	S2		X
Trailing Tick-trefoil	Desmodium humifusum		E	G1G2Q	S1		X
Smooth Tick-trefoil	Desmodium laevigatum			G5	S3		X
Nuttall's Tick Trefoil	Desmodium nuttallii			G5	S2		X

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Few-flower Tick-trefoil	Desmodium pauciflorum		E	G5	SH		X
Squirrel-corn	Dicentra canadensis		E	G5	S1	X	X
Wild Bleeding-heart	Dicentra eximia		E	G4	SH.1		X
Glade Fern	Diplazium pycnocarpon		E	G5	S1	X	X
Leatherwood	Dirca palustris			G4	S2	X	X
Cornel-leaf Aster	Doellingeria infirma			G5	S2		X
Log Fern	Dryopteris celsa		E	G4	S1	X	
Clinton's Woodfern	Dryopteris clintoniana			G5	S2	X	
Goldie's Wood Fern	Dryopteris goldiana			G4G5	S3	X	X
Twisted Spike-rush	Eleocharis tortilis		E	G5	S2	X	
Carolina Elephant-foot	Elephantopus carolinianus		E	G5	SH		X
Aunt Lucy	Ellisia nyctelea		E	G5	S1	X	
Slender Wheatgrass	Elymus trachycaulus		E	G5	S1		X
Narrow-leaf Fireweed	Epilobium angustifolium ssp. circumvagum			G5T5	SH	X	X
Meadow Horsetail	Equisetum pratense		E	G5	S1	X	X
Woodland Horsetail	Equisetum sylvaticum			G5	S3	X	
Marsh Rattlesnake-master	Eryngium aquaticum var. aquaticum			G4T4	S3	X	
Wahoo	Euonymus atropurpurea var. atropurpurea			G5T5	S1	X	X
Smaller White Snakeroot	Eupatorium aromaticum var. aromaticum			G5T5	S1		X
Mist-flower	Eupatorium coelestinum			G5	S3	X	
Britton's Upland Boneset	Eupatorium sessilifolium var. brittonianum			G5T3T5	SU		x
Darlington's Glade Spurge	Euphorbia purpurea		E	G3	S1	X	
Hairy Fimbry	Fimbristylis puberula var. puberula			G5T5	S1	X	
Black Ash	Fraxinus nigra			G5	S3?	x	
Pumpkin Ash	Fraxinus profunda		E	G4	S1	X	
Downy Milk-pea	Galactia volubilis		E	G5	SH		X
Shining Bedstraw	Galium concinnum			G5	SX.1		x
Labrador Marsh Bedstraw	Galium labradoricum		E	G5	S1	X	
Small Bedstraw	Galium trifidum var. trifidum			G5T5	S2	X	
Creeping-snowberry	Gaultheria hispidula		E	G5	S1	X	

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Fringed Bottle Gentian	Gentiana andrewsii var. andrewsii			G5?T5?	S2	X	
Pine Barren Gentian	Gentiana autumnalis			G3	S3	X	
Catesby's Gentian	Gentiana catesbaei			G5	SX.1	x	
Narrow-leaf Gentian	Gentiana linearis		E	G4G5	SH	X	
Stiff Gentian	Gentianella quinquefolia var. quinquefolia			G5T4T5	S2		X
American Manna Grass	Glyceria grandis var. grandis		E	G5T5	S2	X	
Northern Manna Grass	Glyceria laxa			G5	S1	X	
Small Everlasting	Gnaphalium helleri var. micradenium		E	G4G5T3?	SH		X
Oak Fern	Gymnocarpium dryopteris			G5	S1	X	X
Bearded Skeleton Grass	Gymnopogon ambiguus			G4	S3		x
Hoary Frostweed	Helianthemum bicknellii			G5	S3		x
Swamp-pink	Helonias bullata	LT	E	G3	S3	X	
Canada Hawkweed	Hieracium kalmii var. fasciculatum		E	G5T3T5	S1		x
Maryland Hawkweed	Hieracium marianum			G5?	SU		x
Tiny Bluets	Houstonia pusilla			G5	S3		x
Green Violet	Hybanthus concolor		E	G5	S1		X
Golden Seal	Hydrastis canadensis		E	G3G4	S1		X
Broad-leaf Waterleaf	Hydrophyllum canadense		E	G5	S1	X	
Shrubby St. John's-wort	Hypericum prolificum		E	G5	S1	X	
Large-leaf Holly	Ilex montana		E	G5	S1	X	X
False Pennyroyal	Isanthus brachiatus		E	G5	S1		X
Small Whorled Pogonia	Isotria medeoloides	LT	E	G2?	S1		X
Twinleaf	Jeffersonia diphylla		E	G5	S1		X
Butternut	Juglans cinerea			G4	S2	x	x
New Jersey Rush	Juncus caesariensis		E	G2G3	S2	X	
Awl-leaf Rush	Juncus coriaceus		E	G5	S1	X	
Dwarf Juniper	Juniperus communis var. depressa			G5T5	S1		x
Potato Dwarf-dandelion	Krigia dandelion		E	G5	SH.1		X
Grass-leaf Lettuce	Lactuca graminifolia			G5?	SU		x
Large-pod Pinweed	Lechea intermedia var. intermedia			G5T4T5	S2		X
Narrow-leaf Pinweed	Lechea tenuifolia		E	G5	S1		X

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Wood Lily	Lilium philadelphicum var. philadelphicum			G5T4T5	S2		X
Twinflower	Linnaea borealis var. americana		E	G5T5	SH	X	
Grooved Yellow Flax	Linum sulcatum var. sulcatum		E	G5T5	S1		X
Woodland Flax	Linum virginianum			G4G5	S3		x
Heartleaf Twayblade	Listera cordata var. cordata		E	G5T5	S1	X	
Appalachian Twayblade	Listera smallii		E	G4	S1.1	X	
American Fly-honeysuckle	Lonicera canadensis		E	G5	S1	X	X
Hairy Sundial Lupine	Lupinus perennis var. occidentalis			G5T3T5	S2	x	x
Sundial Lupine	Lupinus perennis var. perennis			G5T5?	S3		x
Hairy Wood-rush	Luzula acuminata var. acuminata		E	G5T5	S1	X	X
Northern Bog Club-moss	Lycopodiella inundata			G5	S1	X	
Stiff Club-moss	Lycopodium annotinum		E	G5	S1	X	X
Hickey's Ground-pine	Lycopodium hickeyi			G5	S3		x
Long's Bugleweed	Lycopus americanus var. longii			G5TNRQ	S2S3	x	
Stalked Water-hoarhound	Lycopus rubellus			G5	S2	X	
Climbing Fern	Lygodium palmatum			G4	S2	X	
Western False Lily-of-the-valley	Maianthemum canadense var. interius		E	G5T4	S1.1		X
Three-leaf False Solomon's-seal	Maianthemum trifolium		E	G5	S1	X	
White Adder's-mouth	Malaxis brachypoda		E	G4G5Q	SH	X	
Green Adder's-mouth	Malaxis unifolia		E	G5	SH	X	X
Spiny Wild Crabapple	Malus angustifolia var. puberula			G5?T2T4	S2		X
Virginia Bunchflower	Melanthium virginicum		E	G5	S1	X	
Virginia Bluebells	Mertensia virginica			G5	S2	x	x
Rock Sandwort	Minuartia michauxii var. michauxii		E	G5T5	SH		X
Basil Beebalm	Monarda clinopodia		E	G5	SH	X	
Oswego-tea	Monarda didyma			G5	S2	X	X
Purple Bergamot	Monarda media			G4?	SH	x	x
Long-awn Smoke Grass	Muhlenbergia capillaris var. capillaris		E	G5T5?	S1		X

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Large Woodland Dropseed	Muhlenbergia sylvatica var. robusta			G5TNR	S2	x	x
Woodland Dropseed	Muhlenbergia sylvatica var. sylvatica			G5T3T5	S3	x	x
Spring Forget-me-not	Myosotis verna			G5	S3		x
Virginia Pennywort	Obolaria virginica			G5	S2		X
Hairy Evening-primrose	Oenothera villosa subsp. villosa			G5T5?	SU		x
Virginia False-gromwell	Onosmodium virginianum		E	G4	SH		X
Northern Adder's-tongue	Ophioglossum pusillum			G5	S3	X	
Southern Adder's-tongue	Ophioglossum vulgatum		E	G5	S1	X	X
Sidebells	Orthilia secunda			G5	S2	X	X
White-grained Mountain-rice Grass	Oryzopsis asperifolia		E	G5	S2		X
Slender Mountain-rice Grass	Oryzopsis pungens		E	G5	SH.1		X
Glandular Cinnamon Fern	Osmunda cinnamomea var. glandulosa			G5TNR	S2	x	
American Ginseng	Panax quinquefolius			G3G4	S1		X
Bristling Panic Grass	Panicum aciculare		E	G5	SH		X
Hidden-flowered Panic Grass	Panicum cryptanthum			G3G4Q	S1	x	
Bluish Panic Grass	Panicum dichotomum var. roanokense			G5T4?	SH	x	
Spotted-sheath Panic Grass	Panicum dichotomum var. yadkinense		E	G4Q	SH		X
Rough Panic Grass	Panicum leucothrix			G4?Q	SH		x
Scribner's Panic Grass	Panicum oligosanthes var. scribnerianum			G5T5	S2		x
Dense Panic Grass	Panicum rigidulum var. condensum			G5T5?	SH	x	
Slender Panic Grass	Panicum xanthophysum		E	G5	SH.1		X
Mountain Nailwort	Paronychia montana			G4	SH		x
Smooth Cliffbrake	Pellaea glabella var. glabella			G5T5	S2		X
Smooth Beardtongue	Penstemon laevigatus		E	G5	S1	X	
Fern-leaf Scorpion-flower	Phacelia bipinnatifida		E	G5	S1.1		X
Wild Kidney Bean	Phaseolus polystachios var. polystachios			G5T5?	S2		X

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Northern Beech Fern	Phegopteris connectilis			G5	S2	X	X
Wild Blue Phlox	Phlox divaricata var. divaricata		E	G5T3T5	S1	X	X
Spotted Phlox	Phlox maculata var. maculata			G5T4T5	S2	X	
Downy Phlox	Phlox pilosa var. pilosa		E	G5T5	SH	X	X
Husk-tomato	Physalis pubescens var. integrifolia			G5T5?Q	SH		x
Red Spruce	Picea rubens		E	G5	S1	X	X
Table Mountain Pine	Pinus pungens		E	G4	S1.1		X
Red Pine	Pinus resinosa		E	G5	S1.1		X
Pond Pine	Pinus serotina			G5	S2		X
Loblolly Pine	Pinus taeda			G5	S2	X	X
Wide-leaf Silkgrass	Pityopsis graminifolia var. latifolia			G5T5?	S1.1		x
Yellow Fringed Orchid	Platanthera ciliaris			G5	S2	X	
Crested Yellow Orchid	Platanthera cristata			G5	S3	X	
Southern Rein Orchid	Platanthera flava var. flava		E	G4?T4?Q	S1	X	
Tubercled Rein Orchid	Platanthera flava var. herbiola			G4?T4Q	S2	X	
Large Purple Fringed Orchid	Platanthera grandiflora			G5	S2	X	
Hooker's Orchid	Platanthera hookeri		E	G4	SH		X
Leafy Northern Green Orchid	Platanthera huronensis			G5T5?	SX	x	
Round-leaf Orchid	Platanthera orbiculata		E	G5	S1		X
Purple Fringed Orchid	Platanthera psycodes			G5	S2	X	
Stinking Fleabane	Pluchea foetida var. foetida		E	G5T5	SH	x	
Drooping Spear Grass	Poa languida			G3G4Q	S2		X
Woodland Spear Grass	Poa sylvestris		E	G5	SH		X
Greek-valerian	Polemonium reptans		E	G5	S1	X	
Loose-spike Milkwort	Polygala ambigua			G5T5?	S2		X
Maryland Milkwort	Polygala mariana			G5	S2	X	
Racemed Milkwort	Polygala polygama			G5	S2		X
Seneca Snakeroot	Polygala senega		E	G4G5	S1.1		X
Fringed Black-bindweed	Polygonum cilinode			G5	S3	X	X
Bristly Smartweed	Polygonum setaceum var. setaceum			G5T3T5	S2	X	
Swamp Cottonwood	Populus heterophylla			G5	S2	X	
Indian Physic	Porteranthus trifoliatus			G4G5	S2		X

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Tall Cinquefoil	Potentilla arguta var. arguta			G5T5	S2		X
Mackenzie's Mermaidweed	Proserpinaca intermedia			G4?Q	S3	x	
Allegheny Plum	Prunus alleghaniensis var. alleghaniensis			G4T4	SX		X
Chickasaw Plum	Prunus angustifolia var. angustifolia		G5T4T5	S2		X	
Wafer-ash	Ptelea trifoliata var. trifoliata		E	G5T5	S1	X	X
Basil Mountain-mint	Pycnanthemum clinopodioides		E	G1G2	S1		X
Torrey's Mountain-mint	Pycnanthemum torrei		E	G2	S1		X
Greenish-flower Wintergreen	Pyrola chlorantha		E	G5	S1		X
Shingle Oak	Quercus imbricaria		E	G5	S1.1		X
Overcup Oak	Quercus lyrata		E	G5	S1	X	
Mossy-cup Oak	Quercus macrocarpa var. macrocarpa		E	G5T5	S1.1	x	x
Basket Oak	Quercus michauxii			G5	S3	X	
Water Oak	Quercus nigra		E	G5	S1	X	
Allegheny Mountain Buttercup	Ranunculus allegheniensis		E	G4G5	S1.1		X
Water-plantain Spearwort	Ranunculus ambigens			G4	S2	X	
Early Buttercup	Ranunculus fascicularis		E	G5	S1		X
Rock Buttercup	Ranunculus micranthus			G5	S2		X
Bristly Buttercup	Ranunculus pensylvanicus			G5	S2	X	
Low Spearwort	Ranunculus pusillus var. pusillus			G5T4?	S2	X	
Showy Meadow-beauty	Rhexia mariana var. ventricosa		E	G5T4T5	S2	x	
Rhodora	Rhododendron canadense		E	G5	S1		X
Mountain Azalea	Rhododendron prinophyllum			G5	S3		X
Gray's Beaked-rush	Rhynchospora grayi		E	G4	SH.1		x
Knieskern's Beaked-rush	Rhynchospora knieskernii	LT	E	G2	S2	X	
Slender-fruit Beak Rush	Rhynchospora leptocarpa			G3	S1	x	
Skunk Currant	Ribes glandulosum		E	G5	S1.1		X
Missouri Gooseberry	Ribes missouriense		E	G5	S2	X	X
Swamp Red Currant	Ribes triste			G5	SU	x	
Smooth Blackberry	Rubus canadensis		E	G5	S1	X	X
Pollock's Mill Blackberry	Rubus gnarus			G3?	SH.1		x

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Cold Spring Blackberry	Rubus originalis			G3?	S2		x
Highbush Blackberry	Rubus ostryifolius			G3?Q	SH.1		x
Davis' Dewberry	Rubus pervarius			G4?	SH.1		x
Blanchard's Dewberry	Rubus recurvicaulis			G4?	S1.1	X	
Bristly Blackberry	Rubus setosus			G5	SH.1	x	
Orange Coneflower	Rudbeckia fulgida var. fulgida		E	G5T4?	S1	x	x
Carolina Petunia	Ruellia caroliniensis		E	G5	SH	X	X
Limestone Petunia	Ruellia strepens			G4G5	SX.1		x
Southern Arrowhead	Sagittaria australis		E	G5	S1	X	
Large-fruit Black-snakeroot	Sanicula trifoliata		E	G4	S1		X
Arrow-grass	Scheuchzeria palustris var. americana		E	G5T5	SH	X	
Purple Oat	Schizachne purpurascens		E	G5	S1.1		X
Curly Grass Fern	Schizaea pusilla			G3G4	S3	X	
Chaffseed	Schwalbea americana	LE	E	G2G3	S1	X	
Carolina Nut-rush	Scleria pauciflora var. caroliniana			G5T4T5	S2		X
Bog Buttons	Sclerolepis uniflora			G4	S2	X	
Small Skullcap	Scutellaria leonardii		E	G4T4	S1		X
Veined Skullcap	Scutellaria nervosa			G5	S2		X
Rock Spike-moss	Selaginella rupestris			G5	S2		X
Balsam Ragwort	Senecio pauperculus			G5	S3		X
Three-toothed Cinquefoil	Sibbaldiopsis tridentata		E	G5	S1.1		X
Wild-pink	Silene caroliniana var. pensylvanica			G5T4T5	S3		X
Bear's-foot	Smallanthus uvedalius		E	G4G5	S1	x	x
Laurel-leaf Greenbrier	Smilax laurifolia			G5	S3	X	
Downy Carrion-flower	Smilax pulverulenta			G4G5	S3	x	x
Bristly Greenbrier	Smilax tamnoides			G5	S3	X	X
Hairy Goldenrod	Solidago hispida var. hispida			G5T5	SU		x
Prairie Goldenrod	Solidago rigida var. rigida		E	G5T5	S1		X
Summer Goldenrod	Solidago rugosa subsp. rugosa var. sphagnophila			G5T3T5	S3	x	
Showy Goldenrod	Solidago speciosa var. speciosa			G5T5?	S2		X

Common Name	Scientific Name	Fed T&E	State Status E	G Rank	S Rank	Wetland Forest & Woodland	Upland Forest & Woodland
Stout Ragged Goldenrod	Solidago squarrosa			G4?	S2		X
American Mountain-ash	Sorbus americana			G5	S2		X
Sphagnum	Sphagnum angustifolium		E	G5	S1	X	
Sphagnum	Sphagnum carolinianum			G3	S2	x	
Sphagnum	Sphagnum centrale		E	G5	S1	X	
Sphagnum	Sphagnum quinquefarium		E	G5	S1.1	X	
Sphagnum	Sphagnum squarrosum			G5	S2	X	
Sphagnum	Sphagnum subtile			G5	S2	x	x
Sphagnum	Sphagnum warnstorfii			G5	S2	X	
Swamp Oats	Sphenopholis pensylvanica			G4	S2	X	
Yellowish Nodding Ladies'-tresses	Spiranthes ochroleuca			G4	S3		X
Long-leaf Rush-grass	Sporobolus compositus var. compositus			G5T5	S2		X
Smooth Hedge-nettle	Stachys tenuifolia			G5	S3	X	
Boreal Starwort	Stellaria borealis var. borealis		E	G5T5	S1	X	
Star Chickweed	Stellaria pubera		E	G5	SH	X	
White Twisted-stalk	Streptopus amplexifolius var. amplexifolius		E	G5T5	S1		X
Rosy Twisted-stalk	Streptopus lanceolatus		E	G5	S1	X	X
Pickering's Morning-glory	Stylisma pickeringii var. pickeringii		E	G4T3	S1		X
Pencil-flower	Stylosanthes biflora			G5	S3		X
Yellow-pimpernel	Taenidia integerrima			G5	S3		X
American Yew	Taxus canadensis			G5	S2		X
Purple Meadow-parsnip	Thaspium trifoliatum var. trifoliatum		G5T5	S3		X	
Arborvitae	Thuja occidentalis		E	G5	S1		X
Foamflower	Tiarella cordifolia var. cordifolia		E	G5T5	S1	X	
Fernald's False Manna Grass	Torreyochloa pallida var. fernaldii			G5T4Q	S1	X	
Poison-oak	Toxicodendron pubescens			G5	S3		X
Ohio Spiderwort	Tradescantia ohiensis			G5	S2		X
Walter's St. John's-wort	Triadenum walteri		E	G5	S1	X	
Weft Fern	Trichomanes intricatum		E	G4G5	S1.1	X	
Large-flower Trillium	Trillium grandiflorum		E	G5	S1		x

Common Name	Scientific Name	Fed T&E	State Status E	G Rank	S Rank	Wetland Forest & Woodland	Upland Forest & Woodland
Painted Trillium	Trillium undulatum			G5	S2	X	X
Narrow-leaf Horse-gentian	Triosteum angustifolium		E	G5	SH		X
Three Birds Orchid	Triphora trianthophora		E	G3G4	S1		X
Spreading Globe Flower	Trollius laxus ssp. laxus		E	G5T3	S1	X	
Rock Elm	Ulmus thomasii			G5	SX		x
Pine Barren Bellwort	Uvularia puberula var. nitida		E	G5T3	S2	X	
Beaked Cornsalad	Valerianella radiata		E	G5	S1		X
Narrow-leaf Vervain	Verbena simplex		E	G5	S1		X
Broad-leaf Ironweed	Vernonia glauca		E	G5	S1		X
Veiny-leaf Arrow-wood	Viburnum dentatum var. venosum			G5T4T5	S2	X	
Witch-hobble	Viburnum lantanoides		E	G5	S1	X	X
Highbush-cranberry	Viburnum opulus var. americanum			G5T5	S3	X	
Carolina Wood Vetch	Vicia caroliniana		E	G5	S1		X
Large-leaf White Violet	Viola blanda var. palustriformis			G4G5T4T5	S3	X	X
Britton's Coast Violet	Viola brittoniana var. brittoniana			G4G5T4T5	S3	X	
Canadian Violet	Viola canadensis var. canadensis		E	G5T5	S1		X
Southern Wood Violet	Viola hirsutula			G4	S2		X
Long-spur Violet	Viola rostrata			G5	S3		X
Northern Blue Violet	Viola septentrionalis		E	G5	S1	X	X
Barren-strawberry	Waldsteinia fragarioides var. fragarioides			G5T5	S2		X
Sand Yellow-eyed-grass	Xyris caroliniana		E	G4G5	S1	X	
Chapman's Yellow-eyed-grass	Xyris chapmanii			G3	S1	x	
Death-camus	Zigadenus leimanthoides		E	G4Q	S1	X	

FEDERAL STATUS CODES

The following U.S. Fish and Wildlife Service categories and their definitions of endangered and threatened plants and animals have been modified from the U.S. Fish and Wildlife Service (F.R. Vol. 50 No. 188; Vol. 61, No. 40; F.R. 50 CFR Part 17). Federal Status codes reported for species follow the most recent listing.

LE Taxa formally listed as endangered.
LT Taxa formally listed as threatened.
PE Taxa already proposed to be formally listed as endangered.
PT Taxa already proposed to be formally listed as threatened.
C Candidate Taxa for which the Service currently has on file sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species.
S/A Similarity of appearance species

STATE STATUS CODES

Animals:

Two animal lists provide state status codes after the Endangered and Nongame Species Conservation Act of 1973 (NSSA 23:2A-13 et. seq.): the list of endangered species (N.J.A.C. 7:25-4.13) and the list defining status of indigenous, nongame wildlife species of New Jersey (N.J.A.C. 7:25-4.17(a)). The status of animal species is determined by the Endangered and Nongame Species Program (ENSP), with the review and approval of the Endangered and Nongame Species Advisory Committee.

The state status codes and definitions provided reflect the most recent lists that were revised in the New Jersey Register, Monday, June 3, 1991.

EX **Extirpated species-** a species that formerly occurred in New Jersey, but is not now known to exist within the state.
E **Endangered species-** an endangered species is one whose prospects for survival within the state are in immediate danger due to one or many factors - a loss of habitat, over exploitation, predation, competition, disease. An endangered species requires immediate assistance or extinction will probably follow.
T **Threatened species-** a species that may become endangered if conditions surrounding the species begin to or continue to deteriorate.
D **Declining species-** a species which has exhibited a continued decline in population numbers over the years.
S **Stable species-** a species whose population is not undergoing any long-term increase/decrease within its natural cycle.
INC **Increasing species-** a species whose population has exhibited a significant increase, beyond the normal range of its life cycle, over a long term period.
P **Peripheral species-** a species whose occurrence in New Jersey is at the extreme edge of its present natural range.
U **Undetermined species-** a species about which there is not enough information available to determine the status.
I **Introduced species-** a species not native to New Jersey that could not have established itself here without the assistance of man.

Status for animals separated by a slash (/) indicate a dual status. First status refers to the state breeding population and the second status refers to the migratory or winter population.

SC **Special Concern –** applies to animal species that warrant special attention because of some evidence of decline, inherent vulnerability to environmental deterioration or habitat modification that would result in their becoming a Threatened species. This category would also be applied to species that meet the foregoing criteria and for which there is little understanding of their current population status in the state.

Plants:

Plant taxa listed as endangered are from New Jersey's official Endangered Plant Species List (N.J.A.C. 7:5C – 5.1).

E Native New Jersey plant species whose survival in the State or nation is in jeopardy.

REGIONAL STATUS CODES FOR PLANTS AND ECOLOGICAL COMMUNITIES

LP Indicates taxa listed by the Pinelands Commission as endangered or threatened within their legal jurisdiction. Not all species currently tracked by the Pinelands Commission are tracked by the Natural Heritage Program. A complete list of endangered and threatened Pineland species is included in the New Jersey Pinelands Comprehensive Management Plan.

HL Indicates taxa or ecological communities protected by the Highlands Water Protection and Planning Act within the jurisdiction of the Highlands Preservation Area.

EXPLANATION OF GLOBAL AND STATE ELEMENT RANKS

The Nature Conservancy developed a ranking system for use in identifying elements (rare species and ecological communities) of natural diversity most endangered with extinction. Each element is ranked according to its global, national and state (or subnational in other countries) rarity. These ranks are used to prioritize conservation work so that the most endangered elements receive attention first. Definitions for element ranks are fromThe Nature Conservancy (1982: Chapter 4, 4.1-1 through 4.4.1.3-3).

GLOBAL ELEMENT RANKS

G1 Critically imperiled globally because of extreme rarity (five or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.

G2 Imperiled globally because of rarity (six to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

G3 Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single western state, a physiographic region in the East) or because of other factors making it vulnerable to extinction throughout its range; with the number of occurrences in the range of 21 to 100.

G4 Apparently secure globally; although it may be quite rare in parts of its range, especially at the periphery.

G5 Demonstrably secure globally; although it may be quite rare in parts of its range, especially at the periphery.

GH Of historical occurrence throughout its range i.e., formerly part of the established biota, with the expectation that it may be rediscovered.

GU Possibly in peril range-wide but status uncertain; more information needed.

GX Believed to be extinct throughout range (e.g., passenger pigeon) with virtually no likelihood that it will be rediscovered.

G? Species has not yet been ranked.

GNR Species has not yet been ranked.

STATE ELEMENT RANKS

S1 Critically imperiled in New Jersey because of extreme rarity (five or fewer occurrences or very few remaining individuals or acres). Elements so ranked are often restricted to very specialized conditions or habitats and/or restricted to an extremely small geographical area of the state. Also included are elements which were formerly more abundant, but because of habitat destruction or some other critical factor of its biology, they have been demonstrably reduced in abundance. In essence, these are elements for which, even with intensive searching, sizable additional occurrences are unlikely to be discovered.

S2 Imperiled in New Jersey because of rarity (six to 20 occurrences). Historically many of these elements may have been more frequent but are now known from very few extant occurrences, primarily because of habitat destruction. Diligent searching may yield additional occurrences.

S3 Rare in state with 21 to 100 occurrences (plant species and ecological communities in this category have only 21 to 50 occurrences). Includes elements which are widely distributed in the state but with small populations/acreage or elements with restricted distribution, but locally abundant. Not yet imperiled in state but may soon be if current trends continue. Searching often yields additional occurrences.

S4 Apparently secure in state, with many occurrences.

S5 Demonstrably secure in state and essentially ineradicable under present conditions.

SA Accidental in state, including species (usually birds or butterflies) recorded once or twice or only at very great intervals, hundreds or even thousands of miles outside their usual range; a few of these species may even have bred on the one or two occasions they were recorded; examples include European strays or western birds on the East Coast and vice-versa.

SE Elements that are clearly exotic in New Jersey including those taxa not native to North America (introduced taxa) or taxa deliberately or accidentally introduced into the State from other parts of North America (adventive taxa). Taxa ranked SE are not a conservation priority (viable introduced occurrences of G1 or G2 elements may be exceptions).

SH Elements of historical occurrence in New Jersey. Despite some searching of historical occurrences and/or potential habitat, no extant occurrences are known. Since not all of the historical occurrences have been field surveyed and unsearched potential habitat remains, historically ranked taxa are considered possibly extant and remain a conservation priority for continued field work with the expectation they may be rediscovered.

SP Element has potential to occur in New Jersey, but no occurrences have been reported.

SR Elements reported from New Jersey, but without persuasive documentation which would provide a basis for either accepting or rejecting the report. In some instances documentation may exist, but as of yet, its source or location has not been determined.

SRF Elements erroneously reported from New Jersey, but this error persists in the literature.

SU Elements believed to be in peril but the degree of rarity uncertain. Also included are rare taxa of uncertain taxonomical standing. More information is needed to resolve rank.

SX Elements that have been determined or are presumed to be extirpated from New Jersey. All historical occurrences have been searched and a reasonable search of potential habitat has been completed. Extirpated taxa are not a current conservation priority.

SXC Elements presumed extirpated from New Jersey, but native populations collected from the wild exist in cultivation.

SZ Not of practical conservation concern in New Jersey, because there are no definable occurrences, although the taxon is native and appears regularly in the state. An SZ rank will generally be used for long distance migrants whose occurrences during their migrations are too irregular (in terms of repeated visitation to the same locations), transitory and dispersed to be reliably identified, mapped and protected. In other words, the migrant regularly passes through the state, but enduring, mappable element occurrences cannot be defined.

Typically, the SZ rank applies to a non-breeding population (N) in the state - for example, birds on migration. An SZ rank may in a few instances also apply to a breeding population (B), for example certain lepidoptera which regularly die out every year with no significant return migration. Although the SZ rank typically applies to migrants, it should not be used indiscriminately. Just because a species is on migration does not mean it receives an SZ rank. SZ will only apply when the migrants occur in an irregular, transitory and dispersed manner.

B Refers to the breeding population of the element in the state.

N Refers to the non-breeding population of the element in the state.

T Element ranks containing a "T" indicate that the infraspecific taxon is being ranked differently than the full species. For example, Stachys palustris var. homotricha is ranked "G5T? SH" meaning the full species is globally secure but the global rarity of the var. homotricha has not been determined; in New Jersey the variety is ranked historic.

Q Elements containing a "Q" in the global portion of its rank indicates that the taxon is of questionable or uncertain taxonomical standing, e.g., some authors regard it as a full species, while others treat it at the subspecific level.

.1 Elements only, ever documented from a single location.

Note: To express uncertainty, the most likely rank is assigned and a question mark added (e.g., G2?). A range is indicated by combining two ranks (e.g., G1G2, S1S3).

IDENTIFICATION CODES

These codes refer to whether the identification of the species or community has been checked by a reliable individual and is indicative of significant habitat. These codes are not included on all Natural Heritage Reports.

Y Identification has been verified and is indicative of significant habitat.

BLANK Identification has not been verified but there is no reason to believe it is not indicative of significant habitat.

? Either it has not been determined if the record is indicative of significant habitat or the identification of the species or community may be confusing or disputed.

Animal Species of Greatest Conservation Need (SGCN) by Taxa Group that depend on Forested Habitat (SWAP 2018)

Taxa Group	Number of Taxa	% of Taxa
Mammals	19	9.3%
Birds	72	35.3%
Amphibians	18	8.8%
Reptiles	21	10.3%
Bees	7	3.4%
Butterflies	30	14.7%
Moths	30	14.7%
Odonates	3	1.5%
Tiger Beetles	4	2.0%
	204	100.0%

APPENDIX C:
ASSESSMENT OF NEED AND FOREST LEGACY AREAS

Forest Legacy Program Requirement	SFAP Location Assessment/Strategy Page(s)
Forest Resources and benefits including:	
Aesthetic and scenic values	C6 (pg 88), NP 3 (pg 168)/Below
Fish and wildlife habitat	C1 (pg 30), NP 1 (pg 110)
Public recreation opportunities	C6 (pg 88), NP 3 (pg 165)
Soil productivity	C4 (pg 70)
Forest products and timber management opportunities	C2 (pg 40), C6 (pg 84)
Watershed values including water-quality protection	C4 (pg 73), NP 1 (pg 116)
The present and future threat—as defined by the State—of conversion of forest areas to nonforest uses	C1 (pg 26), C3 (pg 43), NP2 (pg 144)
Historic or traditional uses of forest areas and trends and projected future uses of forest resources	C1 (pg 17), C6 (pg 88)
Current ownership patterns and size of tracts and trends and projected future ownership patterns	C1 (pg 26), NP2 (pg 119)
Cultural resources that can be effectively protected	BELOW
Outstanding geological features	C4 (pg 70)
Threatened and endangered species	C1 (pg 26), NP2 (pg 163)
Other ecological values	C1 (pg 26)
Mineral resource potential	C4 (pg 70)
Protected land in the State, to the extent practical, including Federal, State, municipal and private conservation organization lands	C1 (pg 10)
Issues identified by the State Forest Stewardship Coordinating Committee (SFSCC) and through the public-involvement process	Spatial Priority Area Analysis (pg 186)

Forest Legacy Program Requirement	SFAP Location Assessment/Strategy Page(s)
Identification of applicable eligibility criteria (see pages 19-20 of the Forest Legacy Program Implementation Guidelines)	Below, SCORP 2018
Identification of specific Forest Legacy Areas (FLAs) for designation:	Below, SCORP 2018
Location of each geographic area on a map and a written description of the proposed FLA boundary	Below, SCORP 2018
Summary of the analysis used to identify the FLA and its consistency with the eligibility criteria	Below, SCORP 2018
Identification of important environmental values and how they will be protected and conserved	Below, SCORP 2018
The conservation goals or objectives in each FLA	Below, SCORP 2018
List of public benefits that will be derived from establishing each FLA	Below, SCORP 2018
Identification of the governmental entity or entities that may hold lands or interests in lands (State grant option) or may be assigned management responsibilities for the lands and interests in lands enrolled in the FLP (Federal option)	Below, SCORP 2018
Documentation of the public involvement process and analysis of the issues raised	Below, SCORP 2018
Specific goals and objectives to be accomplished by the FLP	Below, SCORP 2018
Process to be used by the State lead agency to evaluate and prioritize projects to be considered for inclusion in the FLP	Below, SCORP 2018

FOREST LEGACY AREAS

In accordance with Forest Legacy, Assessment of Need and State Forest Action Plan guidelines provided by the US Forest Service, the below information as well as information throughout the NJ State Forest Action Plan and the provided 2018 SCORP, outlines New Jersey's Forest Legacy Areas and the importance to recreation, biodiversity, water, and the people of New Jersey. Forest Legacy Areas are reviewed by the NJ Stewardship Coordinating Committee.

Table 1 summarizes the preserved acreages within the four Forest Legacy Areas identified: ***Highlands, Pinelands and Coastal Zone regions of New Jersey and Natural Heritage Priority Sites.***

The four Forest Legacy Area (FL Areas) identified by the state of New Jersey are grounded in the concepts and ideas defined within the Spatial Priority Area Analysis (SPAA) referenced on page 181 of the NJ State Forest Action Plan. In each of New Jersey's Forest Legacy Area's SPAA central themes like water quality and quantity protection, encouraging forest resilience, discouraging forest fragmentation, forested wetland preservation, carbon storage and emissions reduction measures, watershed protection, expansion of recreational opportunities, the maintenance of healthy fish & wildlife habitat, rare, threatened and endangered species protection, the preservation of scenic and historic areas and climate resiliency measures were all key factors that drive preservation efforts and funding to these regions. These national priorities all align with the goals and funding objectives defined by the Forest Legacy Program.

The chart below attempts to highlight the US Forest Service Matrix priorities and criterion that are most relevant in each Forest Legacy Area (FL Area).

	Highlands	Pinelands	Coastal Zone	Natural Heritage Priority Sites
National Priority (NP)	1, 2 & 3	1, 2 & 3	1, 2 & 3	1, 2 & 3
Criteria Impacted	C1, C2, C3, C5, C6 & C7	C1, C2, C4, C6 & C7	C1, C2, C5, C6 & C7	C1, C2, C4, C6 & C7

State Resource Areas Preserved Lands

Area	Total Acreage	Preserved Acreage	Percent Preserved
Highlands	859,358	314,796	37%
Pinelands*	938,000	463,000	49%
Coastal Zone**	616,428	232,451	37%
Natural Heritage Priority Sites	335,708	183,803	54%
Total	**2,749,494**	**1,194,050**	**43%**

Table 1. Summary of preserved acreages within the four Forest Legacy Areas.

**State designated Pinelands Area*
***Comprises Coastal Area Facilities Review Act (CAFRA) region*
Sources: New Jersey Highlands Council, New Jersey Pinelands Commission, Green Acres Program

HIGHLANDS

The 5,500 acres Highlands Region covers four states: New York, New Jersey, Pennsylvania and Connecticut. In New Jersey, the Highlands Region includes nearly 860,000 acres encompassing 88 municipalities in seven counties in the northwestern part of the state. In 2004 the New Jersey Highlands Water Protection and Planning Act was passed in recognition of the importance of the region's water supply and diverse natural resources. The Act also created the New Jersey Water Protection and Planning Council Highlands Council and charged it with planning for the protection and stewardship of the Highlands Region. In 2008, the Council adopted the Highlands Regional Master Plan which was developed to protect the region's natural, historic, agricultural and recreational resources and accommodate appropriate economic development.

The Highlands Region comprises less than 15% of the state, but it is the source of water for more than 300 municipalities that are home to 70% of the state's population. The Highlands generate nearly 900 million gallons of water daily for potable water and, industrial and agricultural uses. Reservoirs in the Highlands supply 115 billion gallons of drinking water annually to meet the water supply demands of not only the greater New Jersey Metropolitan Area, but also portions of Burlington, Camden, Gloucester, Mercer and Middlesex counties. Land preservation and maintaining forest cover in the Highlands region are key component in protecting these water resources.

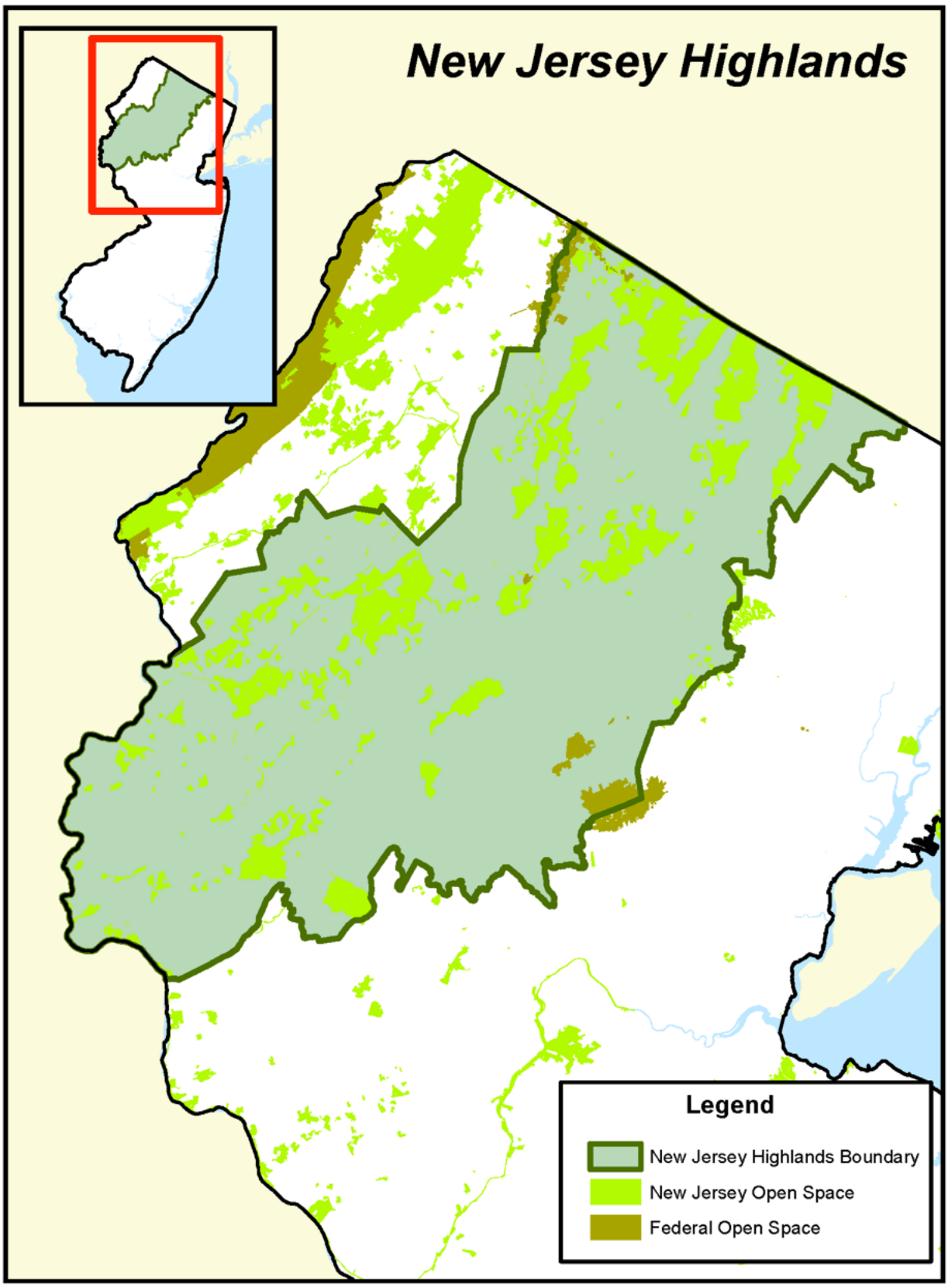
In 2018, the Highlands Council prepared a land preservation status report. The report found 314,796 acres of the Highlands Region or 37%, was preserved. This includes 209,767 acres in the Preservation Area and 105,029 acres in the Planning Area. The report also identified a total of 150,835 acres potentially available for development. The Highlands Council has also released a draft Monitoring Program Recommendation Report which provides an examination of progress made toward achieving the goals of the Highlands Regional Master Plan.

In 2016, the Highlands Council launched the Open Space Partnership Funding Program and Highlands Development Credit (HDC) Purchase program. Both programs are designed to increase protection of Highlands resources while also advancing landowner equity priorities, through deed restrictions or fee simple transactions. The programs are administered under the provisions of the Highlands Open Space Partnership Funding and Highlands Development Credit (HDC) Purchase Program.

The Open Space Partnership Funding Program is a matching grant program that is open to government and nonprofit entities and can be used for fee simple or deed restriction preservation efforts. The HDC Purchase Program is a Transfer of Development Rights program in which eligible property owners may apply for and receive HDC allocations (reflective of lost development potential), which can be sold as HDCs. At present, the HDC Bank is the sole purchaser of HDCs, although the long-term vision is to create a marketplace for credits through the establishment of voluntary receiving zones. The HDC Purchase Program preserves properties via deed restriction.

The Green Acres Program spent $29 million in State Land Acquisition funding on Highlands land preservation projects between 2015 and 2017 which preserved over 4,550 acres. Another 1,639 acres were preserved by local governments and nonprofits during the same time with $23.4 million in Green Acres funding assistance.

The Highlands region was New Jersey's first Forest Legacy Area (FL Area). It remains a focal Forest Legacy Area because the region provides New Jersey with critical water resource protection (both drinking water and surface water). The Highlands is also of conservation importance because it contains unique biodiversity; it is home to many federally listed threatened and endangered species as well as several state threatened or endangered species. The geology of the Highlands area is remarkable, and it


New Jersey Highlands
Legend
New Jersey Highlands Boundary
New Jersey Open Space
Federal Open Space

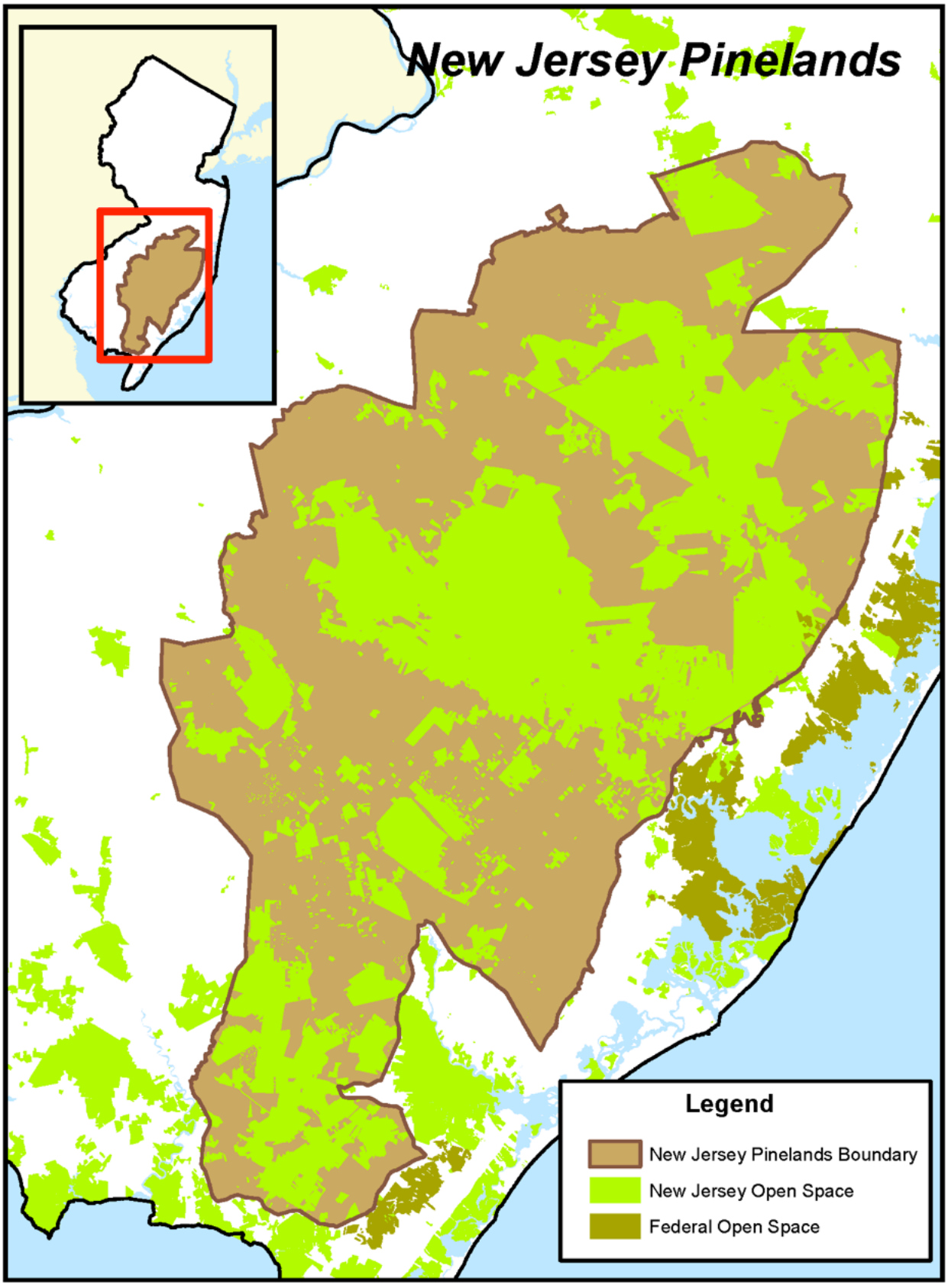
reflects its glacial history. The picturesque ridges and valleys of the NJ Highlands supply spectacular scenic vistas and recreational opportunities. The Highlands of New Jersey contains a heavily traversed section of the Appalachian Trail and one of New Jersey's core forests. This northernmost FL Area containing mature stands of Oak, Hickory, Elm Ash, Maple, Beech and Cottonwoods and it is home to headwaters to category one (C-1) rivers and streams.

The NJ Highlands contains federal land held by the National Park Service (NPS) and the US Fish & Wildlife Service (USFW). The NPS facilities are the Morristown National Historic Park and the Delaware Water Gap National Recreation Area. US Fish & Wildlife Service owns and operates the preserve at the Great Swamp National Wildlife Refuge.

PINELANDS

The National Parks and Recreation Act of 1978 created the Pinelands National Reserve and, with the subsequent establishment of the Pinelands Commission in 1979 and the Pinelands Preservation Act, New Jersey has been reaping the benefits of the preservation and growth management of this 1.1-million-acre region. The Pinelands landscape is a patchwork of pine and oak forests containing an aquifer with 17 trillion gallons of water, five major river systems, two of which, the Maurice River and three of its tributaries, and the Great Egg Harbor River have been inducted into the Wild and Scenic Rivers System. The Pinelands also supports a rich diversity of plants and wildlife species and thriving cranberry and blueberry industries. The Pinelands contain over 463,000 of preserved open space, 94% of which is in conservation-oriented management areas such as the Preservation Area District, according to the Pinelands Commission. The Pinelands are an enormous recreation asset providing opportunities for camping, hiking, canoeing, fishing, hunting and birding, among other activities. The state has several major open space holdings in the Pinelands and has preserved over 218,000 acres in the Pinelands with Green Acres funding. A total of $14.8 million in Green Acres state land acquisition funds was spent on Pinelands land preservation projects between 2013 and 2017 preserving 5,500 acres. Local governments and conservation organizations preserved 3,455 acres between 2013 and 2017. The Pinelands Development Credit Program has preserved 52,194 acres. The protection of the Pinelands has been a feature of New Jersey's SCORP planning for decades. Only continued comprehensive regional planning can ensure the vision of protecting critical Pinelands resources and sustaining economic growth. The permanent protection of Pinelands resources was a fundamental principle mandated by the Pinelands Protection Act. Home to some of New Jersey's core forest comprised of shortleaf, pitch pines, oak, hickory and the vulnerable Atlantic white-cedar. Sea level rise, agricultural land conversion and housing threaten the Pinelands region which accounts for 65% of New Jersey's forested land.

The Pinelands is a Forest Legacy Area because it provides vital water resource protection to the Kirkwood-Cohansey aquifer. The Pinelands is also known for its network of high value rivers, streams and lakes. Preservation efforts in the Pinelands strives to balance the regions ecosystem and natural resource protection needs with its agricultural heritage and its growing demand for housing and outdoor recreation. In the Pinelands FL Area, key SPAA criteria such water surface and groundwater quality and quantity protection, the protection and enhancement of habitat for threatened and endangered species, healthy forest management practices, the avoidance of land conversion and loss of carbon storage have driven decade of conservation and these factors continue to drive the regions open space and agricultural land preservation efforts.


New Jersey Pinelands
Legend
New Jersey Pinelands Boundary
New Jersey Open Space
Federal Open Space

COASTAL ZONE

New Jersey's 127 miles of Atlantic coastline together with the Barnegat, Delaware and Raritan Bays, contain estuaries, rivers, beaches and wetlands that provide abundant opportunities for recreation and tourism. As a peninsula, New Jersey offers residents and visitors a wide variety of water resources for sailing, boating, fishing, swimming, hunting, canoeing and birding. Tidal wetlands provide breeding and nursery habitat for fish and shellfish, provide flood control and, pollution abatement and have tremendous natural resource values. More than 50 species of fish and shellfish support commercial and recreational fisheries. Recreational and commercial fishing creates 65,000 jobs in New Jersey and contribute $2.5 billion to the state's economy. Tourism in New Jersey's coastal communities is a multibillion-dollar industry. The economic power of the Jersey Shore, however, does not stop at the beach or boardwalk. There is no place in the United States with the concentration of migrating raptors in the fall or shorebirds in the spring than Cape May's Delaware Bayshore.

Coastal municipalities can see their summer population double and even triple. More than 1.8 million people visited Island Beach, Barnegat Lighthouse and Cape May Point State parks in FY2016. Another 688,733 used the state's marinas.

Some of the most sensitive coastal ecosystems in the state are also the most heavily used recreational resources. New Jersey's Barnegat Bay is a critically important natural, recreational and economic resource. The 660-square-mile Barnegat Bay watershed encompasses most of the 33 municipalities in Ocean County and four towns in Monmouth County. Its 75-square-mile, environmentally sensitive estuarine system consists of aquatic vegetation, shellfish beds, finfish habitats, waterfowl nesting grounds and spectacular vistas. Since 2011, more than 11,000 acres in Barnegat Bay's watershed have been preserved by Green Acres and the Ocean County Natural Lands Trust. Preserving open space helps to protect the Bay's water quality.

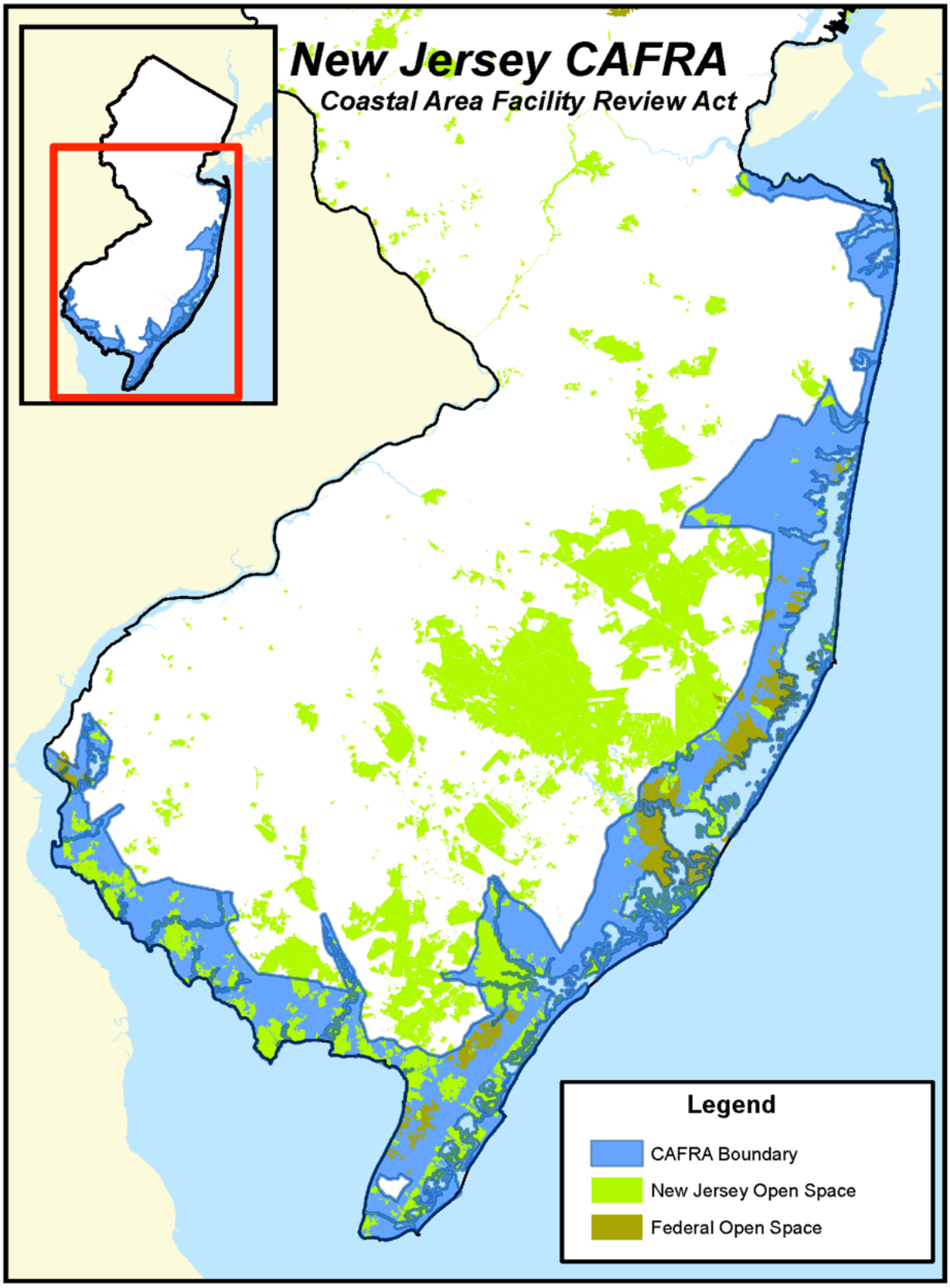
If operated carelessly, boats and personal watercraft can harm environmentally sensitive areas of Barnegat Bay by damaging submerged aquatic vegetation and disturbing habitats. A map depicting important habitat areas was produced by the NJDEP and made available for public use. Boaters can use an online interactive map on mobile devices and computers to locate 16 designated ecologically sensitive zones around Barnegat Bay. The map also shows the locations for marinas, pump out facilities, bait and tackle shops and boat ramps.

In addition to the land preservation and recreational boating actions, the following are some of the other positive actions implemented by the NJDEP to protect Barnegat Bay:

- Negotiating closure of the Oyster Creek Nuclear Generation Station in Lacey Township by the end of 2019, ten years ahead of license expiration;
- Dedicating tens of millions of dollars for local government stormwater infrastructure projects;
- Teaming with research organizations to fund 10 studies that will assist the NJDEP in restoring the Bay;
- Launching a new watershed-wide water quality monitoring network;
- Barnegat Bay Blitz annual watershed-wide clean ups;
- Implementing the strictest fertilizer law in the nation; and
- Release of the Barnegat Bay Restoration, Enhancement and Protection Strategy.

A study by the Barnegat Bay Partnership estimates the Barnegat Bay watershed contributes more than $4 billion to the state's economy each year through outdoor recreation and natural resource activities and directly or indirectly supports more than 60,000 jobs.

New Jersey's Coastal Zone is a Forest Legacy Area because it sits within the coastal plain and it is the cradle of New Jersey's tourism and fishing industries.


New Jersey CAFRA
Coastal Area Facility Review Act
Legend
CAFRA Boundary
New Jersey Open Space
Federal Open Space

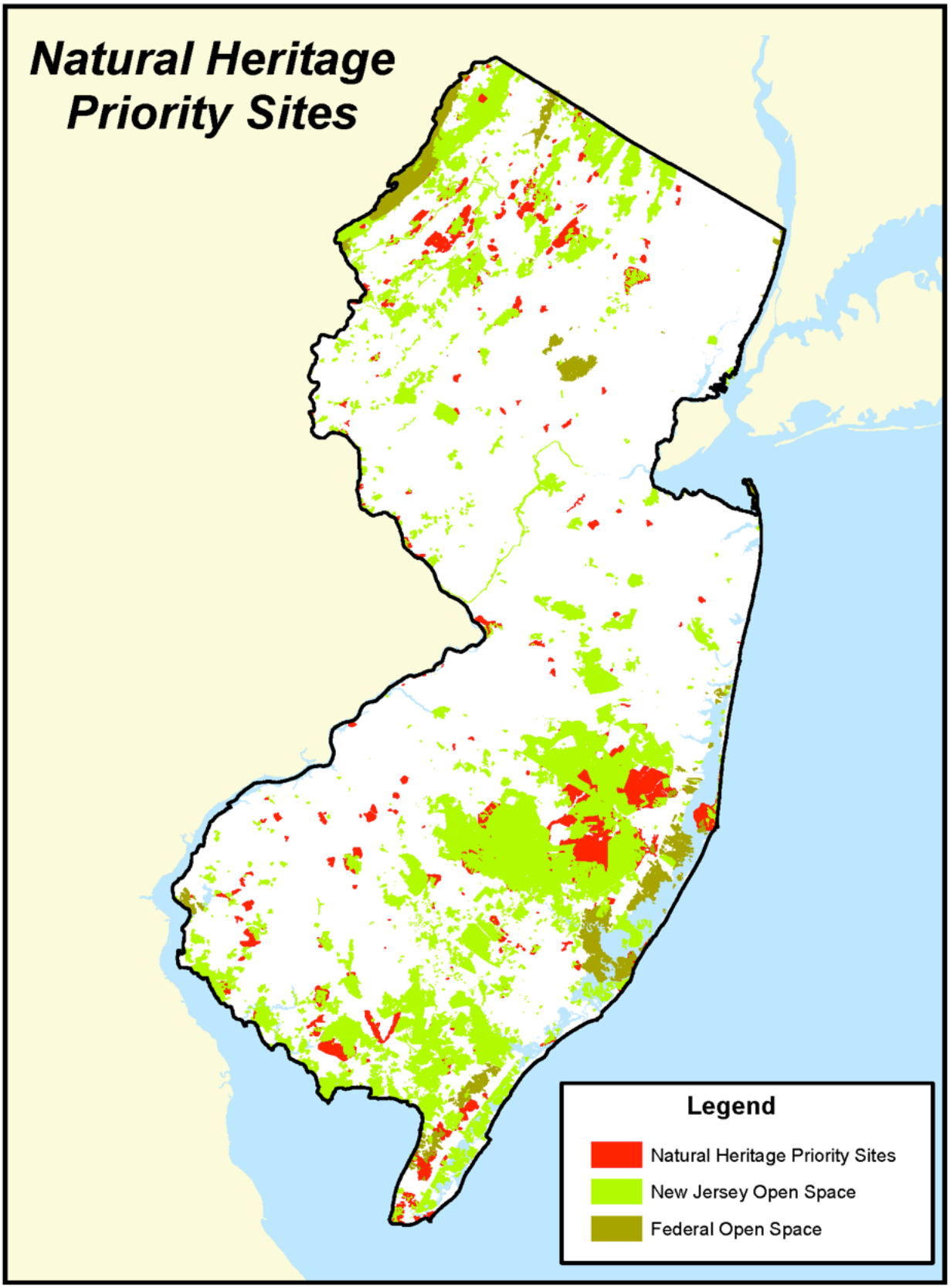
The Coastal Zone contains numerous waterways, buffers vital aquatic ecosystems, provides migratory bird foraging areas and is a critical part of the state's coastal resiliency protection strategies. This region makes up the largest sector of New Jersey's fishing industry, so water quality concerns are crucial to shellfisheries, aquaculture operations and the state's health of coastal marshes and wetlands. The Coastal Zone also sits at the heart of New Jersey's migratory flyway. It provides a much-needed foraging stop over for migrating birds traveling to and from the northern and southern hemispheres. New Jersey's Atlantic coast, Barnegat Bay, Delaware Bay and its Hudson River Estuary are highly vulnerable to sea level rise and they are keystones to the states storm resiliency offensive. A complex system of beaches, dunes, marsh and forested wetlands are complimented by both hard and soft infrastructure to protect eastern New Jersey's communities and the fragile coast from the impacts of year-round coastal storms.

The Coastal Zone contains federally preserved land at Gateway National Recreation Area owned and operated by the National Park Service as well as two US Fish & Wildlife Service National Wildlife Refuges: Edwin B. Forsythe National Wildlife Refuge and Cape May Wetlands National Wildlife Refuge.

NATURAL HERITAGE PRIORITY SITES

Natural Heritage Priority Sites are various sites identified by the NJDEP's Office of Natural Lands Management (ONLM) as areas that contain some of the best remaining habitat for rare species and ecologically unique communities in New Jersey. The ONLM uses the information found in its Natural Heritage Database to identify these sites. The boundaries for Natural Heritage Priority Sites are created to encompass critical habitat or ecological communities. Often the boundaries extend to include additional buffer lands that should be managed to protect the habitat or that would allow for expansion of that habitat. The ONLM has identified over 300 Natural Heritage Priority Sites within New Jersey containing over two thousand native plants. The protection of New Jersey's biodiversity is dependent upon the preservation of these Natural Heritage Priority sites.

New Jersey's system of Natural Heritage Priority Sites are included as a Forest Legacy Area because several of these sites contain segments of core forest. Data suggests that nearly 43% of the Natural Heritage Priority Areas are home to some of the rarest plants in the state, which largely depend on healthy forests and woodland habitats for survival. Natural Heritage Priority Sites protect 142 rare species of trees. Identifying these micro habitat sites as a FL Area will allow preservation resources to be targeted directly to the natural resources and micro ecosystems they seek to preserve and protect.


Natural Heritage
Priority Sites
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Natural Heritage Priority Sites
New Jersey Open Space
Federal Open Space

IDENTIFICATION OF APPLICABLE ELIGIBILITY CRITERIA

A point system of factors is used in the state land, municipality land and non-governmental organizations priority evaluation process. Each process is similar in goals however, due to different ownership process for each were developed to accommodate as such. Acquisitions and proper land stewardship are also addressed below. These factors are: Identification of the governmental entity or entities that may hold lands or interests in lands (State grant option) or may be assigned management responsibilities for the lands and interests in lands enrolled in the FLP (Federal option).

Factor I. Groundwater Protection

A. Wellhead Protection Area Water Supply – 2 points maximum

1. *Feature evaluated:* Whether or the extent to which, the property is located within a Wellhead Protection Area (WHPA) delineated by the New Jersey Geological Survey (NJGS)
2. *Information source:* NJGS WHPA coverage in the Department's GIS
3. Points are assigned as follows:
   a. If the grid cell data from the GIS is converted to a grid cell format, which each grid cell measuring 100 feet by 100 feet; and points are assigned to each of a property's grid cells, on a grid cell basis lies within or intersects with a WHPA – 2 points
   b. If the grid cell lies outside any WHPA – 0 points

B. Groundwater Recharge Area – 5 points maximum

1. *Feature evaluated:* Groundwater recharge capacity of the property's grid cells relative to that of other grid cells in the Watershed Management Area (WMA), as established by the NJGS
2. *Information source:* NJGS Groundwater Ranking Recharge Area by WMA GIS coverage in the Department's GIS
3. Points are assigned, as follows:
   a. If the grid cell is ranked in the top third of all grid cells in the WMA – 5 points
   b. If the grid cell is ranked in the middle third of all grid cells in the WMA – 3 points
   c. If the grid cell is ranked in the lowest third of all grid cells in the WMA – 0 points

C. Aquifer Productivity Statewide – 3 points maximum

1. *Feature evaluated:* The NJGS Aquifer Productivity Ranking
2. *Information source:* NJGS Aquifer Rank GIS coverage
3. Points are assigned, as follows:
   a. If the grid cell has an Aquifer Productivity Ranking of A, B or C (100+ gallons per minute [gpm]) – 3 points
   b. If the grid cell has an Aquifer Productivity Ranking of D (25 to 100 gpm) – 2 points
   c. If the grid cell has an Aquifer Productivity Ranking of E (less than 25 gpm) – 1 point
   d. If the grid cell has no identified aquifer productivity – 0 points

Factor II. Surface Water

A. Public Surface Water Supply Watersheds (intakes) – 3 points maximum

1. *Feature evaluated:* Distance from an existing water supply intake
2. *Information source:* DEP GIS
3. Points are assigned to a grid cell, as follows:
   a. If the grid cell is located within 300 feet of the edge of a water body used for public water supply purposes; and if it is located either no further than 1,500 feet upstream of an existing public water supply intake or no further than 500 feet downstream of an existing public water supply intake (or above a downstream dam that is closer than 500 feet to the intake) – 3 points

b. If the grid cell is located within 300 feet of the edge of a water body used for public water supply purposes; and if it is located more than 1500 feet upstream from an existing public water supply intake – 2 points
c. If the grid cell is located more than 300 feet from the edge of a water body used for public surface water supply, but is located within a watershed that serves an existing public water supply intake – 1 point
d. If the grid cell is not located within a watershed that serves an existing public water supply intake – 0 points

B. Watershed Lands Draining to "Special Surface Water Resources" - 4 points maximum

1. *Feature or characteristic evaluated:* Proximity to a "special surface water body
2. *Information source:* DEP GIS
3. Points are assigned to a grid cell, as follows:
   a. If the grid cell is located within 300 feet of the edge of a surface water body – 1 point
   b. If the grid cell is located further than 300 foot from any surface water body – 0 points

C. Planned Public Water Supply Facility Sites – 2 points maximum

1. *Feature evaluated:* Location in relation to a planned water supply facility site
2. *Information source:* DEP State Water Supply Master Plan.
3. Points are assigned as follows:
   a. If the grid cell is located within a planned water supply facility site – 2 points
   b. If the grid cell is located within a watershed which drains to a planned public water supply facility site – 1 point
   c. If the grid cell is not located within a watershed which drains to a planned water supply facility site – 0 points

Factor III. Flood-prone Areas

A. Flood Hazard Areas – 10 points maximum

1. *Feature evaluated:* Location in relation to flood hazard area
2. *Information sources:* DEP GIS, the New Jersey Flood Hazard Maps
3. Points are assigned, as follows:
   a. If the grid cell is located within a Flood Hazard Area except within the portion of the Flood Hazard Area identified as Zone A – 10 points
   b. If the grid cell is located within the portion of the Flood Hazard Area identified as Zone A – 5 points
   c. If the grid cell is not located within a Flood Hazard Area – 0 points

Factor IV. Natural Resource Features

A. Freshwater and Saltwater Wetlands – 5 points maximum

1. *Feature evaluated:* Location in relation to wetlands
2. *Information source:* DEP GIS
3. Points are assigned as follows:
   a. If the grid cell is located within wetlands and/or within a 300-foot wide wetlands buffer area adjacent to wetlands- 5 points
   b. If the grid cell is not located within wetlands and/or within a 300-foot wide wetlands buffer area adjacent to wetlands – 0 points

B. Forests – 5 points maximum

1. *Feature evaluated:* Presence of forests
2. *Information source:* DEP GIS
3. Points are assigned as follows:
   a. If the grid cell contains forestland – 5 points
   b. If the grid cell does not contain land – 0 points

C. Additional Unique Resources from an Open Space Preservation, Wildlife Conservation or Botanical or Ecological Perspective – 5 points maximum

1. *Feature(s) evaluated:* Presence of notable natural resources, such as distinctive scenic views, old forests and exceptional wetlands from an ecological or botanical perspective
2. *Information sources:* DEP staff knowledge of site.
3. Criteria for assigning points: Points are assigned as follows:
   a. If the property has unique resources of significant value from an open space preservation, wildlife conservation or botanical or ecological perspective – 5 points
   b. If the property's resources are moderately important from an open space preservation, wildlife conservation or botanical or ecological perspective – 2.5 points
   c. If the property's resources are insignificant from an open space preservation, wildlife conservation or botanical or ecological perspective – 0 points

Factor V. Critical Habitat for Imperiled and Priority Wildlife Species

A. Threatened Endangered Animal Species – 10 points maximum

1. *Feature evaluated:* Presence of habitat for animal species that have been determined to be endangered or threatened or classified as a species of special concern, pursuant to the Department's Endangered, Nongame and Exotic Wildlife rules at N.J.A.C. 7:25-4.
2. *Information source:* DEP Landscape Project Maps
3. Points are assigned as follows:
   a. If the grid cell includes land or waters that are classified as habitat for an animal species that is Federally-designated as threatened or endangered, based on documented sightings of the species – 10 points
   b. If the grid cell contains land or waters that are classified as habitat for an animal species that is state-designated as endangered, based on documented sightings of the species – 8 points
   c. If the grid cell contains land or waters that are classified as habitat for an animal species that is state-designated as threatened, based on documented sightings of the species – 6 points
   d. If the grid cell contains land or waters that are classified as habitat for an animal species that is state-designated as a Species of Special Concern, based on documented sightings of the species – 4 points
   e. If the grid cell contains land or waters that are classified as habitat that appears suitable for endangered or threatened animal species, but it is unconfirmed as to whether any such species uses the habitat – 2 points
   f. If the grid cell does not contain land or waters that are classified as containing habitat that is suitable for endangered or threatened animal species – 0 points

B. Natural Heritage Priority Site – 10 points maximum

1. *Feature evaluated:* Presence of a Natural Heritage Priority Site
2. *Information source:*Natural Heritage Priority Sites.
3. Points are assigned as follows:
   a. If the grid cell is within or includes any portion of a Natural Heritage Priority Standard Site that is ranked B1, B2, B3 or B4 for biodiversity – 10 points
   b. If the grid cell is within or includes any portion of a Natural Heritage Priority Standard Site that is ranked B5 for biodiversity; or is within or includes any portion of a Natural Heritage Priority Macrosite that is ranked B1, B2, B3 or B4 for biodiversity – 5 points
   c. If the grid cell is within or includes any portion of a Natural Heritage Priority Macrosite that is ranked B5 for biodiversity – 2 points
   d. If the grid cell is not within or does not include any portion of a Natural Heritage Priority Macrosite or Standard Site – 0 points

Factor VI. Rare Communities

A. Occurrence of Rare Plant or Rare Ecological Community – 10 points maximum

1. *Feature evaluated:* Occurrence of a rare plant or rare ecological community
2. *Information source:* DEP GIS
3. Points are assigned as follows:
   a. If the grid cell includes an occurrence of a rare plant or rare ecological community that is ranked S1, G1 or G2 – 10 points
   b. If the grid cell includes an occurrence of a rare plant or rare ecological community that is ranked S2 or G3 – 8 points
   c. If the grid cell includes an occurrence of a rare plant or rare ecological community that is ranked S3 – 3 points
   d. If the grid cell does not include an occurrence of a rare plant or rare ecological community – 0 points

B. Suitability of Location for Rare Plant or Rare Ecological Community – 10 points maximum

1. *Feature evaluated:* The property's suitability as habitat for a rare plant or rare ecological community
2. *Information sources:* DEP's Natural Heritage Database and staff assessment of property
3. Points are preliminarily awarded to a property pursuant to the criteria in a. below; then the number of points awarded is adjusted pursuant to the criteria in b. below to determine the number of points assigned:
   a. Habitat suitability:
      1) If the property includes habitat that is suitable for a rare plant or rare ecological community ranked S1, G1 or G2 – 10 points
      2) If the property includes habitat that is suitable for a rare plant or rare ecological community ranked S2 or G3 – 8 points
      3) If the property includes habitat that is suitable for a rare plant or rare ecological community ranked S3 – 3 points
      4) If the property does not include habitat that is suitable for a rare plant or a rare ecological community – 0 points
   b. Quality and extent of the habitat on the property:
      1) If the quality or extent of the habitat on the property is assessed by ONLM to be significant for rare plants or a rare ecological community – 100 percent of the points awarded under a. above
      2) If the quality or extent of the habitat on the property is assessed by ONLM to be moderately significant for rare plants or a rare ecological community – 50 percent of the points awarded under a. above
      3) If the quality or extent of the habitat on the property is assessed by ONLM to be insignificant for rare plants or a rare ecological community – 0 percent of the points awarded under a. above

Factor VII. Significant Features

A. Presence of Significant Features – 10 points maximum

1. *Feature evaluated:* Significance of historic or cultural features on the property
2. *Information sources:* Historic Preservation Office (HPO); HPO staff knowledge of site.
3. Points are assigned as follows:
   a. If the property has feature(s) that are on or are eligible for listing on the State or National Register of Historic Places and have statewide significance – 10 points
   b. If the property has feature(s) that are on or eligible for listing on the State or National Register of Historic Places that have local significance – 5 points
   c. If the property has feature(s) that are eligible for listing for State or National Registers of Historic Places and have local significance – 3 points
   d. If the property has no feature(s) eligible for listing for State or National Registers – 0 points

Factor VIII. Open Space – 10 points maximum

1. *Feature evaluated:* Greenways, trails and/or continuity of preserved open space
2. *Information source:* Green Acres Open Space Planning Map
3. Points are assigned as follow:
   a. The extent to which the property represents an integral component of an existing or planned greenway, trail or project area; or connects to an existing preserved open space area – up to 3 points
   b. The extent to which the property enhances a designated or proposed component of the State Trails System or a Federal or state-designated Wild, Scenic or Recreational River – up to 3 points
   c. The extent to which the property contributes to the establishment of a greenbelt around an urban or suburban center – up to 2 points
   d. The extent to which the property acts as a physical or visual buffer between a sensitive area and development – up to 2 points

Factor IX. Recreational Benefit – 14 points maximum

1. *Feature evaluated:* The population that could benefit from recreational opportunities afforded by the property
2. *Information sources:* Site characteristics, as given in the Open Space Planning Map developed by Green Acres and/or in municipal, county and regional park and open space master plans and site recreation master plans; and the most recent decennial U.S. Census from which the relevant data is available.
3. Points are assigned as follows:
   a. Urbanization
      1) If the municipality in which the property is located is a qualifying municipality eligible for urban aid – 3 points
      2) If the municipality in which the property is located is an urbanized municipality with a population density equal to or greater than 5,000 people per square mile; or has a population of 35,000 people or greater – 2 points
      3) If the municipality in which the property is located is a municipality with a population density less than 5,000 people per square mile; or has a population of less than 35,000 people – 1 point
   b. Density of county population
      1) If the county in which the property is located is heavily urbanized and has a population density equal to or greater than 5,000 people per square mile –3 points
      2) If the county in which the property is located is urbanized and has a population density equal to or exceeding 1,000 people per square mile, but less than 5,000 people per square mile – 2 points
      3) If the county in which the property is located has a population density of less than 1,000 people per square mile –1 point
   c. Access to open space
      1) If the distance from the property to existing state open space areas with similar recreation potential is more than 20 miles – 3 points
      2) If the distance from the property to existing state open space areas with similar recreation potential is more than 10 miles but less than 20 miles –2 points
      3) If the distance from the property to existing state open space areas with similar recreation potential is within 10 miles – 0 points
   d. Potential recreational opportunities
      1) If the property offers the potential to provide a wide variety of outdoor recreation opportunities, many of which are not available in the county – up to 5 points
      2) If the property offers the potential to provide a limited number of outdoor recreation opportunities that are generally not available within the county – up to 3 points
      3) If the property offers the potential to provide only outdoor recreation opportunities that are already generally available within the county – 0 points

Factor X. Development Threat/ Property Size/Acquisition Cost

A. Cost, Size and Development Threat – 10 points maximum

1. *Feature evaluated:* The immediacy of the threat that the property will be developed; the size of the property; and the cost of acquiring the property compared to other properties
2. *Information sources:* Green Acres "Application for Sale of Real Estate" Green Acres staff knowledge of site;
3. Points are assigned as follows:
   a. Development potential – 4 points maximum
      1) If the property has local subdivision or site plan approval – 4 points
      2) If the property has a pending local subdivision or site plan application – 3 points
      3) If the property includes developable land but a local subdivision or site plan application has not been submitted – 2 points
4. If the property has no development potential under state regulations – 0 points

   b. Size of the property
      1) If the property is 100 acres or greater – 4 points
      2) If the property is 50 acres or greater but less than 100 acres – 3 points
      3) If the property is 25 acres or greater but less than 50 acres – 2 points
      4) If the property is less than 25 acres – 1 point

   c. Purchase price of the property
      1) If the price of the property is 25% less than its appraised fair market value – 2 points
      2) If the price of the property is less than its appraised fair market value by less than 25% – 1 point
      3) If the price of the property is equal to or higher than its appraised fair market value – 0 points

Factor XI. Planning

A. Planning – 7 points maximum

1. *Feature evaluated:* Consistency of acquisition with applicable plans
2. *Information sources:* State Plan, Green Acres Land Preservation Plan, New Jersey Statewide Comprehensive Outdoor Recreation Plan, Garden State Greenways, Pinelands Comprehensive Management Plan and Highlands Regional Master Plan.
3. Points are assigned as follows:
   a. Consistency with the State Strategic Plan – up to 2 points
   b. Consistency with the Land Preservation Plan – up to 2 points
   c. Consistency with the Pinelands Management Plan, the Highlands Master Plan, Garden State Greenways, Open Space Plans – 1 point
   d. Consistency with Open Space Plans – 1 point
   e. Consistency with Garden State Greenways – 1 point

Local Government Project Priority System Acquisition and Development Projects

*This priority system is used to evaluate the relative merits of proposed acquisition and development projects. The system is designed to reflect the degree to which proposed projects conform with findings, recommendations and priorities of the New Jersey Statewide Comprehensive Outdoor Recreation Plan, the New Jersey State Plan and with statewide goals that are consistent with the Preserve New Jersey Act. The system uses a set of factors to evaluate each project's conservation and recreation features.

Factor 1. Open Space Needs (Acquisition only) - Up to 25 pts

This factor evaluates the extent to which a proposed acquisition project will satisfy local open space needs. Please discuss the needs of the population to be served. The service area for each project will be defined based on population density and the type and size of the project.

Factor 2. Service Area Facility Needs (Development only) - Up to 20 points

Please discuss the needs of the population to be served and evaluate the extent to which the proposed development project will satisfy local recreation needs. The service area for the project will be defined based on population density, scope and type of project.

Factor 3. Environmental Protection (Acquisition only) - Up to 3 points each

This factor is used to determine to what extent a proposed acquisition meets key conservation and environmental protection goals.

a) Lands that are of sufficient size and located to:
   1. Protect critical wildlife habitat;
   2. Enhance or preserve a critical site identified in the State Plan, New Jersey Meadowlands Master Plan, the Pinelands Comprehensive Management Plan and Highlands Regional Master Plan, as applicable and or another unique natural area or land type (for example, steep slopes, dunes, beach, wetlands, forest lands);
   3. Provide additions to or link between existing public recreation and/or open space areas;
   4. Support a regional open space and/or conservation initiative (for example, shore protection or the preservation of landscape ecology, biodiversity, wildlife corridors and/or greenways; and
   5. Protect documented endangered and/or threatened species habitat.

b) Greenways and water resource protection projects, including forests, shorelines and stream corridors that are of sufficient size and located to:
   1. Establish an integral link in an existing or planned local, regional or statewide conservation initiative or a component of a Wild and Scenic Rivers system under the National Wild and Scenic Rivers Act, 16 U.S.C. § 1271-1287 and/or the New Jersey Wild and Scenic Rivers Act, N.J.S.A. 13:8-45 et seq.;
   2. Facilitate water resource protection efforts;
   3. Provide significant natural flood protection;
   4. Act as a physical or visual buffer between a significant natural resource or feature and development or provide visual or physical access to the water; and
   5. Protect headwaters, tributaries or corridors of any waterbodies classified as "Category One Waters," pursuant to N.J.A.C. 7:9B and associated special water resource protection areas established pursuant to N.J.A.C. 7:8, as well as other streams or rivers.

Factor 4. Historic Resource Preservation (Acquisition only) - Up to 3 points each

This factor is used to determine to what extent a proposed acquisition meets key historic resource preservation goals.

a) If the project is on, contained within or adjacent to a site included on or eligible for inclusion in the New Jersey Register of Historic Places under N.J.S.A. 13:IB- 15.128 et seq. and/or the National Register of Historic Places under 16 U.S.C. §470 et seq. or is a Critical Historic Site identified in the State Plan, New Jersey Meadowlands Master Plan, Pinelands Comprehensive Management Plan or Highlands Regional Master Plan, as applicable.

b) If the project is an historic project that provides an extension or linkage between existing public recreation and/or open space areas.

c) The degree to which the project is a significant and/or contributing component of an historic district designated as such under N.J.S.A. 13: IB-15.128 et seq.

d) If the project is part of an ongoing historic preservation or restoration project or historic study or investigation.

e) The extent to which the project is one with historic integrity of location, design, setting, materials, workmanship, feeling and association.

Factor 5. Public Participation/Support/Planning (Acquisition and Development)

This factor evaluates public involvement and support in the planning process beyond the minimum requirement of a public hearing.

a) *Support* - Up to 5 points
Public support for a project is encouraged and should be demonstrated through letters from the municipal and county planning boards, park agencies, recreation departments, environmental commissions, user groups and the public.

b) *Planning* - Up to 10 points
Applicants should demonstrate consistency with the New Jersey State Plan, New Jersey Meadowlands Master Plan, Pinelands Comprehensive Management Plan or Highlands Regional Master Plan, as applicable; the New Jersey Statewide Comprehensive Outdoor Recreation Plan; and local and county land use plans, especially open space and recreation elements thereof, as demonstrated in excerpts from or specific references to such plans in the project application; and whether proof of an approved petition for plan endorsement by the State Planning Commission or, for a local government unit in the Pinelands, certification from the Pinelands Commission that its master plan and land use ordinances or regulations are consistent with the minimum standards of the Pinelands Comprehensive Management Plan, pursuant to N.J.A.C. 7:50-3 Part II or IV, as applicable.

Factor 6. Project Quality (Acquisition and Development)

This factor evaluates project elements and features.

a) *Accessibility (Acquisition and Development)* - 1 point each
The site location:
1. Is close to population centers;
2. Is accessible by public transportation;
3. Is accessible by walking and bicycling; or
4. Creates public access where none exists or where existing access is undeveloped or restricted.

b) *Recreation Potential (Acquisition only)* - Up to 2 points each
The site:
1. Is suitable for major outdoor recreation facility development;
2. Is suitable for the use and/or development of appropriate water dependent recreation activities or facilities;
3. Represents part of a planned or existing waterfront development or redevelopment plan;
4. Provides environmental and/or historic interpretive opportunities; or
5. Improves management or expansion of recreation facilities.

c) *Water Access (Acquisition and Development)* - Up to 6 points (see table 1)
This subfactor evaluates the extent to which a project improves needed visual and/or physical public access to water.

d) *Design Quality (Development only)* - Up to 2 points each
The design:
1. Includes multiple recreation and conservation purposes;
2. Uses effective landscaping;
3. Provides opportunities for various active and passive recreational uses by diverse user groups; and
4. Includes significant shade tree plantings.

e) *Cost Effectiveness (Acquisition and Development)* - Point range: +8, -8
This subfactor evaluates the quality of conservation or recreation opportunities provided by a project in comparison to the anticipated cost. Considerations include:
1. Cost of alternative locations and facilities;
2. Whether the land is available at lower cost due to bargain sale, easement, donation of land value or partnerships (acquisition) or donation of labor, equipment or materials or partnerships (development);
3. Cost of future operation and maintenance; and
4. Whether the project site has development approvals from local planning board (Acquisition only).

Factor 7. Project Priorities (Acquisition and Development)- 1 point each

The following acquisition and development project elements are encouraged:

a) Private investment and/or ecotourism potential, public/private sector venture and/or supports municipal and county (urban complex) strategic revitalization plans and programs consistent with the State Plan, New Jersey Meadowlands Master Plan, Pinelands Comprehensive Management Plan or Highlands Regional Master Plan, as applicable;
b) Waterfront development or redevelopment;
c) Trails, bike paths or greenways;
d) Historic or archeological resource enhancement or preservation;
e) Wildlife habitat protection;
f) Protection of any waterbodies classified as "Category One Waters," pursuant to N.J.A.C. 7:9B and associated special water resource protection areas established pursuant to N.J.A.C. 7:8; or protection of other water resources;
g) Multiple uses and provides active and passive recreation opportunities;
h) Addition to or the development of a prior Green Acres-funded acquisition or development project;
i) Private donation of land, equipment, labor or cash;
j) Likelihood or threat of private development for other than recreation and conservation purposes, (Acquisition only);
k) Design and construction that utilizes clean and renewable energy and maximizes energy efficiency (Development only);
1) Rehabilitation or redevelopment of an existing recreational facility (Development only);
m) Supports a school construction initiative in an Abbott District established pursuant to N.J.A.C.6A:10A;
n) Reclamation of a former brownfields site;
o) A project undertaken by a municipality in the Highlands that has amended its development regulations in accordance N.J.S.A. 13:20-13 to establish one or more receiving zones for transfer of development potential from a sending zone in the Highlands); and
p) A project undertaken by a municipality that has amended its development regulations in accordance with the State Transfer of Development Rights Act (P.L. 2004, c. 2 N.J.S.A. 40:55D-137 et seq.) to establish one or more receiving zones for the transfer of development potential.

Factor 8. First Time Applicant (Acquisition and Development)- 5 points

Applies to a project sponsored by a county or municipality that previously has not received Green Acres funding.

Factor 9. Facility Design Sensitivity And Site Suitability (Development only)

a) *General recreation facilities* - Up to 4 points each
The environmental features of the site will be used to determine the design sensitivity of the project. Projects that will have a significant negative impact on the site's natural resources will not be considered. Project design should minimize adverse impacts on the environmentally sensitive features of the site by:
   1. Locating proposed facilities in already cleared areas, to minimize additional clearing of trees and vegetation;
   2. Locating proposed facilities where topography and soil conditions are suitable, to minimize grading, excavation, fill and drainage of a site; and
   3. Retaining, enhancing or establishing vegetative buffers or incorporating other site-sensitive techniques, to minimize impacts on sensitive areas such as shellfish beds, beach/dune systems, forests, wetlands, steep slopes, endangered or threatened species habitat and aquifer recharge areas.

b) *Structures/Buildings* - 1 point
For projects involving structures, project is designed and constructed to meet the U.S. Green Building Council's (USGBCs) Leadership in Energy and Environmental Design (LEEDTM) Green Building Rating System for New Construction and Major Renovations Version 2.1.

Local Government Project Priority System Stewardship Projects

This Priority System is used to evaluate the relative merits of a proposed stewardship project and its conservation and recreation features.

Factor 1. Natural Resource Protection - Up to 3 points each

This factor is used to determine to what extent a proposed project meets key conservation and environmental protection goals.

a) Enhance or restore a site identified in the State Plan, New Jersey Meadowlands Master Plan, the Pinelands Comprehensive Management Plan and Highlands Regional Master Plan, as applicable and or another unique natural area or land type (for example, steep slopes, dunes, beach, wetlands, forest lands);
b) Provide link between existing public recreation and/or open space areas;
c) Support a regional open space and/or conservation initiative (for example, shore protection or the preservation of landscape ecology, biodiversity, wildlife corridors and/or greenways; and
d) Protect, enhance or restore documented endangered and/or threatened species habitat.
e) Facilitate water resource protection efforts;
f) Provide significant natural flood protection;
g) Site is a physical or visual buffer between a significant natural resource and development or provide visual or physical access to the water;
h) Protect, restore or enhance headwaters, tributaries or corridors of any waterbodies classified as "Category One Waters," pursuant to N.J.A.C. 7:9B and associated special water resource protection areas established pursuant to N.J.A.C. 7:8, as well as other streams or rivers; and
i) Enhance or restore a historic landscape.

Factor 2. Public Participation/Support/Planning

This factor evaluates public involvement and support in the planning process beyond the minimum requirement of a public hearing.

a) *Support* - Up to 5 points
Public support for a project is encouraged and should be demonstrated through letters from the

municipal and county planning boards, park agencies, recreation departments, environmental commissions, user groups and the public.

b) *Planning* - Up to 5 points
Applicants should demonstrate consistency with the New Jersey State Development and Redevelopment Plan (State Plan), New Jersey Meadowlands Master Plan, Pinelands Comprehensive Management Plan or Highlands Regional Master Plan, as applicable; the New Jersey Statewide Comprehensive Outdoor Recreation Plan; and local and county land use plans, as demonstrated in excerpts from or specific references to such plans in the project application.

Factor 3. Project Quality

This factor evaluates project elements and features.

a) *Accessibility* - 1 point each
The site location:
1. Is close to population centers;
2. Is accessible by public transportation;
3. Is accessible by walking and bicycling; or
4. Creates public access where none exists or where existing access is undeveloped or restricted.

b) *Site Suitability* - Up to 2 points each
The site:
1. Is suitable for water dependent recreation activities or facilities;
2. Provides environmental and/or historic interpretive opportunities; or
3. Improves management of conservation lands.

d) *Project Quality* - Up to 2 points each
The proposed project:
1. Includes multiple recreation and conservation purposes;
2. Uses effective landscaping with native species;
3. Provides opportunities for passive recreation;
4. Includes significant plantings of native tree species; and
5. Removes impervious surfaces.

e) *Cost Effectiveness* - Up to 2 points each
This subfactor evaluates the quality of conservation opportunities provided by a project in comparison to the anticipated cost. Considerations include:
1. Partnerships or donation of labor, equipment or materials; and
2. Cost of future operation and maintenance.

Factor 4. Project Priorities - 1 point each

The following project elements are encouraged:

a) Private investment and/or ecotourism potential or public/private sector venture;
b) Trails or greenways;
c) Historic or archeological resource enhancement or preservation;
d) Wildlife habitat protection, restoration or enhancement;
e) Provides passive recreation opportunities;
f) Project site is a prior Green Acres-funded acquisition or development project;
g) Private donation of land, equipment, labor or cash;
h) Reclamation of a former brownfields site; and
i) Retaining, enhancing or establishing vegetative buffers or incorporating other site-sensitive techniques, to minimize impacts on sensitive areas such as shellfish beds, beach/dune systems, forests, wetlands, steep slopes, endangered or threatened species habitat and aquifer recharge areas.

Factor 5. First Time Applicant - 5 points

Applies to a project sponsored by a municipality that previously has not received Green Acres funding.

Nonprofit Project Priority System Acquisition and Development Projects

*This priority system is used to evaluate the relative merits of proposed acquisition and development projects. The system is designed to reflect the degree to which proposed projects conform with findings, recommendations and priorities of the New Jersey Statewide Comprehensive Outdoor Recreation Plan, the New Jersey State Plan and with statewide goals that are consistent with the Garden State Preservation Trust Act. The system uses a set of factors to evaluate each project's conservation and recreation features.

Factor 1. Open Space Needs (Acquisition only) - Up to 25 points

This factor evaluates the extent to which a proposed acquisition project will satisfy local open space needs. Please discuss the needs of the population to be served. The service area for each project will be defined based on population density and the type and size of the project.

Factor 2. Service Area Facility NEEDS (Development only) - Up to 20 points

Please discuss the needs of the population to be served and evaluate the extent to which the proposed development project will satisfy local recreation facility deficits. The service area for the project will be defined based on population density, scope and type of project.

Factor 3. Environmental Protection (Acquisition only) - Up to 3 points each

This factor is used to determine to what extent a proposed acquisition meets key conservation and environmental protection goals.

a) Lands that are of sufficient size and located to:
   1. Protect critical wildlife habitat;
   2. Preserve sites in identified in the State Plan, Meadowlands Master Plan, Pinelands Comprehensive Management Plan and Highlands Regional Master Plan Critical Environmental Sites, unique natural areas or land types (steep slopes, dunes, scenic overlooks, wetlands, forest lands);
   3. Provide additions to or linkages between existing public recreation/open space areas;
   4. Support regional open space/conservation initiatives such as shore protection or the preservation of landscape ecology, biodiversity, wildlife corridors and/or greenways; and
   5. Protect documented endangered and/or threatened species habitat.

b) Greenways and water resource protection projects, including forests, shorelines and stream corridors that are of sufficient size and located to:
   1. Establish an integral link in an existing or planned local, regional or statewide conservation initiative, greenway or designated or potential Wild and Scenic River;
   2. Assist water resource protection efforts;
   3. Provide significant natural flood protection;
   4. Act as a physical or visual buffer between a significant natural resource or feature and development or provide visual or physical access to the water; and
   5. Protect an aquifer; headwaters, tributaries or the corridor of a designated Category One stream; or other streams or rivers.

Factor 4. Historic Resource Preservation (Acquisition only) - Up to 3 points each

This factor is used to determine to what extent a proposed acquisition meets key historic resource preservation goals.

a) If the project is on, contained within or adjacent to a site included on or eligible for inclusion in the New Jersey Register of Historic Places under N.J.S.A. 13:IB- 15.128 et seq. and/or the National Register of Historic Places under 16 U.S.C. §.§470 et seq. or is a Critical Historic Site identified in the State Plan, New Jersey Meadowlands Master Plan, Pinelands Comprehensive Management Plan or Highlands

Regional Master Plan, as applicable.

b) If the project is an historic project that provides an extension or linkage between existing public recreation and/or open space areas.
c) The degree to which the project is a significant and/or contributing component of an historic district designated as such under N.J.S.A. 13: IB-15.128 et seq.,
d) If the project is part of an ongoing historic preservation or restoration project or historic study or investigation.
e) The extent to which the project is one with historic integrity of location, design, setting, materials, workmanship, feeling and association.

Factor 5. Public Participation/Support/PLANNING (Acquisition and Development)

This factor evaluates public involvement and support in the planning process beyond the minimum requirement of a newspaper notice.

a) *Support* - Up to 5 points
Public support for a project is encouraged and should be demonstrated through letters from the municipal and county planning boards, park agencies, recreation departments, environmental commissions, user groups and the public.
b) *Planning* - Up to 10 points
Applicants should demonstrate consistency with the New Jersey State Plan, the New Jersey Meadowlands Master Plan, the Pinelands Comprehensive Management Plan, the Highlands Regional Master Plan, as appropriate; the New Jersey Statewide Comprehensive Outdoor Recreation Plan; and with local and county land use plans, especially open space/recreation elements as demonstrated in excerpts from or specific references to such plans in the project application.

Factor 6. Project Quality (Acquisition and Development)

This factor evaluates project elements and features.

a) *Accessibility (Acquisition and Development)* - 1 point each
The site location:
1. Is close to population centers;
2. Is accessible by public transportation;
3. Is accessible by walking and bicycling; or
4. Creates public access where none exists or where existing access is undeveloped or restricted.

b) *Recreation Potential (Acquisition only)* - Up to 2 points each
The site:
1. Is suitable for major outdoor recreation facility development;
2. Is suitable for the use and/or development of appropriate water dependent recreation activities or facilities;
3. Represents part of a planned or existing waterfront development or redevelopment plan;
4. Provides environmental and/or historic interpretive opportunities; or
5. Improves management or expansion of recreation facilities.

c) *Water Access (Acquisition and Development)* - Up to 6 points (see table 1)
This subfactor evaluates the extent to which a project improves needed visual and/or physical public access to water.
d) *Design Quality (Development only)* - Up to 2 points each
The design:
1. Includes multiple recreation and conservation purposes;
2. Uses effective landscaping;
3. Provides opportunities for various active and passive recreational uses by diverse user groups; and
4. Includes significant shade tree plantings.

e) *Cost Effectiveness (Acquisition and Development)* - Point range: +8, -8
This subfactor evaluates the quality of conservation or recreation opportunities provided by a project in comparison to the anticipated cost. Considerations include:
1. Cost of alternative locations and facilities;
2. Whether the land is available at lower cost due to bargain sale, easement, donation of land value or partnerships (acquisition) or donation of labor, equipment or materials or partnerships (development);
3. Cost of future operation and maintenance; and
4. Whether the project site has development approvals from local planning board (Acquisition only).

Factor 7. Project Priorities (Acquisition and Development) - 1 point each

The following acquisition and development project elements are encouraged:

a) Private investment and/or ecotourism potential, public/private sector venture and/or supports municipal and county (urban complex) strategic revitalization plans and programs consistent with the State Plan, New Jersey Meadowlands Master Plan, Pinelands Comprehensive Management Plan or Highlands Regional Master Plan, as applicable;
b) Waterfront development or redevelopment;
c) Trails, bike paths or greenways;
d) Historic or archeological resource enhancement or preservation;
e) Wildlife habitat protection;
f) Protection of any waterbodies classified as "Category One Waters," pursuant to N.J.A.C. 7:9B and associated special water resource protection areas established pursuant to N.J.A.C. 7:8; or protection of other water resources;
g) Multiple uses and provides active and passive recreation opportunities;
h) Addition to or the development of a prior Green Acres-funded acquisition or development project;
i) Private donation of land, equipment, labor or cash;
j) Likelihood or threat of private development for other than recreation and conservation purposes, one point. Examples of actions that may indicate a possible impending development may include whether the property is on the market or is the subject of local planning board action or if any development permits or approvals have been sought for the property (Acquisition only);
k) Design and construction that utilizes clean and renewable energy and maximizes energy efficiency (Development only);
1) Rehabilitation or redevelopment of an existing recreational facility (Development only);
m) Supports a school construction initiative in an Abbott District established pursuant to N.J.A.C.6A:10A; and
n) Reclamation of a former brownfields site.

Factor 8. Facility Design Sensitivity And Site Suitability (Development only)

a) *General recreation facilities* - Up to 4 points each
The environmental features of the site will be used to determine the design sensitivity of the project. Projects that will have a significant negative impact on the site's natural resources will not be considered. Project design should minimize adverse impacts on the environmentally sensitive features of the site by:
1. Locating proposed facilities in already cleared areas, to minimize additional clearing of trees and vegetation;
2. Locating proposed facilities where topography and soil conditions are suitable, to minimize grading, excavation, fill and drainage of a site; and
3. Retaining, enhancing or establishing vegetative buffers or incorporating other site-sensitive techniques, to minimize impacts on sensitive areas such as shellfish beds, beach/dune systems, forests, wetlands, steep slopes, endangered or threatened species habitat and aquifer recharge areas.

b) *Structures/Buildings* - 1 point
For projects involving structures, project is designed and constructed to meet the U.S. Green Building Council's (USGBCs) Leadership in Energy and Environmental Design (LEEDTM) Green Building Rating System for New Construction and Major Renovations Version 2.1.

Nonprofit Stewardship Project Priority System

This Priority System is used to evaluate the relative merits of a proposed stewardship project and its conservation and recreation features.

Factor 1. Natural Resource Protection - Up to 3 points each

This factor is used to determine to what extent a proposed project meets key conservation and natural resource protection goals.

a) Enhance or restore a site identified in the State Plan, Meadowlands Master Plan, Pinelands Comprehensive Management Plan and Highlands Regional Master Plan Critical Environmental Sites, unique natural areas or land types (steep slopes, dunes, scenic overlooks, wetlands, forest lands);
b) Provide link between existing public recreation/open space areas;
c) Support regional open space/conservation initiatives such as shore protection or the preservation of landscape ecology, biodiversity, wildlife corridors and/or greenways; and
d) Protect, enhance or restore documented endangered and/or threatened species habitat;
e) Projects located on state or local government owned public land;
f) Facilitate water resource protection efforts;
g) Provide significant natural flood protection;
h) Site is a physical or visual buffer between a significant natural resource and development or provide visual or physical access to the water;
i) Protect, restore or enhance headwaters, tributaries or corridors of any waterbodies classified as "Category One Waters," pursuant to N.J.A.C. 7:9B and associated special water resource protection areas established pursuant to N.J.A.C. 7:8, as well as other streams or rivers; and
j) Enhance or restore a historic landscape.

Factor 2. Public Participation/Support/Planning

This factor evaluates public involvement and support in the planning process beyond the minimum requirement of a newspaper notice.

a) *Support* - Up to 5 points
Public support for a project is encouraged and should be demonstrated through letters from the municipal and county planning boards, park agencies, recreation departments, environmental commissions, user groups and the public.
b) *Planning* - Up to 5 points
Applicants should demonstrate consistency with the New Jersey State Development and Redevelopment Plan (State Plan), the New Jersey Meadowlands Master Plan, the Pinelands Comprehensive Management Plan, the Highlands Regional Master Plan, as appropriate; the New Jersey Statewide Comprehensive Outdoor Recreation Plan; and with local and county land use plans, especially open space/recreation elements as demonstrated in excerpts from or specific references to such plans in the project application.

Factor 3. Project Quality

This factor evaluates project elements and features.

a) *Accessibility* - 1 point each
   The site location:
   1. Is close to population centers;
   2. Is accessible by public transportation;
   3. Is accessible by walking and bicycling; or
   4. Creates public access where none exists or where existing access is undeveloped or restricted.

b) *Site Suitability* - Up to 2 points each
   The site:
   1. Is suitable for water dependent recreation activities or facilities;
   2. Provides environmental and/or historic interpretive opportunities; or
   3. Improves management of conservation lands.

c) *Project Quality* - Up to 2 points each
   The proposed project:
   1. Includes multiple recreation and conservation purposes;
   2. Uses effective landscaping with native species;
   3. Provides opportunities for passive recreation;
   4. Includes significant planting of native tree species; and
   5. Removes impervious surfaces.

d) *Cost Effectiveness* - Up to 2 points each
   This subfactor evaluates the quality of conservation opportunities provided by a project in comparison to the anticipated cost. Considerations include:
   1. Partnerships or donation of labor, equipment or materials;
      1. Cost of future operation and maintenance;

Factor 4. Project Priorities - 1 point each

The following project elements are encouraged:

a) Private investment and/or ecotourism potential or public/private sector venture;
b) Trails or greenways;
c) Historic or archeological resource enhancement or preservation;
d) Wildlife habitat protection; restoration, enhancement;
e) Provides passive recreation opportunities;
f) Project site is a previously Green Acres-funded acquisition or development project;
g) Private donation of land, equipment, labor or cash;
h) Reclamation of a former brownfields site.
i) Retaining, enhancing or establishing vegetative buffers or incorporating other site-sensitive techniques, to minimize impacts on sensitive areas such as shellfish beds, beach/dune systems, forests, wetlands, steep slopes, endangered or threatened species habitat and aquifer recharge areas.

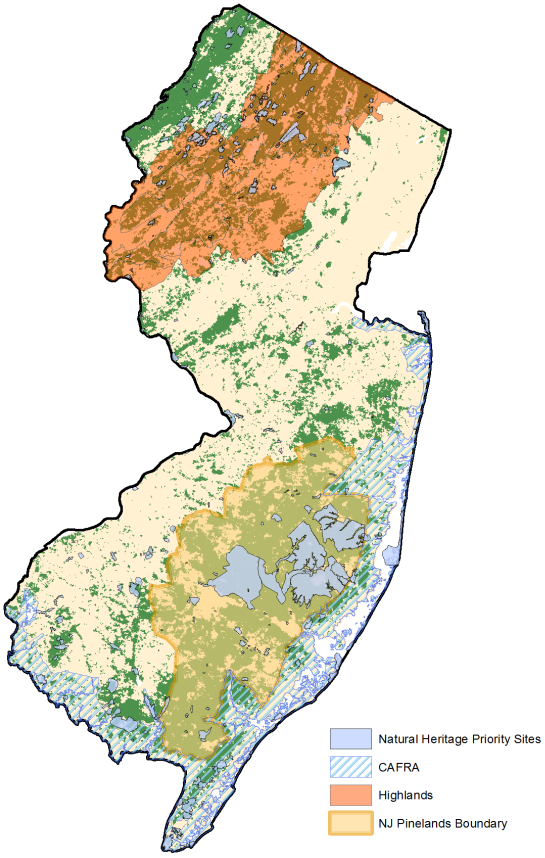
B. IDENTIFICATION OF SPECIFIC FOREST LEGACY AREAS (FL AREAS) FOR DESIGNATION

Highlands

In New Jersey, the Highlands Region includes nearly 860,000 acres encompassing 88 municipalities in seven counties in the northwestern part of the state. In 2004, the New Jersey Highlands Water Protection and Planning Act was passed in recognition of the importance of the region's water supply and diverse natural resources. The Act also created the New Jersey Water Protection and Planning Council Highlands Council and charged it with planning for the protection and stewardship of the Highlands Region. In 2008, the Council adopted the Highlands Regional Master Plan which was developed to protect the region's natural, historic, agricultural and recreational resources and accommodate appropriate economic development.

The Highlands Region comprises less than 15% of the state, but it is the source of water for more than 300 municipalities that are home to 70% of the state's population. The Highlands generate nearly 900 million gallons of water daily for potable water and, industrial and agricultural uses. Reservoirs in the Highlands supply 115 billion gallons of drinking water annually to meet the water supply demands of not only the greater New Jersey Metropolitan Area, but also portions of Burlington, Camden, Gloucester, Mercer and Middlesex counties. Land preservation is a key component in protecting these water resources.

In 2018, the Highlands Council prepared a land preservation status report. The report found 314,796 acres of the Highlands Region or 37%, was preserved. This includes 209,767 acres in the Preservation Area and 105,029 acres in the Planning Area. The report also identified a total of 150,835 acres potentially available for development. The Highlands Council has also released a draft Monitoring Program Recommendation Report



which provides an examination of progress made toward achieving the goals of the Highlands Regional Master Plan.

In 2016, the Highlands Council launched the Open Space Partnership Funding Program and Highlands Development Credit (HDC) Purchase program. Both programs are designed to increase protection of Highlands resources while also advancing landowner equity priorities, through deed restrictions or fee simple transactions. The programs are administered under the provisions of the Highlands Open Space Partnership Funding and Highlands Development Credit Purchase Program.

The Open Space Partnership Funding Program is a matching grant program that is open to government and nonprofit entities and can be used for fee simple or deed restriction preservation efforts. The HDC Purchase Program is a Transfer of Development Rights program in which eligible property owners may apply for and receive HDC allocations (reflective of lost development potential), which can be sold as HDCs. At present, the HDC Bank is the

sole purchaser of HDCs, although the long-term vision is to create a marketplace for credits through the establishment of voluntary receiving zones. The HDC Purchase Program preserves properties via deed restriction.

Green Acres spent $29 million in State Land Acquisition funding on Highlands land preservation projects between 2015 and 2017 which preserved more than 4,550 acres. Another 1,639 acres were preserved by local governments and nonprofits during the same time with $23.4 million in Green Acres funding assistance.

Coastal Zone

New Jersey's 127 miles of Atlantic coastline together with the Barnegat, Delaware and Raritan Bays, contain estuaries, rivers, beaches and wetlands that provide abundant opportunities for recreation and tourism. As a peninsula, New Jersey offers residents and visitors a wide variety of water resources for sailing, boating, fishing, swimming, hunting, canoeing and birding. Tidal wetlands provide breeding and nursery habitat for fish and shellfish, provide flood control and pollution abatement and have tremendous natural resource values. More than 50 species of fish and shellfish support commercial and recreational fisheries. Recreational and commercial fishing creates 65,000 jobs in New Jersey and contributes $2.5 billion to the state's economy. Tourism in New Jersey's coastal communities is a multibillion-dollar industry. The economic power of the Jersey Shore, however, does not stop at the beach or boardwalk. There is no place in the United States with the concentration of migrating raptors in the fall or shorebirds in the spring than Cape May's Delaware Bayshore.

Coastal municipalities can see their summer population double and even triple. More than 1.8 million people visited Island Beach, Barnegat Lighthouse and Cape May Point State parks in FY2016. Another 688,733 used the state's marinas.

Some of the most sensitive coastal ecosystems in the state are also the most heavily used recreational resources. New Jersey's Barnegat Bay is a critically important natural, recreational and economic resource. The 660-square-mile Barnegat Bay watershed encompasses most of the 33 municipalities in Ocean County and four towns in Monmouth County. Its 75-square-mile, environmentally sensitive estuarine system consists of aquatic vegetation, shellfish beds, finfish habitats, waterfowl nesting grounds and spectacular vistas. Since 2011, more than 11,000 acres in Barnegat Bay's watershed have been preserved by Green Acres and the Ocean County Natural Lands Trust. Preserving open space helps to protect the Bay's water quality.

If operated carelessly, boats and personal watercraft can harm environmentally sensitive areas of Barnegat Bay by damaging submerged aquatic vegetation and disturbing habitats. A map depicting important habitat areas was produced by the NJDEP and made available for public use. Boaters can use an online interactive map on mobile devices and computers to locate 16 designated ecologically sensitive zones around Barnegat Bay. The map also shows the locations for marinas, pump out facilities, bait and tackle shops and boat ramps.

In addition to the land preservation and recreational boating actions, the following are some of the other positive actions implemented by the NJDEP to protect Barnegat Bay:

- **Negotiate closure** of the Oyster Creek Nuclear Generation Station in Lacey Township by the end of 2019, ten years ahead of license expiration;
- **Dedicate tens of millions of dollars** for local government stormwater infrastructure projects;
- **Team with research organizations** to fund 10 studies that will assist the NJDEP in restoring the Bay;
- **Launch** a new watershed-wide water quality monitoring network;
- **Clean ups** at Barnegat Bay Blitz annual watershed-wide;
- **Implement the strictest fertilizer law** in the nation; and
- **Release** of the Barnegat Bay Restoration, Enhancement and Protection Strategy.

A study by the Barnegat Bay Partnership estimates the Barnegat Bay watershed contributes more than $4 billion to the state's economy each year through outdoor recreation and natural resource activities and directly or indirectly supports more than 60,000 jobs.

The U.S. Department of Interior, Fish and Wildlife Service, Wildlife and Sport Fish Restoration Program provides grant opportunities under the Sport Fish Restoration Act of 1950, providing opportunity to restore, conserve, manage or enhance sport fish populations as well as education and boating access to the public. (USF&WS NCWC NOFA) Green Acres has been applying for these grant funds since 2000. The funds allow for the acquisition of high-quality coastal wetlands and areas that encourage marsh migration. These grants complement NJDEP's other coastal resiliency efforts and will help protect low lying back bay areas as sea level continues to rise.

Pinelands

The National Parks and Recreation Act of 1978 created the Pinelands National Reserve. With the subsequent establishment of the Pinelands Commission in 1979 and the Pinelands Preservation Act, New Jersey has been reaping the benefits of the preservation and growth management of this 1.1-million-acre region. The Pinelands landscape is a patchwork of pine and oak forests containing an aquifer with 17 trillion gallons of water, five major river systems, two of which, the Maurice River and three of its tributaries and the Great Egg Harbor River have been inducted into the Wild and Scenic Rivers System. The Pinelands also supports a rich diversity of plants and wildlife species and thriving cranberry and blueberry industries. The Pinelands contain more than 463,000 acres of preserved open space, 94% of which is in conservation-oriented management areas such as the Preservation Area District, according to the Pinelands Commission. The Pinelands are an enormous recreation asset providing opportunities for camping, hiking, canoeing, fishing, hunting, mountain biking and birding, among other activities. The state has several major open space holdings in the Pinelands and has preserved more than 218,000 acres in the Pinelands with Green Acres funding. A total of $14.8 million in Green Acres state land acquisition funds was spent on Pinelands land preservation projects between 2013 and 2017 preserving 5,500 acres. Local governments and conservation organizations preserved 3,455 acres between 2013 and 2017. The Pinelands Development Credit Program has preserved 52,194 acres. The protection of the Pinelands has been a feature of New Jersey's SCORP planning for decades. The permanent protection of Pinelands resources was a fundamental principle mandated by the Pinelands Protection Act. Only continued comprehensive regional planning can ensure the vision of protecting critical Pinelands resources and sustaining economic growth.

Natural Heritage Priority Sites

Natural Heritage Priority Sites are sites identified by the NJDEP's Office of Natural Lands Management (ONLM) as areas that contain some of the best remaining habitat for rare species and ecological communities in New Jersey. The ONLM uses the information found in its Natural Heritage Database to identify these sites. The boundaries for Natural Heritage Priority Sites are developed to encompass critical habitat for rare species or ecological communities. Often the boundaries extend to include additional buffer lands that should be managed to protect the habitat. The ONLM has identified more than 300 Natural Heritage Priority Sites within New Jersey. The protection of New Jersey's biodiversity is dependent upon the preservation of New Jersey's Natural Heritage Priority sites.

A Summary of the analysis used to identify the FLA and its consistency with the eligibility criteria/ List of public benefits that will be derived from establishing each FLA follows.

Summary of Findings

Since New Jersey began its open space preservation efforts nearly 60 years ago, New Jersey has successfully preserved more than 1.5 million acres of open space and farmland. Preserved open space in New Jersey (including farmland) accounts for 34% of land in the state, slightly more than almost 33% of land that is developed.

According to Census data, New Jersey's population in 2017 was 9,005,644, an increase of 213,691 since 2010. With 1,224 persons per square mile, New Jersey is the most densely populated state in the nation. This population density will create increased demand for additional park and recreation facilities within the state. Land preservation will help to satisfy this demand.

With population growth comes land development, reflected by more than 138,000 residential building permits issued between 2013 and 2017. **Table 2** (SCORP, 2018) shows statewide land cover changes based on the NJDEP land use data for 2007-2012. Table 3 (SCORP, 2018) shows the counties with the greatest urban land increases during the same period.

Climate change and sea-level rise, in particular, have the potential to negatively impact public open space and park and recreation resources. In October 2012, Hurricane Sandy inflicted unprecedented damage to New Jersey. The state sustained nearly $37 billion in damage, with 346,000 homes and housing units destroyed or damaged. The impact of Sandy upon New Jersey's parklands was considerable. Statewide nearly 184,000 acres of federal, state and local public open space was inundated by the Sandy storm surge. Approximately, 75% of the NJDEP's park facilities sustained damage from the storm, including serious damage to the two most popular parks in the state park system, Liberty and Island Beach state parks. Public parklands and recreation facilities can expect to be subjected to increasing impacts of climate change and sea level rise. Rising temperatures, heat waves and stronger storms, including hurricanes and northeasters are anticipated as a result. Warming temperatures may affect water temperatures, both freshwater and marine and could impact recreational fisheries.

Given the affinity people have for the water, sea level rise is a major concern as many recreation facilities such as marinas, docks and boardwalks are vulnerable to sea-level rise. New Jersey is a peninsula, the state is bordered on the west by the Delaware Bay, the Delaware River, the Hudson River to the east and the Atlantic Ocean to the southeast. Only the northern border with New York is land. The state's 239 coastal communities, 42% of all New Jersey municipalities, provide water associated park and recreation opportunities. These communities will need to address sea-level rise that could range from 1 to 1.8 feet by 2050 and 2.4 to 4.5 feet by 2100. Adapting to sea-level rise will require communities to plan for resilience by engaging a wide variety of constituencies. The NJDEP has prepared a planning guide for coastal communities, **Building Ecological Solutions to Coastal Community Hazards**, which details ways local governments can plan for resiliency.

The State has initiated work on the development of a Coastal Resilience Plan to protect lives, property, infrastructure and natural resources in New Jersey's Coastal Zone. Responding to climate change and reducing its impacts are a NJDEP priority. Approximately 53 percent of New Jersey's population resides in the coastal zone. The Plan will serve as a blueprint to ensure all coastal communities adapt to sea level rise effectively. The NJDEP is developing a planning support system that will inform resilience policies, strategies and funding. The geographic scope of the Plan will include the urbanized areas of Raritan and Sandy Hook Bays, coastal headlands of Monmouth County, barrier islands of central and southern New Jersey and the Delaware Bay region. Given this landscape diversity, the Plan will focus on innovation, flexibility and commitment to planning and preparation. This approach will not only increase resiliency for coastal communities and natural resources, but also for socially vulnerable populations and will attract equitable and sustainable investments. It is anticipated that the Coastal Resilience Plan will be completed by summer 2021.

Below are goals and objectives which also identify important environmental values and how they will be protected and conserved via the actions laid out below each. Government entities or interested parties are listed given the specific action under a specific goal/objective.

The 2018 New Jersey SCORP identified five issues and developed policies for addressing them. These policies are the objectives for the forest legacy criteria.

I. GOAL: Land Preservation

Two approaches (blue acres and tax exemption program)

Objective: It is the objective of the State of New Jersey to continue to preserve land to protect water resources, biodiversity, historic resources, mitigate the effects of climate change and provide statewide public recreation opportunities.

Actions:

1. Continue to provide Green Acres funding for the acquisition of land for state parks, forests, wildlife management areas, historic sites and other natural areas. (NJDEP)

2. Continue to provide funding to local governments and conservation organizations for open space preservation projects. (NJDEP, local governments, conservation organizations)

3. Focus open space preservation projects on protecting water resources, biodiversity and climate change mitigation. (NJDEP, Blue Acres, Highlands Council, Pinelands Commission, local governments and conservation organizations)

4. Support federal open space preservation by the National Park Service and US Fish and Wildlife Service in New Jersey. (NJDEP, local governments, conservation organizations)

5. Continue to provide programs such as the Green Acres Tax Exemption Program as a way to preserve private open space and recreation areas. (NJDEP, local governments, private providers)

6. Promote the preservation of open space and farmland through cooperative projects. (NJDEP, Farmland Preservation Program, Highlands Council, Pinelands Commission)

7. Continue to provide funding for Blue Acres projects. (NJDEP)

8. Promote the statewide use of the New Jersey Conservation Blueprint for open space planning. (NJDEP, local governments, conservation organizations)

II. GOAL: Recreation

Providing funding for park and recreation development, particularly in urban park and recreation areas through the Urban Aid funding.

Objective: It is the objective of the State of New Jersey to continue the funding of recreation facilities on state open space and recreation areas and to provide funding to local governments and conservation organizations for park and recreation projects.

Actions:

1. Continue to acquire land for recreational open space. (NJDEP, local governments, conservation organizations)

2. Continue to provide Green Acres funding to local governments and nonprofits for the development of park and recreation facilities on municipal, county and state parkland or nonprofit-owned land. (NJDEP, local governments, conservation organizations)

3. Continue the Green Acres Tax Exemption Program to provide for public access to private lands and recreation facilities. (NJDEP, local governments, private recreation providers, private landowners)

4. Implement the recommendations of the New Jersey Trails Plan through funding, planning and technical assistance programs. (NJDEP, NJDOT Bicycle and Pedestrian Programs, federal and local governments, trail user organizations and conservation organizations)

5. Foster cooperation between state, local governments and nonprofits to promote the health benefits of outdoor recreation. (NJDEP, local governments, nonprofits)

6. Continue local government and nonprofit funding for urban open space and recreation projects. (NJDEP, local governments, conservation organizations)

7. Continue the preservation of land by the state for conservation and recreation purposes in urbanized counties. (NJDEP)

8. Implement urban river and park initiatives that include public access, habitat protection, restoration and partnerships. (NJDEP, local governments, conservation organizations)

III. GOAL: State Resource Areas

Protection of critical natural resources, most critically water.

Objective: It is the objective of the State of New Jersey to continue the protection of the State Resource Areas through land preservation, land use planning, participation in regional projects and continued funding and planning assistance to local governments and conservation groups.

Actions:

1. Continue to preserve important natural resource areas of the Pinelands consistent with the Pinelands Comprehensive Management Plan and the Pinelands Land Protection Plan. (NJDEP, Pinelands Commission)

2. Continue funding for local governments and conservation organizations to preserve land and develop recreation facilities in the Pinelands. (NJDEP, local governments, Pinelands Commission, conservation organizations)

3. Continue to protect important water resources and other natural resources in the Highlands. (NJDEP, Highlands Council, local governments, conservation organizations)

4. Continue funding for local governments and conservation organizations to preserve land and develop recreation facilities in the Highlands (NJDEP, local governments, Highlands Council, conservation organizations)

5. Utilize funds from the federal Forest Legacy Program and the Highlands Conservation Act to protect lands in the Highlands. (NJDEP, Highlands Council, National Park Service, United States Forest Service)

6. Continue to provide Green Acres funding to improve public access to local government and conservation organizations to improve public access to coastal and waterfront projects. (NJDEP, local governments, conservation organizations)

7. Continue to provide Green Acres funding to improve local government and conservation organization acquisition projects for Barnegat Bay, Delaware Bay and the Hudson-Raritan Estuary. (NJDEP)

8. Continue to provide Green Acres funding for the protection of Natural Heritage Priority Sites. (NJDEP)

9. Continue to provide Green Acres funding for the preservation of historic sites. (NJDEP)

10. Promote ecotourism to provide sustainable economic development and protect important natural, recreation, scenic and historic resources. (NJDEP, Highlands Council, Pinelands Commission, local governments, conservation organizations)

IV. GOAL: Greenways and trails

Economical and efficient wat to preserve public open space throughout New Jersey and close to home recreational opportunities.

Objective: It is the objective to the State of New Jersey to promote greenway and trail planning and implementation.

Actions:

1. Support greenway and trail projects through Green Acres local government funding and technical assistance. (NJDEP, local governments, environmental commissions, conservation organizations)

2. Implement recommendations of the New Jersey Trails Plan. (NJDEP, New Jersey Trails Council, local governments, trail user organizations and conservation organizations)

3. Encourage local governments to adopt greenways and trails as part of municipal and county master

plans. (NJDEP, local governments, conservation organizations, environmental commissions)

4. Continue to work with the New Jersey Department of Transportation on open space and recreation projects. (NJDEP, NJDOT, local governments, conservation organizations)

5. Work with Farmland Preservation Program to provide trails on preserved farmland. (NJDEP, State Agricultural Development Committee)

V. GOAL: Stewardship

The caring for the lands and resources in public ownership and the challenges facing this care.

Objective: It is the objective of the State of New Jersey to provide stewardship funding and continue stewardship planning.

Actions:

1. Continue Green Acres funding for stewardship, land preservation, park, recreation and historic preservation projects. (NJDEP, local governments, conservation organizations)

2. Increase public access to public open space and recreation areas. (NJDEP, local governments and conservation organizations).

3. Provide technical assistance to local governments and conservation organization on natural resource protection, restoration and open space and recreation planning. (NJDEP)

4. Support environmental education facilities and programs through funding and technical assistance. (NJDEP, local governments, conservation organizations)

Documentation of the public involvement process and analysis of the issues raised.

Public Participation

Recognizing the importance of public involvement in open space and recreation planning, Green Acres requires that local governments applying for Green Acres funding hold a public hearing on their application. This requirement ensures that local governments are providing an opportunity for residents to discuss open space and recreation issues. Green Acres staff also participate in conferences and other public events that address open space and recreation concerns statewide. Green Acres posts information on its website, *www.nj.gov/dep/greenacres*, on funding awards to local governments and conservation organizations. Beginning in 2019, Green Acres will also post information on individual funded projects to improve and increase public transparency and participation.

The preparation of the SCORP has provided opportunities for public participation. Copies of the draft plan were sent to a variety of federal, state and regional agencies for review and comment. County park and planning agencies also were sent copies for their input. Every New Jersey municipality received notification of the availability of the draft plan for comment. Interested parties such as nonprofit land trusts and conservation organizations were also sent copies for comment. The draft SCORP was also available on the Green Acres website for public review and comment. Comments submitted by these various agencies organizations and individuals have been incorporated into the 2018 New Jersey SCORP.

C. GREEN ACRES STRATEGIC PLANNING OBJECTIVES

- **To create** an interconnected system of public and private lands to preserve open space and provide recreation opportunities;
- **To protect** New Jersey's water resources, biodiversity, scenic landscapes and historic resources;
- **To foster** partnerships with the state's local governments, conservation community and private sector and the federal government through cooperative projects, funding, planning and technical assistance;
- **To promote** the quality of life in the state's communities by providing assistance for open space preservation and park development as integral statewide components of sustainable growth and resiliency;

- **To complement** natural resource-based businesses such as tourism, agriculture, forestry, recreational and commercial fishing and outdoor recreation equipment retailing;
- **To maintain** and enhance New Jersey's quality of life by providing accessible recreation, retaining community character and preserving important natural and historic resources and;
- **To implement** open space and recreation policies that are consistent with NJDEP goals and account for population growth and future development.

State Land Acquisition Strategies:

- **Willing Sellers:** Acquire land from willing sellers;
- **Partnerships:** Seek public, nonprofit and private sector partners for open space preservation projects;
- **Blue Acres Program:** Continue property buyout program as a statewide hazard mitigation and resiliency tool;
- **Geographic Information System:** Use GIS technology for mapping, planning, data sharing and the maintenance of a statewide open space map;
- **Preservation Tools:** Use open space acquisition and preservation techniques including fee simple, easement and development rights purchases and donations;
- **Federal Funding:** Seek federal funding such as the LWCF, Forest Legacy Program and the North America Wetlands Conservation Act grants.

The 2018 SCORP has been prepared to meet the following goals:

- **To assess** the amount of open space available for current and future public recreational use and for the conservation of natural resources important to protecting New Jersey's biodiversity and quality of life.
- **To provide** close-to-home park and recreation opportunities for residents statewide.
- **To present** current information on the supply and demand for recreation and open space in New Jersey.
- **To implement** open space and recreation planning policies and projects that are consistent with NJDEP goals.
- **To encourage** open space and recreation planning by local governments and conservation organizations.
- **To effectively use funds** from the Preserve New Jersey Act, LWCF, Forest Legacy Program and other sources of funding which may become available.

D. FOREST LEGACY PROGRAM REQUIREMENTS: PROCESS USED TO EVALUATE AND PRIORITIZE

Step 1 - Project Approval/Funding

Project areas are submitted to the Garden State Preservation Trust for approval. The New Jersey Legislature appropriates the project funds. Amounts for funding for each project area are based on policy initiatives, ongoing projects, funding demand and land costs.

Step 2 - Project Identification

Green Acres receives offers throughout the year to sell land to the state from landowners statewide. Green Acres can target land in a project area. Additionally, lands are recommended for preservation by the NJDEP Division of Fish & Wildlife, NJDEP Division of the Parks and Forestry or the NJ Natural Lands Trust, as well as by conservation organizations and other interested parties.

Step 3 - Project Evaluation

Land offers are mapped in the Green Acres GIS open space map. Project parcels are evaluated using the GIS portion of the State Land Acquisition Priority System. The offers are then submitted for agency review.

Step 4 – Division Review

The offers are circulated to the NJDEP Division of Parks and Forestry, NJDEP Division of Fish & Wildlife and the NJ Natural Lands Trust to ascertain potential ownership and management interest. If an offering is of interest, then it will be further evaluated by Green Acres using the Priority System. The combined point value derived from both evaluations will represent the final point score for a project. Information on parcels where there is no state interest is shared with local governments and conservation organizations. Opportunities for cooperative management are explored as appropriate.

Step 5 - Project Assignment

Once interest has been shown by an agency the project is assigned to a Green Acres project manager. Assignments are based on the geographic location of the property. Project management staff are organized into the following six teams:

Central Team: Hunterdon, Mercer, Middlesex, Monmouth and Somerset counties

North East Team: Bergen, Morris and Passaic counties

North West Team: Sussex and Warren counties

South Central Team: Atlantic, Burlington, Camden and Ocean counties

South Team: Cape May, Cumberland, Gloucester and Salem counties

Park Development and Urban Acquisition Team: Hudson, Essex and Union counties, statewide park development and acquisition in designated urban centers and communities.

These teams are responsible for state land, local government and nonprofit project management. The project manager contacts the landowner to begin the state land acquisition process.

Step 6 - Technical Work

The project managers order a title search and two appraisals for properties with an estimated value of more than $250,000. Preliminary site assessment work to investigate previous land uses and the potential for hazardous waste concerns is performed by Green Acres staff. Appraisals are reviewed by Green Acres appraisal staff to determine the fair market value of a property.

Step 7 - Purchase Decision / Purchase Offer

A state purchase contract of sale is prepared upon the acceptance of the purchase offer by the property owner. The Green Acres project manager drafts purchase contracts and sends them to the seller to effectuate. (The state purchase contracts are Deputy Attorney General approved contract templates. The DAG does not prepare each individual purchase contract. If a legal issue warrants the modification of a state purchase contract template, then a DAG will direct changes to the template. Typically, the DAG doesn't get involved or assigned an acquisition project until the purchase contract is signed by NJDEP and the transaction moves towards closing.)

Steps 8 and 9 - Closing and Property Assignment

Once the land survey and metes and bounds description are complete and approved by NJDEP's staff surveyor, then a Deputy Attorney General is engaged and the transaction proceeds to closing. After closing, the property is assigned for management to either the NJDEP Division of Parks and Forestry, the NJDEP Division of Fish & Wildlife or the NJ Natural Lands Trust.

APPENDIX D:
ANIMAL SGCN BY TAXA GROUP

Animal Species of Greatest Conservation Need (SGCN) by Taxa Group that depend on Forested Habitat (SWAP 2017)

Taxa Group	Number of Taxa	% of Taxa
Mammals	19	9.3%
Birds	72	35.3%
Amphibians	18	8.8%
Reptiles	21	10.3%
Bees	7	3.4%
Butterflies	30	14.7%
Moths	30	14.7%
Odonates	3	1.5%
Tiger Beetles	4	2.0%
	204	100.0%

Species list of species of greatest conservation need (SGCN) that depend on forested habitat.

REPTILES

ENDANGERED

Rattlesnake, timber *(Crotalus h. horridus)*
Snake, corn *(Elaphe g. guttata)*
Snake, queen *(Regina septemvittata)*
Turtle, bog *(Glyptemys muhlenbergii)***

THREATENED

Snake, northern pine *(Pituophis m. melanoleucus)*
Turtle, wood *(Glyptemys insculpta)*

AMPHIBIANS

ENDANGERED

Salamander, blue-spotted *(Ambystoma laterale)*
Salamander, eastern tiger *(Ambystoma tigrinum)*
Treefrog, southern gray *(Hyla chrysocelis)*

THREATENED

Salamander, eastern mud *(Pseudotriton montanus)*
Salamander, long-tailed *(Eurycea longicauda)*
Treefrog, pine barrens *(Hyla andersonii)*

MAMMALS

ENDANGERED

Bat, Indiana *(Myotis sodalis)***
Bobcat *(Lynx rufus)*
Woodrat, Allegheny *(Neotoma magister)*
Bat, Northern Long-eared *(Myotis septentrionalis)*

***Federally endangered or threatened*

INVERTEBRATES

ENDANGERED

Beetle, American burying *(Nicrophorus americanus)***
Beetle, northeastern beach tiger *(Cincindela d. dorsalis)***
Copper, bronze *(Lycaena hyllus)*
Floater, brook (mussel) *(Alasmidonta varicosa)*
Floater, green (mussel) *(Lasmigona subviridis)*
Petaltail, gray (dragonfly) *(Tachopteryx thoreyi)*
Satyr, Mitchell's (butterfly) *(Neonympha m. mitchellii)***
Skipper, arogos (butterfly) *(Atrytone arogos arogos)*
Skipper, Appalachian grizzled (butterfly) *(Pyrgus wyandot)*
Wedgemussel, dwarf *(Alasmidonta heterodon)***

THREATENED

Baskettail, robust(dragonfly) *(Epitheca spinosa)*
Clubtail, banner (dragonfly) *(Gomphus apomyius)*
Clubtail, harpoon (dragonfly) *(Gomphus descriptus)*
Elfin, frosted (butterfly) *(Callophrys irus)*
Emerald, Kennedy's (dragonfly) *(Somatochlora kennedyi)*
Floater, triangle (mussel) *(Alasmidonta undulata)*
Fritillary, silver-bordered (butterfly) *(Bolaria selene myrina*)
Jewelwing, superb (dragonfly) *(Calopteryx amata)*
Lampmussel, eastern (mussel) *(Lampsilis radiata)*
Lampmussel, yellow (mussel) *(Lampsilis cariosa)*
Mucket, tidewater (mussel) *(Leptodea ochracea)*
Pondmussel, eastern (mussel) *(Ligumia nasuta)*
Snaketail, brook, (dragonfly) *(Ophiogomphus asperses)*
White, checkered (butterfly) *(Pontia protodice)*

BIRDS

ENDANGERED

Bittern, American *(Botaurus lentiginosos* BR)
Eagle, bald *(Haliaeetus leucocephalus* BR)
Falcon, peregrine *(Falco peregrinus* BR)
Goshawk, northern *(Accipiter gentilis BR)*
Grebe, pied-billed *(Podilymbus podiceps BR)*
Harrier, northern *(Circus cyaneus BR)*
Hawk, red-shouldered *(Buteo lineatus BR)*
Knot, red *(Calidris canutus NB)*
Owl, short-eared *(Asio flammeus BR)*
Plover, piping *(Charadrius melodus)***
Rail, black *(Laterallus jamaicensis BR)*
Sandpiper, upland *(Batramia longicauda)*
Shrike, loggerhead *(Lanius ludovicianus NB)*
Skimmer, black *(Rynchops niger)*
Sparrow, Henslow's *(Ammodramus henslowii)*
Sparrow, vesper *(Pooecetes gramineus BR)*
Tern, least *(Sternula antillarum)*
Tern, roseate *(Sterna dougallii)***
Warbler, golden-winged *(Vermivora chrysoptera BR)*
Wren, sedge *(Cistothorus platensis)*

THREATENED

Bobolink *(Dolichonyx oryzivorus* BR)
Eagle, bald *(Haliaeetus leucocephalus* NB)
Egret, cattle *(Bubulcus ibis BR)*
Kestrel, American *(Falco sparverius)*
Lark, horned *(Eremophila alpestris BR)*
Night-heron, black-crowned *(Nycticorax nycticorax BR)*
Night-heron, yellow-crowned *(Nyctanassa violacea)*
Osprey *(Pandion haliaetus BR)*
Owl, barred *(Strix varia)*
Owl, long-eared *(Asio otus)*
Rail, black *(Laterallus jamaicensis NB)*
Sparrow, grasshopper *(Ammodramus savannarum BR)*
Sparrow, Savannah *(Passerculus sandwichensis BR)*
Woodpecker, red-headed *(Melanerpes erythrocephalus)*

***Federally endangered or threatened*
BR – Breeding population only
NB – non-breeding population only

APPENDIX E:
FOREST HEALTH

DCA	Host affected	Region at Greatest Risk	Native/Non-Native	Year detected in NJ	Current Survey/Monitoring	Frequency	Current Suppression Activities	Emerging /Establish
Beech Leaf Disease	Beech Species	State-wide	Unknown	Not yet detected	Visual Surveys	As Needed	None	Emerging
Agrilus smaragdifrons	Ailanthus	State-wide	Non-native	2011	Trapping in conjunction with EAB trapping, visual survey	As Needed	none	Emerging
Asian Ambrosia Beetle (Xylosandrus crassiusculus)	Polyphagus, includes oaks, maples, cherry, hickory, redbud, dogwood, beech	State-wide	Non-native	1974 in South Carolina	None	As Needed	None	Established
Asian Longhorned Beetle	Various species - Maples, Willows, Ash, Poplars, Sycamore	State-wide; previous populations detected in Hudson, Middlesex, and Union Counties	Non-native	2002	Trapping, visual survey	As Needed	None - ALB is considered eradicated from NJ	Emerging
Beech Bark Disease	American Beech	Northern half	Non-native	1935	Visual survey, permanent plots	2-3 year cycle	None	Established
Butternut Canker	Butternut	Northern half	Non-native	1967 in Wisconsin	None	As Needed	None	Established
Chestnut Blight	American Chestnut	State-wide	Non-native	1904 in New York	None	As Needed	None	Established
Dutch Elm Disease	American Elm	State-wide	Non-native	1928 in Ohio, 1933 in NJ*	None	As Needed	None at this time	Established
Elongate hemlock scale	Eastern hemlock	Northern half	Non-native	1908 in Queens NY	Visual survey	As Needed	Pesticide application on individual trees in conjunction with HWA treatment	Established
Emerald Ash Borer	Ash species, White Fringetree	State-wide	Non-native	2014	Visual survey	As Needed	Biological control, pesticide application on individual trees	Established
Gypsy Moth	Polyphagous, highly prefer oak species	State-wide	Non-native	1920	Aerial survey, Egg mass survey, visual survey	Annual	Aerial application BtK when egg mass surveys exceed 500 EM per acre	Established
Hemlock Woolly Adelgid	Eastern hemlock	Northern half	Non-native	1978	Visual survey, permanent plots	As Needed	Biological control, pesticide application on individual trees	Established
Laurel Wilt Disease	Lauraceae Family	state-wide	Non-native	Not yet detected	Visual survey, trapping (?)	As Needed	None at this time	Emerging
Oak Wilt	Oak species, red oak family highly susceptible	State-wide	Non-native	Not yet detected	Aerial survey, visual survey	Annual	None at this time	Emerging
Red Pine Scale	Red Pine	Northern half	Non-native	1960	Visual Survey	As Needed	None	Emerging
Spotted Lanternfly	Polyphagous, impacts on tree species is currently unknown	state-wide	Non-native	2018	Visual survey	Annual	Ailanthus trap tree method	Established
Thousand Cankers Disease	Black Walnut	State-wide	Non-native	Not yet detected	Trapping, visual survey	Annual	None at this time	Emerging
Winter Moth	Polyphagous but prefer Maple, Oak, and Blueberry species	Coastal	Non-native	Not yet detected - 1990s detected in New England	Trapping, visual survey	Annual	None at this time	Emerging
Sirococcus Tip Blight	Eastern hemlock	Northern half	Native to Western North America	2006 first report in Maine	Visual survey	As Needed	None	Established
Bacterial Leaf Scorch	Oak species, red oak family highly susceptible	State-wide	Native to Southern US	1985 - first recorded tree damage	Visual survey	As Needed	None	Established
Anthracnose	Various species - sycamore, dogwoods, oak, maples	state-wide	native	N/A	visual survey	As Needed	None	Established
Armillaria	Hardwood species	State-wide	Native	N/A	None	As Needed	none	Established
Ash Yellows	Ash species	Northern half	Native	N/A	None	As Needed	none	Established
Gouty Oak Gall	Oak Species	Southern half	Native	N/A	None	As Needed	none	Emerging
Hypoxilon Canker of oaks	Oak species	State-wide	Native	N/A	None	As Needed	none	Established
Oak Sawfly	Oak species	State-wide	Native	N/A	None	As Needed	none	Emerging
Oak Shothole leaf miner	Oak Species	Northern half	Native	N/A	None	As Needed	none	Emerging
Orange Striped Oakworm	Oak species	Southern half	Native	N/A	None	As Needed	none	Established
Pine Nematode	Pine species	Southern half	Native	N/A	None	As Needed	none	Established
Southern Pine Beetle	Pine species	Southern half	Native	2001 - first recorded outbreak	Aerial survey, trapping, visual survey	Annual	Cut-and-Leave, Cut-and-Remove techniques; Preventative thinning	Established
Turpentine Beetle	Pine species	Southern half	Native	N/A	None	As Needed	none	Established
Two-lined chestnut borer	Oak species	State-wide	Native	N/A	None	As Needed	none	Established

APPENDIX F:
PRIVATE LANDS PLANNING CRITERIA

MINIMUM GUIDELINES FOR NJ STATE FOREST STEWARDSHIP PLANS 1/18/2018

1. Title Page

1a. Title for the plan e.g. Forest Stewardship Plan for Jetson Farm

1b. Owners legal name, mailing address and phone number.

1c. Name of the Approved Forester with whom the owner prepared the plan.

1d. The property's address, total and forest land acreage, whether the owner intends to submit for farmland assessment, county(s) and municipality(s) and for each municipality, each block and lot numbers.

1e. Two certifications and signatures, one for the landowner and one for the Approved forester. See page 2.

1f. For properties under NJ Pineland's jurisdiction add the Stewardship pledge signed by landowner. See page 2.

1g. Space for the NJFS to record received date, date of notice of approval, start and end dates of the plan and ID number.

2. Background and Goals

2a. Directions provided for ease of locating property for inspections (e.g. house number, distance from intersection) and a statement to indicate if property is within the Highlands or Pinelands.

2b. History of the property including present condition, past ownership, change in land use, past forest management activities and if applicable past plan type, reason past plan ended, past plan stand objectives/ monitoring data/trends.

2c. Whether the property includes wetlands and/or associated transition areas, flood hazard areas or riparian zones, easements that could constrain forest management and any other relevant factors.

2d. Long term goals of the property including ensuring the sustainability of the land and whether the property will be managed in coordination with other properties.

2e. Statement acknowledging owners' obligation of monitoring and record keeping as well as a statement indicating proposed management will ensure sustainability and eliminate excessive and unnecessary cutting.

3. Property Overview

3a. Including, how the boundaries are marked, forest use (current and/or proposed), acreage, location of the forest on the property, topography, soil characterization, hydrology (resource value, TA and RZ widths), infrastructure to cross a regulated area, ecology and biodiversity (including fire), state and federally listed threatened and endangered species*, threats to sustainability including pests, diseases and storms.

3b. Stewardship principles including carbon sequestration, cultural resources, recreation, fish and wildlife habitat, timber, forest products, aesthetics. Agroforestry and estate planning.

4. Forest Stands

4a. For each stand: A unique identifier, acreage and a forest inventory including; species of the overstory and understory, forest type, stand structure (age class, DBH class, crown class), stocking level, volume, growth, site index.

4b. For stands prescribed treatment during the plan period: A stand and stock table, size class, vigor, density (in BA), status of biodiversity, status of regeneration, invasive species, damage causing agents and litter cover.

4c. Desired future condition of each stand and relationship to the goals, set measurable objective(s) to achieve such goals. 4d. For each objective, parameters to be measured, how the parameters will be measured (including constraints or conditions to be observed), units to be recorded and a baseline value for each parameter.

4e. State if the stand will not receive management and if the stand will receive management: rationale (silviculture) and extent of prescription, whether the treatment could adversely impact or potentially impact a regulated area, State or Federally listed threatened or endangered species or any cultural resource. Include any mitigation measures used to avoid impact.

5. Management Schedule

5a. Schedule shall be presented in table format in chorological order. The table shall indicate the stands in which the practices will carried out, the extent of the practice and the years or range of years in which the practice will take place.

6. Appendices

6a. A copy of the State and Federal threatened and endangered species searches*.

6b. Maps including Soils map, locator map, property map (including physical features e.g. waterbodies, roads, trails, structures, wetlands or associated transition areas, flood hazard areas or riparian zones, easements, land uses, regulated crossings, boundaries, stands including labels).
Such maps shall include scale, at least one map on color photography, title, owners name and address, date prepared, north arrow, source and legend.

** Information regarding the presence of federal threatened or endangered species which might be affected by proposed activities must be obtained from the US Fish and Wildlife Service. This information can be obtained from the USF&WS IPaC web application. Alternatively, a letter can be requested from the USF&WS NJ Field office at: Atlantic Professional Park, 4 East Jimmy Leeds Road, Galloway, NJ 08205, 609.646.9310. The Natural Heritage Database (NHD) information also needs to be included and addressed in the plan. Obtain the NHD from the Office of Natural Land Management, PO Box 404, Trenton, NJ 08625. Telephone: 609.984.1339*

NJFS approval of a plan does NOT relieve the landowner from complying with other applicable Federal or State requirements. For other plan criteria or information please refer to N.J.A.C 7:3.

MINIMUM GUIDELINES FOR NJ STATE FOREST STEWARDSHIP PLANS

1e. Certifications:

1. To be signed and dated by the owner: "I certify that I am the owner of the property or am authorized by the owner to make this certification. I have read the within forest stewardship plan and the information contained in the plan is true. To the best of my knowledge, the plan meets the requirements of the Forest Stewardship Program rules at N.J.A.C. 7:3- 5 and applicable Federal and State law. The owner agrees to implement the plan, as approved or as subsequently amended"; and

2. To be signed and dated by the Approved Forester: "I prepared the within forest stewardship plan in consultation with the owner of the property. I certify that, to the best of my knowledge, the plan meets the requirements of the Forest Stewardship Program rules at N.J.A.C. 7:3-5 and applicable Federal and State law."

1f. To be signed and dated by the owner: Pledge: "As a forest landowner I believe the right to own land also carries the responsibility for stewardship of the natural resource in my care. I have read the attached ten-year Forest Stewardship Plan and agree to implement it to the best of my ability."

CRITERIA OF A WOODLAND MANAGEMENT PLAN CHECKLIST

☐ 1. A cover page for the plan shall be prepared delineating the following:

- ☐ a. The owner's name and mailing address.
- ☐ b. The municipality and county where subject woodland is located.
- ☐ c. The Block(s) and Lot(s) of subject woodland.
- ☐ d. The amount of acreage of the subject woodland.
- ☐ e. The name and address of the approved forester who prepared the plan, of not prepared by the owner.
- ☐ f. The date the plan was prepared and the period time the plan covers.

☐ 2. A clear and concise statement of the owner's objectives in managing the woodland.

☐ 3. A description of how the property boundaries are or will be marked and delineated.

☐ 4. A brief description of past activities that have had an effect on the woodland including, but not limited to wildlife, insect and disease outbreaks, timber sales, planting, thinning and weedings.

☐ 5. A statement description for each defined forest stand incorporating the following factors:

- ☐ a. The number of acres.
- ☐ b. The species composition including overstory and understory.
- ☐ c. The general condition and quality.
- ☐ d. The structure including age classes, DBH classes and crown classes.
- ☐ e. The overall site quality.
- ☐ f. The condition and species composition of advanced regeneration when applicable.
- ☐ g. The stocking levels, growth rates and volumes.

☐ 6. A description of the Silvicultural prescriptions, management recommendations, activities and practices specified and planned for each forest stand and an explanation of these sequences of treatment are integrated into the overall coordinated plan and time frame to meet the stated management objectives. Such management recommendations and practices shall be prepared for a period of 10 years.

☐ 7. A statement of average overall productivity capabilities of the woodland.

☐ 8. A map of the property shall be prepared to include but not necessarily be limited to the following:

- ☐ a. The owner's name, address and the date the map was prepared.
- ☐ b. An arrow designating the north direction.
- ☐ c. A scale not smaller than 1" = 1320' not larger than 1" = 400.
- ☐ d. A legend defining the symbols appearing on the map.
- ☐ e. The location of property lines.
- ☐ f. An identification of forest stands which are keyed to written prescriptions.
- ☐ g. A delineation of physical features such as roads, streams and structures.
- ☐ h. An identification of soil group classes (a separate map can be used for this purpose).
- ☐ i. A brief description or a map inset of the land for the purpose of identifying the location of the property in relation to the local area.

☐ 9. A Schedule of Activities – a summary of prescribed management practices to be carried out in the 10-year period covered by the plan.

☐ 10. Address the wetlands and flood hazard area requirements set forth in N.J.A.C. Freshwater Protection Act Rules at 7:7A or Flood Hazard Area Control; Act Rules at 7:13, as applicable. Wetland activities exempted from permit and/or waiver requirement are located at 7:7A-2.8. Flood Hazard Area Control Act permit-by-rule are located at 7:13(f). The NJ Forestry and Wetlands Best Management Practices Manual, 1995 can be found at: *http://www.state.nj.us/dep/parksandforests/forest/nj_bmp_manual1995.pdf*

Revised: 5/21/2013

APPENDIX G:
STAKEHOLDER TIMELINE & ENGAGEMENT

Below is a timeline of the NJ SFAP/Forest Legacy -AON development and stakeholder involvement and engagement outreach and meetings as well as a list of stakeholders. The remainder of Appendix G are copies of stakeholder letters provided to the stakeholders identified (but not limited to) below. To provide individualized involvement, external stakeholders are separated into related interest groups for internal stakeholders to contact.

NJ State Forest Action Plan – Timeline & Stakeholder Engagement

November 15, 2017
Internal Stakeholder Meeting to discuss the State Forest Action Plan and the ins and outs of what the group will be asked to participate and provide

May 21, 2018
The State Forest Action Plan check-in and progress. How to move forward

June 23, 2018
Forest Action Plan 2020, Assessment Meeting. Meeting Goal: to discuss Forest Action Plan (FAP) assessment data and information currently collected and any changes/additions to that section to internally start to finalize; and to touch on strategy ideas for the new SFAP

January 8, 2019
Private Lands Program Strategies Meeting

January 14, 2019
Forest Health Program Strategies Meeting

January 18, 2019
Urban & Community Forestry Strategies Meeting

February 7, 2019
ONLM Strategies Meeting

February 12, 2019
NJ Forest Service – Strategy writing sessions begin

February 25, 2019
NJ Forest Fire Service Strategies Meeting

March
USDA Forest Service SFAP Virtual Roundtable Begin

March 5, 2019
NJDEP Divison of Fish & Wildlife Strategies Meeting

March 5, 2019
USDA Forest Service Check-in

March 19, 2019
Engaging Stakeholder Briefing

April 12, 2019
SFAP summary one-page developed – NJ Land Conservation Rally SFAP table (Road Show Begins - Taking the State of NJ's Forests to stakeholders)

May 16, 2019
Forest Legacy Meeting with Green Acres Program

May 23, 2019
NJ Highlands Council – Science Staff: Trends & Conditions Meeting

May 30, 2019
NJ Pinelands Commission – Science Staff: Trends & Conditions Meeting

June 21, 2019
External stakeholder finalized

June 27, 2019
Director Glenn welcome stakeholder participation letter sent to external stakeholders

July 8, 2019
External stakeholder letter call to action and due date for input – August 30, 2019. NJFS and stakeholder representatives asking for 5-year update information and input on strategies

July 16, 2019
Director Glenn local government letter sent to all municipals and counties with survey.

August 30, 2019
USDA Forest Service SFAP guidelines are finalized and shared with stakeholders

September 1, 2019
Deadline extended for SFAP external feedback to September 20, 2019

September 27,2019
Presentation of SFAP and NJ Forest Conditions to Endangered and Nongame Species Advisory Committee

October 11, 2019
American Forest/SFAP presentation

October 2019 through June 2020
Assessment development and analysis.

January 9, 2020
Urban Forest Council SFAP Presentation

January 15, 2020
NJ Forest Service update and call to action for participating programs for strategy development

January
Prioritization survey sent to Stewardship Committee

February 5, 2020
Prioritization Analysis begins

February 21, 2020
NRCS State Technical Committee SFAP Letter.

March 5, 2020
NJ SFAP First Draft sent to internal stakeholders to review

April 6, 2020
Preliminary meeting with USDA Forest Service

April 29, 2020
NRCS State Technical Committee SFAP Presentation

September 2020 to December 2020
External Stakeholder Review of SFAP/30 Day Public Comment Period

December 2020
Submission

FOREST ACTION PLAN STAKEHOLDERS

NJ State Stakeholders

*NJ State Forest Stewardship Coordinating Committee
*NJDEP Division of Fish and Wildlife
*NJDEP Green Acres Program
BPU
Bureau of Nonpoint Pollution Control - Stormwater and Green Infrastructure
Delaware and Raritan Canal Commission
Department of State - State Plan
DOT & NJTA
Emergency Management
NJ Board of Tree Experts
NJ Department of Agriculture
NJ Div of Air Quality
NJ Div of Fire Safety
NJ Economic Development Authority
NJ Highlands Council
NJ Natural Lands Trust
NJ Pinelands Commission
NJ Urban and Community Forestry Council
NJ Water Monitoring and Standards
NJ Watershed Management
NJDEP Bureau of Coastal Land Use Enforcement
NJDEP Division of Land Resource Protection
NJDEP NJ Forest Fire Service
NJDEP NJ Forest Service
NJDEP NJ State Park Service
NJDEP Office of Coastal and Land Use Planning
NJDEP Office of Natural Lands Management
NJDEP Office of Natural Resource Restoration
NJDEP Office of Science
Office of Environmental Justice
Solid Waste and Recycling
Water Quality - Clean Water State Revolving Fund

Local Governments

565 Municiplaties
21 Counties

Required under USDA FS Guidance

Research and Education Institutions

Kean University
Ramapo College of New Jersey
Raritan Valley Community College
Rowan University School of Earth and Environment
Rutgers Cooperative Extension
Rutgers University
Stockton University
The Academy of Natural Sciences of Drexel University

Federal

APHIS PPQ
*NRCS - Technical Committee
*USDA Forest Service
FEMA
National Park Service
Urban Waters Federal Partnership
US Department of Defense
US Fish and Wildlife Service
USDA Farm Services Agency

*NJFS Stewardship Committee/Coordinating Committee

Association of Municipal Assessors of New Jersey
Consulting Forester
Division of Taxation in New Jersey's Department of the Treasury
Forest Stewardship Land owner
New Jersey State Office of USDA's Farm Service Agency
NJ Deprtment of Agriculture
NJ Forestry Association
NJ Natural Lands Trust
NJDEP Division of Fish and Wildlife
Nonprofit conservation group
Owner operator of private forest products company
Representative of a nonprofit environmental advocacy organization
Rutgers Cooperative Extension
Society of American Foresters, NJ Division Allegheny Chapter
State Forester
US Fish and Wildlife Service
USDA Forest Service, Northeastern Area
USDA Natural Resource Conservation Service

NGO/Private

*Forest Industry Professionals
*US Fish and Wildlife Service, Northeast Fire Management
*US Fish and Wildlife Service, Wildland Support Module
*USDOD - Air National Guard, Fire Department
*USDOD - Joint Base McGuire-Dix-Lakehurst, Fire Department
American Motorcycle Association
American Public Works Association (NJ Chapter)
Association of NJ Environmental Commissions
Conserve Wildlife Foundation of New Jersey
Delaware Valley Regional Planning Commission
Dr. Walt Bien (Drexel, Retired)
Drexel University Laboratory of Pinelands Research
Duke Farms
Electric Utilities
Forest Stewards Guild
Friends of Hopewell Valley Open Space
Jersey Water Works
Lake Hopatcong Commission
League of Municipalities
Musconetcong Watershed Association
National Park Service, Delaware Water Gap NRA
National Park Service, Gateway NRA
New Jersey Municipal Management Association (NJMMA)
NJ Association of Counties
NJ Association of Environmental Commissions
NJ Audubon Society
NJ Chapter of the Wildlife Society
NJ Conservation Foundation
NJ Emergency Preparedness Association
NJ Federation of Sportsmen's Clubs
NJ Fire Safety Council
NJ Forestry Association
NJ Highlands Coalition
NJ Invasive Species Strike Team
NJ Outdoor Alliance
NJ Recreation and Parks Association
NJ Shade Tree Federation
NJ Tree Farm Program
NJ Tree Foundation
NJ Trout Unlimited
North Atlantic Fire Science Exchange
Northeast Regional Strategy Committee
Northeastern Forest Pest Council
Partnership for the Delaware Estuary
Pinchot Institute
Pinelands Preservation Alliance
Raritan Headwaters
Ruffed Grouse Society, NJ Chapter
Society of American Foresters
Society of Certified Tree Experts
Society of Municipal Arborists
Sourlands Alliance
Sustainable Jersey
The Land Conservancy of New Jersey
The Native Plant Society
The Nature Conservancy, NJ Chapter
The Wetlands Institute
Trust for Public Land
USDA Forest Service - Northern Research Station
USDA Forest Service - State & Private Forestry, Fire & Aviation

**Required under USDA FS Guidance*

All stakeholders referenced here are consulted, coordinated with and engaged in the NJ SFAP developmental process to address landscape level interests and issues through an established framework.

New Jersey Forests Overview

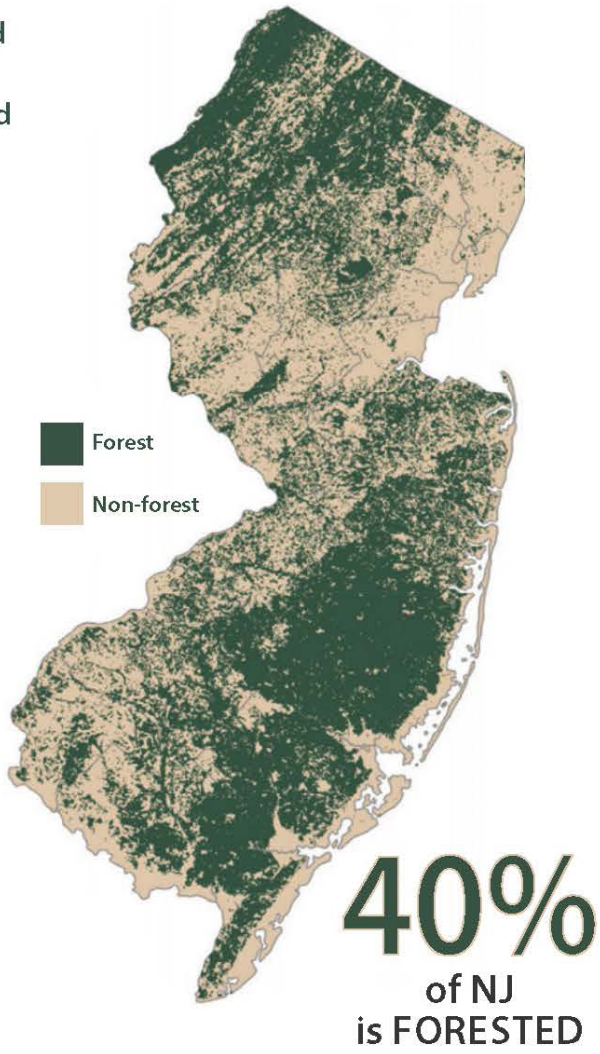
Considerations for NJ Forest Action Plan 2020-2030

The New Jersey Forest Service is working on a ten-year **Forest Action Plan**. The long-term strategies in this plan will help partners across the state such as you better prioritize forestry projects.

Forest Ownership

51% Publicly Owned

49% Privately Owned



40% of NJ is FORESTED

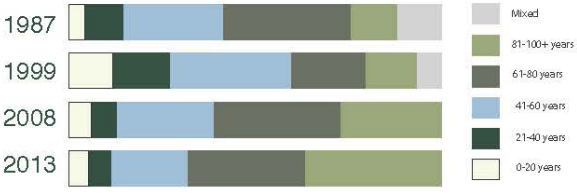
Forest Distribution

New Jersey's forests border urban areas. The forest is affected by land use change, fragmentation, and invasive species outbreaks. This also affects how people co-exist with nature.

Diverse Forest Ages

We are fortunate that forest more than 100 years old have been steadily increasing. However, young forests have been in decline. A healthy statewide ecosystem requires forest growth in all stages to support a greater number of plant and animal species.

Forest Age Class Distribution



Your input is essential to the **Forest Action Plan** *planning process.*

Help us keep NJ's Forests GREEN & GROWING !

The New Jersey Forest Service along with the USDA Forest Service are currently assessing NJ's forests and making a plan for statewide forest goals through 2030.

SEE REVERSE FOR A SHORT SURVEY

NJ Forest Service
Mail Code: 501-04
PO Box 420
Trenton, NJ 08625-0420

New Jersey Forest Action Plan Survey

Have you heard of the Forest Action Plan? Yes No
Do you own a woodlot? Yes No
Are you a natural resource professional? Yes No

The USDA Forest Service has identified three national priorities. Of these priorities, circle the ONE the affects you most:

Priority 1: Conserve and Manage Working Forest Landscapes for Multiple Values and Uses
Priority 2: Protect Forests from Threats
Priority 3: Enhance Public Benefit from Trees and Forests

Seven criteria are identified in the Forest Action Plan as a part of the internationally recognized Montreal Process for monitoring. Of these criteria listed below, circle the ONE that you feel is most important to monitor the most rigorously?

1. Conservation of biological diversity
2. Maintenance of productive capacity of forest ecosystems
3. Maintenance of forest health and vitality
4. Conservation of and maintenance of soil and water resources
5. Maintenance of forest contribution to global carbon cycles
6. Maintenance and enhancement of multiple long-term socio-economic benefits to meet the needs societies
7. Legal, institutional, and economic framework for forest conservation and sustainable management

Prior to taking this survey, were you aware of the criteria identified under the Montreal Process, and the strategies used to develop reachable/attainable goals under the state's Forest Action Plan?

Yes No

Out of the following trends and conditions, which are you most important/interested in?
(Circle all that apply)

Forest Ownership	Patch Size	Forested Area
Urban Forest	Core Habitat	Age Distribution
Carbon	Mortality Rate	Fuels and Wildland Urban Interface
Insects and Diseases		

What is your email address? *PLEASE PRINT NEATLY*

_____ @ _____

We will be reaching out shortly about NJ's Forest Action Plan and how you can be a part of it.

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
NATURAL & HISTORIC RESOURCES
NEW JERSEY FOREST SERVICE
MAIL CODE 501-04
P.O. BOX 420
TRENTON, NJ 08625-0420
TEL: # 609-292-2532 FAX: # 609-984-0378

PHILIP D. MURPHY
Governor

SHEILA Y. OLIVER
Lt. Governor

CATHERINE R. McCABE
Commissioner

June 27, 2019

Dear Valued Stakeholder,

New Jersey Forest Action Plan developed by

in cooperation with

From habitat fragmentation to invasive species, New Jersey's environmental issues that impact forests are complex. We are assessing these issues for the 2020 New Jersey Forest Action Plan. This document, which we submit to the US Forest Service for approval and funding, outlines forest management priorities to focus on in the next 10 years.

Your input is essential to the planning process. When New Jersey environmental organizations work cooperatively toward the same forest management goals, we are able to make a more significant impact to improve the health and resilience of our forest resource.

The ten-year Forest Action Plan:

- Sets forest management priorities across the state
- Makes organizations possibly eligible for funding toward priority projects
- Supports the conservation, protection, and enhancement of New Jersey's forests and trees

The New Jersey Forest Action Plan will summarize the current status of the forest and act as a strategic plan for responsible forest stewardship. In addition, the Forest Legacy Assessment of Need, a document that highlights forested areas in the state that could or should be protected, will be incorporated into 2020 Forest Action Plan. In the past, this was a stand-alone document.

NJ Department of Environmental Protection programs and partners involved in the planning process will reach out to you shortly on behalf of the New Jersey Forest Service. They will keep you updated on the process, solicit your input, send notifications of approaching deadlines, and answer any questions you may have along the way.

Thank you for your time and contributions to the New Jersey Forest Action Plan. We look forward to working with you in this collaborative process.

Sincerely,

Olivia C. Glenn
Director, Division of Parks and Forestry
NJ Department of Environmental Protection

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PHILIP D. MURPHY
Governor

SHEILA Y. OLIVER
Lt. Governor

CATHERINE R. McCABE
Commissioner

July 16, 2019

Dear Valued Stakeholder,

From habitat fragmentation to invasive species, the environmental issues that impact NJ's trees and forests are complex. The NJ Forest Service is currently assessing these issues for the 2020 New Jersey Forest Action Plan. This action plan, which is submitted to the US Forest Service for approval, serves as the state's basis for federal forestry funding, and outlines the state's forest management priorities to focus on over the next 10 years. The NJ 2010 Forest Action Plan can be found at http://bit.ly/forestactionplan.

New Jersey Forest Action Plan developed by

in cooperation with

Your input is essential to the planning process. When New Jersey works cooperatively toward the same forest management goals, we are able to make a more significant impact to improve the health, safety, and resilience of our tree and forest resource.

The ten-year Forest Action Plan:

- Sets forest management priorities across New Jersey
- Supports the conservation, protection, and enhancement of New Jersey's forests and trees
- Allows local governments the opportunity to be eligible for grant funding toward priority projects

The New Jersey Forest Action Plan will summarize the current assessments of the state's traditional and urban and community forests and serve as a strategic plan for responsible forest stewardship. In addition, the Forest Legacy Assessment of Need, a document that highlights forested areas in the state that could or should be protected, will be incorporated into 2020 Forest Action Plan. In the past, this was a stand-alone document.

The NJ Department of Environmental Protection and the NJ Forest Service welcome your input into the New Jersey Forest Action Plan. Please complete the online survey at http://bit.ly/municipalsurvey to provide us with some general information about your community and how it relates to the NJ Forest Action Plan. For more detail contact the NJ Forest Service – Urban and Community Forestry Program Coordinator, Carrie Sargeant at carrie.sargeant@dep.nj.gov. We will be accepting your input up until August 30, 2019.

Thank you for your time and participation in the New Jersey Forest Action Plan development process. We look forward to working with you in this collaborative process.

Sincerely,

Olivia C. Glenn
Director, Division of Parks and Forestry
NJ Department of Environmental Protection

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PHILIP D. MURPHY
Governor

SHEILA Y. OLIVER
Lt. Governor

CATHERINE R. McCABE
Commissioner

Dear Valued Stakeholder,

In 2008, the Farm Bill required each state to prepare a State Forest Action Plan (SFAP) to assess the state's forest resource and to lay out strategies for the conservation and stewardship of those resources over the forthcoming decade. New Jersey's last plan, completed in 2010, may be viewed or downloaded at: www.forestactionplans.org/states/new-jersey. Today, we are in the planning stages for next 10-year update – to be completed June 2020 and have identified your organization as a stakeholder in this process and would like to solicit your organization's input into the strategies of the State Forest Action plan. The strategies in New Jersey's plan are organized under three nationally-prescribed priorities which are:

- Conserve and manage working forest landscapes for multiple values and uses.
- Protect forests from threats.
- Enhance public benefits from trees and forests

The intent for updating the SFAP is to provide more robust and up-to-date information about our forest resources, and to develop new, modify, or continue to pursue strategies which address the issues that face these resources in the State of New Jersey. In addition, the Forest Legacy Assessment of Need will be incorporated into 2020 Forest Action Plan instead of its own stand-alone document. We believe that the help and collaboration your organization can provide in developing the new SFAP will better guide the state's overall goals as well as regional initiatives.

We are asking you to identify strategies that your organization has applied over the last 10-year planning period or is interested in applying in addition to projects and/or data sources that you may have found useful in addressing these strategies. We ask that you provide any updates regarding projects related to the SFAP since the plan's last review in 2015.

We may or may not be able to incorporate all items you and others submit for addition to the new 2020 SFAP. However, we will review all "bullet points" that are submitted and assess them as a group for inclusion. We hope to acknowledge as many programs, agencies, organizations and other stakeholders as possible whose work and ideas contribute to the conservation, restoration, and enhancement of forest land in New Jersey. Understand that the NJ Forest Service may need to edit your submission to keep the SFAP succinct and stylistically consistent.

Please provide your response to me via email at william.zipse@dep.nj.gov by **August 30, 2019**. Please also copy Samantha Hensen, at samantha.hensen@dep.nj.gov.

We value the diversity of ways forests are supported and cared for in New Jersey and your participation in that. Thank you in advance for the submissions you offer for inclusion in the 2020 New Jersey SFAP.

Thank you for your participation in the State Forest Action Plan,

William Zipse
Supervising Forester – NJ Forest Planner
New Jersey Forest Service
william.zipse@dep.nj.gov

State of New Jersey
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PHILIP D. MURPHY
Governor

SHEILA Y. OLIVER
Lt. Governor

CATHERINE R. McCABE
Commissioner

Dear NRCS Technical Committee,

In 2008, the Farm Bill required each state to prepare a State Forest Action Plan (SFAP) to assess the state's forest resource and to lay out strategies for the conservation and stewardship of those resources over the forthcoming decade. New Jersey's last plan, completed in 2010, may be viewed or downloaded at: www.forestactionplans.org/states/new-jersey. Today, we are in the planning stages for next 10-year update – to be completed June 2020 and have identified your organization as a stakeholder in this process and would like to solicit your organization's input into the strategies of the State Forest Action plan. The strategies in New Jersey's plan are organized under three nationally-prescribed priorities which are:

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Please provide your response to me via email at william.zipse@dep.nj.gov by March 13, 2020. Please also copy Samantha Hensen, at samantha.hensen@dep.nj.gov.

We value the diversity of ways forests are supported and cared for in New Jersey and your participation in that. Thank you in advance for the submissions you offer for inclusion in the 2020 New Jersey SFAP.

Thank you for your participation in the State Forest Action Plan,

William Zipse
Supervising Forester – NJ Forest Planner
New Jersey Forest Service
william.zipse@dep.nj.gov

APPENDIX H:
FIVE-YEAR UPDATE BY NATIONAL PRIORITIES

The five-year update by national priorities, are required to be submitted every five years beginning with the first submission in 2015. These updates are submitted as a portion of a five-year review report or with a revised NJ SFAP. In this case, these updates are being submitted with the 2020 NJ SFAP. Details provided as part of an update include descriptions of success stories or actions contributing to each national priority set forth in the State Forest Action Plan. Lists or brief summaries of updates from the last five years (2015 – 2020) are described below by national priority. Updates are described under the 2020 outlined strategies which also correspond with strategies from the 2010 NJ SFAP. Under these strategies, updates are organized by subject matter or by the agency, program or organization with updated project information. These updates were comprised in conjunction with the stakeholder outreach process for the revised 2020 NJ SFAP regarding implementation of actions from the last five-year review until now.

NATIONAL PRIORITY 1: CONSERVE AND MANAGE WORKING FOREST LANDSCAPES FOR MULTIPLE VALUES AND USES

1: Forest Function

Density Management Strategies

Stockton University

• Thinning operations were conducted in 2015 within an upland pine-oak stand on campus owned property.

• A Stoddard-Neel thinning operation (approach used in longleaf pine ecosystems) in 2017 within an upland pine-oak stand was conducted on campus owned property.

NJ Forest Service

• Approximately 715 acres of low and from below thinning operations in various stages of completion have been performed across several parcels (Whiting Wildlife Management Area, Brendan T. Byrne State Forest, Double Trouble State Park and Wharton State Forest) from 2017 to 2020.

• Discussion points were presented at the New Jersey Assembly, Agricultural and Natural Resources Committee Hearing (March 2019) by State Forester John Sacco:

"We must execute broad-scale forest management that is both cost-effective and respectful of the natural resource concerns that drove the acquisition of so much public land in the first place. We must explore and support options for commercial utilization of wood from fuel reduction activities, especially low-quality small diameter material. Continue to promote our philosophy of managing the public's forests for ecological services such watershed protection, wildlife habitat, plant diversity and carbon sequestration and address the public's negative emotions about forest management activities through evidence and communication. Stakeholdering with the public and interdisciplinary experts, building consensus based upon empiric data and obtaining necessary permits and approvals from other resource agencies is essential in formulating effective forest management plans. This is very important to us, as we aspire to put forth the best plans and gain as much agency buy-in and public support as possible. However, these activities are time-intensive, complex and require substantial staff resources."

NJ Forest Fire Service

• Discussion points were presented at the New Jersey Assembly, Agricultural and Natural Resources Committee Hearing (March 2019) by State Forest Fire Warden Greg McLaughlin:

"It is time to identify WUI "Zones" and adopt WUI standards for fuels mitigation treatments within these zones. Silvicultural and forestry practices are agricultural activities and as such, should be afforded the same protections under the NJ Right to Farm Act. The FFS has the full authority of the law to take the actions necessary to control a wildfire. Similarly, there must be a means to achieve swift, deliberate and planned actions in high-risk WUI 'Zones'."

Water Quality Management Strategies

• A Freshwater restoration team launched floodplain reforestation efforts in cooperation with several dozen partners since 2015, which has resulted in 83,000 trees planted in state watersheds. There is a goal to plant 100,000 trees by June of 2020.

• In March of 2019, the NJDEP proposed redefining Category 1 streams, designating more than 749 more miles of rivers and streams. This was the first time in more than a decade that waterways have been designated to a higher level of protection as Category 1. These waterways are found within the Upper Delaware, Lower Delaware, Northwest and Raritan and Atlantic Coastal regions. There was a public comment period and hearing held as part of this process and the proposal is currently pending adoption.

• Within the Pinelands Area, the Comprehensive Management Plan authorizes forestry in wetlands, provided certain conditions are met. The forestry activities must be approved as part of a forestry application with the New Jersey Pinelands Commission on private or public lands. Comprehensive Management Plan wetlands conditions that must be met include meeting NJDEP's Forestry and Wetlands Best Management Practices Manual, maintaining Streamside Management Zones (SMZ), limiting the creation of new access roads through wetlands, limiting bridges to temporary crossings and requiring that log landings be placed out of wetlands wherever feasible.

• New Jersey's Integrated Water Quality Assessment Reports–forests are addressed in these biennial reports *https://www.nj.gov/dep/wms/bears/assessment.htm#/ for most recent report see https://www.nj.gov/dep/wms/bears/docs/2014_final_integrated_report.pdf.*

Age-Class Distribution Strategies

Stockton University

Patch clearcutting with variable retention treatments were performed to create approximately four acres of openings in 2016 to 2017 on campus owned property. The objective was to initiate a patch of early successional habitat with the goal of benefiting wildlife associated with open habitat.

2: Forest Restoration Strategies-Species of Concern

Shortleaf Pine

• The NJ Forest Service has performed approximately 106 acres of shortleaf pine restoration activities from 2017 to 2020.

• In 2015 the NJ Forest Service became part of the 22 state Shortleaf Pine Initiative, which is also comprised of the USDA Forest Service, Private Consulting Foresters, Southern Group of State Foresters, National Wild Turkey Federation, the US Fish and Wildlife Service and The Nature Conservancy.

Oak

• The NJ Forest Service has implemented oak regeneration/restoration activities within Brendan T. Byrne State Forest composed of approximately 64 acres, in addition to approval for 50 acres of oak regeneration/restoration activities within Stokes State Forest.

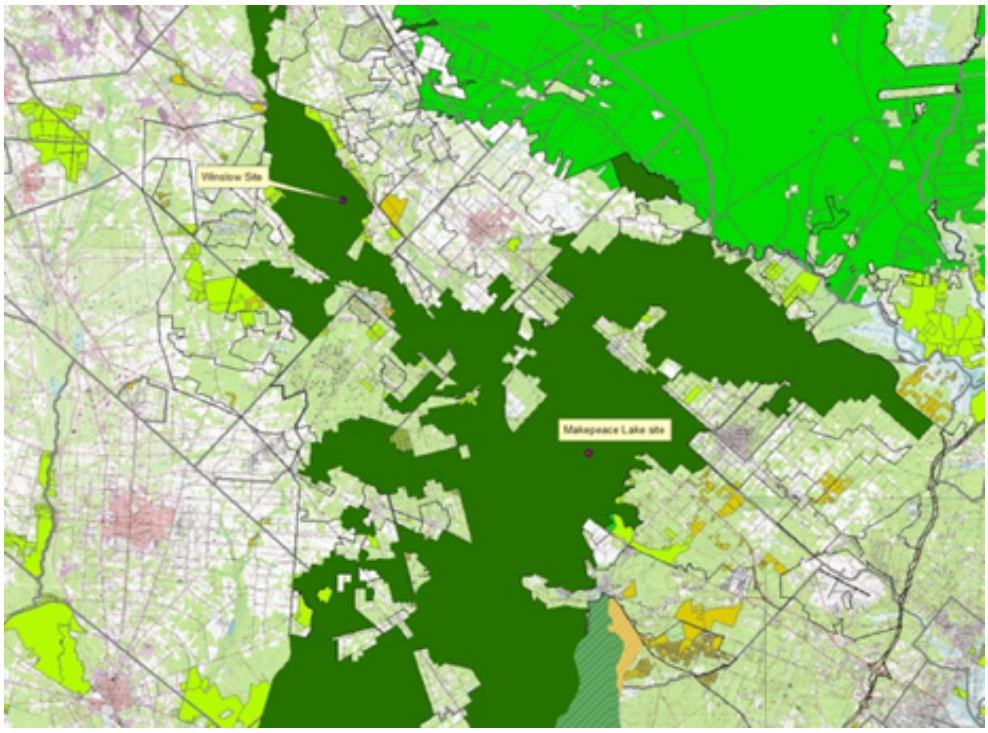
Eastern Hemlock

• The NJ Forest Service began silvicultural restoration activities in 2019 to re-establish eastern hemlock in Stokes State Forest, in addition to planning for other range appropriate locations (Walpack Wildlife Management Area) through the restoration of site conditions, natural regeneration, breeding and propagation of hemlock woolly adelgid naturally resistant trees and continued planting of trees to conserve residual hemlock stands across approximately 193 acres.

• The NJ Forest Service continued assistance with studies and research in cooperation with the University of Rhode Island, NC State and the USDA Forest Service with hemlock woolly adelgid resistant trees and stands.

Atlantic White-Cedar

The NJ Forest Service gained a legislative mandate in 2019 for the restoration of more than 10,000 acres of Atlantic white-cedar (AWC) over an approximately ten-year time period or for an overall increase of 30% of its current presence. Funding was appropriated through the mandate to complete restoration activities. Initial restoration activities were chosen for interior disjointed stands in the western portion of Wharton State Forest that are at low risk of saltwater intrusion issues from severe storms.



Using the NJPC's Pineview ArcGIS mapping, potential AWC restoration sites were selected based on various factors, including watersheds with historic AWC, adjacent AWC forest patches, availability to local population centers and road access.

• During the period from 2015 to 2020, no Pinelands area public land forestry applications proposing Atlantic White Cedar (AWC) regeneration were filed with the New Jersey Pinelands Commission. However, the New Jersey Pinelands Commission staff met twice in 2018 with the NJ Forest Service to discuss the site ranking system for choosing potential AWC restoration projects on state owned lands in the Pinelands Area for the strategic restoration plan. The permitting required for the Pinelands Commission, in order for the NJ Forest Service to accomplish the implementation of the strategic restoration goals, was discussed and an existing Memorandum of Agreement (MOA) between the NJDEP and the Pinelands Commission for AWC restoration on state lands was agreed upon to be used in streamlining the New Jersey Pinelands Commission permitting process.

• A total of 850 acres of AWC restoration projects were approved in accordance with the provisions of the Comprehensive Management Plan on private lands between 2015 and 2020. This made up approximately 600 more acres than the last five year period, mostly due to two very large (more than 10,000 acres each) private properties having Forest Stewardship Plans approved during this period. These two properties included the Pine Island Cranberry Company and a former cranberry farm owned by the New Jersey Conservation Foundation known as the Franklin Parker Preserve.

• In some instances, forestry is undertaken within the Pinelands Area on private lands without receiving the required approvals or are not consistent with an approved forest stewardship plan. The Pinelands Commission staff has worked and will continue to work with NJDEP staff and municipal officials to resolve these private land forestry violations. During the 2015 to 2020 time period two parcels were investigated in Franklin Township, Gloucester County for unapproved forestry activity in wetlands.

3: Forest Management Plan Strategies (Scalable Management)

Public Lands Management Plans

• The NJ Forest Service developed a 14-step natural resource stewardship plan process in 2014 with the inclusion of a multitude of interested stakeholders.

• The NJ Forest Service will continue the planning and implementation of parcel wide state forest stewardship plans. Two forest stewardship plans have begun the process of implementation from 2012 to 2020, Whiting Wildlife Management Area and Double Trouble State Park. Two other forest stewardship plans are in the planning stages, Stokes State Forest and High Point State Park. Parcels next on the docket for planning include Penn State Forest and Wharton State Forest, which will contain goals and objectives scalable with the 2020 State Forest Action Plan.

• Since 2014, NJ Forest Service has conducted 29 silvicultural projects related to fire mitigation totaling approximately 4,000 acres, more than had been done in the 10 preceding years.

• State Forester John Sacco and State Forest Fire Warden Gregory McLaughlin testified in front of the New Jersey Assembly, Agricultural and Natural Resources Committee Hearing (March 2019) discussing the need for forest management and fire mitigation strategies.

• The New Jersey Pinelands Commission staff routinely discusses forestry application requirements and standards with municipal officials within the Pinelands Area. In 2017, the New Jersey Pinelands Commission sent a letter about forestry permitting requirements to 21 municipalities in the Pinelands Area reminding them that the respective municipal ordinances require issuance of forestry permits.

• During 2015-2020, the New Jersey Pinelands Commission reviewed and/or approved 12 different forestry applications on public lands. Two State forestry applications proposed the management of at least 4,493 acres of public forest lands, including forestry in the Double Trouble State Park Forest Stewardship Plan and activities within Wharton State Forest.

• Since 2015, the New Jersey Pinelands Commission staff has coordinated with NJDEP to streamline the review process for forestry applications on non-state owned public lands (e.g. county, municipal). One example is for Ocean County in which they developed a Forest Stewardship Plan for the 2,200 acre Wells Mills Wilderness Park. The Forest Stewardship Plan was reviewed jointly by NJDEP and Pinelands Commission staff. The Forest Stewardship Plan was approved at a New Jersey Pinelands Commission monthly meeting in early 2020.

• In 2018, the New Jersey Pinelands Commission staff worked with Manchester Township officials and Ocean County officials to revise a 2013 Fire Mitigation Plan for Roosevelt City, located within Manchester Township. The Plan had originally been initiated, but not completed with the Commission. The NJ Forest Fire Service staff had awarded a contract to a private forester to develop the plan in 2013. Residents in the area had raised concerns over controlled burning and in 2019 a revised plan was submitted to the New Jersey Pinelands Commission for review. The revised plan addresses wildfire preparedness concerns for Roosevelt City, which contains more than 20,000 people and is surrounded on three sides by large expanses of forest, including State Forest and WMAs.

Private Lands Management Plans – Forest Stewardship Act

• The NJ Forest Service has continued since 2015 to avoid non-active participants in tax incentive programs and to convey the role and strategic importance of private forest lands in achieving the desired outcomes and future conditions for the priority forest landscapes and associated areas. As well as continuing to motivate landowners to implement their forest management plans.

• The NJ Forest Service has also continued to review, comment and complete inspections of activities outlined within Woodland Management Plans and Forest Stewardship Plans

• The NJ Forest Service has also continued to foster interagency and stakeholder cooperation throughout the state through the implementation and approval of private land management plans such as Woodland Management Plans and Forest Stewardship Plans.

• The NJDEP is also in the process of assembling and codifying the Forest Stewardship Coordinating Committee.

• The Pinelands Area is divided into nine land management areas. Land management areas permit varying intensities of development ranging from intensive development in Pinelands Regional Growth Areas to limited development in the Pinelands Preservation Area District. Forestry is permitted in all nine land management areas. Public and private forestry applications were reviewed by the Pinelands Commission in all Pinelands land management areas, except Military and Federal Installation Areas.

• Of the total acreage of forest management activities occurring on private lands, almost 20% of approved Forest Stewardship Plan parcels were located within the Pinelands Preservation Area District. Two of these private lands parcels each contained more than 10,000 acres of woodlands.

• During the period from 2015 to 2020, the New Jersey Pinelands Commission staff reviewed more than 246 different Forest Stewardship Plans on private lands within the Pinelands Area. Of those plans, more than 198 Forest Stewardship Plans were enrolled in the NJ Forest Service, Forest Stewardship Program; comprising more than 37,079 acres of woodlands. The remaining 48 Forest Stewardship Plans were not completed. Forestry was not typically proposed on all woodland acreage in each parcel enrolled in the Forest Stewardship Program. This is important to keep in mind when considering the 37,079 acres, the acreage subject to active forestry is actually a lesser amount in most cases.

• Also, during 2015 to 2020, approximately 39% or 77 of the 198 Forest Stewardship Plans enrolled in the NJ Forest Service, Forest Stewardship Program did not require application to the Pinelands Commission, since the extent of proposed forestry was so modest. The Pinelands Comprehensive Management Plan contains specific provisions indicating that no application to the Pinelands Commission is required if only timber stand improvement thinning is proposed on five acres or less or five cords of wood or less is being harvested in any given year.

• The change in regulations to State Farmland Assessment (FLA) /Woodlot Assessment requirements during 2015 to 2020 allowing Farmland Assessment, while not requiring wood harvesting is reflected in the fact that 39% of Forest Stewardship Plans submitted to the New Jersey Pinelands Commission did not require application to the Commission based upon the small acreage of proposed forestry. The Pinelands Commission anticipates that based upon the Farmland Assessment requirements, even more forestry plans will propose forestry activities in small acreages that, based upon the regulations contained within the Pinelands Comprehensive Management Plan, no application to the Pinelands Commission is required.

• In 2018, possibly the largest forested public land acquisition by a public agency within New Jersey Pinelands Commission history occurred within Ocean County. Ocean County acquired more than 7,000 acres of property and is currently preparing a Forest Stewardship Plan for the management of the parcel which should be completed by the end of 2020.

• From 2015 to 2017 the following preparation of forestry rules occurred for Chapter 3: Forestry (N.J.A.C. 7:3): Subchapter 1. General Provisions, Subchapter 2. Forestation Program of the NJ State Forest Nursery, Subchapter 3. List of Approved Foresters, Subchapter 4. (Reserved), Subchapter 5. Forest Stewardship Program, Subchapter 6. Forest Stewardship Advisory Committee.

• NJ Forest Service Private Lands Annual Review of Forest Management Plans, Annual FLA Applications & Inspections:

Year	FSP1 Plans/Acres	WMP2 Plans/Acres	FLA3 Applications/Acres	On-site Inspections
2015	302/15,552	555/28,677	5,914/249,800	FSP 322 WMP 922
2016	259/29,301	595/24,079	6,100/251,000	FSP 371 WMP 956
2017	196/9,520	543/23,146	5,800/250,000	FSP 299 WMP 966
2018	175/9,609	567/23,726	5,715/257,600	FSP 159 WMP 441
2019	240/21,000	587/23,937	5,786/259,800	FSP 483 WMP 1,013
2020	TBD/TBD	158/6,098	TBD/TBD	FSP TBD WMP TBD

[1] *Forest Stewardship Plans* [2] *Woodland Management Plans* [3] *Farmland Assessment*

Urban and Community Forest Management Plans

• The NJ Forest Service, Urban and Community Forestry Program has continued to integrate urban and community forestry into all scales of planning including comprehensive and master community planning; city, regional and state-scale plans such as the State Forest Action Plan; provide public awareness and education campaigns to recognize the value of urban trees and forests as important contributors to community sustainability and resistance; increased community capacity to use urban trees in public space planning, infrastructure and private development; Improved management, maintenance and arboricultural practices. All of these items that the Urban and Community Forestry Program has continued to implement over the last five years are components of the USDA Forest Service, Strategic Focus Areas.

• The NJ Forest Service also has encouraged municipalities and counties with currently approved Community Forest Management Plans to become accredited through training and Continuing Education Units. In addition, the program has continued to encourage municipalities and counties currently accredited, to maintain accreditation through training as well.

4: Inventory and Monitoring Strategies

NJ Forest Service

• State Forest Inventory was completed for multiple parcels including Stokes State Forest, High Point State Park, Flatbrook-Roy Wildlife Management Area, Bear Swamp Wildlife Management Area, Walpack Wildlife Management Area, Wharton State Forest, Oswego Natural Area, Batsto Natural Area and Penn State Forest at a scale of approximately 1 plot per 20 acres for a total of approximately 8,813 plots.

• Urban and Community Forest Inventory grants to accredited counties and municipalities with approved Community Forest Management Plans to implement urban forest inventory have been distributed or will be distributed from 2016 to 2019 totaling approximately $247,052 dollars.

In 2016 state Resiliency Planning Grants totaled approximately $46,910, in 2017 they totaled approximately $45,642, in 2018 approximately $78,000 and in 2019 approximately $76,500.

• Forest Inventory and Analysis Program urban and traditional forest inventories were conducted. Urban forest inventory was implemented in 2018, while traditional inventory continued at double intensity for a more robust supply of data for the state's forested resources.

Natural Heritage Program

• Multiple types of inventory and condition assessment data for forest, wetlands and rare ecological community classifications were entered into both the VegBank (538 plots) and EcoObs (114 plots) databases.

• Rare plant and rare plant community surveys were conducted in conjuncture with forest management activities within priority sensitive areas.

• The Office of Natural Lands Management Program has continued to frequently maintain the Natural Heritage Plant Database.

Invasive Species Strike Team

• The continued frequent maintenance of a database of invasive species present in New Jersey forests was conducted. All of the data that the strike team gathers is uploaded into this database where it is mapped, analyzed and shared through their web site. The data was also displayed as an interactive map.

• A tool was created in 2014 (*IPCConnect.org/New* Jersey) that allows users to track and monitor invasive species eradication activities, including pesticide applications. This data is then integrated directly into the existing strike team database as well as the nationwide Early Detection and Distribution Mapping System (EDDMapS).

5: Forest Products Strategies (Utilization and Marketing, U&M)

• A forest industry professionals meeting was held on December 14, 2014 to engage loggers, woodland owners, sawmill operators, consultant foresters and state agencies. The purpose of the meeting was to enhance a dialogue between forest industry professionals and NJDEP, in order for NJDEP staff to hear unknown constraints facing the industry and for industry professionals to put forth recommendations for how NJDEP can support the industry.

• The NJ Forest Service will continue work with IMPLAN economic analyses under the USDA Forest Service Landscape Scale Restoration (LSR) grant involving 20 other Northeast/Midwest states, "Economic Contributions of the Forest Products Industries in the 20 northeastern States," which involves documentation and analyses of the importance of forestry and the forest products industry within the region. These analyses provide a basis for comparison with other regions (south) and other industries throughout the United States such as agriculture. This grant also serves to disseminate information to various interested stakeholders and the public on the importance of the forest products industry and properly managed forests. This grant was entered into in 2018 and the first analysis report was received in March of 2020.

• The NJ Forest Service will continue work with the "No Markets, No Management" LSR Grant, this grant helps to ensure that forests are sustainably managed across the state with the maintenance and development of more robust local markets for forest products both non-traditional such as biomass and ecosystem services, as well as traditional markets. This grant will also provide training for state utilization and marketing staff including workshops and technical assistance. The planning process for an urban centric utilization and marketing workshop has began at the end of 2019 and continues, with plans for the workshop to be held in 2021 and other useful resources/tools to follow shortly after. This grant was entered into in 2019.

NATIONAL PRIORITY 2: PROTECT FORESTS FROM THREATS

1: Resiliency Strategies

Stockton University

• In 2015 Stockton University initiated a prescribe burning experiment testing six different fire return intervals on the campus property. This has given students a wealth of opportunities, including participation in prescribe burning treatments and learning about fire effects in upland pine-oak forests. Prescribe burning as part of this study has occurred annually since its inception.

NJ Forest Fire Service

• Community Wildfire Protection Plans (CWPPs) work in coordination with the NJ Forest Fire Service strategies for communities on "Firewise" projects and improvements to reduce the effects of wildfires, reduce fuel hazards and increase preparedness for areas at risk. Currently there are 13 CWPPs including Barnegat Township, Buena Vista Township, Hamilton Township (Atlantic County), Hardwick, Lacey Township, Little Egg Harbor Township, Manchester Township, Medford Township, Waretown/Ocean Township, Southampton Township, Stafford Township, Vineland Township, Waterford Township. The NJ Forest Fire Service Plans to continue with 12 other communities including: Atco, Berkeley Heights, Egg Harbor City, Hopatcong, Liberty, Little Egg Harbor Township, Manahawkin, Matawan, Maurice River Twp., Millburn, Newton, Tuckerton.

• The NJ Forest Fire Service also identified a priority list of areas for wildfire protection and fuels management in May of 2019. Those areas included Allen Road within Bass River State Forest, Beatrice Lane within Jackson Wildlife Management Area, Belcoville within Hamilton Wildlife Management Area, Buckshutem within Lawrence Wildlife Management Area, Forked River Mountains within Lacey Wildlife Management Area, locations within Hammonton Township, Atlantic County on Parks and Forestry property, Nugentown located within Bass River State Forest, Pancoast West and Paramount Escapes located within Stafford Wildlife Management Area, Sanctuary in Evesham Township, Burlington County on Parks and Forestry Property and Union Lake within Millville Wildlife Management Area.

Joint Base McGuire-Dix-Lakehurst (JBMDL)/ US Fish and Wildlife Service

• Over the last ten years there has been approximately 19,508 acres prescribe burned within the installation boundaries. These prescribed fire treatments are primarily for the reduction of hazardous fuel accumulations. However, prescribed fire also plays a key role in maintaining the Pine Barrens ecosystem, including habitat for the Arogos Skipper Butterfly (NJ Endangered Species) which has a population on the installation. Moving forward, a realistic goal for prescribe burning treatments on JBMDL is 2,000 acres per year with ambitions to exceed that goal annually.

• JBMDL is also currently implementing a mechanical hazard mitigation plan focusing on installation boundaries that have the greatest threat of wildfires leaving or coming onto the military installation. These treatments include mastication with a forestry cutter on a Bobcat. After these locations have been attended to JBMDL will move to interior infrastructure projects or Wildland Urban Interface (WUI) projects.

Drexel University

• Drexel University is currently using historic fire data to develop a fuel-load model for estimating aboveground biomass of pitch pine (Pinus rigida) in the New Jersey East Pine Plains. This provides an estimate of the biomass of an individual tree. The aboveground biomass mean and density mean can be used to estimate the standing pine tree biomass for a given burned area.

NJ Pinelands Commission

• Within the Pinelands Area, several thousand acres of private land were proposed to be prescribed burned as part of lands enrolled in the Forest Stewardship Program that proposed regulated forestry activities during 2015 to 2020.

Several hundred acres of County land located within the Pinelands Area were proposed to be prescribed burned as part of a Forest Stewardship Plan for Wells Mills County Wilderness Area in 2019.

• Seven New Jersey State Forest Service projects proposing regulated forestry approved within the Pinelands Area during 2015-2020 all included the use of prescribed burning within project timelines.

Carbon

• The NJDEP recently rejoined the Regional Greenhouse Gas Initiative (RGGI) to reduce carbon emissions, reduce energy use, obtain net sequestration of carbon and to be more responsive to the Global Warming Response Act. In June of 2019 the NJDEP adopted the Global Warming Solutions Fund rule to establish a framework for using proceeds from RGGIs carbon dioxide allowance auctions. Executive Order No. 7 established the emphasis of projects benefiting environmental justice communities or those disproportionately impacted by climate change.

• NJ Forest Service Nursery produced approximately 300,000 bareroot trees and shrubs and sold approximately 280,100 in 2019. The SFS works with more than 5,800 applicants participating in private lands management with woodland management and Forest Stewardship Plans covering more than 250,000 acres. These efforts of providing bareroot nursery stock to woodland owners and those seeking to create woodlands aid in carbon management by sequestering carbon above and belowground while adding to biomass accretion.

2: DCA Strategies

Invasive Management

• The NJ Forest Service identified and removed dead or dying ash trees in locations that posed the greatest risk of injury on Parks and Forestry property, as well as conducted pesticide treatments on culturally or socially significant trees. In 2017 to 2019 hazardous ash removal was implemented along various sections of the Delaware and Raritan Canal State Park, as well as portions of Washington

• Crossing State Park in 2016. In addition, alternative species were planted along the Delaware and Raritan Canal State Park to reforest treated areas, approximately 400 seedlings of native shrub and tree species were planted in 2018.

• The NJ Forest Service continued with a Gypsy Moth spraying and monitoring program in conjunction with the New Jersey Department of Agriculture from 2015 to 2020.

• The NJ Forest Service also implemented Hemlock Woolly Adelgid pesticide treatments and conducted monitoring on multiple sites during 2015 to 2020.

• The USDA Plant Protection Quarantine (PPQ) program continued to work closely with state and local cooperators to carry out and/or fund surveys for a number of invasive pests, including Asian defoliators, exotic wood boring and bark beetles, Phytophthora ramorum, spotted lanternfly and plum pox virus. These surveys helped to quickly detect and rapidly respond to pest incursions and protect economically important commodities and forest resources.

• Research conducted by Jay Kelly (2019), Professor of Biology and Environmental Science and co-Director of the Center for Environmental Studies at Raritan Valley Community College during 2014 to 2018 throughout northern New Jersey and the combined analysis of data from the same locations in 1948 to 1973, determined that there were 5 to 40 times more exotic shrub, liana and herb cover during the time period between 1948-1973 and 2014-2018. He also determined that a major shift in overall species composition from predominately native species cover (≥95%) to a majority of exotic species cover in shrubs and lianas (54%).

• The New Jersey Invasive Species Strike Team has partnered with various organizations for control or eradication of invasive animals (insects) and pathogens from 2015 to 2020. The most current organizations include: Hilltop Conservancy, NJ Highlands Coalition, NJ Audubon, The Land Conservancy of NJ, Fox Foundation and Cranbury Township Environmental Commission.

• The New Jersey Invasive Species Strike Team utilized a USDA Forest Service grant from 2013 to 2016 to address three main priorities outlined within the previous state action plan including the conservation of biological diversity through identification of areas most in need of protection from invasives; maintenance of forest health and vitality through site specific removal and utilization of their database for assisting land managers in early detection and rapid response; as well as the maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of society through their database, field work and public outreach activities.

• Since 2015, the New Jersey Invasive Species Strike Team has detected more than 6,000 populations of invasive species and of those populations, approximately 1,100 have been eradicated. Eradication methods include mechanical control (pulling, mowing, girdling) and/or chemical control (herbicides)—basal area bark and foliar spray or both (cut-stump herbicide application).

• The New Jersey Invasive Species Strike Team has also finalized plans for 15 properties and has completed hundreds of eradication treatments of massive infestations on more than 10 acres. The Victoria Foundation has generously provided funding to the Strike Team for developing five 10-year Invasive Species Management Plans with numerous project partners in Northern New Jersey.

• The total number of target invasive species for the New Jersey Invasive Species Strike Team was 145, this list included 101 plants and 44 animals.

• During 2015 to 2019 the Pinelands Commission reported about a quarter of the reviewed Forest Stewardship Plans within the Pinelands Area proposed measures to further mitigate Southern Pine Beetle (SPB) infestation in the forests where SPB damage had already occurred.

Herbivory

• Duke Farms is currently implementing a deer management program to reduce deer densities both inside and outside their square-mile deer exclosure. Research conducted from 2005-2017 found major increases in native species cover and tree regeneration in response to deer management.

• Research conducted by Jay Kelly (2019), Professor of Biology and Environmental Science and co-Director of the Center for Environmental Studies at Raritan Valley Community College compiled forest understory data from 1948 to 1973 from sites throughout northern NJ, when deer densities were less than 10 per square mile. When the same sites were revisited in 2014-2018, he found 70-80% declines in tree seedling and sapling densities and total cover of native herbs and shrubs, due to the dramatic increase of deer populations in these areas. Changes in tree species composition were also observed in relation to deer browse preferences.

• Another research study conducted by Jay Kelly (2019) included nine large experimental deer exclosures of different ages (4-20 years), which showed a doubling of sapling numbers every 3-4 years and increases in seedling and sapling heights over time. In addition, a full recovery of sapling abundance and species composition to historic levels was apparent after 11-20 years, due to the removal or reduction of deer browse pressure.

4: Fragmentation/Habitat Restoration Strategies

• The Highlands region which connects Connecticut, New York, New Jersey and Pennsylvania included continuous conservation efforts from 2015 to 2020 from the Appalachian Trail conservancy to provide links through different land ownerships.

NJ Pinelands Commission

• All forestry applications from 2015 to 2020 located within the Pinelands Area were required to address the protection of Threatened and Endangered plant and animal species of the Comprehensive Management Plan or potential habitat of plant species.

• If Threatened and Endangered plants were a concern within forestry applications, proposed forestry is required to either follow seasonal harvesting restrictions or provide a 100 foot "No Activity" buffer to any known or suspected habitat for threatened and endangered plant populations.

• In order to protect Threatened/Endangered Animal species within forestry applications, a visual search for potential critical habitat for bird species must be done of the trees proposed for harvest and time of year restrictions proposed for other animal species. For example, potential critical habitat for the State Endangered Timber rattlesnake was conserved throughout the Pinelands Area by requiring summer tree harvesting in wetlands which support streams which could provide winter dens. An exception to this time of year restriction is if low ground pressure forestry harvesting equipment is used.

• From 2015 to 2020 state endangered Bobcat habitat was addressed in two Pinelands Preservation Area Forest Stewardship Plans on private lands. In the Pinelands Area, Bobcat denning habitat is limited to uprooted trees and dense shrub thickets as opposed to rock dens elsewhere in New Jersey. Forest stands which had dense thickets had to conserve these areas within the stand.

• In the Pinelands Area, forest openings for basking reptiles and amphibians was also encouraged for forestry applications from 2015 to 2020 where known habitat occurred.

NJDEP Division of Fish & Wildlife Service

• In 2019 the NJDEP Division of Fish & Wildlife rolled out tools for prioritizing habitat conservation in New Jersey, including the Connecting Habitat Across New Jersey (CHANJ) mapping tool and the CHANJ Guidance Document.

• The creation of CHANJ was an effort to make New Jersey landscape and roadways friendlier to wildlife movement by identifying key areas and actions needed to achieve habitat connectivity across the state. The project was designed to help prioritize land protection, inform habitat restoration and management and guide mitigation of road barrier effects on wildlife and their habitats. CHANJ offers the tools and resources to guide these goals forward in a strategic way. Whether on the local or statewide scale, the tools can help land managers, transportation planners, conservation groups and the general public to visualize their place in New Jersey's habitat connectivity puzzle and to be more proactive and collaborative in their planning efforts. This can also reduce conflicts between agencies, which saves time and money. The success of CHANJ in fact depends on a variety of user groups and partnerships implementing its guidance.

NATIONAL PRIORITY 3: ENHANCE PUBLIC BENEFIT FROM TREES AND FORESTS

1: Biodiversity Strategies

American Chaffseed *(Schwalbea americana)*

• Raritan Valley Community College, under the guide of Professor Jay Kelly and with the help of NJ Forest Service, Forest Nursery personnel, conducted American Chaffseed plant rearing work and associated out-planting in various areas from 2015 to 2020.

• The NJ Forest Service, NJ Forest Fire Service and Office of Natural Lands Management completed American Chaffseed habitat restoration work from 2015 to 2020 in Brendan T. Byrne State Forest and Wharton State Forest and additional areas. This included site preparation treatments for the establishment of plants, in addition to planting efforts.

Broom Crowberry *(Corema conradii)*

• The NJDEP Division of Fish & Wildlife, NJ Forest Fire Service and Office of Natural Lands Management worked collaboratively in completing broom crowberry habitat restoration and enhancement activities from 2015 to 2020 on Stafford Forge Wildlife Management Area.

Pickering's Morning Glory *(Stylisma pickeringii var. pickeringii)*

• The New Jersey Conservation Foundation and Office of Natural Lands Management completed work from 2015 to 2020 in Wharton State Forest to protect current populations of Pickering's Morning Glory.

Pine Barren Gentian *(Gentiana autumnalis)*

• Drexel University, Laboratory of Pinelands Research, studies directed by Dr. Walt Bien from 2011 to 2013 at the Warren Grove Air to Ground Gunnery Range examined the effect of winter prescribed burning on the demography of the rare New Jersey Pine Barren gentian and its associated insect visitors. The goal of the research was to develop conservation and management guidelines for this fire-adapted species. It was found that winter prescribed burns conducted before the growing season, had a positive same year effect on the demography of Pine Barren gentian. Winter prescribed burns helped to maintain an open-canopied habitat that was essential for Pine Barren gentian and other early-successional species. Although winter prescribed burns conducted before the growing season were positive for Pine Barren gentian, the optimal fire return interval and frequency remains unknown.

• The NJ Forest Service, NJ Forest Fire Service, Office of Natural Lands Management and Pinelands Preservation Alliance collaboratively worked in 2018 to 2020 on a project within the Brendan T. Byrne State Forest to create additional habitat for the Pine Barren gentian, as well as improve habitat for present populations of the rare plant.

• Discussions in 2020 between the NJ Forest Service, Office of Natural Lands Management and Pinelands Preservation Alliance included plans for Pine Barren gentian habitat improvement and creation within Wharton State Forest.

2: Recreation Strategies

• In 2014 New Jersey residents approved a 14th referendum that permanently dedicates 4% of the State's Corporate Business Tax (CBT) for open space, farmland and historic preservation purposes. This funding can be used to make enhancements and improvements to infrastructure and stewardship within NJ State Parks, as well as NJDEP Division of Fish & Wildlife facilities. It is estimated that approximately $75 million a year will be generated by this dedication. The CBT dedication increased to 6% in fiscal year 2019.

• In September of 2018 NJDEP completed the Statewide Comprehensive Outdoor Recreation Plan to meet several goals including: assessing the amount of open space available for current and future public recreational use and for the conservation of natural resources important to protecting New Jersey's biodiversity and quality of life; providing close-to-home park and recreation opportunities for residents statewide; presenting current information on the supply and demand fore recreation and open space; implement open space and recreation planning policies and projects consistent with overall NJDEP goals; encourage open space and recreation planning by local governments and conservation organizations; effectively use funds from the Preserve New Jersey Act, LWCF, Forest Legacy Program and other sources of funding which may become available.

3: Education, Communication, and Outreach

• Backyard Forestry (BYF) in 90 minutes is a monthly event sponsored by Rutgers Extension, the NJ Forestry Association and the NJ Forest Service for adults to learn more about natural resource management that includes forestry, wildlife management, invasive species management, forest health monitoring and mitigation and wildfire mitigation which are under the umbrella of stewardship. This event started in the Fall of 2014 and due to the popularity of BYF, as of winter of 2019, will be expanded to northern NJ and will be held at the Frelinghuysen Arboretum.

• The NJ Woodland Stewards Program is a four-day workshop sponsored by the NJ Forestry Association in partnership with Rutgers New Jersey Agricultural Experiment Station (NJAES), the Natural Resources Conservation Service, NJ Forest Service and NJDEP Division of Fish & Wildlife. Upon completing the 4-day workshop, participants are asked to provide 30 hours of volunteer time in order to complete their training. Many individuals volunteer with the NJ Forest Service Nursery or NJ Forest Service. The program trains approximately 25 participants each year in topics including forest stewardship (including

Year	NJ SAF4 / Approved Foresters	Municipal Tax Assessors w/Division of Taxation and Dept. of Agriculture	Woodland Owners with Tree Farm & NJFA5	Backyard Forestry
2015	1	2	2	12
2016	1	2	2	12
2017	1	2	2	11
2018	1	2	4	11
2019	1	2	1	18
2020	1	1	TBD	6

[4] *Society of American Foresters* [5] *NJ Forestry Association*

government sponsored incentive programs available to forest landowners), silviculture, forest and wildlife ecology and management, tree identification and outreach strategies. The program is targeted to forest landowners in NJ. This Woodland Stewards program has been around since 2010 and about 140 people have participated over the last nine years, in fact 2019 was the largest class ever.

NJ Forest Service

• NJ Forest Service continued to partner with universities/colleges to develop an integrated forest ecology curriculum from 2015 to 2020.

• Approximately 100 big and heritage trees were recorded on the official big and heritage tree registry, with an official launch of the Heritage Tree Conservation and Education Program in 2017.

• Private Lands Program Training and Engagement and Stakeholder Sessions:

New Jersey Tree Foundation

• The New Jersey Tree Foundation offered "TreeKeepers" workshops to cities with hands-on and classroom instruction on how to care for new trees, tree ID and hazard awareness, importance of green infrastructure, stormwater management and watershed health from 2015 to 2020.

• The Foundation also offered regional "Right Tree, Right Place, Planted the Right Way" seminars for NJ residents (more than 1,000) to learn about proper tree planting and maintenance, insects and diseases, calling 811, trees and extreme weather and sustainable forestry practices since 2015.

New Jersey Shade Tree Federation

• The NJ Shade Tree Federation is a non-profit organization with more than 1600 members who partners with the NJDEP Urban and Community Forestry Program to offer.

• Annual educational conference which brings together more than 600 individuals from more than 200 municipalities and counties throughout the State of New Jersey to engage in two days of education regarding the care and maintenance of shade trees throughout the state.

• The conference also hosts a networking/ community event where shade tree commissions and professionals in the tree care industry exchange communication regarding the activities of shade tree commissions within the municipalities as well as the tree industry itself all with the same goal of preserving the tree canopy throughout the State of New Jersey.

NJ Forest Fire Service

• The NJ Forest Fire Service continued to promote fire prevention programs from 2015 to 2020 including Fire-wise communities and Smokey Bear, in addition to more than 350 other wildfire prevention programs.

• In 2019 the NJ Forest Fire Service also planned a large event for Smokey's 75th birthday at Liberty State Park in Jersey City.

Rutgers University

• The Rutgers Urban Forestry Program partnered with the NJ Forest Service, Urban and Community Forestry Program (NJUCF) and New Jersey Shade Tree Federation to provide an "Inventory Training & i-Tree Workshop" as part of the NJ Shade Tree Federation Annual Conference in 2014, 2015, 2016 ,2017 and 2018. Each year this workshop contained 2 or 3 hours of content specific to i-Tree and had an estimated average of 25 people in attendance. This workshop was not included in the 2019 conference due to changes in the conference structure and anticipated updates to the NJUCF CFMP Guidelines, with the focus shifting from training volunteers in i-Tree to training consulting foresters who will be working with municipal shade tree program volunteers to provide inventory interpretation using i-Tree. Funding is in place to ensure that Rutgers Urban Forestry Program will continue to partner with NJUCF to provide these training opportunities in i-Tree, either on campus or in association with the NJSTF conference or both.

• The Rutgers Urban Forestry Program Outreach Coordinator has included the use of i-Tree Design in many presentations to municipal shade tree program representatives on the topic of Emerald Ash Borer, as a means of providing cost benefit analysis when deciding whether to treat or remove and replace an ash tree, since EAB was confirmed in NJ in 2014. In addition, i-Tree Design and MyTree have been included in Project Learning Tree workshops from 2015 to 2020.

• The Rutgers Urban Forestry Program has included i-Tree in the curriculum for the Urban Forestry class since 2016 and in recent years has provided training for multiple i-Tree applications for Landscape Architecture and Environmental Education classes as well.

• A Forestry Club was organized in 2019 with applications submitted for the New Jersey Arborists chapter of the International Society of Arboriculture and the NJ Division of the Allegheny Society of American Foresters.

New Jersey Invasive Species Strike Team

• The Strike Team conducted training of conservation professionals on the identification and treatment of emerging invasive species (65 individuals reached) and will continue in coming years, especially focusing on foresters and others that can expand the network of detectors across the state's forest lands.

• Collaborated with the trust for Public Land and United Parks to develop educational programs for Newark-based high school students. These programs include 8 hours of instruction for 20 students over a two day period.

• The Strike Team also initiated training sessions to support existing or new local groups to work within natural areas in their own towns. The work typically involves a 1-hour presentation and associated field visit to survey for key invasive species threats. A set of tables are provided to list invasive species and provide a prioritized list of stewardship activities over a 10-year period. Following the visit and recommendations, the Strike Team makes themselves available to provide implementation advice. In June 2019, the Strike Team held their first "Community Conference" aimed at informing and supporting local citizens to become stewards. They have worked with about 10 groups so far.

• The Strike Team provided educational presentations to groups such as property managers, elected officials, garden clubs and civic associations. Topics included invasive species, landscape use of native species and deer management. Volunteer Ambassadors represented the Strike Team with a table-top display at several community events. A total of 58 sessions were held reaching

approximately 1,550 participants from 2018 through June of 2019.

Raritan Valley Community College

• Professor Jay Kelly conducted more than 80 public presentations on the impacts of deer and invasive plant species on forest health to varied audiences, including local town officials, public libraries, conferences, workshops, schools and Non-Government Organizations.

City of Summit

• A series of seminars to promote sound forestry and why trees are important were conducted by the city of Summit, four in total were conducted during the fall of 2019.

Communication

• The NJ Forest Service page, which was first created on April 10, 2012, currently has 37,627 "likes" and 38,788 "followers." Posts to the Forest Service page frequently are viewed by 20,000 to 30,000 Facebook users and it is not uncommon for popular posts to be viewed more than 100,000 times. In addition, the Forest Service has also relayed it's messaging through the Department of Environmental Protection Facebook (*Facebook.com/newjerseydep*) and Twitter (*@newjerseydep*) accounts and the New Jersey State Park Service's Instagram account (*@newjerseystateparks*). Post types, descriptions and frequencies from the NJ Forest Service and NJ Forest Fire Service Facebook pages are described below:

NJ Forest Service

Post Type: NJ Forest Service Program Highlight
Post Description: The public will begin to gain a better understanding of what the NJ Forest Service does by seeing the work that staff are actually doing on the ground. Accurate descriptions of the work will be provided in a manner that is easy to understand by the general public. These posts may also recap events or other programs that the Forest Service has participated in. Posts can also include video.
Post Frequency: Weekly, Tuesdays

Post Type: What is happening at the NJ Forest Service Nursery/FREC?
Post Description: In an effort to better publicize the NJ Forest Service Nursery and FREC, a monthly photo or video post will be made to explain what is currently going on there. These posts could be calls to action for volunteers or just a general "hey what's up" post.
Post Frequency: Monthly

Post Type: #iheartNJforests
Post Description: #iheartNJforests is an ongoing online and social media campaign that highlights the work of the NJ Forest Service. These posts are primarily videos that showcase the work of the Forest Service. These posts will also highlight the other programs that report to the State Forester which include ONRR and ONLM. Please see the # plan for additional details.
Post Frequency: Bi-Weekly, Wednesdays

Post Type: #ThrowbackThursday
Post Description: A weekly segment with old photos from the NJ Forest Service's archives. These photos are of various forestry operations and practices and will highlight a number of programs that are ongoing today, such as NJUCF.

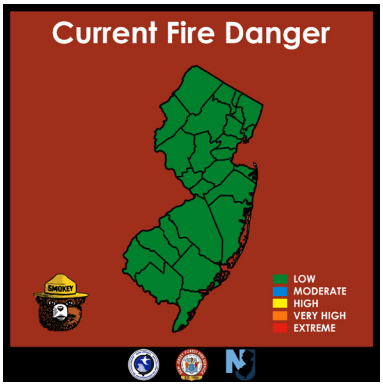
Post Frequency: Weekly, Thursdays

Post Type: Events Post
Post Description: The NJ Forest Service hosts various events throughout the year, from the Fall Forestry Festival, to public meetings and other stakeholder gatherings. The NJ Forest Service page will be used to publicize these events and drive page followers to attend these events.
Post Frequency: As Needed

NJ Forest Fire Service

Post Type: Current Fire Danger

Post Description: A map of the state will show the current fire danger for Division A, B and C coverage areas. Additional posts will be made if campfire or other restrictions are currently in effect.



Post Frequency: Weekly – up to twice weekly if fire danger levels change

Post Type: NJ Forest Fire Service Program Highlight

Post Description: The public will begin to gain a better understanding of what the NJ Forest Fire Service does by seeing the work that staff are actually doing on the ground. Some areas of the state do not live in a direct Forest Fire Service coverage area and these residents will be able to gain an understanding of the benefit the Forest Fire Service has to other parts of the state. Posts can be photos or videos.

Post Frequency: As needed

Post Type: Prescribed Burning Notification

Post Description: During Prescribed Burn Season notifications will be posted the day of a prescribed burn to alert residents that if they see smoke in an area if it is from a prescribed burn. A notice will be posted at the end saying "when in doubt call 911 or 1-877-WARN-DEP.

Post Frequency: As needed

Post Type: #ThrowbackThursday

Post Description: A weekly segment with old photos from the NJ Forest Fire Service's archives. Often these will be photos of old equipment and crewmembers conducting a wide range of work with the Forest Fire Service.

Post Frequency: Weekly, Thursdays

Post Type: Current Wildfire

Post Description: When an active major wildfire is ongoing, the NJ Forest Fire Service Facebook page will be used to provide accurate and up to date information. This will allow the public to receive accurate information right from the Forest Fire Service and not from a third hand source who posted their own messaging on Facebook. This will help to stop the spread of false information like what was seeing during the 2019 Spring Hill Fire.

Post Frequency: As needed

• Internet Visits to NJ Forest Service, Private Lands Management Web Pages:

2015	**16,512**
2016	**5,132**
2017	**12,090**
2018	**12,879**
2019	**9,763**
2020	**2,216**

• From 2015 to 2020, the Raritan Valley Community College has developed and integrated a forest ecology-related curriculum into several classes and is working with local schools and park systems to do the same at the K-12 levels.

• Raritan Valley Community College has also worked in more than 100 local parks and municipalities to provide direct technical assistance and services with forest and deer monitoring from 2015 to 2020. These include installation of forest monitoring plots, deer exclosures, tree plantings and studies of local deer densities using either road-based spotlight surveys or infrared drone surveys.

• A conference at Raritan Valley Community College was held in 2019 on "Ecological Changes in Northern NJ Forests: Implications for Effective Stewardship," co-sponsored by the New Jersey Academy of Sciences. The event brought together and featured more than a dozen researchers from

New Jersey universities, government agencies and non-government organizations to provide current research and perspectives on forest health in order to inform public policy, forest management and public awareness.

• NJUCF created Facebook Page on May 4, 2017. It currently has increased its followers by 94% over last year's numbers and has a five-star rating.

• The NJ Forest Service, Urban and Community Forestry Program continued to integrate into other departments throughout 2015 to 2020, including subjects such as solid waste, debris management, environmental justices and the Regional Greenhouse Gas Initiative.

• The Urban and Community Forestry Program continued to encourage other municipalities to become "Tree City's" since 2015 as well. The following standards are required to become a "Tree City": creating some type of tree related ordinance, spending $2 per capita on some type of tree related work, creating some type of board or department dedicated to maintenance of trees and celebrating Arbor Day.

4: Data and Research Strategies

• The New Jersey Conservation Foundation has expanded its fire ecology research from 2015 to 2020 at Franklin Parker Preserve.

• Kean University, from 2015 to 2020 has been studying the effects of prescribed fire as a restoration tool in the New Jersey Pine Barrens at Ash Brook Reservation in Union County and Lewis Morris Park in Morris County.

• The NJ Forest Service has been engaged in a Joint Venture Agreement (JVA) since 2016 with the USDA Forest Service, FIA program to develop data tools and products by supporting a community of professionals and enthusiasts through open source project development. The JVA provides opportunities for technology transfer, multi-state and federal support and has built an online community to develop open source software and data products.

• The Raritan Valley Community College, Center for Environmental Studies, is currently investigating deer population densities in northern NJ forests using infrared drone technologies, as well as the effects of prescribed burning on tree regeneration and invasive species suppression, the impacts of land use history and post-agricultural soils on forest development, and the effectiveness of different deer management strategies at enhancing forest understory conditions.

APPENDIX I:
FOREST TYPE VS FOREST TYPE GROUP

	Forest Type Group										
Forest Types	white/red/jack pine	loblolly/shortleafpine	other eastern softwoods	oak/pine	oak/hickory	oak/gum/cypress	elm/ash/cottonwood	maple/beech/birch	aspen/birch	other hardwoods	nonstocked
Eastern white pine	x	-	-	-	-	-	-	-	-	-	-
Loblolly pine	-	x	-	-	-	-	-	-	-	-	-
Shortleaf pine	-	x	-	-	-	-	-	-	-	-	-
Virginia pine	-	x	-	-	-	-	-	-	-	-	-
Pitch pine	-	x	-	-	-	-	-	-	-	-	-
Eastern redcedar	-	-	x	-	-	-	-	-	-	-	-
Eastern white pine / northern red oak / white as	-	-	-	x	-	-	-	-	-	-	-
Eastern redcedar / hardwood	-	-	-	x	-	-	-	-	-	-	-
Shortleaf pine / oak	-	-	-	x	-	-	-	-	-	-	-
Virginia pine / southern red oak	-	-	-	x	-	-	-	-	-	-	-
Loblolly pine / hardwood	-	-	-	x	-	-	-	-	-	-	-
Other pine / hardwood	-	-	-	x	-	-	-	-	-	-	-
Chestnut oak	-	-	-	-	x	-	-	-	-	-	-
White oak / red oak / hickory	-	-	-	-	x	-	-	-	-	-	-
White oak	-	-	-	-	x	-	-	-	-	-	-
Northern red oak	-	-	-	-	x	-	-	-	-	-	-
Yellow-poplar / white oak / northern red oak	-	-	-	-	x	-	-	-	-	-	-
Sassafras / persimmon	-	-	-	-	x	-	-	-	-	-	-
Sweetgum / yellow-poplar	-	-	-	-	x	-	-	-	-	-	-
Scarlet oak	-	-	-	-	x	-	-	-	-	-	-
Yellow-poplar	-	-	-	-	x	-	-	-	-	-	-
Black walnut	-	-	-	-	x	-	-	-	-	-	-
Black locust	-	-	-	-	x	-	-	-	-	-	-
Chestnut oak / black oak / scarlet oak	-	-	-	-	x	-	-	-	-	-	-
Cherry / white ash / yellow-poplar	-	-	-	-	x	-	-	-	-	-	-
Elm / ash / black locust	-	-	-	-	x	-	-	-	-	-	-
Red maple / oak	-	-	-	-	x	-	-	-	-	-	-
Mixed upland hardwoods	-	-	-	-	x	-	-	-	-	-	-
Sweetgum / Nuttall oak / willow oak	-	-	-	-	-	x	-	-	-	-	-
Overcup oak / water hickory	-	-	-	-	-	x	-	-	-	-	-
Atlantic white-cedar	-	-	-	-	-	x	-	-	-	-	-
Sweetbay / swamp tupelo / red maple	-	-	-	-	-	x	-	-	-	-	-
Black ash / American elm / red maple	-	-	-	-	-	-	x	-	-	-	-
River birch / sycamore	-	-	-	-	-	-	x	-	-	-	-
Cottonwood	-	-	-	-	-	-	x	-	-	-	-
Willow	-	-	-	-	-	-	x	-	-	-	-
Sycamore / pecan / American elm	-	-	-	-	-	-	x	-	-	-	-
Sugarberry / hackberry / elm / green ash	-	-	-	-	-	-	x	-	-	-	-
Silver maple / American elm	-	-	-	-	-	-	x	-	-	-	-
Red maple / lowland	-	-	-	-	-	-	x	-	-	-	-
Sugar maple / beech / yellow birch	-	-	-	-	-	-	-	x	-	-	-
Black cherry	-	-	-	-	-	-	-	x	-	-	-
Hard maple / basswood	-	-	-	-	-	-	-	x	-	-	-
Red maple / upland	-	-	-	-	-	-	-	x	-	-	-
Aspen	-	-	-	-	-	-	-	-	x	-	-
Paper birch	-	-	-	-	-	-	-	-	x	-	-
Other hardwoods	-	-	-	-	-	-	-	-	-	x	-
Nonstocked	-	-	-	-	-	-	-	-	-	-	x

GLOSSARY

Abiotic: The nonliving parts of an ecosystem, such as soil particles, bedrock, air, water.

Adaptive management: Dynamic approach to forest management in which the effects of treatments and decisions are continually monitored and used, along with research results, to modify management on a continuing basis ensuring objectives are met.

Afforestation: The process of establishing trees on land that has lacked forest cover for a very long period of time or land that has never been forested.

Age-class distribution: The location or proportionate representation or both, of different age classes in a forest.

Anthropogenic factors: Of, relating to or resulting from the influence of humans relating to forest resources.

Avoided Emission (Carbon Defense): methods or procedures that reduce risk of emission from forest carbon pools.

Basal area: The cross-sectional area of all stems of a species or stems in a stand measured at breast height and expressed per unit of land area.

Biodiversity: An index of richness in a community, ecosystem or landscape and relative abundance of these species.

Biomass: The aboveground weight of wood and bark in live trees 1.0 inch (2.5 cm) DBH and larger from the ground to the tip of the tree, excluding all foliage. The weight of wood and bark in lateral limbs, secondary limbs and twigs under 0.5 inch (1.3 cm) in diameter at the point of occurrence on sampling-size trees is included but is excluded on poletimber and sawtimber-size trees. Biomass is typically expressed as green or oven-dry weight and the units are tons.

Biotic: Pertaining to living organisms and their ecological and physiological relations.

Board feet: A unit of volume used for softwood and hardwood lumber: one board foot equals 1/12 of a cubic foot.

Bulk density: The weight per unit of volume of a material.

Carbon Flux Refers to the direction and rate of transfer or flows, of carbon between pools.

Carbon Pools: Reservoirs of carbon having the capacity to take in and release carbon.

Carbon sequestration: The uptake and storage of carbon. Trees and plants, for example, absorb carbon dioxide, release the oxygen and store the carbon. Fossil fuels were at one time biomass and continue to store the carbon until burned. Storage of carbon through natural, deliberate or technological processes in which carbon dioxide is diverted from emissions sources or removed from the atmosphere and stored biologically in the ocean and terrestrial environments (e.g., vegetation, soils and sediment) or in geological formations (*USGS.gov*).

Carbon sink: A carbon reservoir that absorbs and stores carbon from another part of the carbon cycle. A sink stores more carbon than it emits to the atmosphere. This store of carbon can also be termed a reservoir or pool. Although a growing forest can be considered a carbon sink, when the forest stops growing and its trees die and start decomposing, it becomes a carbon source, because it emits more carbon than it stores. A compartment within the Earth system that acquires carbon from the atmosphere and stores it for a specified period of time.

Carbon Storage: the quantity of forest carbon deposited in various pools and held for a period of time.

Climax forest: The final stage of forest succession, usually composed of shade-tolerant species that are self-perpetuating without a disturbance.

Climate Change: Changes in average weather conditions that persist over multiple decades or longer. Climate change encompasses both increases and decreases in temperature, as well as shifts in precipitation, changes in frequency and location of severe weather events and changes to other features of the climate system.

Cord: A stack of wood that has a gross volume of 128 cubic feet. A cord measures 4 feet by 4 feet by 8 feet and contains approximately 80 cubic feet of solid wood, with the remainder being air space.

Course Woody Debris: The standing and downed dead wood in a forest.

Decline condition: That is characterized by a progressive decline in a tree's health and in its growth and that may kill it. While the causes of this phenomenon are not known, it is generally believed that a combination of factors such as, pollution, soil acidification, drought and freeze-thaw action is to blame.

Defoliation: The removal of all or most of a plant's leaves by natural disturbance agents (e.g., insects) or through the actions of humans (e.g., the application of herbicides).

Down Woody Material: DWM is dead material on the ground in various stages of decay. It includes coarse and fine wood material. Previous named down woody debris (DWD). The depth of duff layer, litter layer and overall fuelbed; fuel loading on the microplot; and residue piles are also measured as part of the DWM indicator for FIA.

Ecological forestry: an approach to forest management placing special emphasis on and consideration of ecological processes and function.

Ecosystem function: The major process of ecosystems that regulate or influence the structure, composition and pattern. These include nutrient cycles, energy flows, trophic levels (food chains), diversity patterns in time/space development and evolution, cybernetics (control), hydrologic cycles and weathering processes.

Ecosystem Services: The combined resources and processes of natural ecosystems that provide benefit to humans, including, but not limited to, the production of food and water, the control of climate and disease, cycling of nutrients and crop pollination, spiritual and recreational benefits and the preservation or maintenance of biodiversity.

Erosion: The loss of surface soil due to water, wind, gravity and/or human activities.

Evapotranspiration: The conversion of water, whether surface water, soil moisture or within plants into water vapor that is released to the atmosphere.

Fire-dependent systems: Forests, grasslands and other ecosystems historically composed of species of plants that evolved with and are maintained by fire regimes.

Fire regime: Describes the role of fire in ecosystems. Fire regimes describe and categorize patterns of fire ignition, seasonality, frequency, type (crown, surface or ground fire), severity, intensity and spatial continuity (pattern and size) that occur in a particular area or ecosystem.

Forest Density: The quantity of trees per unit of area, usually expressed as trees per acre.

Forest land: Land that has at least 10 percent crown cover by live tally trees of any size or has had at least 10 percent canopy cover of live tally species in the past, based on the presence of stumps, snags or other evidence. To qualify, the area must be at least 1.0 acre in size and 120.0 feet wide. Forest land includes transition zones, such as areas between forest and nonforest lands that meet the minimal tree stocking/cover and forest areas adjacent to urban and built—up lands. Roadside, streamside and shelterbelt strips of trees must have a width of at least 120 feet and continuous length of at least 363 feet to qualify as forest land. Unimproved roads and trails, streams and clearings in forest areas are classified as forest if they are less than 120 feet wide or less than an acre in size. Tree-covered areas in agricultural production settings, such as fruit orchards or tree—covered areas in urban settings, such as city parks, are not considered forest land.

Forest type: A classification of forest land based upon and named for the tree species that forms the plurality of live-tree stocking. A forest type classification for a field location indicates the predominant live-tree species cover for the field location; hardwoods and softwoods are the first group to be determine predominant group and Forest Type is selected from the predominant group.

Forest type groups: A combination of forest types that share closely associated species or site requirements.

Fragmentation (habitat): The break-up of a large continuous land area by reducing and dividing into smaller patches isolated by areas converted to a different land type. Habitat can be fragmented by natural events or development activities.

Fragmentation (forest): The breakup of a large land forest area into smaller patches isolated by areas converted to a different land type. Opposite of connectivity.

Genetic diversity: The genetic variability within a population or species, usually assessed at three levels: within breeding populations, between breeding populations and within species.

Genetic drift: A change in gene frequency and population characteristics due to chance rather than selection and usually more prevalent in small populations.

Geographic Information System (GIS): An organized collection of computer hardware, software and geographic data designed for capturing, storing, updating, manipulating, analyzing and displaying all forms of geographically referenced information.

Greenhouse gas (GHG): A gas—such as water vapour, carbon dioxide, nitrous oxide, methane and ozone—that is transparent to incoming solar radiation but less so to the infrared radiation reflected back by the Earth's surface, hence trapping part of the solar energy and warming the planet's surface enough to sustain life. The build-up of greenhouse gases from industrial activities enhances the natural "greenhouse effect" and is partly responsible for global warming.

Habitat: The environment in which a population or individual lives; includes not only the place where a species is found, but also the particular characteristics of the place (for example, climate or the availability of suitable food and shelter) that make it especially well-suited to meet the life cycle needs of that species.

Impervious Surface: Surfaces which impede precipitation infiltration to ground-water increases the amount of runoff, impacts ground-water recharge, frequency and magnitude as well as pollutant levels and degrades biological activity.

Impact Analysis for Planning (IMPLAN) Model: A computer–based system used by the Forest Service for constructing input-output models to measure economic input. The system includes a database for all counties in the United States and a set of computer programs to retrieve data and perform the computational tasks for input-output analysis.

INVASIVE SPECIES

Invasive nonnative species: Are those animal and plant species with an extraordinary capacity for multiplication and spread at the expense of other native species. Plants in this category may or may not be designated as noxious weeds.

Invasive plant species: Nonnative plant species that invade or are introduced into an environment or ecosystem in which they did not evolve where they have the ability to compete with and at times overshadow, the existing native plant species. Invasive species are also likely to cause economic or environmental harm or harm to human health. Invasives include seeds, eggs, spores or other biological material capable of propagating that species, that is not native to that ecosystem (with respect to a particular ecosystem). Noxious weeds are a specific type of invasive plants that carry a legal designation due to their potential for detrimental impacts to the environment.

Inventory (forest): A survey of a forest area to determine data such as area, condition, timber, volume and species for a specific purpose, such as planning, purchasing, evaluating, managing or harvesting.

Keystone species: A species whose presence and role within an ecosystem has a disproportionate on other organisms within the system.

Land Use: Activities taking place on land, such as growing food, cutting trees or building cities.

Leakage Can refer to leakage of methane or other gases during drilling and storage and during transfers through pipelines. Leakage also can refer to the situation in which a carbon sequestration activity (e.g., tree planting or avoided deforestation) on one piece of land inadvertently, directly or indirectly, triggers an activity, which in whole or in part counteracts the carbon effects of the initial activity.

Mesophication: The escalation of mesic microenvironmental conditions, accompanied by ever-diminishing prospects for fire and fire-dependent helophytic species.

Monitoring: A process of collecting information to evaluate whether or not objectives of a project and its mitigation plan are being realized. Monitoring allows detection of undesirable and desirable changes so that management actions can be modified or designed to achieve desired goals and objectives while avoiding adverse effects to ecosystems.

Montréal Criteria and Indicators Process: This global initiative was so named because the first meeting sponsored by the Conference on Security and Cooperation in Europe was held in Montreal. Currently, 12 countries representing 90% of the world's boreal and temperate forests have agreed to collaborate to develop national C&I for the conservation and sustainable management of all boreal and temperate forests.

Mortality: Death or destruction of forest trees as result of competition, disease, insect damage, drought, wind, fire, old age and other factors, excluding harvesting.

Ownership: A legal entity having an ownership interest in land regardless of the number of people involved. An ownership may be an individual; a combination of persons; a legal entity such as corporation, partnership, club or trust; or a public agency. An ownership has control of a parcel or group of parcels of land.

Overstory: The portion of the trees, in a forest of more than one story, forming the upper or uppermost canopy layer.

Pioneer species: A species adapted to early stages of natural forest succession or growth on newly available sites.

Prescription: A management pathway to achieve a desired objective(s).

Primary wood-using mill: A mill that converts roundwood products into other wood products. Common examples are sawmills that convert saw logs into lumber and pulpmills that convert pulpwood into wood pulp.

Proforestation: is the practice of growing a forest and keeping it intact in order to maximize its ecological potential.

Proxy: Indirect measurement of climate aspects. Examples of proxy data are biological or physical records from ice cores, tree rings and soil boreholes.

Pulpwood: Roundwood, whole-tree chips or wood residues used for the production of wood pulp.

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

Reforestation: the reestablishment of forest cover either naturally or artificially.

Riparian area: An area with distinctive soils and vegetation between a stream or other body of water and the adjacent upland area consisting of vegetation that requires free or unbound, water for survival.

Roundwood products: Logs, bolts or other round timber generated from harvesting trees for industrial or consumer uses. Includes sawlogs; veneer and cooperage logs and bolts; pulpwood; fuelwood; pilings; poles; posts; hewn ties; mine timbers; and various other round, split or hewn products.

Saplings: Live trees 1.0 to 4.9 inches (2.5-12.5 cm) in diameter (DBH/DRC).

Seedlings: Live trees smaller than 1.0-inch (2.5 cm) DBH/DRC that are at least 6 inches (15.2 cm) in height for softwoods and 12-inches (30.5 cm) in height for hardwoods.

Shade tolerance: A tree's capacity to develop and grow in the shade of and in competition with, other trees. Examples of shade-tolerant species in the eastern US include American beech, sugar maple and dogwood.

Silviculture: Applying knowledge of silvics to culture the forest. Silviculture is practiced in four stages: establishment, intermediate operations and harvesting and stand/forest protection.

Site Index: Is a species-specific measure of actual or potential forest productivity, expressed in height of trees included in a specified stand component at a specified index or base age.

SLOSH model: (Sea, Lake and Overland Surges from Hurricanes) model is a numerical model used by the National Weather Service to compute storm surge. Storm surge is defined as the abnormal rise of water generated by a storm, over and above the predicted astronomical tides.

Soil productivity: Is defined as the capacity of soil, in its normal environment, to support plant growth and is reflected in the growth of forest vegetation or the volume of organic matter produced on a site.

Spatial Integrity: The integration of three important facets of fragmentation affecting some aspect of forest ecosystem functioning—patch size, local forest density and patch connectivity to core forest areas—to create a single resulting metric for comparison.

Species Composition: All species across genuses that collectively make up the diversity of trees existing in a forest (e.g., the species composition of a given area may consist of mixed oak, hickory, poplar and sweetgum).

Stakeholder: An individual or group that is directly or indirectly affected by or interested in the outcomes of decisions.

Stand: A group of trees on a minimum of 1 acre of forest land that is stocked by forest trees of any size.

Stand density: A quantitative measurement of tree stocking, expressed in terms of number of trees, total basal area or volume, per unit of area. More precisely, a measure of the degree of crowding of trees within a stand.

Stem exclusion: A stage in succession that follows crown closure in which, through competition for limited resources (light and water), a forest is thinned by natural mortality.

Succession: The process of one plant community modifying the environment in such a way that favors the establishment and eventual domination of another plant community. One overtakes another, which is then overtaken by another.

Thinning: The cutting and/or harvesting living trees to scientifically determined lower targeted densities, where a majority of the forest growth during this planning cycle in treated areas will come from existing living trees retained within the forest, rather than from the establishment of new trees (regeneration).

Timberland: Forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. (Note: Areas qualifying as timberland are capable of producing in excess of 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included.)

Understory: All forest vegetation growing under an overstory and midstory in a forest.

Urban heat island effect: The tendency for higher air temperatures to persist in urban areas because of heat absorbed and emitted by buildings and asphalt, tending to make cities warmer than the surrounding countryside.

Value-added product: A product that has had value added to it through further processing. Examples include windows, doors, kitchen cabinets, flooring and mouldings. Value-added pulp and paper products include items such as packaging, diapers, coated papers, tissue, business papers, stationery and other consumer paper products.

Vertical structure: The structure formed by different layers of vegetation in a forest.

Watershed: The area drained by an underground or surface stream or by a system of streams. 1) The region draining into a river, river system or body of water; or 2) subdivisions within a subbasin, which generally range in size from 40,000 to 250,000 acres; the fifth level (10-digit) in the hydrologic hierarchy.

Wildland-urban interface: The line, area or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. Describes an area within or adjacent to private and public property where mitigation actions can occur to prevent damage or loss from wildfire.

ACRONYMS & ABBREV.

ANJEE: Alliance for New Jersey Environmental Education

API: Application Programming Interface

BBD: Beech Bark Disease

BLD: Beech Leaf Disease

BLS: Bacterial Leaf Scorch

BMP: Best Management Practice

CAFRA: Coastal Area Facilities Review Act

CBT: Corporate Business Tax

CFA: Conservation Focal Area

CHANJ: Connecting Habitat Across New Jersey

CRSSA: Center for Remote Sensing and Spatial Analysis

CSO: Combined Sewer Overflow

CWPP: Community Wildfire Protection Plan

DCA: Damage Causing Agent

DVRCP: Delaware Valley Regional Planning Commission

EAB: Emerald Ash Borer

EHS: Eastern Hemlock Scale

ENSP: Endangered and Nongame Species Program

FDA: U.S. Food and Drug Administration

FHACA: Flood Hazard Area Control Act

FHTET: Forest Health Technology Enterprise Team (USDA Forest Service)

FIA: Forest Inventory and Analysis

FLA: Farmland Assessment

FL Area(s): Forest Legacy Area

FREC: Forest Resource Education Center

FSP: Forest Stewardship Program

GM: Gypsy Moth

HWA: Hemlock Wooley Adelgid

LiDAR: Light Detecting and Ranging

LWCF: Land and Water Conservation Fund

NGO: Non-Governmental Organization

NFI: National Forest Inventory

NJAISA: New Jersey Arborists, Chapter of the ISA

NJBPU: New Jersey Board of Public Utilities

NJDEP: New Jersey Department of Environmental Protection

NJDOT: New Jersey Department of Transportation

NJEDA: New Jersey Economic Development Authority

NJFA: New Jersey Forestry Association

NJUCF: New Jersey Urban and Community Forestry

NMSFA FRPC: Northeast Mid-west State Forester Alliance

NNL: No Net Loss

NOAA: National Oceanic and Atmospheric Administration

NWOS: National Woodland Owner Survey

ONLM: Office of Natural Lands Management

ONRR: Office of Natural Resource Restoration

RGGI: Regional Greenhouse Gas Initiative

SAF: Society of American Foresters

SCORP: (NJ) Statewide Comprehensive Outdoor Recreation Plan

SLF: Spotted Lantern Fly

SOD: Sudden Oak Death

SPB: Southern Pine Beetle

SPI: Shortleaf Pine Initiative

SWAP: (NJ) State Wildlife Action Plan

TDC: Thousand Canker Disease

TMDL: Total Maximum Density Load

TPO: Timber Product Output

UFIA: Urban Forest Inventory and Analysis

USDA APHIS: United States Department of Agriculture, Animal and Plant Health Inspection Service

USDA FS: United States Department of Agriculture, Forest Service

USDA FS FIA: United States Department of Agriculture, Forest Service, Forest Inventory and Analysis

USDA NRCS: United States Department of Agriculture, Natural Resources Conservation Service

U&M: Utilization and Marketing

UWFP: Urban Waters Federal Partnership

WMP: Woodland Management Plan

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"Private nonfarm employment: Forestry and logging" "Private nonfarm employment: Wood Product Manufacturing" "Private nonfarm employment: Paper Manufacturing" "Private nonfarm employment: Furniture and Related Product Manufacturing"

Table SA7N Wages and Salaries by NAICS Industry.
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USDA FOREST SERVICE MATRIX

NATIONAL PRIORITY 1: CONSERVE AND MANAGE WORKING FOREST LANDSCAPES FOR MULTIPLE VALUES AND USES

Strategy	Page	Criteria Impacted	*Resources Available	^Federal Programs	Performance Measures	National Priority	Multi-state/ agency
1: FOREST FUNCTION							
Age Class Distribution Young Forests/Mature Forests/Regeneration: Promote and manage for diverse distribution of forest age across the landscape. Ensure adequate forest regeneration into the future.	110	C1, C2, C3, C5	S/P/F	St	Water	1, 2, 3	Multi-Agency (NJ, F&W, ONLM)
Density Management: Conduct silviculture thinning for density across ownership lines: reducing stress-induced mortality, fuels and carbon emissions and improving growth of remaining trees. Mesophication: Alteration of forest density & composition to support hydrologic cycle.	112	C1, C2, C4	S/P/F/ Fire/ NGOs	Fire/St/H	Water/Fire	1, 2, 3	Multi-Agency (NJFFS)
Water Quality Filtration/Watershed Management: Apply silviculture prescriptions through multi-state/ regional initiatives, DCA mgt. and avoided land use conversions (AON, FL Areas) are strategized to reduce stress from competition and water. The creation of functional urban systems in a watershed via NJUCF sewershed goals.	116	C1, C4	S/P/F	St	Water	1,3	Multi-State/ Agency/Regional
2: FOREST RESTORATION							
Species of Concern: 1) Research life history and efficacy of restoration practices. 2) Restore and monitor species and systems of concern on the landscape.	121	C1-C5	S/P/F/Fire	St/H	Water/Fire	1, 2	Multi-State/ Agency
3: FOREST MANAGEMENT PLANS							
State lands: Provide scalable, data-drive approach to forest planning facilitating meaningful practices on the ground.	127	C1 thru C7	Fire/S	St/H/Fire/FL	Water/Fire	1, 2, 3	
Private lands: Incentives active sustainable forest stewardship on privately held properties.	128	C1 thru C7	S/P/F/Fire	St/H/Fire	Water/Fire/ Jobs	1, 2, 3	
CWPPs: Focus on three goals identified in National Cohesive Wildland Fire Management Strategies.	133	C1, C3	S/P/Fire/ NGOs	St/Fire	Fire	1, 2, 3	Multi-State
Fire as a Management Tool/Wildfire Mitigation: Mitigate cataphoric wildfire, make use of fire for restoration, regeneration, invasive control, establishment of rare plants, habitat for rare wildlife species.	134		S/P/NGOs/ FIRE	St/Fire/H	Fire/Jobs	1, 2, 3	Multi-Agency
Urban & Community Plans	132	C1 thru C7	S/L/F	St/U	Water/Fire/ Jobs	1, 2, 3	

Strategy	Page	Criteria Impacted	*Resources Available	^Federal Programs	Performance Measures	National Priority	Multi-state/ agency
4: INVENTORY							
Inventory: 1) Establish, implement and adapt scalable (both spatial and temporal) forest resource data collection for planning, decision, making and monitoring. 2) Support diverse distribution methods of inventory data for a wide variety of uses.	136	C1, C3, C7	S/P/L/F/Fire	St/H/U	Water/Fire/ Jobs	1, 2, 3	Multi-Agency (NJFFS, ONLM, NJ F&W)
5: FOREST PRODUCTS							
Current & Niche/Nontraditional Markets: Promote and understand current markets for forest products in NJ and the relationship to markets across stateliness. To establish connections between existing markets and forest resource management needs. Explorational of specialty and emerging markets for new products to enable forest resource management in line with societal values.	141	C 1, C2, C6	S/P/L/F	St/U	Jobs	1	Multi-State/ Multi-Agency
NATIONAL PRIORITY 2: PROTECT FORESTS FROM THREATS							
1: RESILIENCY							
Climate and Carbon: 1) Manage for diverse, resilient forest ecosystems that have the greatest chance of persisting as the global climate changes. 2) Recognize anthropogenic impacts that leave forest resources vulnerable to climate change and address in management planning. 3) Recognize and manage for carbon storage and sequestration (Carbon Offense and Carbon Defense).	145	C1, C3, C5	S/P/L/F	St/H/L	Water/Fire/ Jobs	1, 2, 3	Multi-State/ Agency
Policies Addressing Climate and Forest Carbon: Participate in regional, national and global initiatives (Re-entering RGGI, US Climate Alliance) addressing global climate change.	150	C5, C7	S/P/L	FL	Water/Fire/ Jobs	1, 2	
2: DCA's							
Forest Health: Establish preventative measures for DCA's, apply early detection, rapid response techniques where suppression is practical, regenerate and restore impacted forest ecosystems, establish and adhere to protocols for monitoring and reporting of trends.	151	C1, C3	S/P/U/F/Fire	St/H	Water/Fire/ Jobs	1, 2	Multi-Agency (NJFFS, ONLM, NJ F&W)
Wildfire Suppression: Maintain and adapt wildfire fighting capacity to facilitate resiliency communities that interface the forest.	159	C1, C3	S/P/U/ Fire/NGOs	ST/H	Fire/Jobs	2	Multi-Agency (NJFFS, ONLM, NJ F&W)
Herbivory: Address herbivory by mammals as a part of forest restoration and management.	159	C1, C3	S/P/U/F/Fire	St/H	Jobs	1, 2	Multi-Agency (NJFFS, ONLM, NJ F&W)

Strategy	Page	Criteria Impacted	*Resources Available	^Federal Programs	Performance Measures	National Priority	Multi-state/ agency
3: CLIMATE							
Climate: 1) Enable public entities to acquire properties vulnerable to storms and flooding. 2) Utilize forest legacy to acquire forested properties likely impacted by climate change or has potential to store and sequester carbon. 3) Participate in RGGI to disincentives emissions passing procedures to rate payers and providing funds for managing forest sequestering and storing carbon across programmatic boundaries. 4) Consider and recommend potential alternative species to maintain forest ecosystem function as climate impacts accelerate.	160	C1, C3, C5, C7	S/P/U/ F/NGOs	St/H/FL	Water/Jobs/ Fire	1, 2, 3	Multi-State/ Multi-Agency
4: FRAGMENTATION/HABITAT RESTORATION							
Priority areas of high integrity: Identify forest areas of high spatial integrity and potential corridors to connect these areas.	162	C1, C2, C4	S/P/U/F	St/H	Water/Fire	1, 2, 3	
Acquisition: Acquire forested properties of high integrity for public stewardship through Green Acres/FLPs; Facilitate acquisition by state and local governments and NGO partners.	162	C1, C2, C4, C6, C7	S/P/		Water/Fire	1, 2, 3	
Incentives: Provide tax incentives to keep high integrity forests as forests and manage core and connecting forest habitats appropriately. Encourage public lands managers to manage landscapes to protect spatial integrity and enhance connectivity where appropriate with tools such as CHANJ and USDA FS Spatial Integrity Index data; Good neighbor opportunities	166	C1, C3, C4, C6, C7	S/P/F	St/H	Water/Fire/ Jobs	1, 3	
No Net Loss: Disincentivize forest loss through development of state-owned, forested lands	166	C1, C6, C7	S/P		Water/Fire	2, 3	

NATIONAL PRIORITY 3: ENHANCE PUBLIC BENEFIT FROM TREES AND FORESTS

1: BIODIVERSITY							
Biodiversity in management: Adopt forest management policies including those that encourage structural complexity, spatial heterogeneity, natural disturbance cycles or biological legacies. Utilize scalable data, classification and forest stewardship practices as a part of these policies too.	166	C1, C2, C3	S/P/F/L	St/H	Water/Fire	1, 2, 3	

Strategy	Page	Criteria Impacted	*Resources Available	^Federal Programs	Performance Measures	National Priority	Multi-state/ agency
Biodiversity networking: Engage a broad range of experts in forest resource planning on public lands. Incentivize management for biodiversity through tax incentives. Document and distribute data and information regarding historic land use and ecosystem life history.	166	C1, C2, C3	S/P/F/L	St/H/U	Water/Fire/ Jobs	1, 2, 3	
2: RECREATION							
Update outdated and maintain existing facilities and infrastructure	168	C6	S/F/NGO	FL	Jobs	1, 3	Multi-Agency (NJPS)
Seek alternative funding	169		S/F/P/NGO	St	Water/Fire/ Jobs	3	
Address degradation of natural resources through use and other threats; Includes providing for responsible ORV use in State Parks and Forests, protecting water quality, thwarting the spread of invasive species.	169		S/F/NGO	St/H/Fire		1, 2, 3	Multi-Agency (NJPS)
3: EDUCATION/OUTREACH/COMMUNICATION							
Collaborative process: Provide robust, transparent and flexible stakeholder process and involvement; stakeholders involved as participants in forest planning process	171	C6, C7	S/P/U/F/Fire	St/H/Fire	Water/Fire/ Jobs	1, 3	Multi-Agency
Inclusion & Relevance: 1) Engage population in ways meaningful to them. 2) Understand and communicate broader range of conservation ideals and professional experiences. 3) Raise awareness of and address differences in values, backgrounds, and demographics of conservation professionals and population whose resources they manage.	171	C6, C7	S/P/U/F/Fire	St/H/U/FL/	Fire Water/ Fire/Jobs	1, 2, 3	Multi-Agency
Educational Programming: Partner and provide a wide range of educational programs that effectively message forest resource management goals	173	C6	S/P/NGO/F/ U/Fire		Water/Fire/ Jobs	1, 2, 3	Multi-Agency
Communication/Social Media/Digital Engagement: Provide effective messaging to a wide array of audiences by leveraging multiple diverse platforms including digital media, audio, data dashboards and web products, social media, video games and applications.	178		Fire/S/U/P	St/Fire/H	Water/Fire/ Jobs	1, 2, 3	Multi-State/ Multi-Agency
FREC: Provide a physical nexus for education and interpretation in the state; includes potential outreach by multiple partners including academic institutions, professional organizations	179		S/P/Fire/U	St/H/Fire		1, 2, 3	
Big Tree and Heritage Tree: Provide messaging about the importance of trees through recognition of champion and historic trees.	181		S/P/U/F/Fire	St/H		1, 3	

Strategy	Page	Criteria Impacted	*Resources Available	^Federal Programs	Performance Measures	National Priority	Multi-state/ agency
Rutgers Extension: Support development of forestry programs at Rutgers University; provide continuing education opportunities; Facilitate mandatory NJUCF CORE program	182		S/P/U/F/Fire	St/H	Water/Fire	1, 3	
Data-Driven Strategic Planning and Management: Embrace emerging data processing and analytical technologies and techniques; Improve ethical distribution of data, data products and software products, prepare traditional domain experts to leverage emerging and otherwise useful technologies for forest resource management; Provide data services, software development assistance to multi-state, NGO, federal and academic institutions	182		S/P/U/NGO/ F/L/Fire	St/H/ U/Fire	Water/Fire/ Jobs	1, 3	Multi-State/ Multi-Agency
5: GAPS							
Identify data, methods, information and procedures not fully addressed for various reasons during this planning cycle.	183		S/P/U/F/Fire	St/H/ Fire/FL	Water/Fire/ Jobs	1, 2, 3	Multi-State/ Multi-agency

*Resources Available: State (S), Private (P), Fire, Federal -NRCS/Military installations (F), Local government (L), NGO

^Federal Programs: Stewardship (St), Forest Legacy (FL), Fire, Health (H), Urban & Community (U)

Statewide Forest Resource Assessments and Strategies (State Forest Action Plans) Requirements Checklist for New Jersey

State Forest Assessments and Strategies must be updated at least every 10 years and submitted to the relevant USDA Forest Service (FS) Region or International Institute of Tropical Forestry (IITF) with this checklist signed by the State Forester. Federal review will focus on these requirements as outlined in the Cooperative Forestry Assistance Act SEC. 2A. [16 U.S.C 2101a] (amended by the 2008, 2014, and 2018 Farm Bills).

Submitted by the State Forester: John N Sacco

State Forester certifies the required elements below are included. Click above to e-sign if possible.
FS Region or IITF fills out the checklist.

Statewide Forest Resource Assessment Includes:

The conditions and trends of forest resources in the state ..... Yes ☒ No ☐
The threats to forest lands and resources in the state consistent with national priorities ..... Yes ☒ No ☐
Areas or regions of the state that are a priority ..... Yes ☒ No ☐
Any multi-state areas that are a regional priority ..... Yes ☒ No ☐

Statewide Forest Resource Strategy Includes:

Long-term strategies to address threats to forest resources in the state* ..... Yes ☒ No ☐
Description of resources necessary for state forester to address statewide strategy* ..... Yes ☒ No ☐
Strategy addresses national priorities for state and private forestry ..... Yes ☒ No ☐

** Can be presented in a strategies matrix with columns for (a) programs that contribute, (b) resources required, (c) national priority(ies), and (d) performance measure(s) that will be used for each strategy (optional).*

Stakeholder Groups Coordinated with for the Statewide Assessment and Strategy:

Note: this can be identified in the body of the documents or in an appendix.

State Forest Stewardship Coordinating Committee (required) ..... Yes ☒ No ☐
State Wildlife Agency (required) ..... Yes ☒ No ☐
State Technical Committee (required) ..... Yes ☒ No ☐
Lead agency for the Forest Legacy Program (if not the state forestry agency) (required) ..... N/A ☐ Yes ☒ No ☐
Applicable Federal land management agencies (required) ..... Yes ☒ No ☐
Military installations (as appropriate and feasible) ..... Yes ■ No ☐

Other Plans Incorporated in the Statewide Assessment and Strategy:

Community wildfire protection plans (required) ..... Yes ☒ No ☐
State wildlife action plans (required) ..... Yes ☒ No ☐
Other ..... Yes ☒ No ☐

Forest Legacy Program (FLP) Requirements Included (for States with FLP) ..... N/A ☐ Yes ☒ No ☐

See Forest Legacy Program Implementation Guidelines. Some options include:

- All required Forest Legacy components are integrated into the State Forest Action Plan (Assessment and/or Strategy), including Eligibility Criteria to identify Forest Legacy Areas, delineation of Forest Legacy Areas, and outline of the State's project evaluation and prioritization procedures. These elements are reviewed by the FS Region or IITF FLP staff as part of the assessment and strategy certification process. It is helpful to provide a crosswalk to identify location of FLP components in the State Forest Action Plan.
- A separate Forest Legacy Assessment of Need document (with above Forest Legacy requirements) is included as an appendix of the State Forest Action Plan. This document has been previously approved by the FS Region or IITF Forest Legacy Program staff. Documentation of FS approval and most recent review by the State Forest Stewardship Committee review should also be provided.

Review by FS Regional Forester or IITF Director *(as relevant)**:***

☒ **Deemed Sufficient (all requirements met)**
Comments: Pleased to recommend for approval. See additional requirements documentation in Pinyon.

☐ **Deemed Not Sufficient (missing one or more requirements)** Corrective Action(s) Necessary to Meet Sufficiency Requirement:

Certified by Regional Forester or IITF Director:

Decision by Forest Service Deputy Chief for State and Private Forestry:

Approval authority delegated from the USDA Secretary. **Approve:** ■ **Disapprove:** ☐

Forest Service, Deputy Chief for State and Private Forestry:

THE 2020 ASSESSMENT OF NEW JERSEY'S FOREST RESOURCES

This assessment uses the Montreal Process' seven criteria:

1. Conserve Biological Diversity
2. Maintain Productive Capacity of Forest Ecosystems
3. Maintain Forest Ecosystem Health and Vitality
4. Conserve and Maintain Soil and Water Resources
5. Maintain Forest Contributions to Global Carbon Cycles
6. Maintain and Enhance Long-Term Multiple Socioeconomic Benefits to Meet the Needs of Societies
7. Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

NATIONAL PRIORITIES

Strategies guiding forest management in New Jersey connect and scale on a global, national, regional, state, and local levels.

1. Conserve and Manage Working Forest Landscapes for Multiple Values and Uses
2. Protect Forests from Threats
3. Enhance Public Benefits from Trees and Forests