Forest Resiliency: A Natural Climate Solution

Envirothon Forestry Training
Delaware Department of Agriculture
February 22, 2025

Michael A. Valenti
Outreach & Site Director
Abbott's Mill Nature Center

Delaware

- 1.2 million acres
- Approx. 1/3 forested

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- *Clean air and water*
- *Moderate temperatures*
- *Erosion control*
- *Wildlife habitat*
- *Recreation*
- *Hunting*
- *Forest products*
- *Carbon storage/sequestration*

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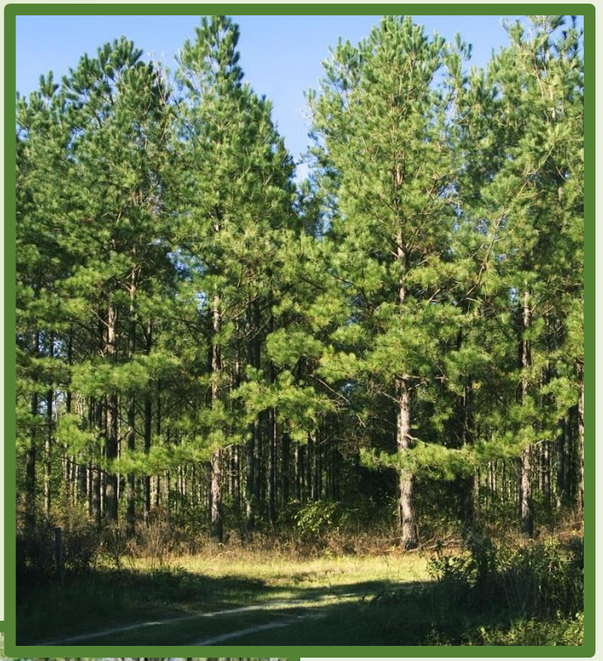
Forests are recognized as a vital part of our society's essential <u>INFRASTRUCTURE</u>

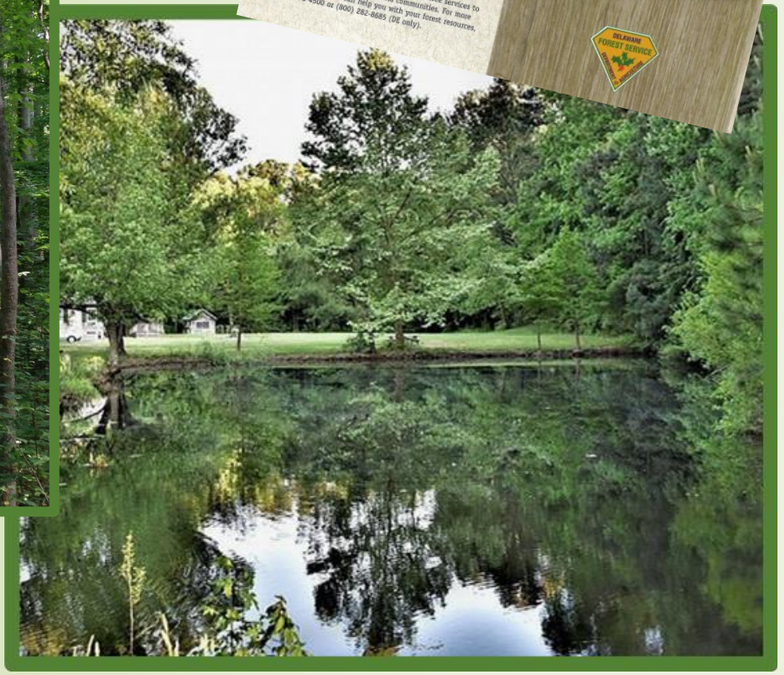
High tree div… because Delaware is in a flora… between:

- *Nor… …ods*
- *Sou… …es*
  - *Lo…*
  - *Sou… …ds*
  - *Botto… …oods*
  - *Cypre… …amps*



Delaware State Forests

“Discover the Hidden Beauty”



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Blackbird State Forest

6,031 acres near Townsend - New Castle Co.

Taber State Forest

1,323 acres in southwestern - Kent Co.

Redden State Forest

14,009 acres N of Georgetown - Sussex Co.

21,363 Total Acres

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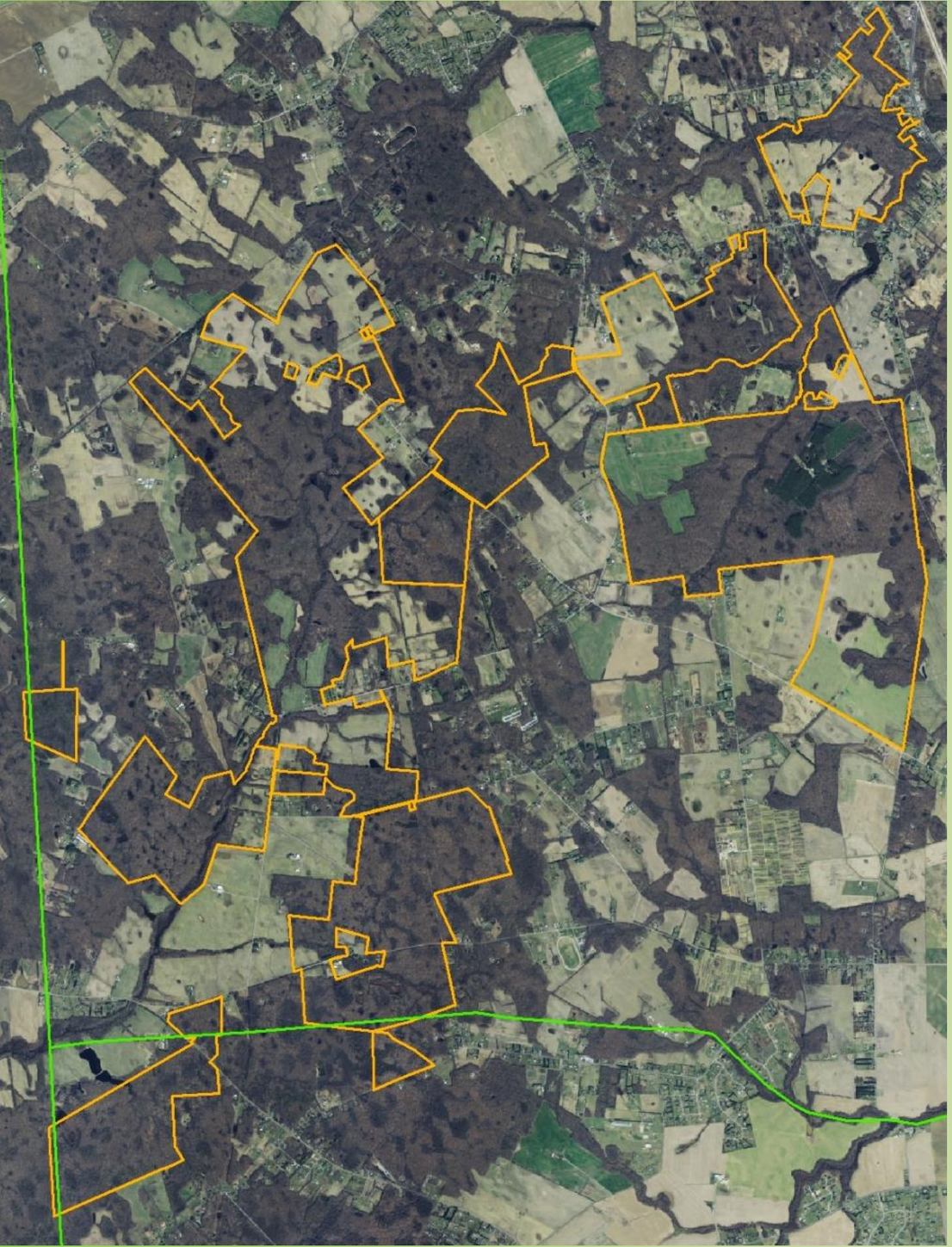

Blackbird State Forest

northwest of Smyrna
6,031 total acres
1,660 acres of cropland
mixed hardwoods
eastern white pine
loblolly pine
vernal pools
trail system

Naudain Tract

vernal pools and Ambystomid salamanders

Taber State Forest

southwest of Harrington
1,323 total acres
432 acres of cropland
mixed hardwoods
loblolly pine
primitive lands

Trice Tract

dozens of shallow pools created for wildlife habitat

Redden State Forest

north of Georgetown
14,009 total acres
176 acres of cropland
loblolly pine management
mixed hardwoods

historical structures

Jester Tract

Quality Deer Management

5,000 acres cut per year prior to 2008
2,500 acres per year after 2008

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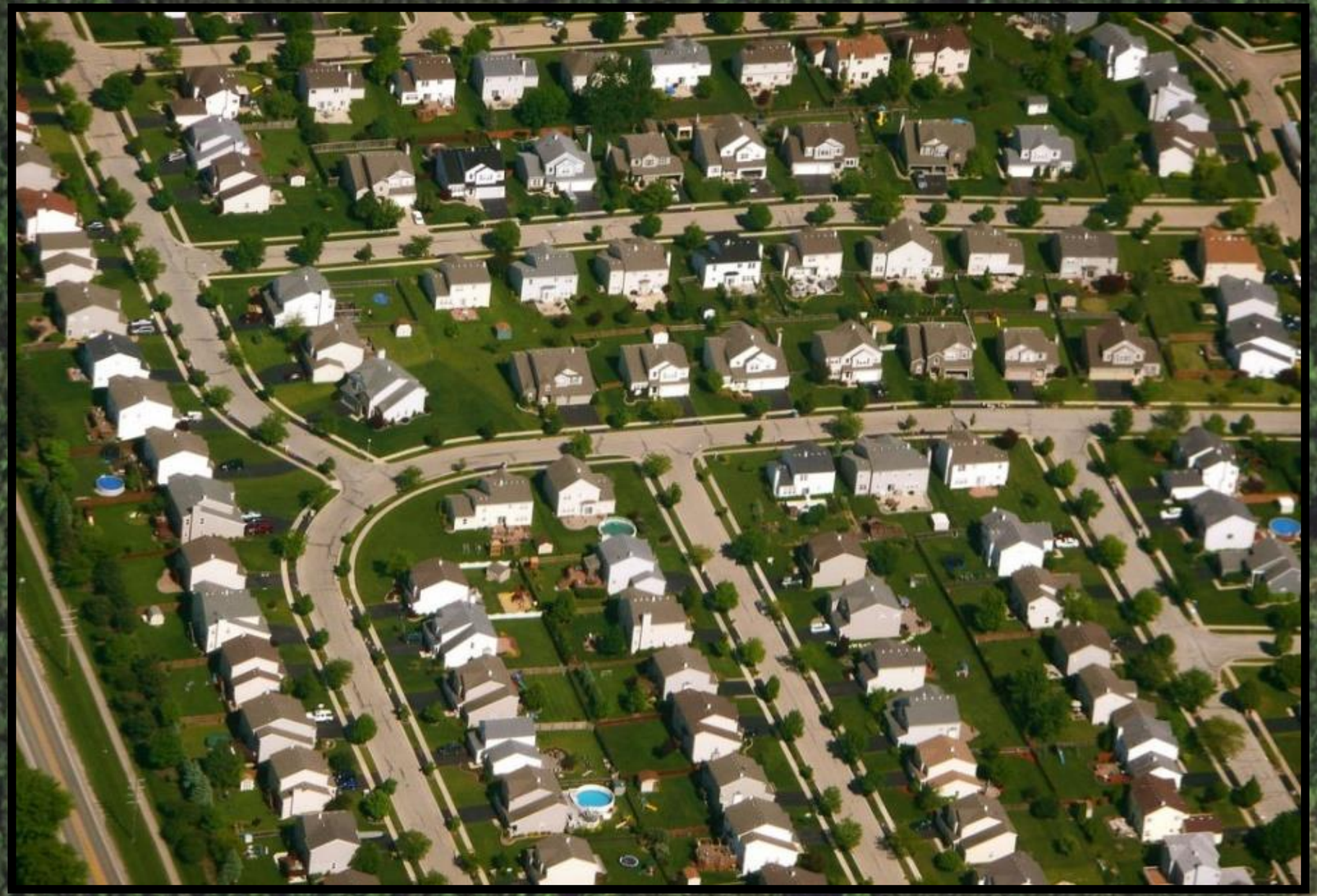

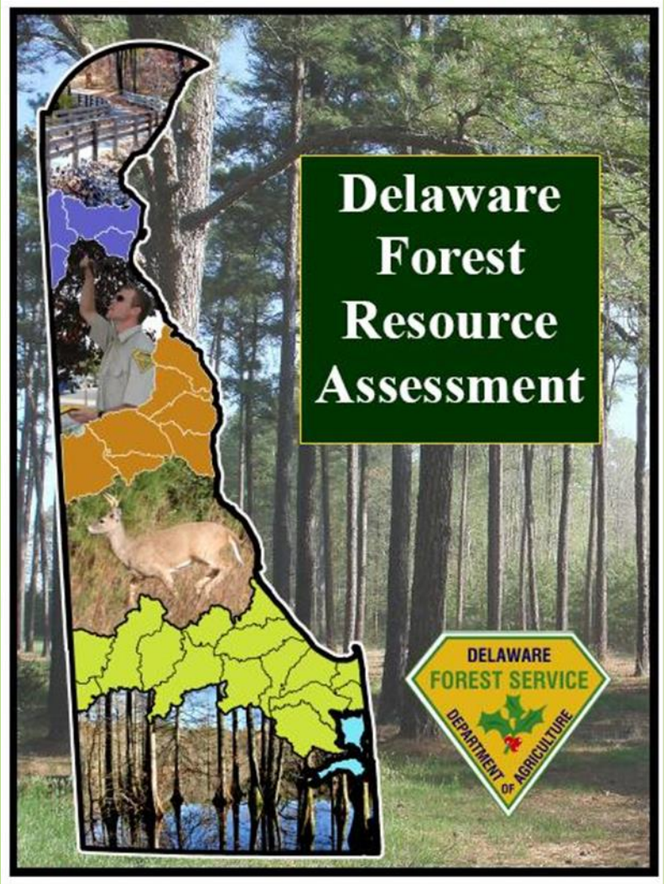

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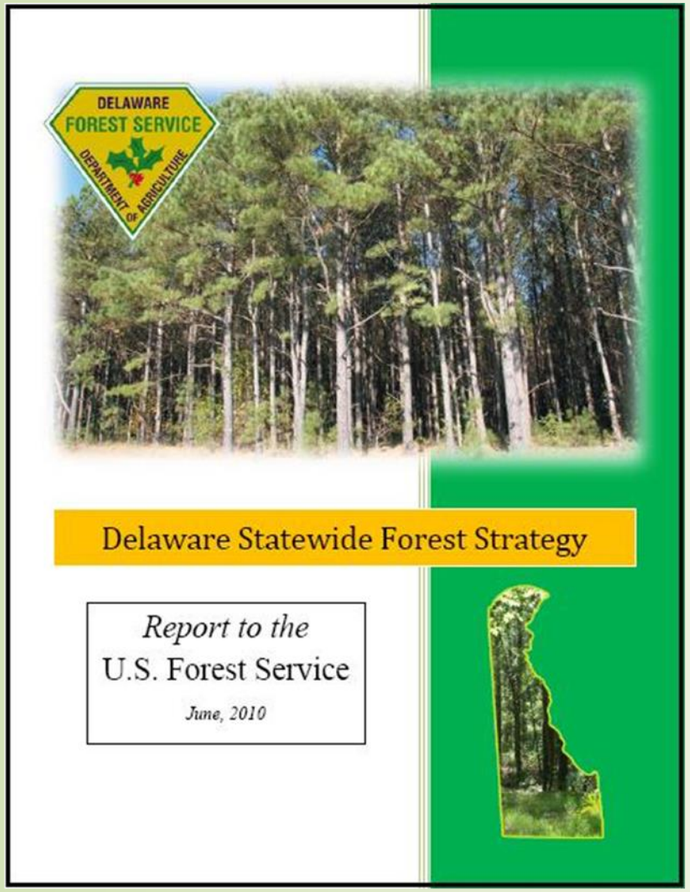

= **Forest Action Plan**

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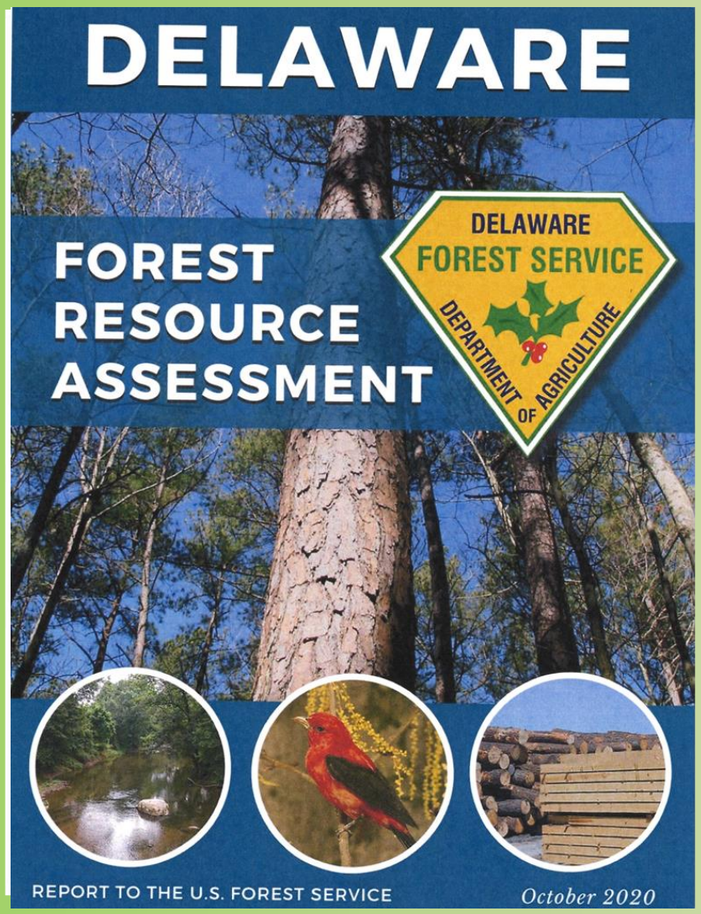

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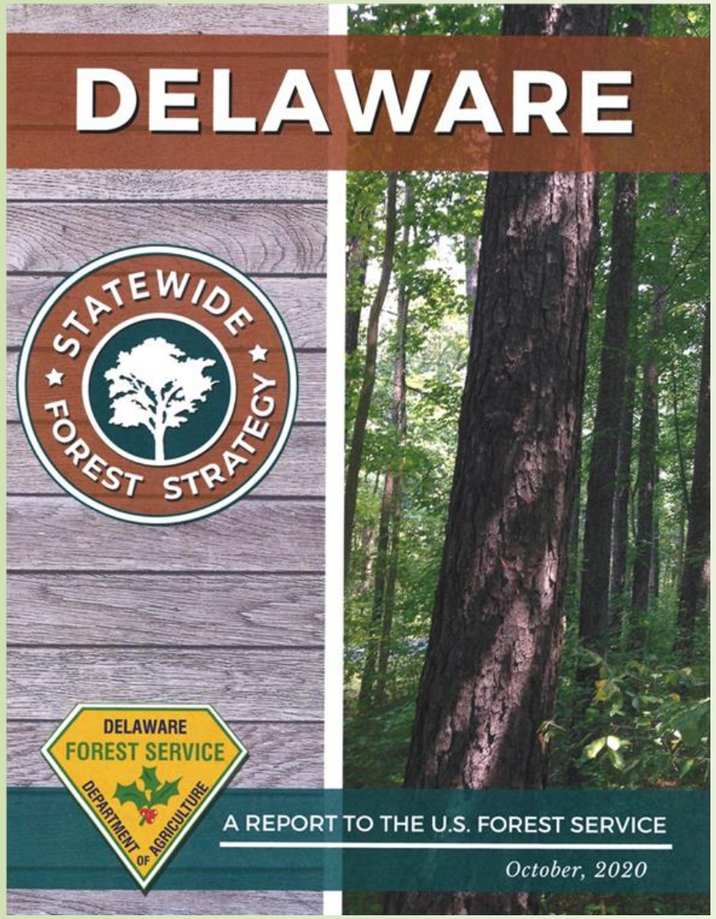
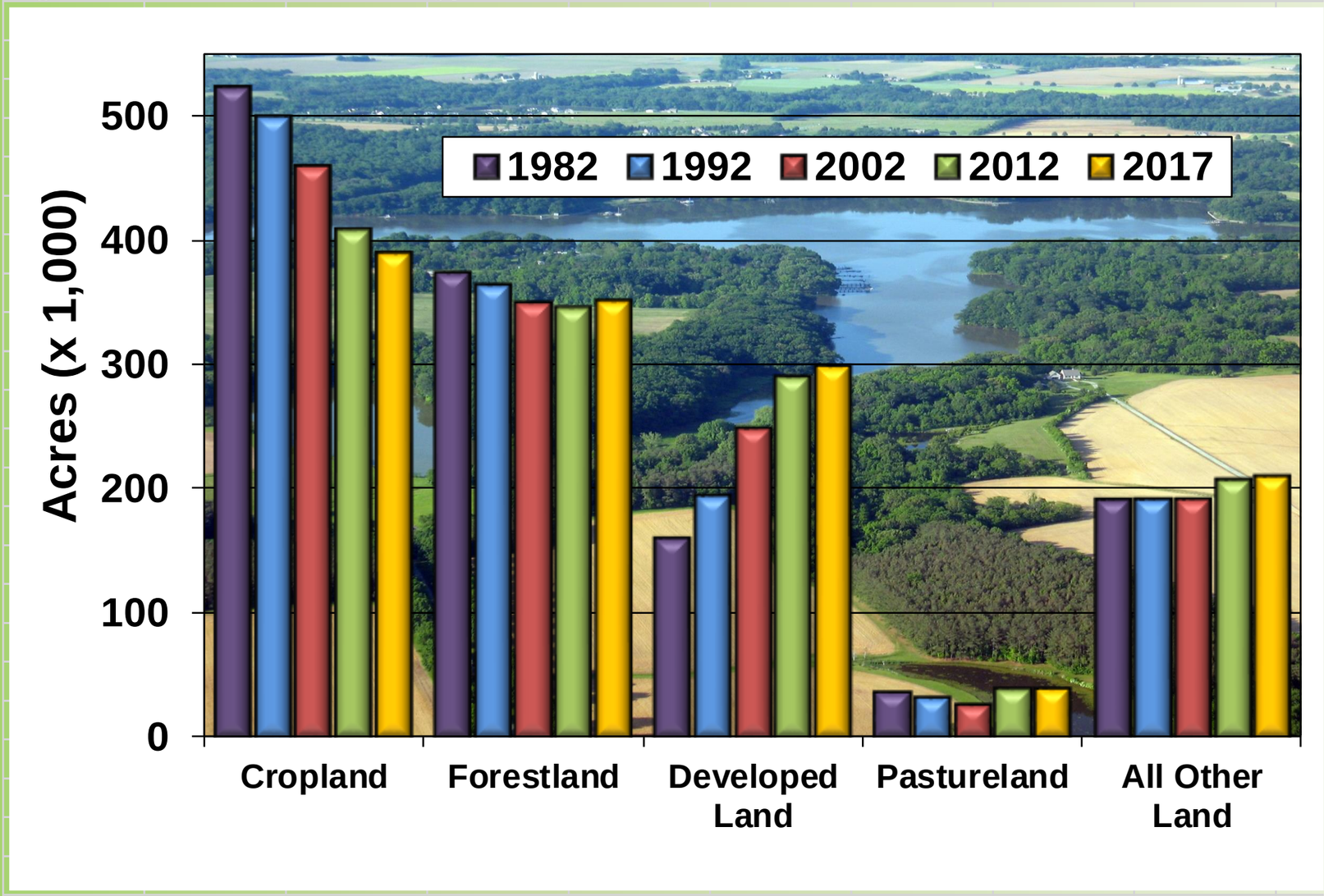


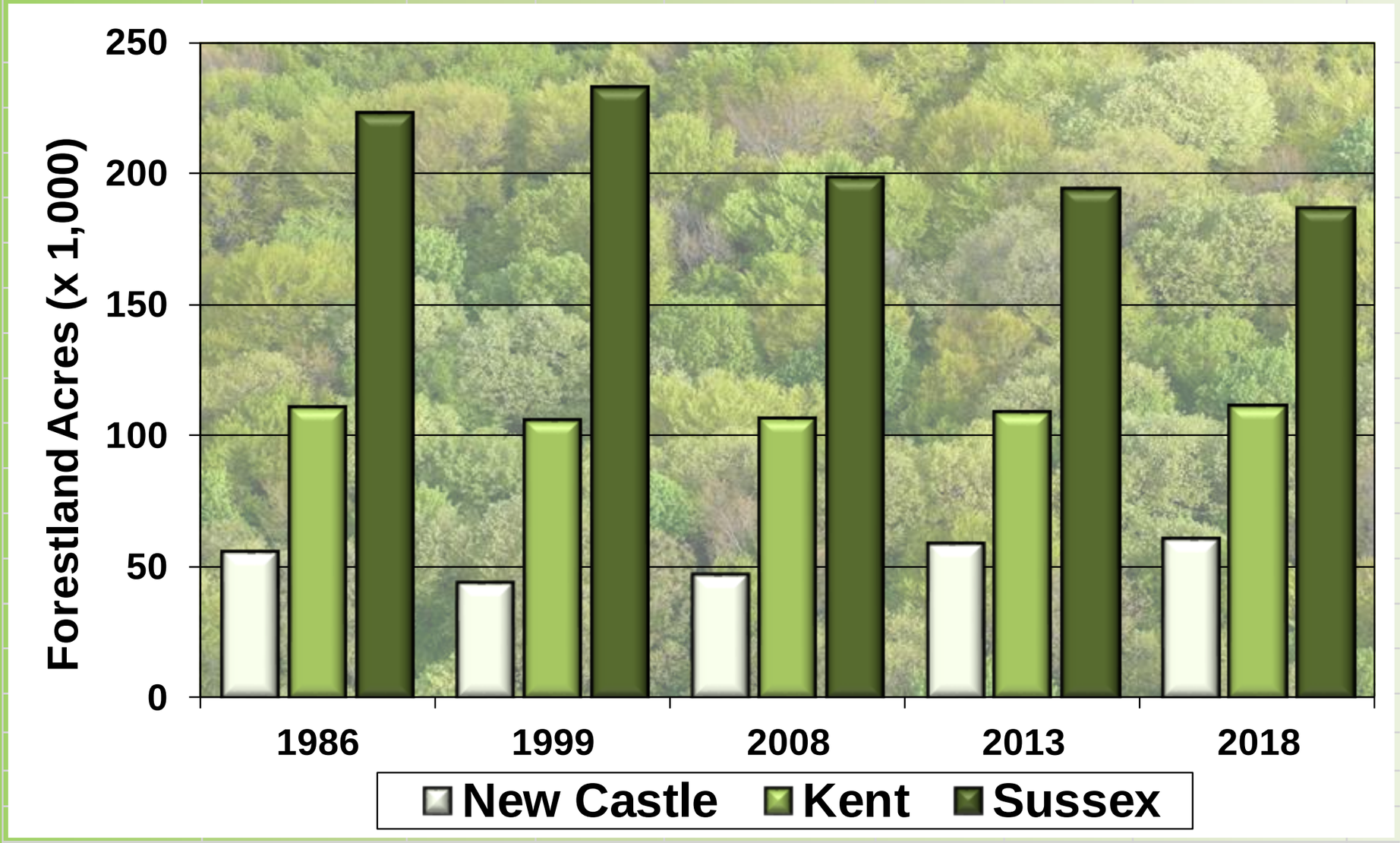
= **Forest Action Plan**

Figure 2. Acres by land cover type in Delaware, 1982–2017.



Source: USDA NRCS 2017 National Resoucres Inventory Summary Report.

Figure 3. Delaware forest acres by county, 1986–2018.



Source: U.S. Forest Service Forest Inventory and Analysis.

Table 1. Delaware forest acres.

Year	*Acres (x 1,000)*
1907	350
1920	351
1938	423
1953	454
1963	392
1977	392
1986	389
1999	382
2008	352
2012	348
2016	355
2018	359

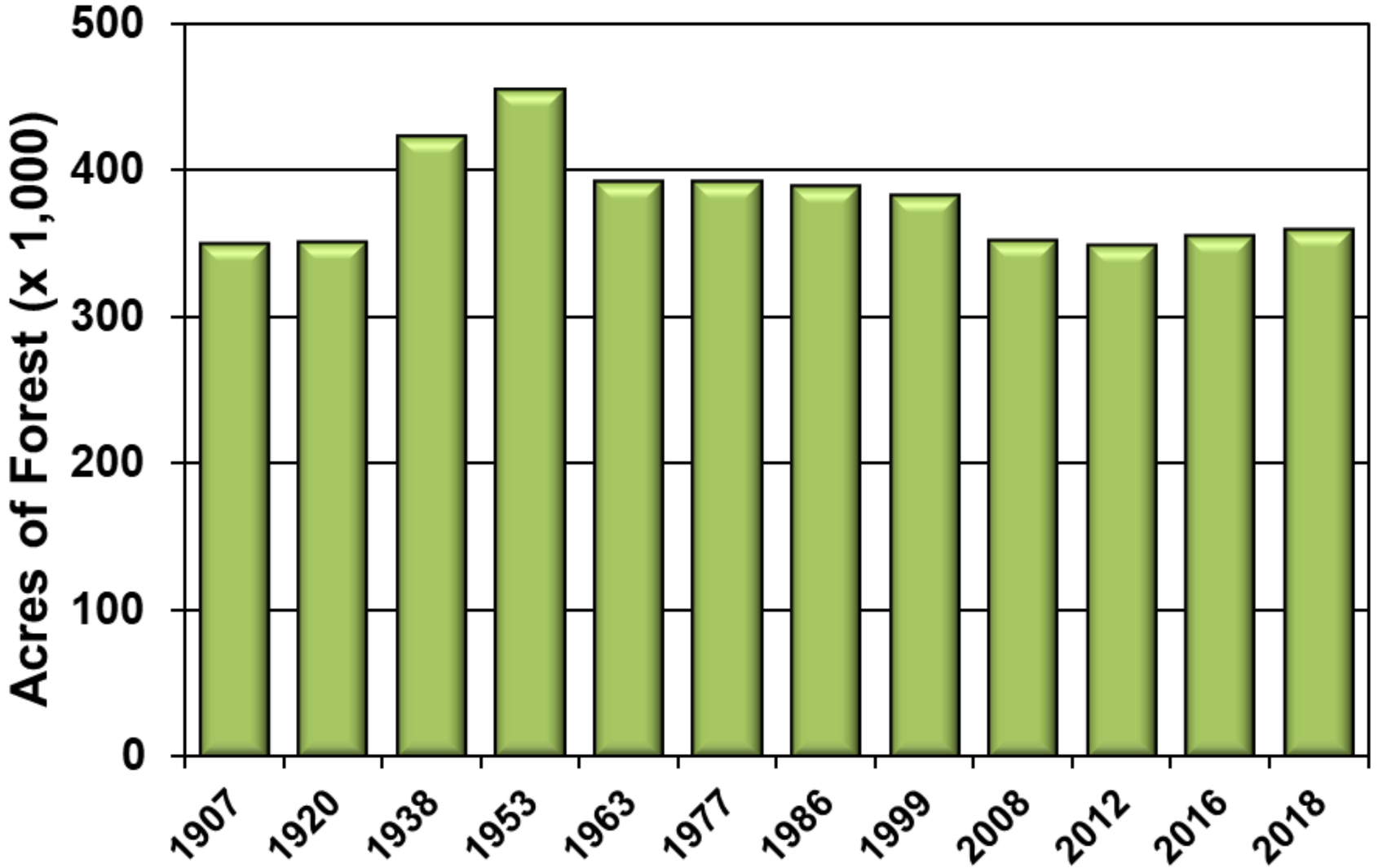
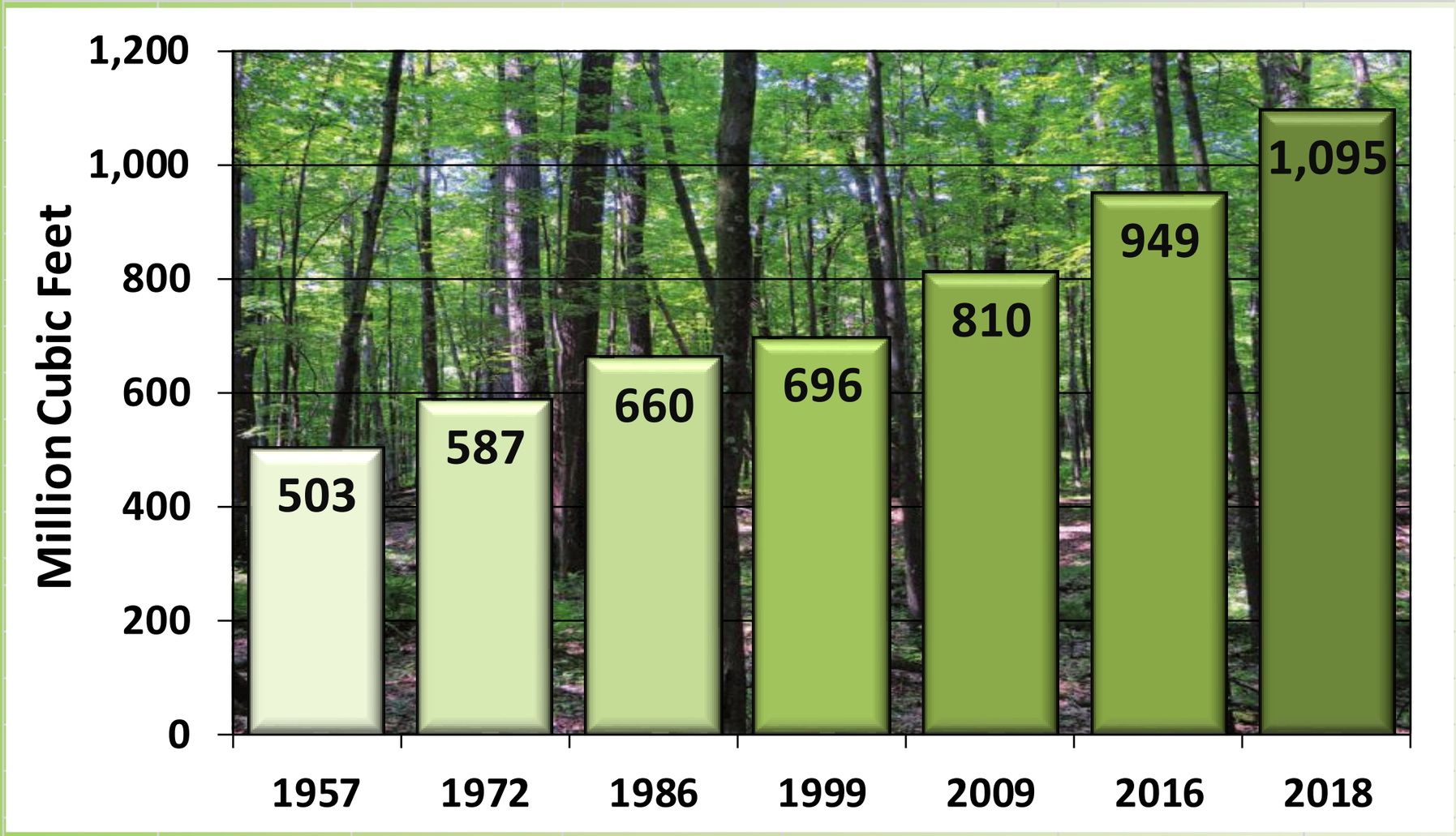
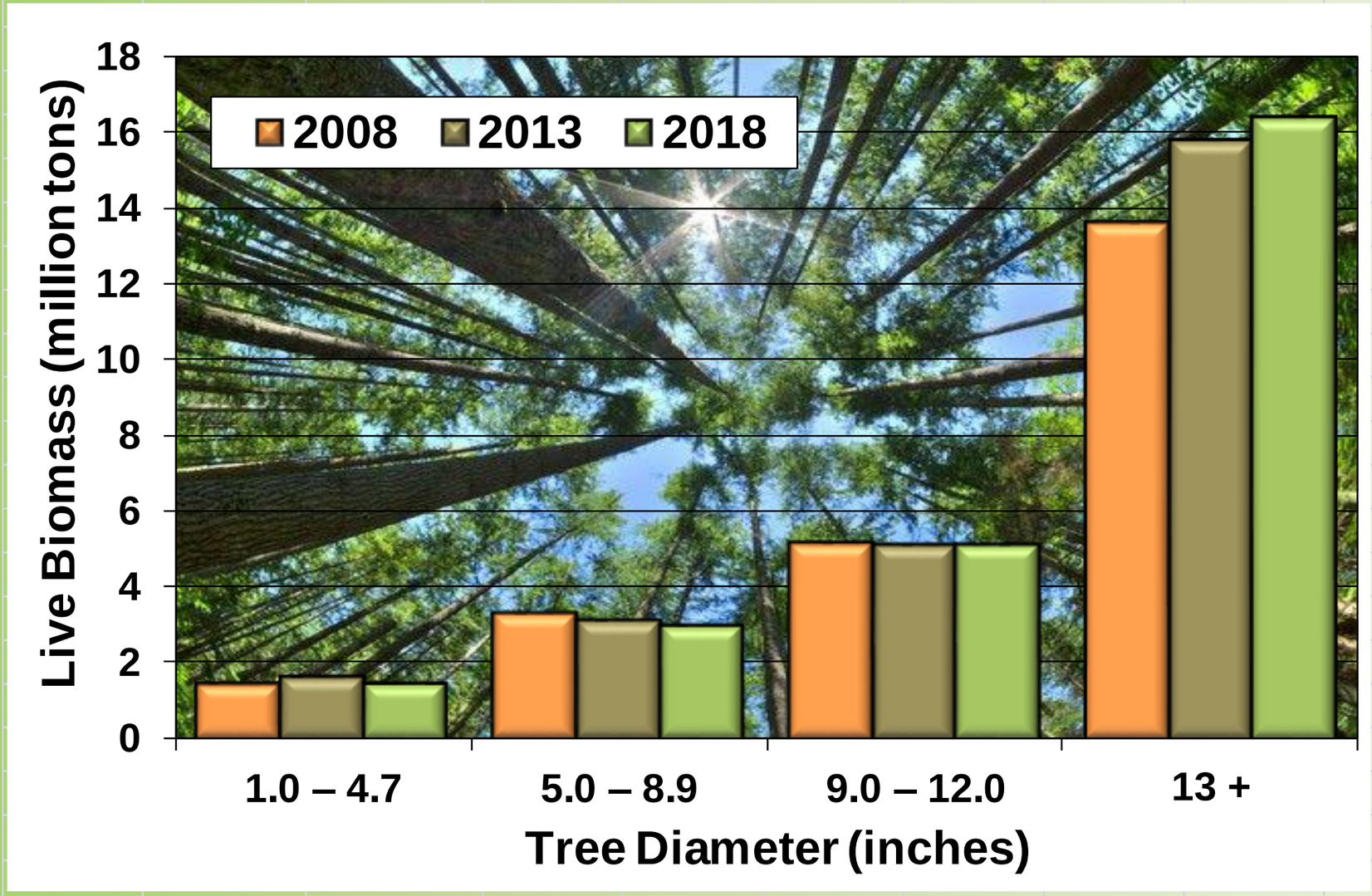


Figure 10. Net volume of trees in Delaware for all diameter classes, 1957–2018.



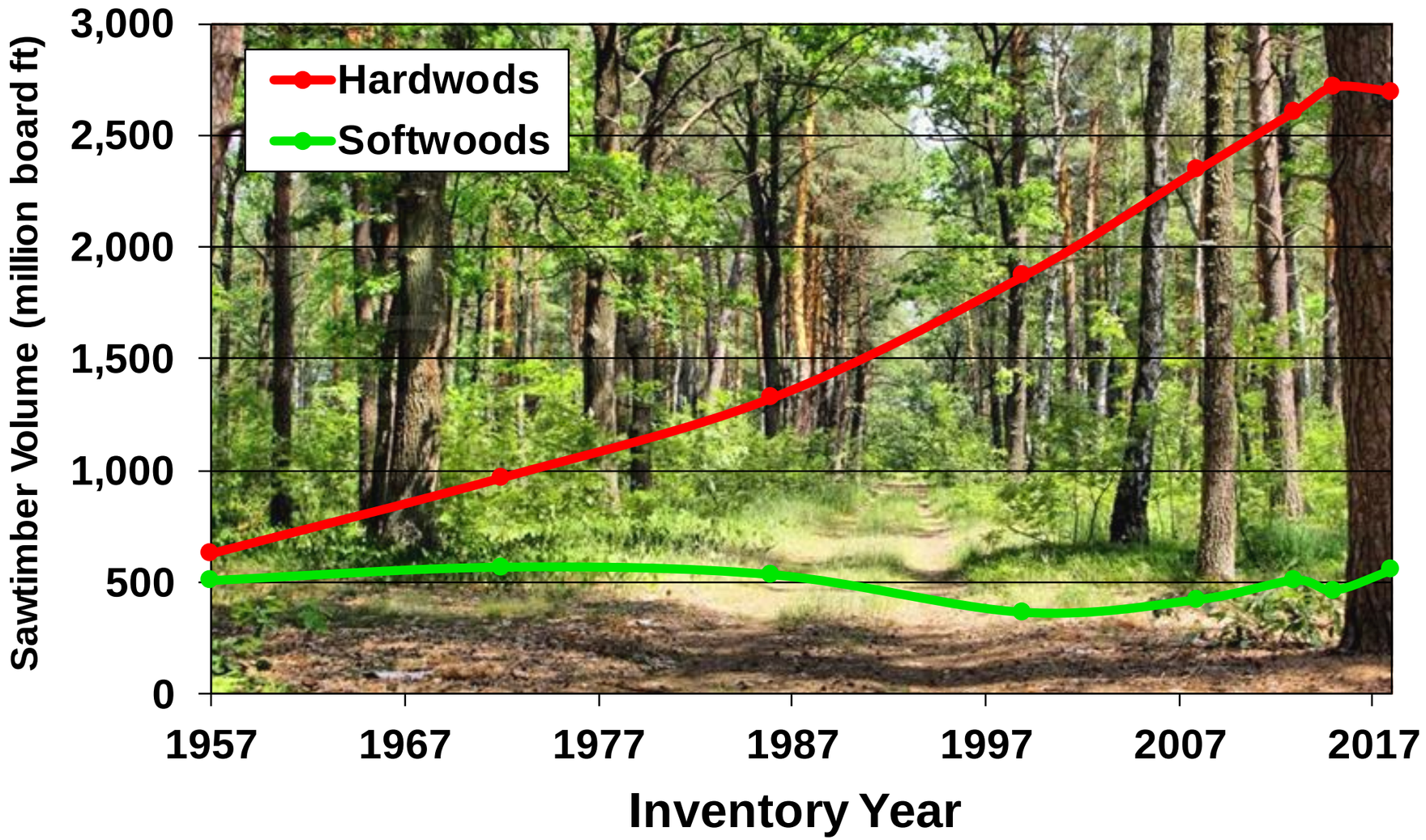
Source: U.S. Forest Service Forest Inventory and Analysis.

Figure 12. Live-tree biomass (trees at least 1 inch dbh) on forestland by diameter class, 2008–2018.



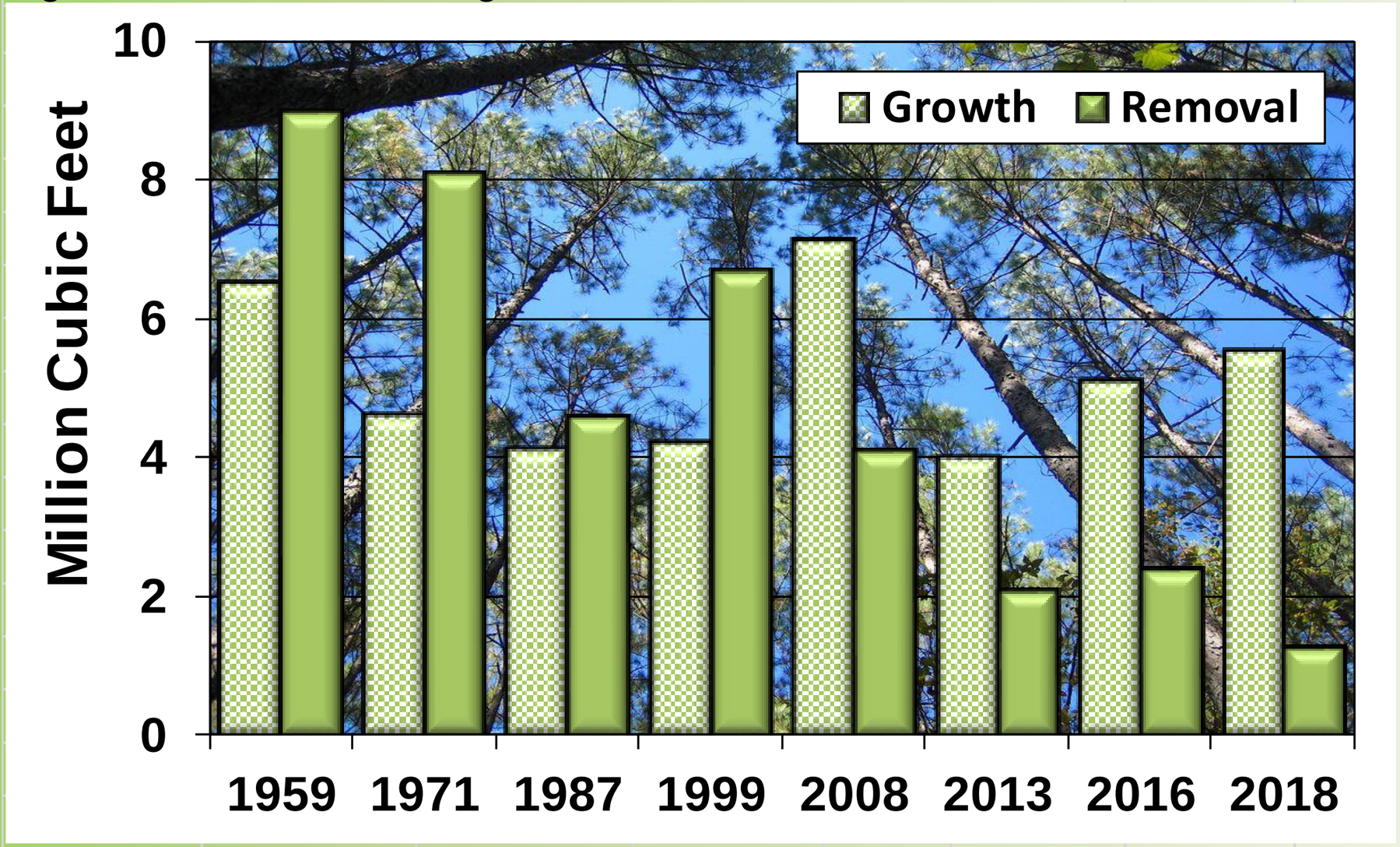
Source: U.S. Forest Service Forest Inventory and Analysis.

Figure 14. Sawtimber volume in board feet (1/4-inch rule), 1957–2018.



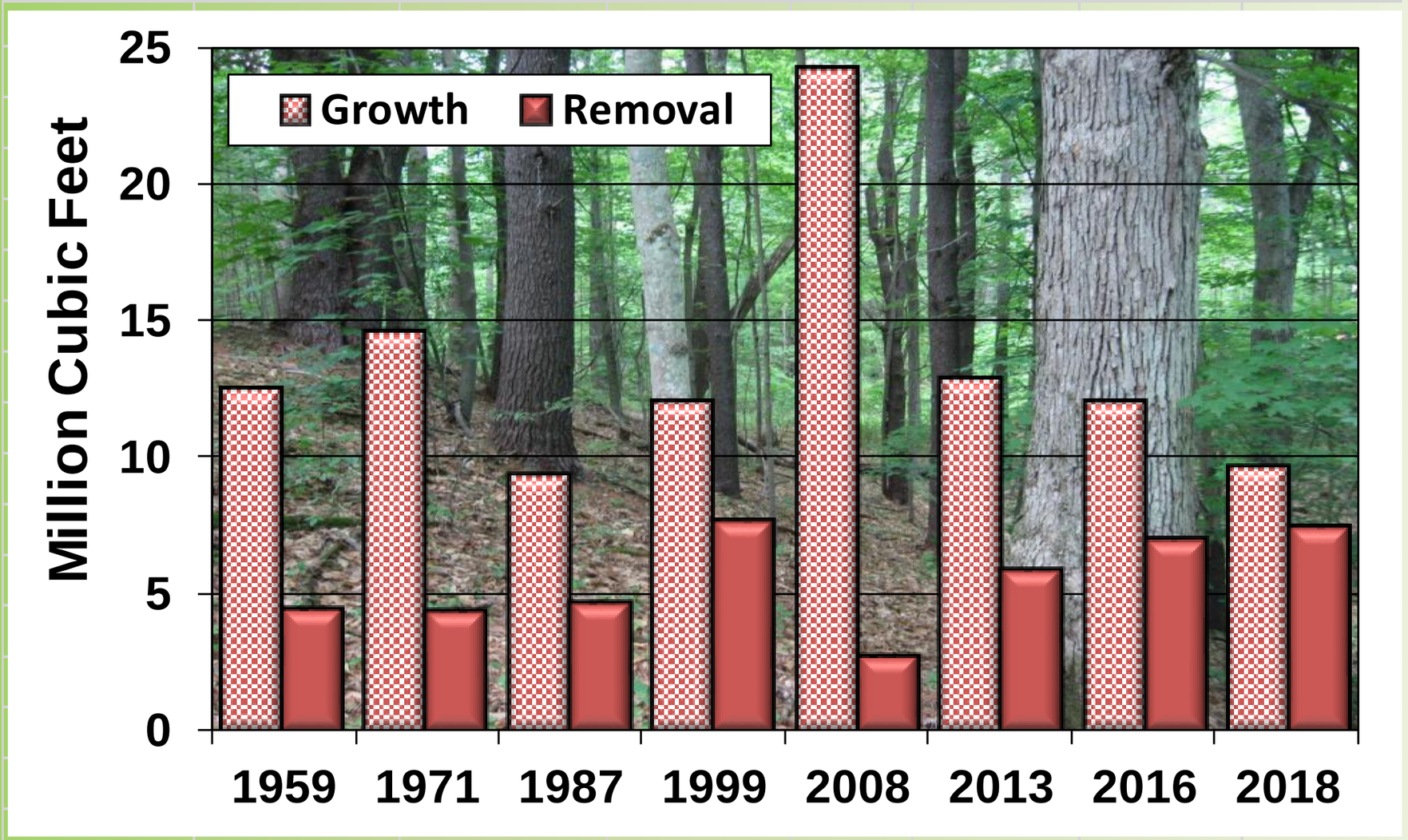
Source: U.S. Forest Service Forest Inventory and Analysis.

Figure 21. Annual softwood growth and removals, 1959–2018.



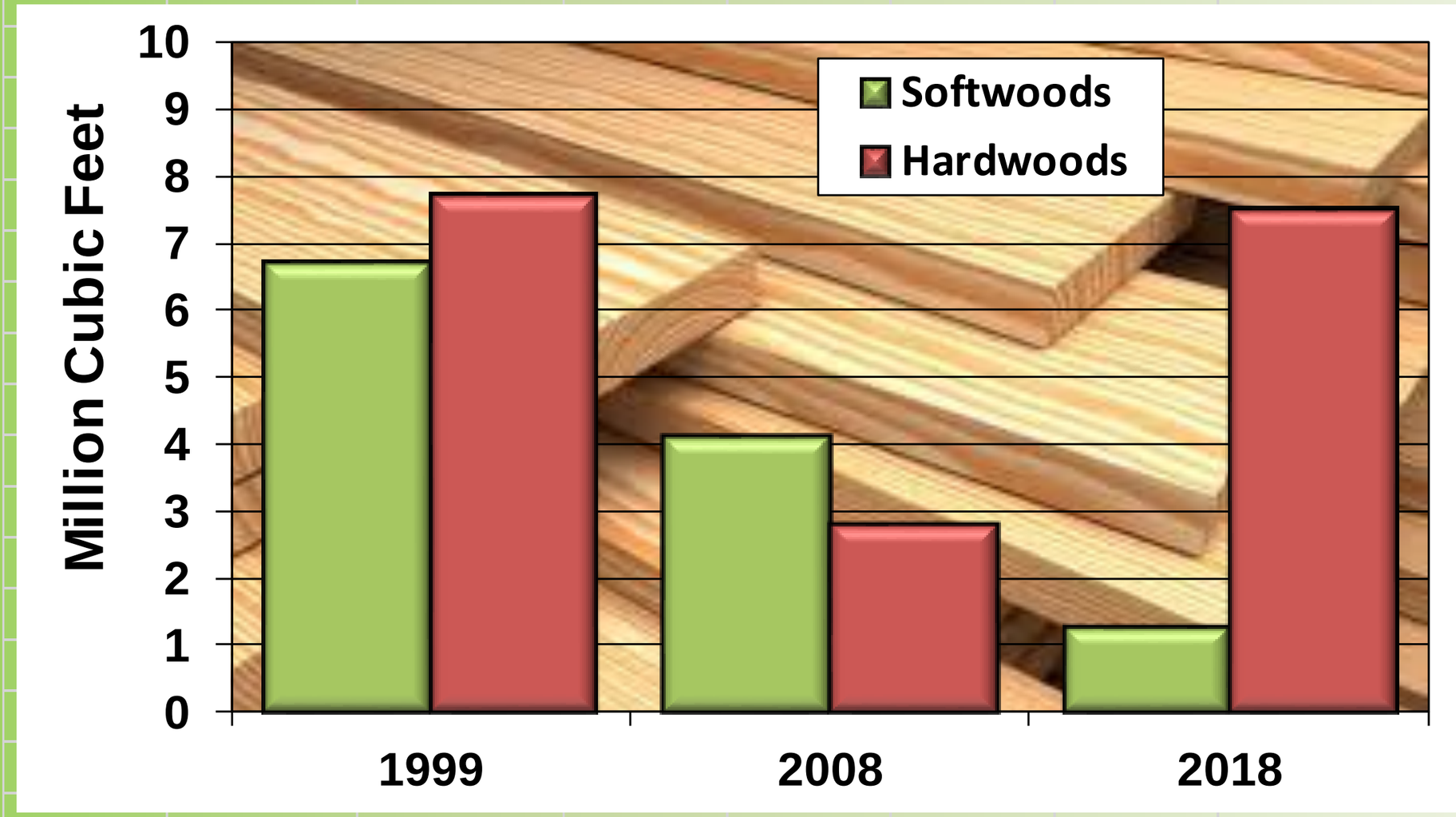
Source: U.S. Forest Service Forest Inventory and Analysis.

Figure 22. Annual hardwood growth and removals, 1959–2018.



Source: U.S. Forest Service Forest Inventory and Analysis.

Figure 35. Wood removals in Delaware, 1999, 2008 and 2018.



Source: U.S. Forest Service Forest Inventory and Analysis.

Figure 23. Annual mortality of growing-stock trees (at least 5 inches dbh), 2008–2018.

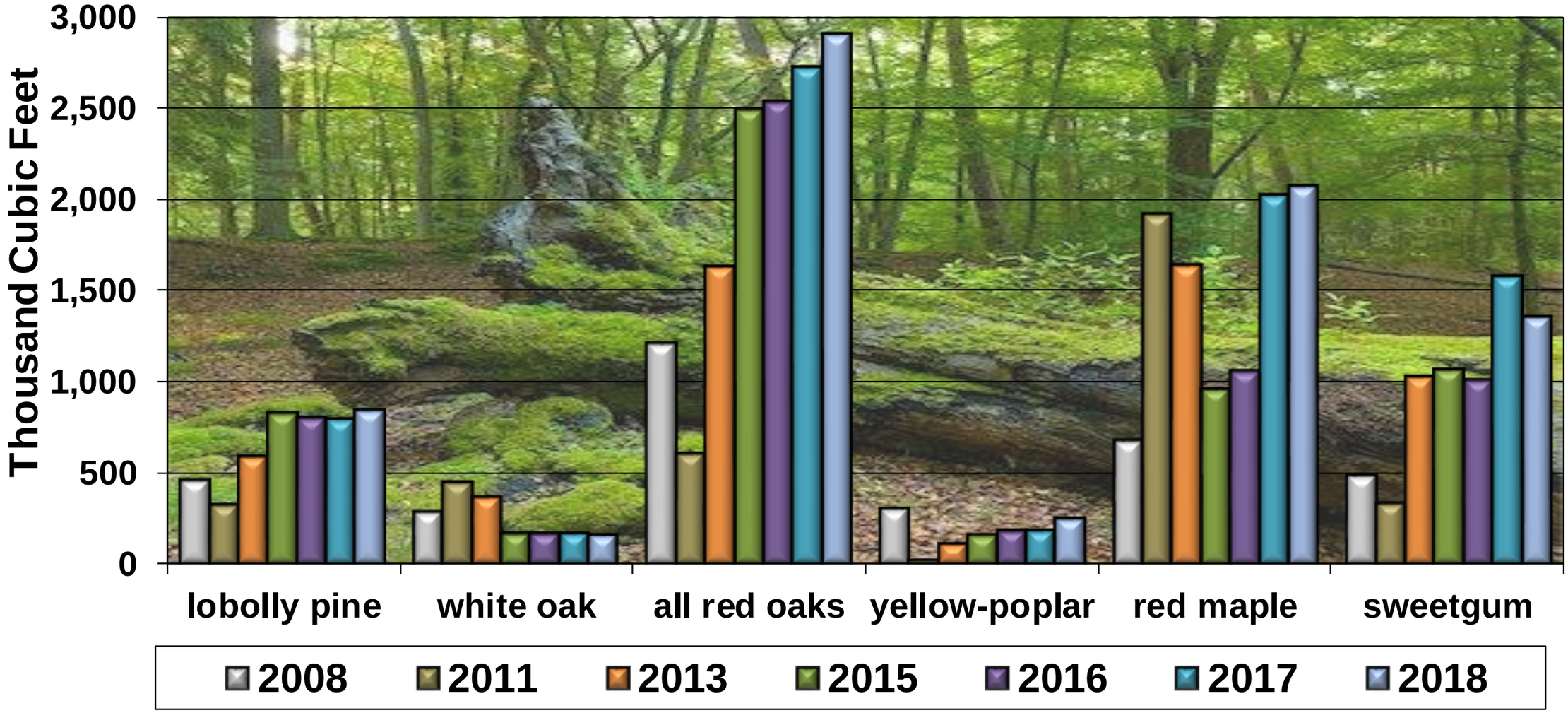
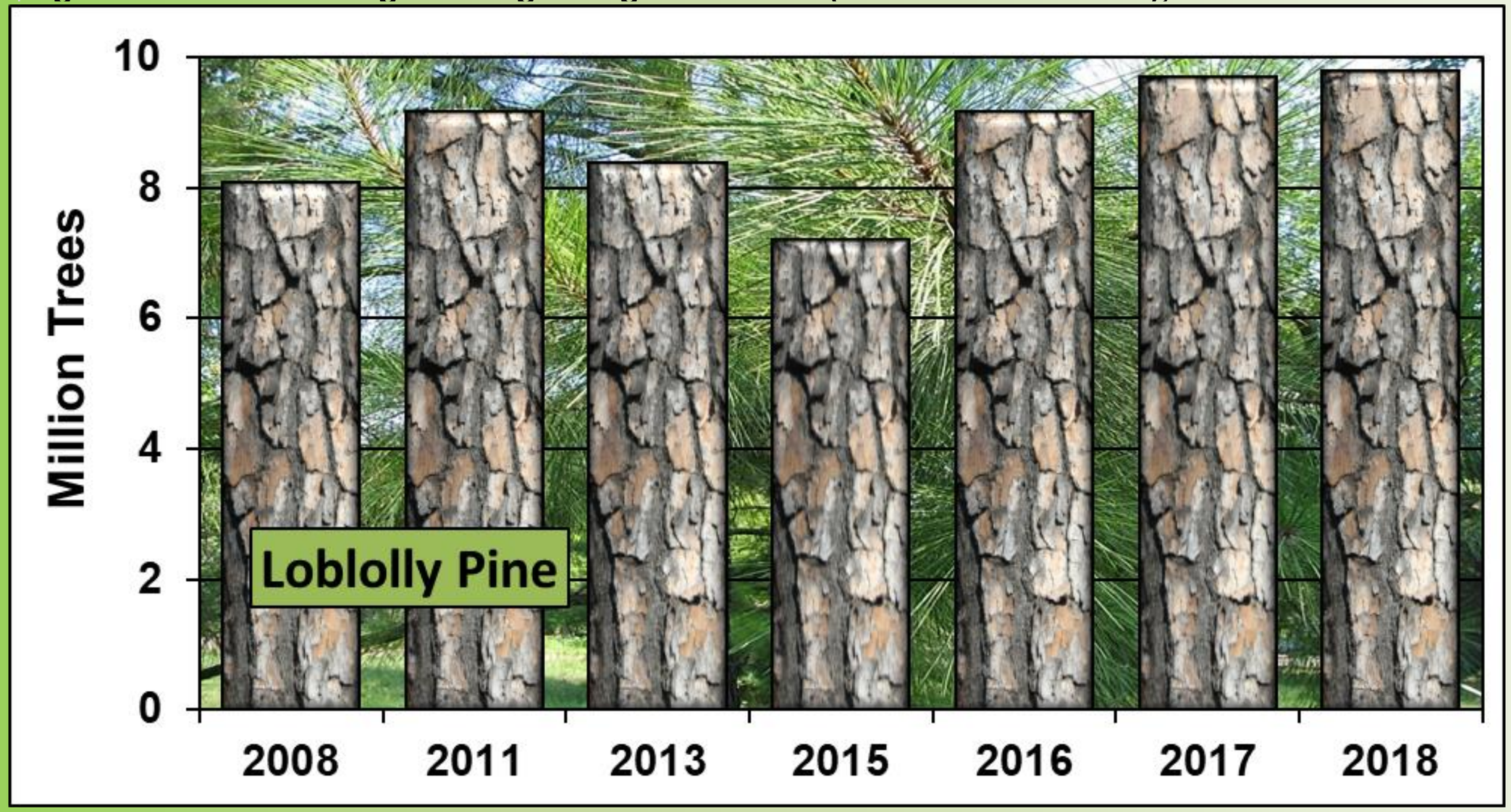
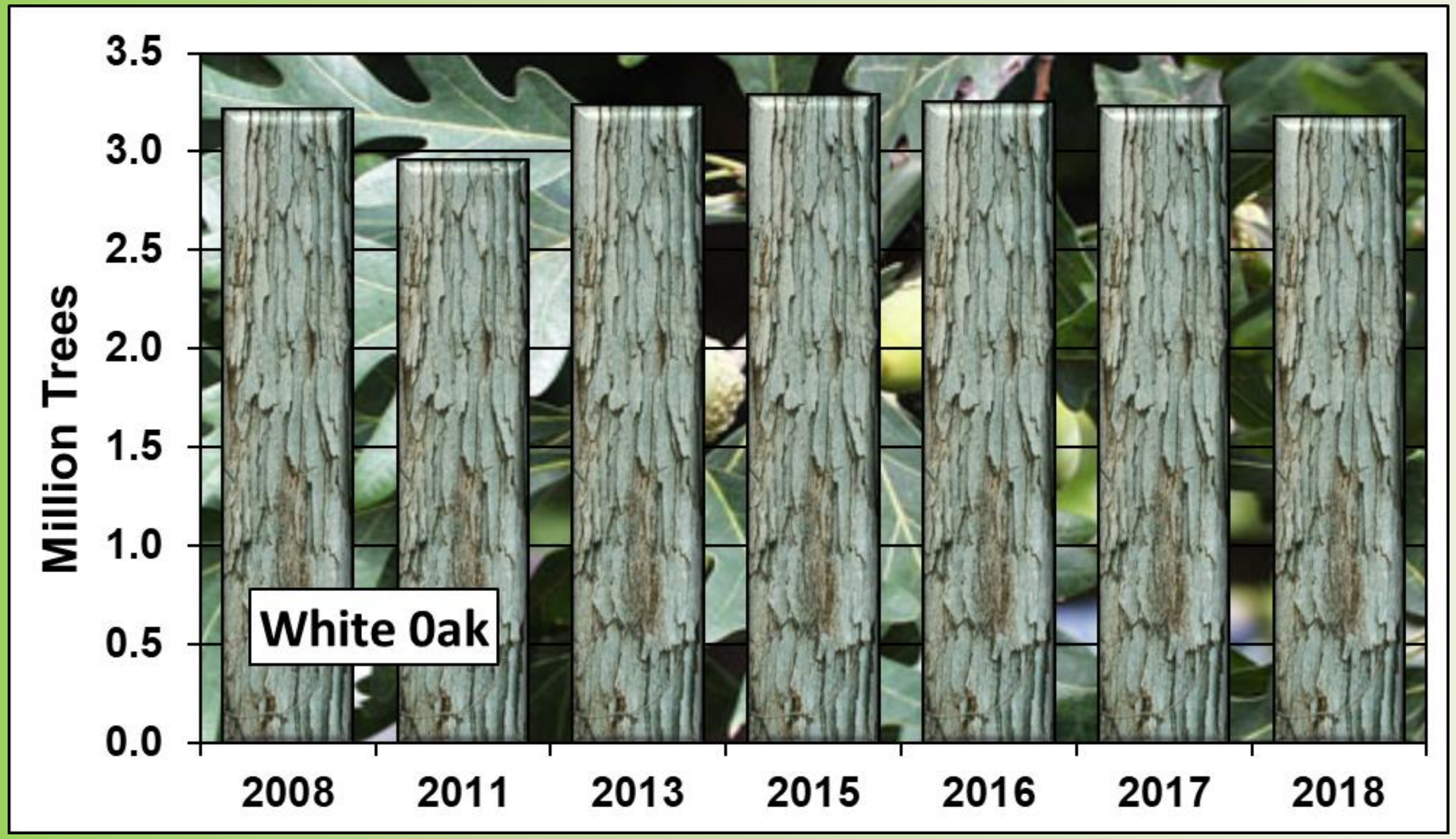


Figure 24. Number of high-value growing-stock trees (at least 5 inches dbh), 2008–2018.





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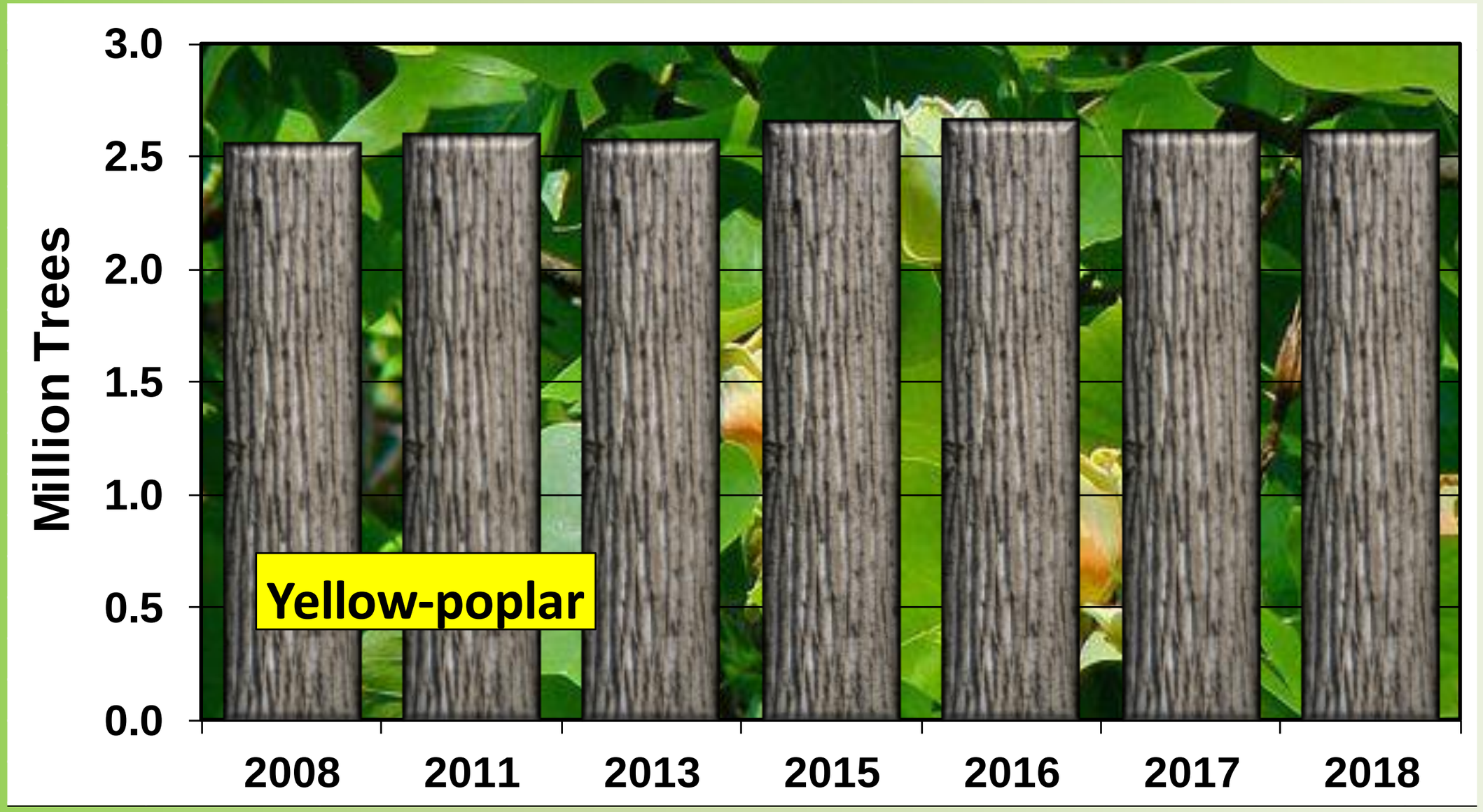

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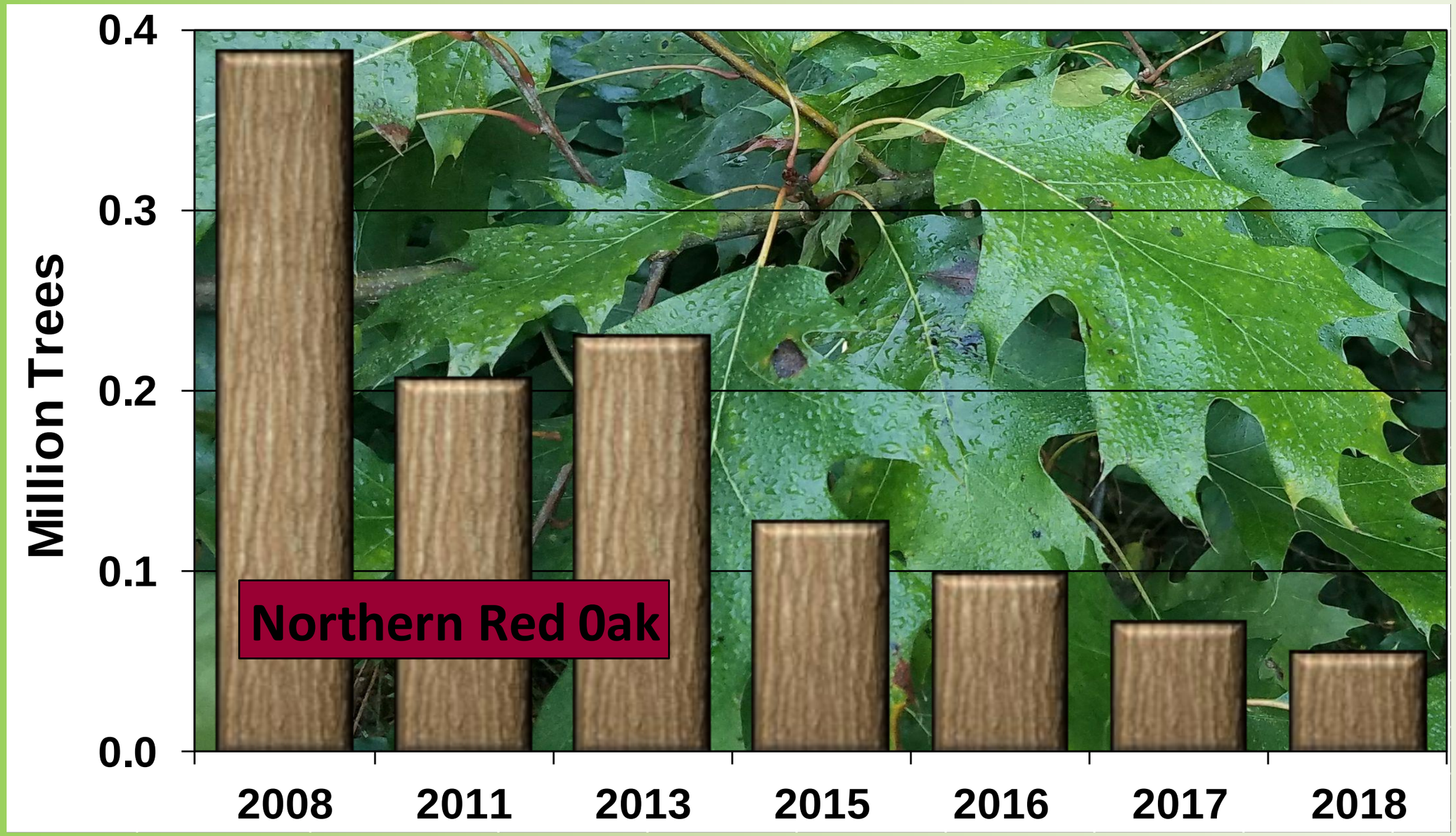

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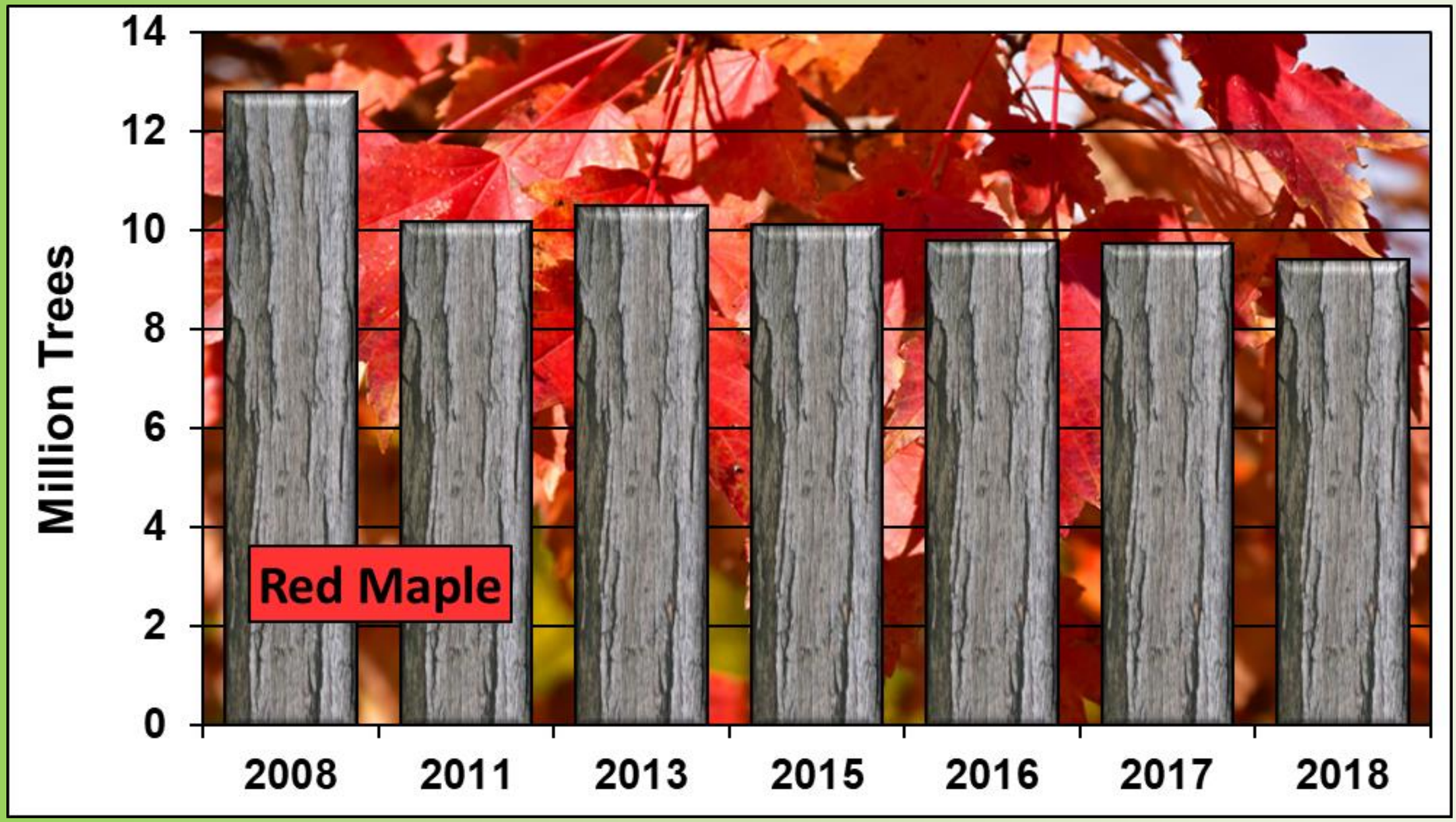

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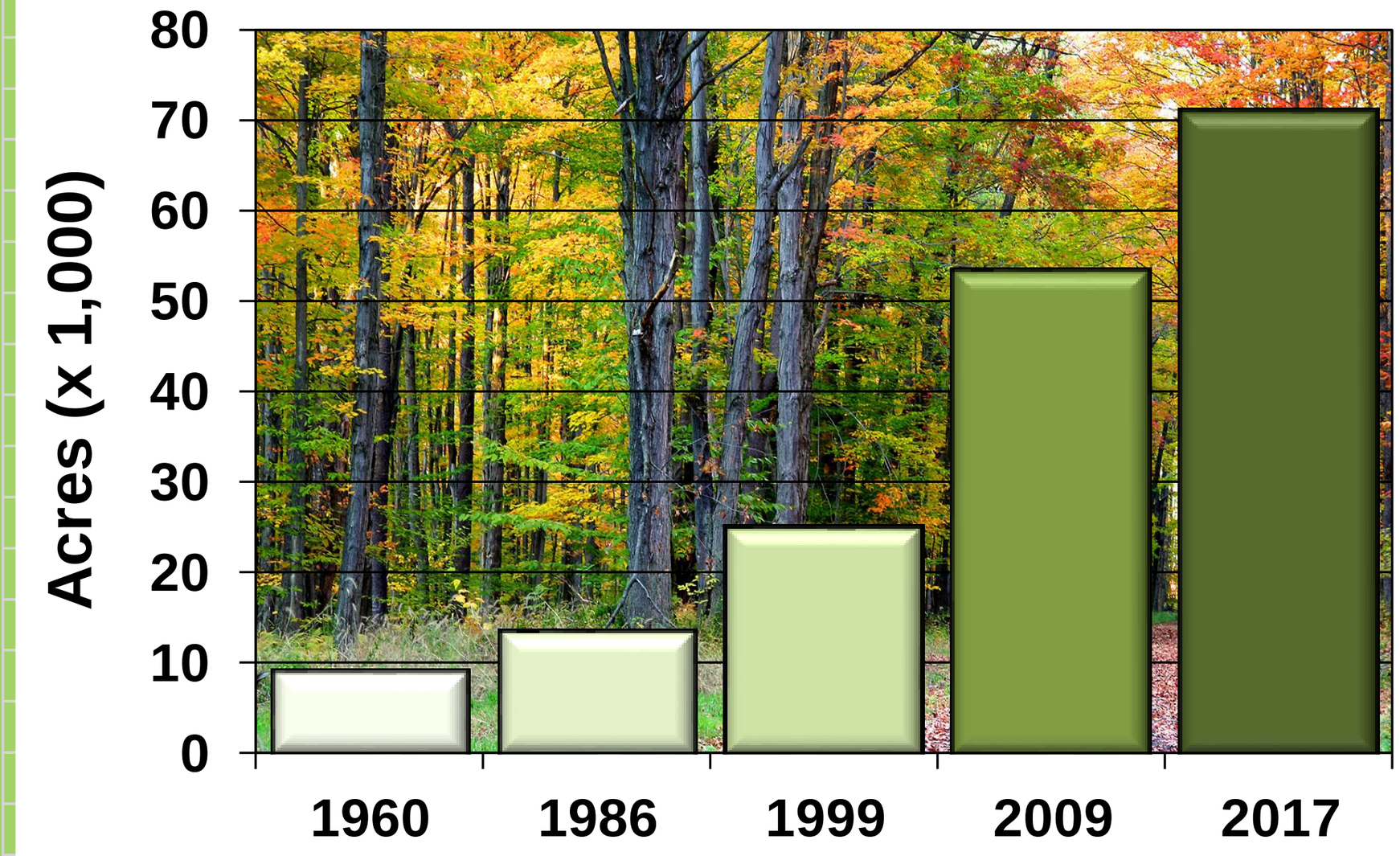
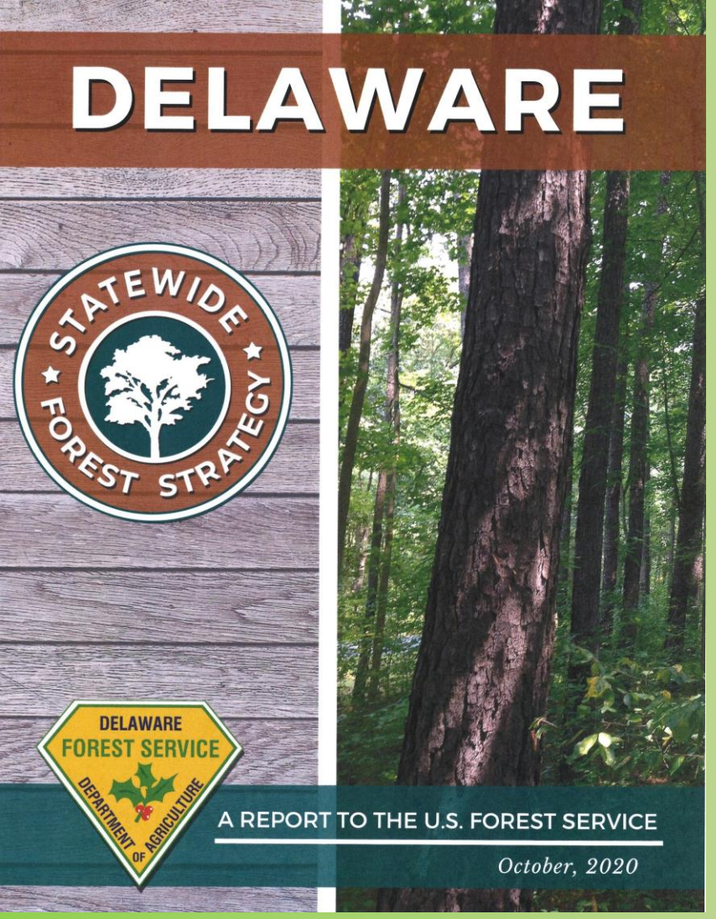
Figure 5. Protected forestland in Delaware.





Delaware Statewide Forest Strategy

Issues
Threats
Opportunities

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Delaware Priority Forestry Issues

1. Forest Health and Functionality

2. Forest Markets

Title 7, Chapter 60
"Incinerator Law"

3. Sustainable Forest Management

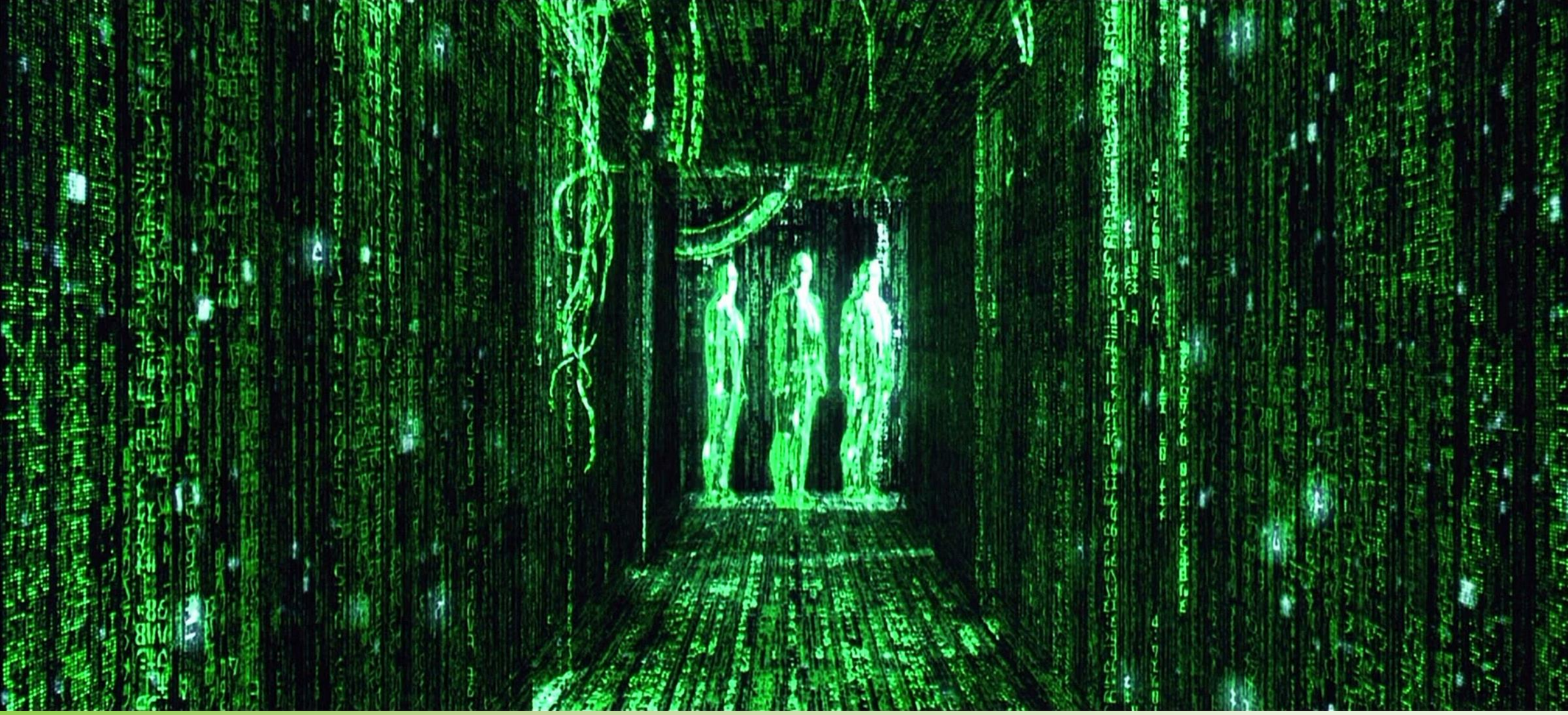
SUSTAINABLE FORESTRY INITIATIVE

Good for you. Good for our forests.

SFI-00037

FSC

4. Public Awareness and Appreciation of Forests



A new Strategy Matrix for 2020 . . . . . .

State Issue #1: Forest Health and Functionality

A sufficient, healthy forestland base ensures the perpetual production of forest outputs (lumber, wildlife habitat, recreational opportunities, water quality protection, etc.).

DE-1.1 Maintain an updated, accurate inventory of Delaware's forests (public and private/ rural and urban) including forest types/species, age, growth, and removals.

Priority Landscape Area(s)	Other State Issues Addressed	Key Stakeholders	Resources Available/ Required for Implementation
Rural and Urban	Forest Markets	USFS DNREC – Division of Fish & Wildlife, Wildlife Species Conservation & Research Program – Division of Climate, Coastal, & Energy Forest industry	Forest Stewardship Forest Health State funds USFS FIA program

Performance Goals/Measures of Success	National S&PF Objectives
DE-1.1.1 Periodically review annualized FIA data for updated estimates of forest types, size classes, and loblolly pine acreage.	1.1 Identify and conserve high priority forest ecosystems and landscapes 1.2 Actively and sustainably manage forests 3.4 Maintain and enhance the economic benefits and values of trees and forests
DE-1.1.2 Maintain annual estimates of timber harvest volumes.	
DE-1.1.3 Maintain U&CF database established in 2019.	
DE-1.1.4 **Identify/delineate boundaries of remaining mature forests using aerial imagery from 1937. Complete by 2022, update by 2025.**	
DE-1.1.5 Support multi-agency efforts to create updated tree canopy data including crucial supporting datasets (e.g., current aerial photography).	

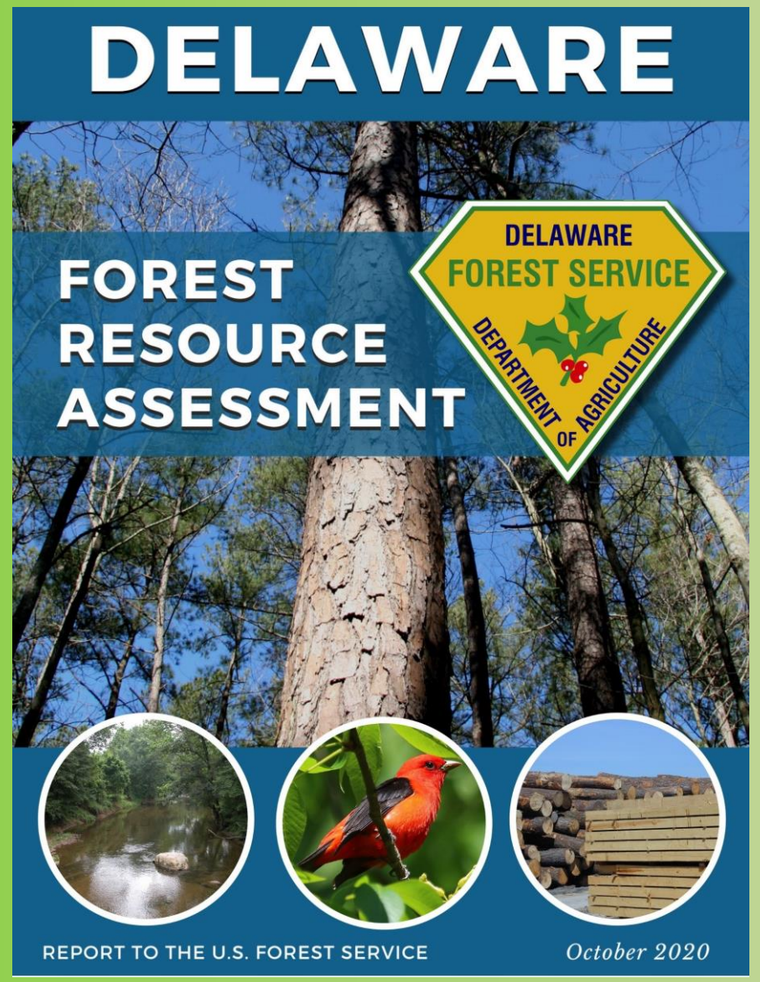
State Issue #2: Forest Markets

Adequate and diverse forest markets are available to landowners to satisfy their goals for their property.

DE-2.1 Promote the importance of Delaware's forests and forest industry.

Priority Landscape Area(s)	Other State Issues Addressed	Key Stakeholders	Resources Available/ Required for Implementation
Statewide	Forest Health and Functionality Public Awareness and Appreciation	Delaware Forestry Association Delaware Tree Farm Committee Forest industry Delaware Cooperative Extension Governor's Council on Forestry	Delaware Prosperity Partnership Delaware Cooperative Extension USFS Forest Utilization & Marketing Conservation Education Forest Stewardship

Performance Goals/Measures of Success	National S&PF Objectives
DE-2.1.1 Complete a follow-up economic impact study of forests and the forest industry by 2026.	3.4 Maintain and enhance the economic benefits and values of trees and forests 3.6 Connect people to trees and forests, and engage them in environmental stewardship activities
DE-2.1.2 **Complete a DFS marketing plan by 2023 that includes a public campaign to promote forests and forestry.**	
DE-2.1.3 Continue coordinating with the USFS sawmill study and update as needed.	
DE-2.1.4 Provide annual status update to all state and federal legislators.	



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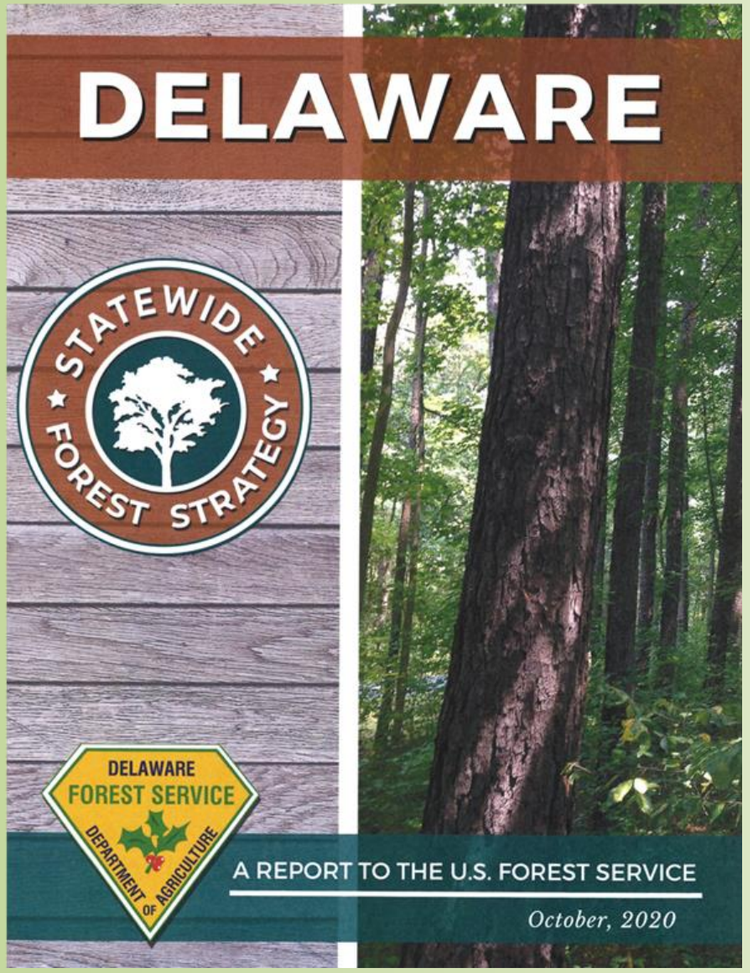

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DELAWARE FOREST ACTION PLAN

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Implementation goals/strategies to improve carbon sequestration/storage:

- *Avoid conversion to non-forest uses*
- *Reforestation and afforestation projects*
- *Increase number of stewardship plans*
- *Maintain updated forest inventories*
- *Constantly monitor forest threats statewide*
- *Develop forest products industry in Delaware*
- *Expand urban and community tree canopy*

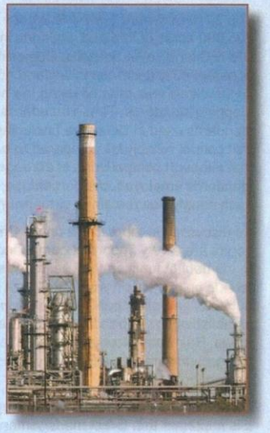
Criterion 5: Maintenance of Forest Contribution to Global Carbon Cycles

Forests are renewable and one of the largest terrestrial reservoirs of biomass and soil carbon. They have an important role in global carbon cycles as sinks and sources of carbon. Carbon stocks in forests include aboveground biomass, belowground biomass, dead and decaying organic matter and soil carbon. Carbon is also stored in wood products.

The biosphere has a significant influence on the chemical composition of the atmosphere. Vegetation draws CO_2 from the atmosphere through photosynthesis and returns it through respiration and the decay of organic matter. The interchange between the biosphere and atmosphere is large—approximately one-seventh of total atmospheric CO_2 passes into vegetation each year.

Global climate change could have significant impacts on the structure, distribution, productivity, and health of temperate forests as well as impacts on forest carbon stocks and fluxes.

Forest management practices also affect the carbon cycle and fluxes. Deforestation has a negative impact, but management activities that maintain and enhance the carbon stored in forests and forest products over the medium to long term can help mitigate atmospheric CO_2 levels. In addition, biomass from forests can substitute for fossil fuels thereby reducing greenhouse gas emissions.



INDICATOR 11

Forest ecosystem biomass and forest carbon pools

Trees store carbon (referred to as a carbon sink) in their xylem (wood) and other tissues. Carbon storage is important because carbon (in the form of carbon dioxide) plays a role in the greenhouse effect and the warming of the Earth. Carbon dioxide concentrations in the atmosphere have risen every year since the industrial revolution. Forests "lock up" some of the carbon emissions produced each year and reduce the rate of increase of atmospheric carbon dioxide. Forest inventory data can be used to quantify carbon storage in Delaware's forests.

Forest ecosystem biomass

Forest biomass is closely related to forest carbon stocks—conditions that increase rates of tree growth will also increase rates of carbon storage within forests. The conditions that influence growth can include environmental conditions such as patterns of temperature and rainfall, atmospheric CO_2, and nitrogen deposition. Forest management practices, such as invasive plant control and forest thinning, also influence tree growth. FIA data for Delaware from 2017 shows that live aboveground forest biomass was an estimated 25.7 million tons, an increase of 9% since 2011 (Table 11).

Table 11. Delaware forest characteristics, 2011 and 2017.

Characterisic	*2011*	*2017*
Area (thousands of acres)	340	356
Aboveground biomass of live trees (dry weight, thousand tons)	23,570	25,711
Net volume of live trees (million cubic feet)	861	947

Source: U.S. Forest Service Forest Inventory and Analysis

Forest carbon pools

In forest ecosystems, carbon is stored in different pools or stocks: aboveground live biomass, belowground live biomass, dead wood, litter, and forest understory (Table 12). Carbon fluxes are the amount of carbon moving from one stock to another over a specified period of time. Carbon is also stored in harvested wood, such as durable wood products (e.g., lumber for housing) that can last for a century or longer. Data from the 2017 growing season estimate the aboveground live tree carbon storage in Delaware's forests at 12.86 million U.S. tons (up from 12.60 in 1999). Dead, understory, litter, and belowground components account for an additional 6.59 million U.S. tons for a total forest carbon pool of 19.45 million tons in 2017.

Carbon may be a consideration in forest management activities even if it is not the primary objective. Carbon management often focuses on the amount of carbon stored in biomass and soil, as well as the rate new carbon is absorbed (sequestered) from the atmosphere to support tree growth.

Table 12. Total forest component carbon pool, 2017.

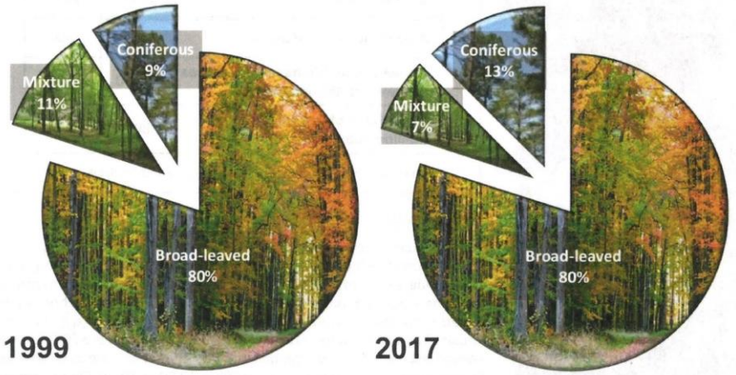
Component	*U.S. Tons (millions)*
Aboveground live tree	12.86
Standing dead	0.61
Understory	0.32
Down dead wood	1.35
Litter	1.76
Belowground live roots	2.55
Total	*19.45*

Source: U.S. Forest Service Forest Inventory and Analysis

Forest carbon by forest type

Four-fifths of the aboveground carbon is found in broad-leaved stands (Figure 33). These are forests dominated by deciduous trees such as red and white oaks (*Quercus* spp.), maples (*Acer* spp.), sweetgum (*Liquidambar styraciflua*), and yellow-poplar (*Liriodendron tulipifera*).This percentage is the same as it was in 1999, however there is a noticeable shift in aboveground carbon (4%) away from mixed to coniferous forests. Most of this increase is attributable to the increases in loblolly pine acreage and volume. Both forest types sequester and store carbon at various rates depending on age, condition of trees, and other factors.

Figure 33. Aboveground live tree carbon by forest type in 1999 and 2017.



Source: U.S. Forest Service Forest Inventory and Analysis and DNREC Division of Climate, Coastal & Energy

Urban and community forests

Urban and community forests play an important role in carbon sequestration and storage. Trees in urban and community environments may have higher rates of carbon sequestration as a result of lower tree densities, greater foliar biomass, irrigation, and fertilization (from stormwater runoff and/or landscape management). Proper siting and maintenance are important for maximizing the carbon benefit of urban forests. Trees that are well-adapted to their site have higher growth rates and lower mortality rates, thus providing more long-term carbon storage.

Trees in both forest and urban and community settings absorb atmospheric carbon through photosynthesis. This ongoing process of carbon sequestration adds to the amount of carbon storage as trees accumulate more biomass. The annual rates of carbon sequestration by urban and community forests continue to grow as tree canopy cover in urbanized areas expands.

The U.S. Forest Service has conducted research on urban and community forest carbon sequestration and storage (Nowak, et al. 2008, Nowak and Greenfield 2012, 2018). Carbon sequestration and storage estimates were updated in 2018 using urban land estimates from the 2010 U.S. Census, with tree cover estimates and carbon values based on earlier published methods. Some of the estimated benefits for Delaware are:

- Carbon storage: 3.1 million U.S. tons
- Carbon sequestration: 136,300 U.S. tons annually
- Air pollution removal: 2.7 U.S. tons annually
- Number of trees per capita: 25.3 trees

Trees in urban and community settings provide other environmental benefits. Trees remove air pollutants by filtering particulate matter on plant surfaces and absorb some pollutants through respiration— these values vary under local conditions based on the amount of tree canopy cover, pollution concentrations, and other factors. The estimates shown above are a first-order approximation of a statewide total. It should be noted, however, that local-scale design of trees and forests can affect local-scale pollutant concentrations.

Urban trees and forests also shade buildings and act as wind buffers, thus reducing energy demand for cooling and heating. Reducing building energy use results in avoided emissions of greenhouse gases and other pollutants that would have been generated through fossil-fuel combustion from heating and electricity production.

Change in forest carbon

The amount of carbon absorbed and stored within a forest ecosystem is affected by land-use change, management activities, disturbance, and climate. Disturbances—both natural and human-induced—influence the composition, structure, and function of forests. Natural disturbances include insect pests, disease, fire, and wind. Climate change will affect forests by altering the frequency and severity of disturbance.

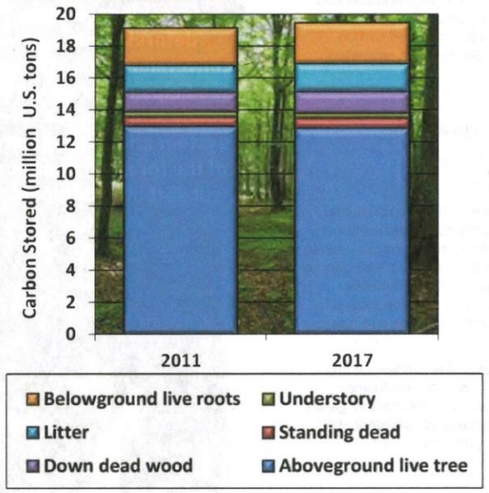
Avoiding forest losses resulting from deforestation and conversion to non-forest uses helps maintain both the carbon already stored in the forest system and the capacity of the forest to continue absorbing (sequestering) additional carbon.

In the past decade, forestland acreage in Delaware has not changed significantly. However, forest growth has increased the total amount of biomass in forest ecosystems. Annual net growth of forest trees has outpaced annual harvest removals and annual mortality.

Figure 34 shows the change in carbon storage in different pools from 2011 to 2017. Total carbon storage increased by 1.7% from 19.13 to 19.45 million tons. The increase since 1986 is 8.1%. These increases are expected because trees in Delaware's forests are growing larger (see Figure 11). While larger trees can store more carbon in living biomass and the trend of increasing carbon storage is desirable, it is important to remember that as forests continue aging, their ability to sequester additional carbon decreases. Therefore, maintaining a balanced mixture of young through mature forests is important not only for wildlife habitat, sustainable forest management, and other purposes, but also for carbon sequestration.

Avoiding forest losses from deforestation and conversion to non-forest uses helps maintain carbon already stored in the forest system and the capacity of the forest to continue absorbing additional carbon.

Figure 34. Carbon pools of Delaware forests in 2011 and 2017.



Source: U.S. Forest Service Forest Inventory and Analysis and DNREC Division of Climate, Coastal & Energy

Conclusions

Delaware's forests are excellent carbon sinks. Furthermore, research has shown that forest management activities can increase the amount of carbon stored by forests. Preserving forests during periods of increased development is also important for carbon storage because affected forests are usually not replaced or, at best, only partially replaced so this carbon storage source is eliminated or greatly reduced. Voluntary carbon markets still exist within the United States and Delaware is a member of the Regional Greenhouse Gas Initiative (RGGI), which includes ten northeastern and mid-Atlantic states. All except New Hampshire have formally committed to advance the goals of the Paris Agreement and reduce their emissions 26–28% below 2005 levels by 2025. Currently, forestry practices approved by RGGI for carbon credit are afforestation (planting open land with trees), improved forest management (to increase carbon stocks), and avoided conversion (of privately-owned forestland). Conserving our existing forests, expanding forestland where possible (including urban forest areas and community open spaces), and including carbon storage in forest management plans will help maintain and increase the role of Delaware's forests in the global carbon cycle.

Preserving forests during periods of increased development is important for carbon storage because affected forests are usually not replaced or, at best, only partially replaced.

Forests in Delaware contain nearly twenty million tons of carbon and this amount has increased with maturation of the forests.

Summary – Criterion 5

Forests in Delaware currently contain nearly twenty million tons of carbon and this amount has increased with maturation of the forests. Urban forests, in addition to removing pollutants, also reduce energy consumption by cooling urban areas in the summer and warming them during the winter. This helps mitigate the effects of global climate change, which is directly related to the S&PF national priority to *Enhance public benefits from trees and forests*. Forest management activities can lead to increased growth rates and increased uptake of carbon in vigorously growing stands. Expanding forested areas in both rural and urban areas—and reducing their permanent loss to development and other land uses—increases carbon sequestration and storage. Maintaining and managing our rural and urban forest resources provides a wide variety of benefits, including carbon sequestration and storage.

Forest Legacy Assessment of Need

Appendix 3

DELAWARE FOREST SERVICE
FOREST LEGACY PROGRAM
ASSESSMENT OF NEED

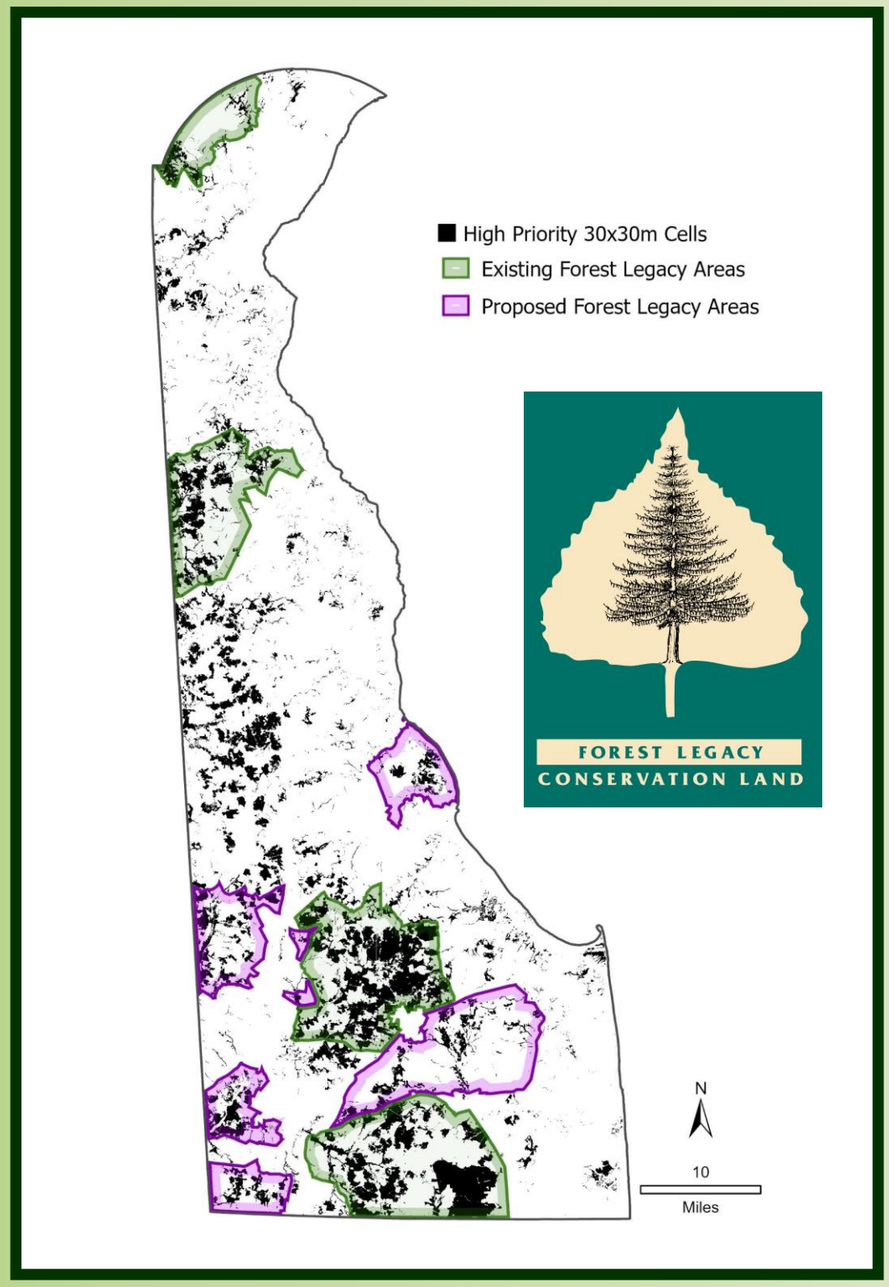
October 2020

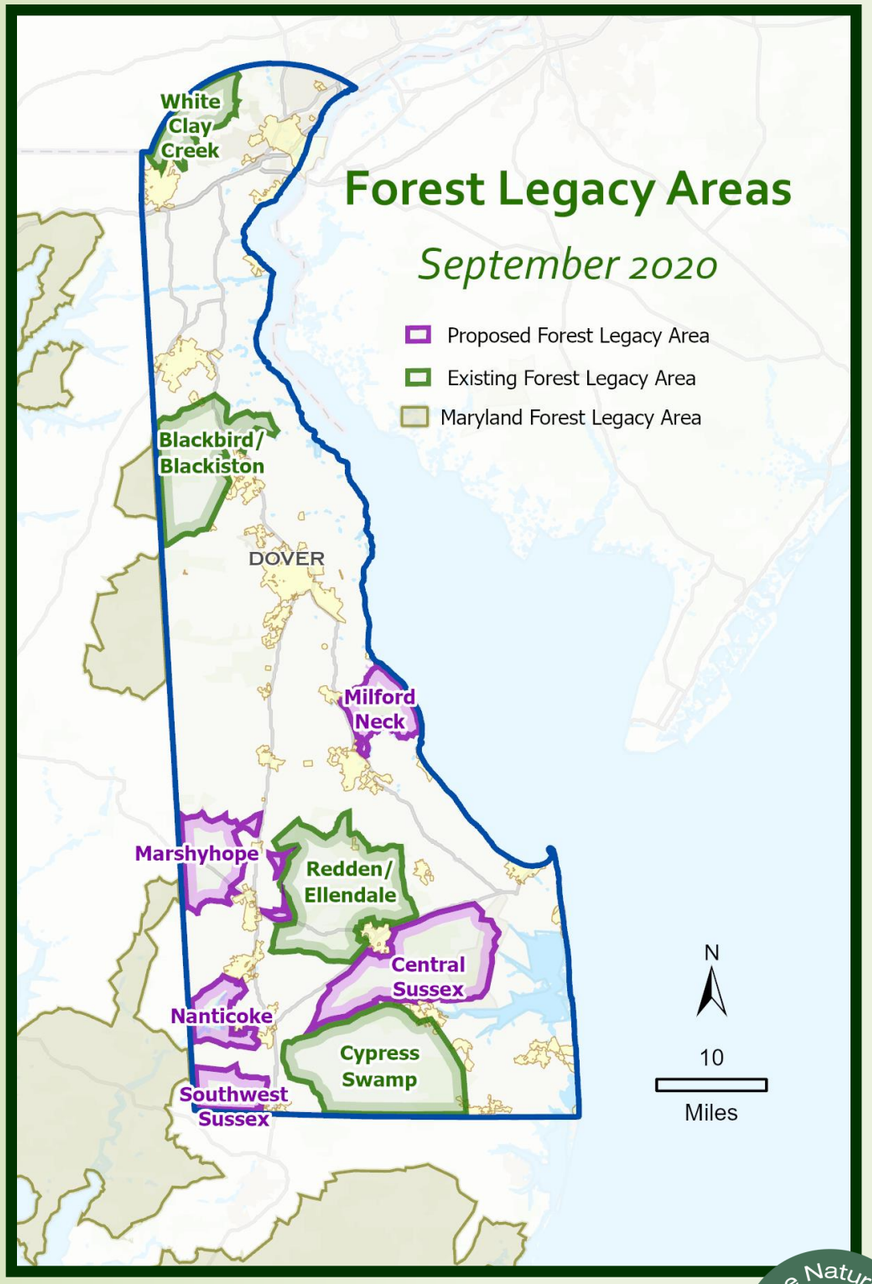
USDA Forest Service Forest Legacy Program

Purpose:

To ascertain and protect environmentally important forest areas that are threatened by conversion to nonforest uses

Forest Legacy Areas





DELAWARE FOREST SERVICE
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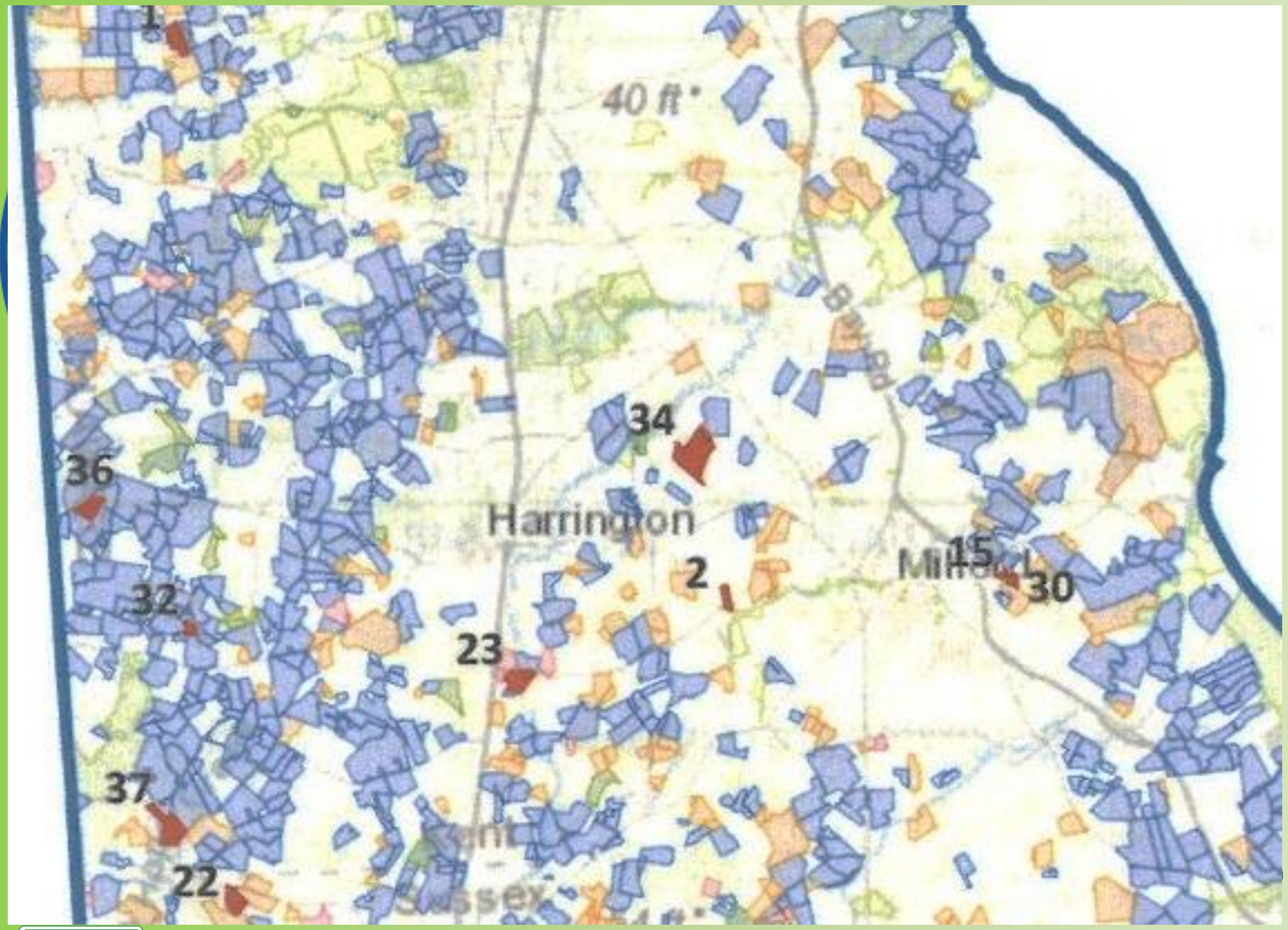
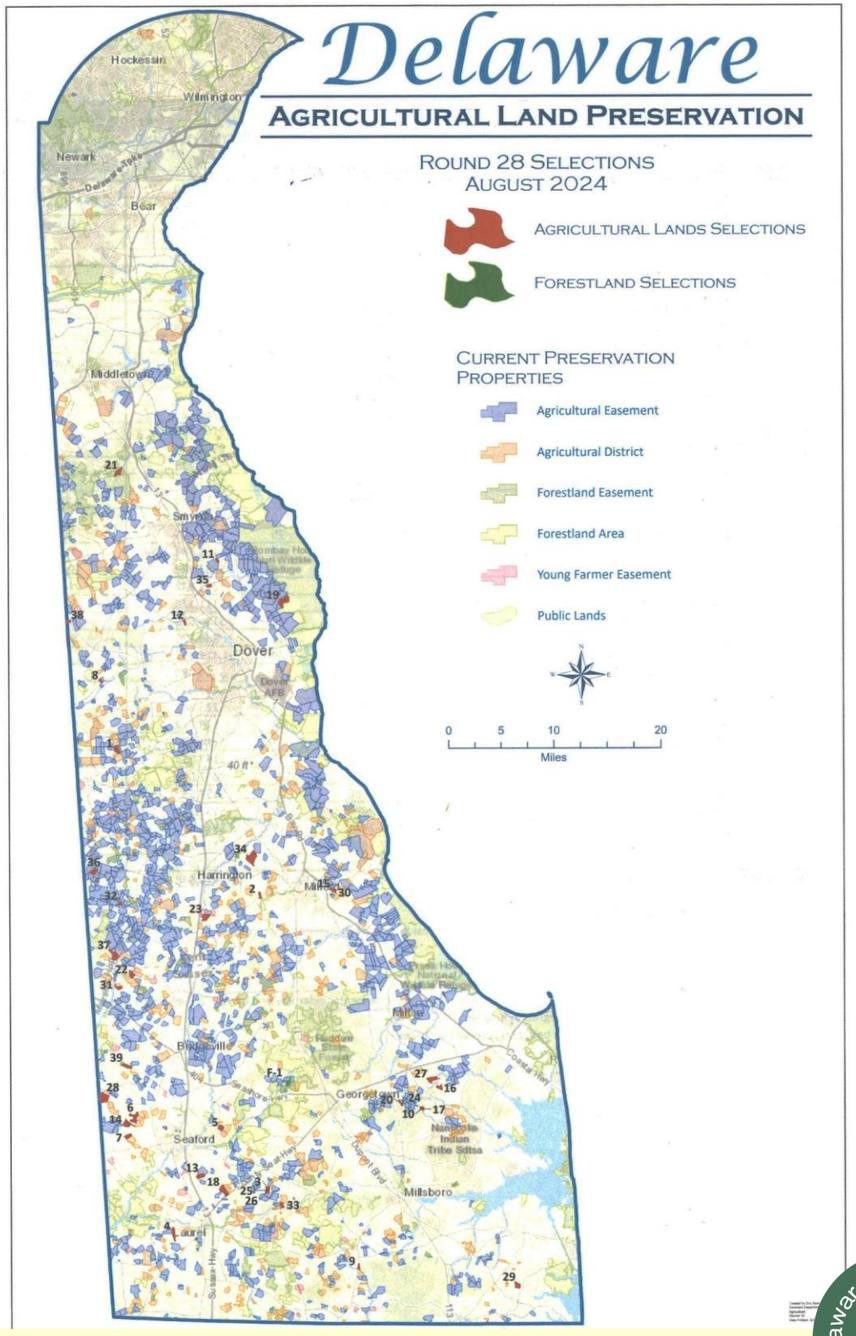
Delaware Nature Society

Delaware Nature Society

Forestland Preservation





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Delaware Open Space Program

1990-2020 PROJECT SUMMARY BY COUNTY

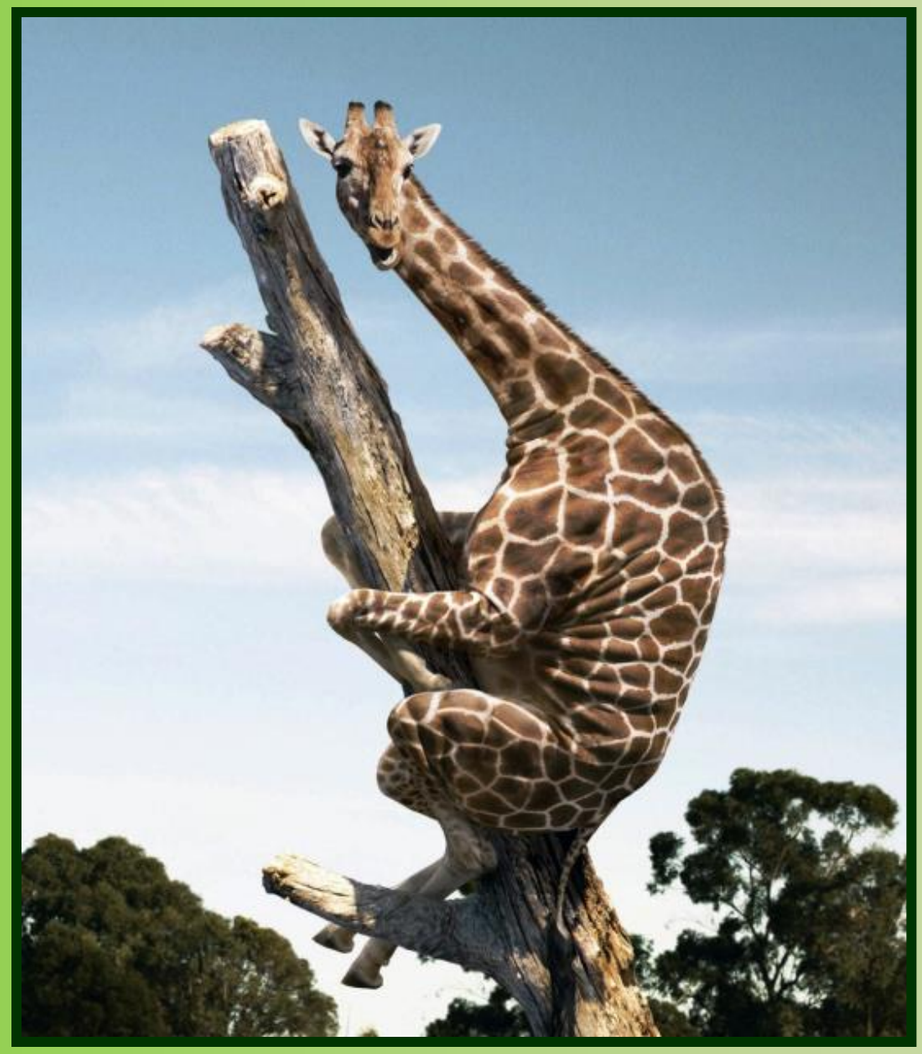
	Projects	Acres	Open Space Funds	Partner Funds
New Castle	187	14,194	$141,437,807.67	$29,665,326.18
Kent	94	10,286	$26,734,273.32	$5,451,394.58
Sussex	207	39,419	$118,639,954.05	$68,025,548.71
TOTAL	**488**	**63,899**	**$286,812,035.04**	**$103,142,269.47**

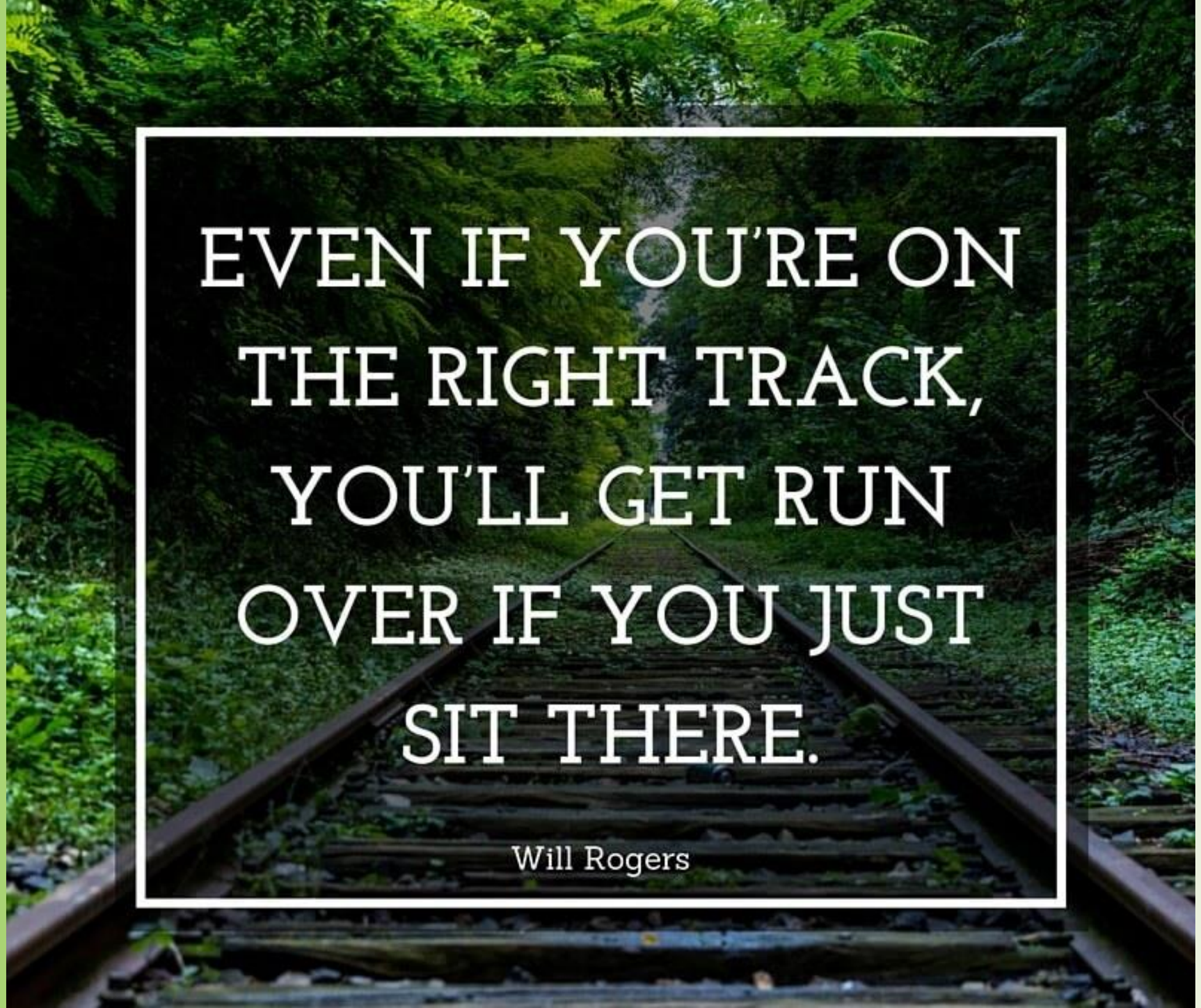
DELAWARE FOREST SERVICE
DEPARTMENT OF AGRICULTURE

Delaware Nature Society

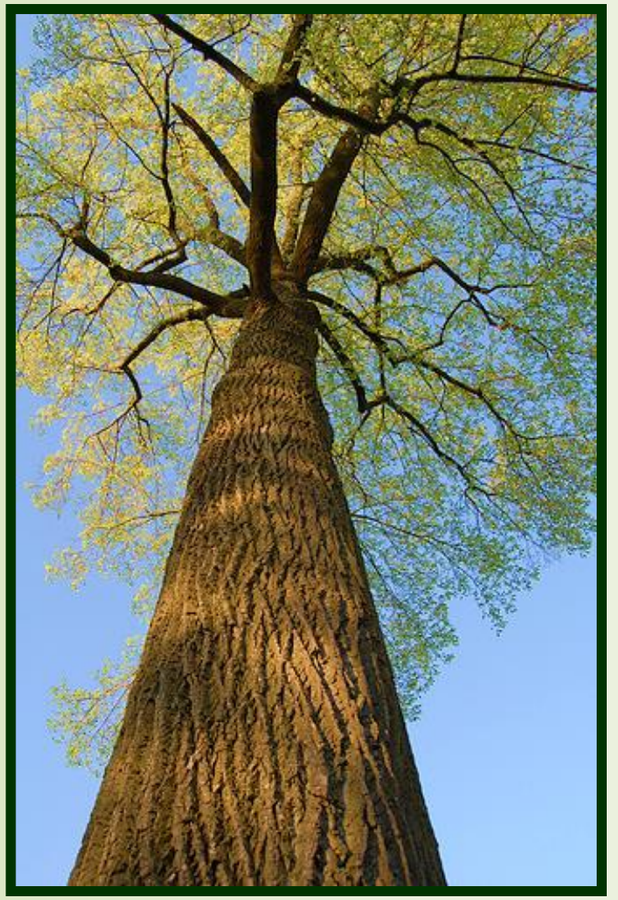
Delaware Nature Society

Don’t panic, plan for the future . . . . .




EVEN IF YOU'RE ON THE RIGHT TRACK, YOU'LL GET RUN OVER IF YOU JUST SIT THERE.
Will Rogers

Questions?



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