Honor Camp Trail

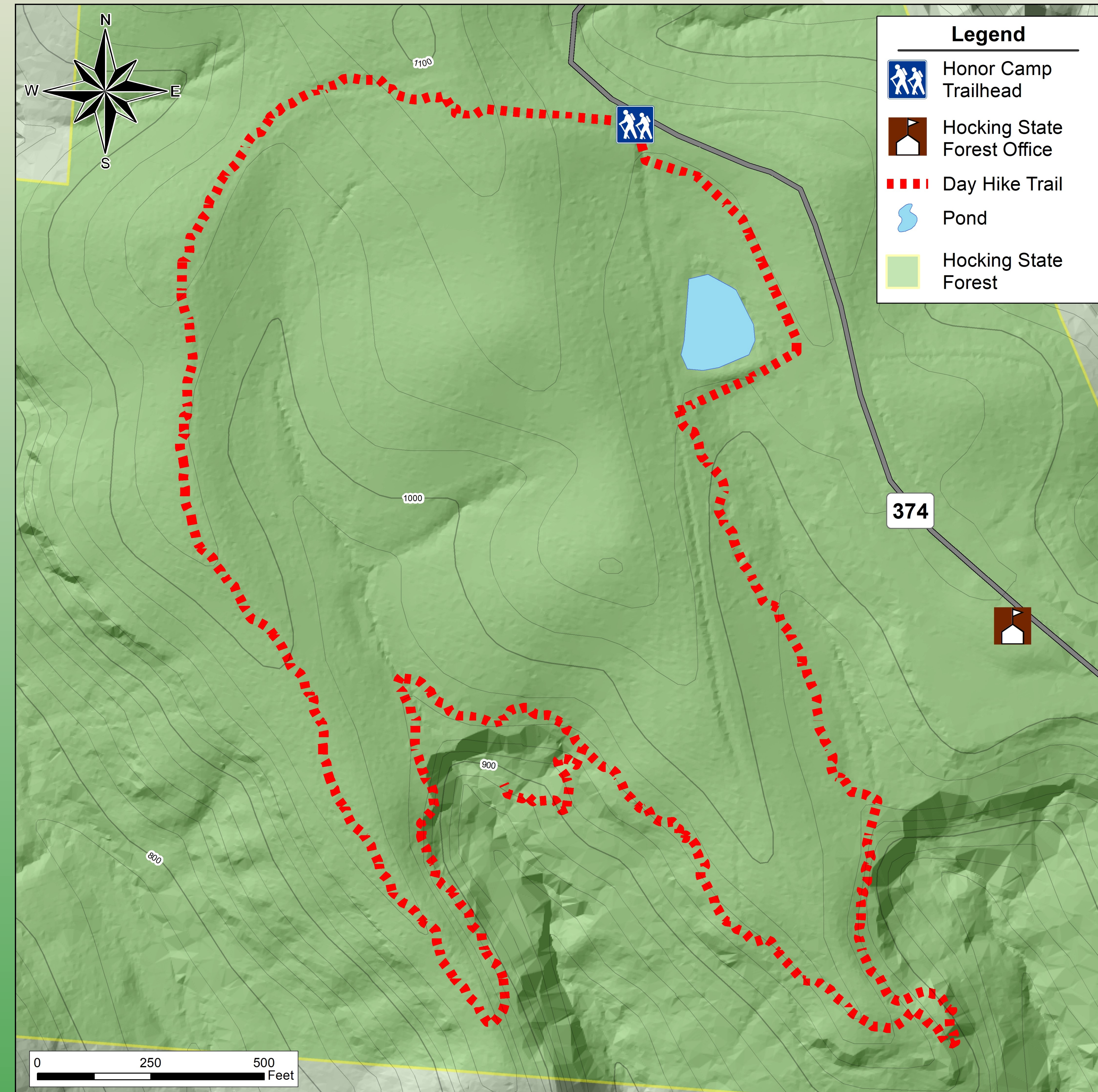
Hocking State Forest

Trailhead

Throughout the next century, the forecasted climate includes rising temperatures, changing precipitation patterns, and increasing frequency of extreme weather events. These factors could have drastic impacts on Ohio's forests, because of the influence of climate on vegetation, fire, hydrology, and forest infrastructure. While forest managers must always plan for the future to ensure sustainability, these new climate concerns pose new challenges when managing forests. Utilizing appropriate adaptive strategies today is crucial in creating forest landscapes that can remain healthy in future.

These strategies include maintaining adaptable tree species, removing threats to forest health, enhancing infrastructures, and preparing for higher seasonal risks, such as wildfires. Along this trail are examples of forest management designed to create a forest that is resilient to potential changes in climate while continuing to provide recreational, financial, and ecological benefits.

The signs along this trail were developed in partnership with the Northern Research Station, Northeastern Area State and Private Forestry, and the Northern Institute of Applied Climate Science.



The Honor Camp Trail is a 1.6 mile loop with a .1 mile spur to a waterfall.

Read more about climate-informed management here:

In cooperation with the U.S. Department of Agriculture, Forest Service. USDA is an equal opportunity provider, employer, and lender.

Honor Camp Trail

Hocking State Forest

Best Management Practices

Water quality can be threatened by a variety of forest disturbances, including timber harvests, trail use, and climate change. Rain events are becoming more intense, with more rain falling during a single storm. Total rainfall has also increased, making erosion and runoff prevention measures increasingly important.

In order to protect water quality, Ohio has developed Best Management Practices (BMPs) for erosion control. These should be followed on timber harvests and trail construction. BMPs are methods that prevent erosion and soil entering water sources. These methods include preplanning, applying erosion control structures (Figure 1), stream protection (Figure 2), and revegetating disturbed areas. Along this trail, culverts have been installed to divert waterflow and protect the trail.

By applying these methods on state forests, we can help maintain water quality and sustainable forest use and productivity for future generations.

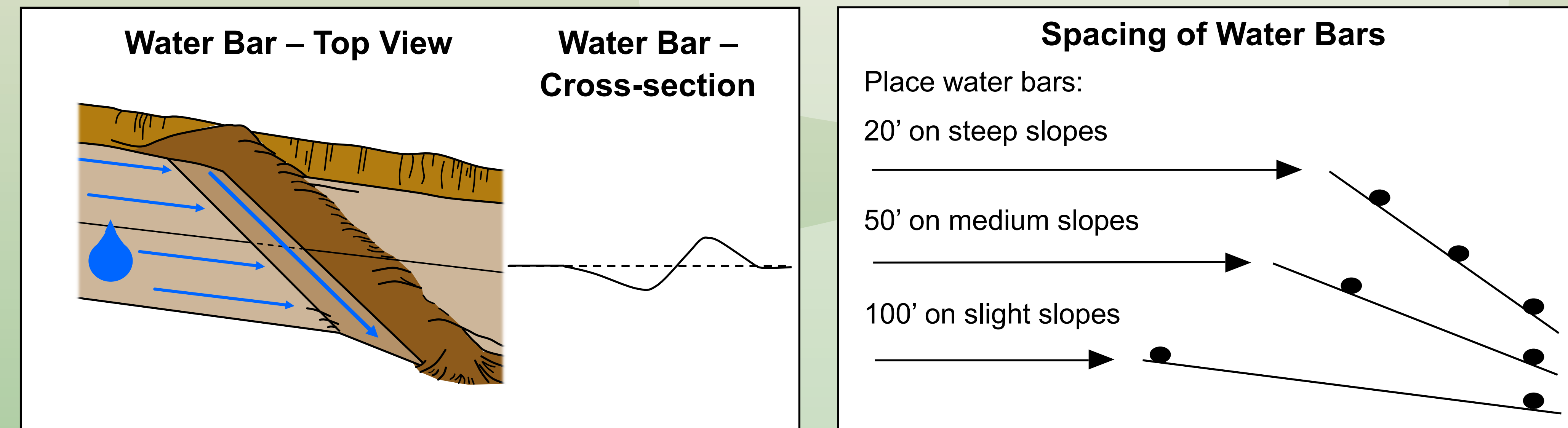


Figure 1. Diagram of water bar (left). Water traveling down skid trails is slowed and redirected off the trail where it is absorbed into the undisturbed forest floor. Diagram of water bar spacing (right). Steeper slopes require closer water bars to reduce the speed of the flowing water.

Adapted from:

Ohio State University Extension. 2004. BMPs for Erosion Control for Logging Practices in Ohio. Bulletin 916. 60 pp.

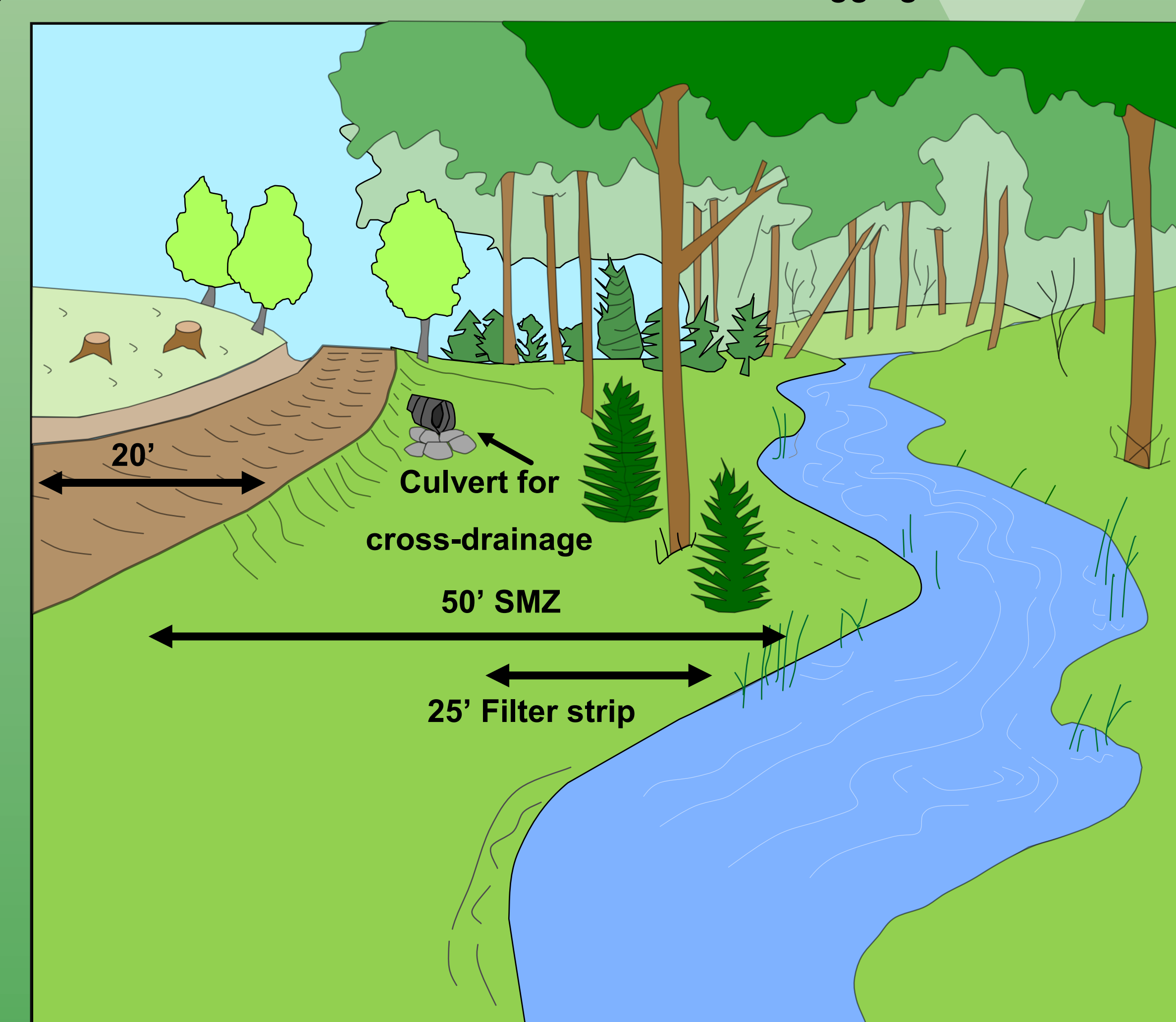


Figure 2. Diagram of streamside management zone (SMZ). No trees are removed within the 25’ filter strip while 75% of the canopy cover is retained in the rest of the SMZ. The width of the SMZ is based on the slope.

Adapted from:

Ohio State University Extension. 2004. BMPs for Erosion Control for Logging Practices in Ohio. Bulletin 916. 60 pp.

For more information visit ohiodnr.gov

Honor Camp Trail

Hocking State Forest

Eastern Hemlocks

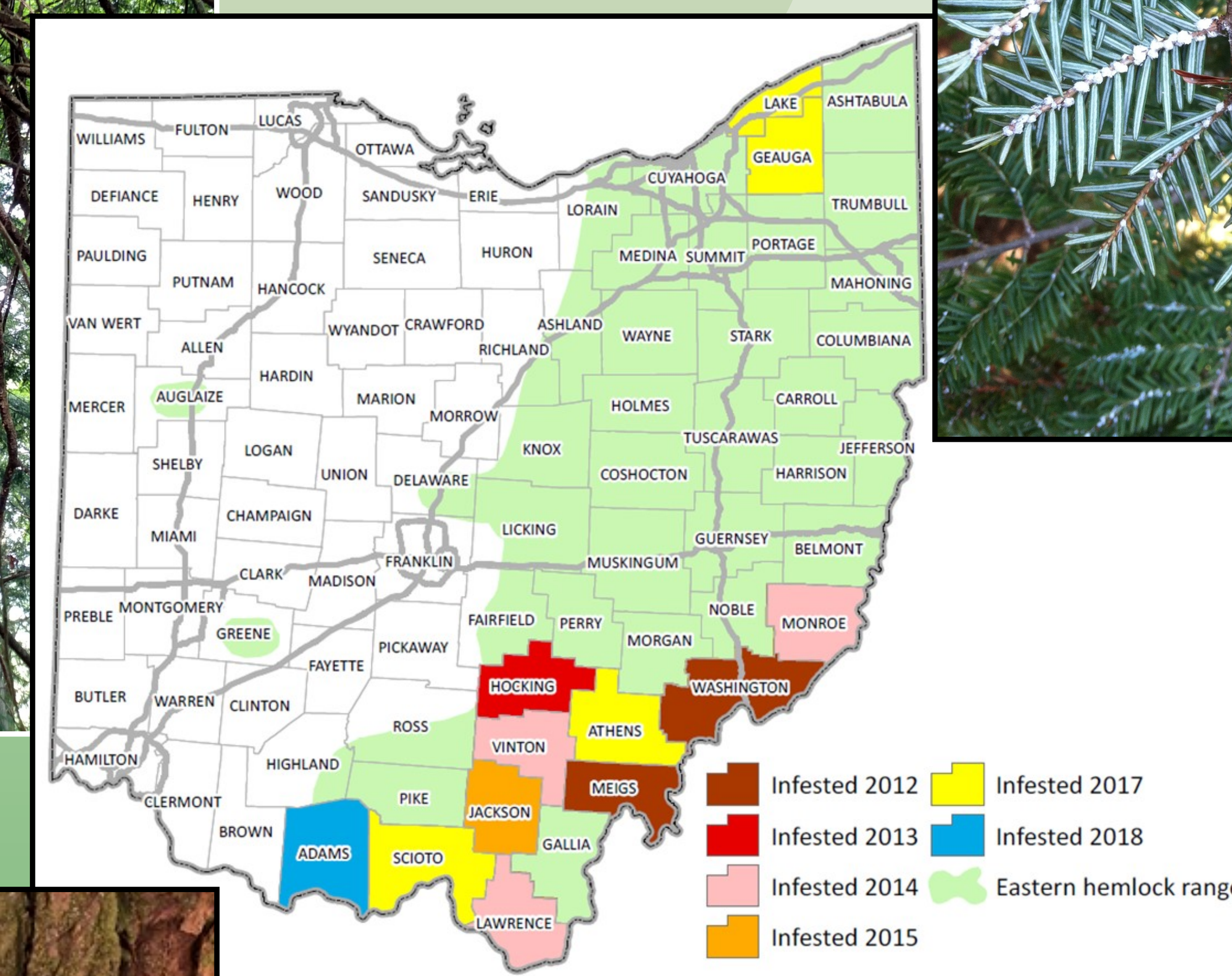
Eastern hemlocks (*Tsuga canadensis*) are long-lived, shade tolerant conifers found primarily in the cool microhabitats found in gorges and steep slopes. These trees are considered a foundation species, because they can regulate local ecosystem processes. They provide habitat for many wildlife species, create shade that maintains low stream temperatures, lower soil pH, and form forests that draw visitors to their beauty.

In the past decade, eastern hemlocks have been threatened by the arrival of hemlock woolly adelgid (HWA), which is an aphid-like insect from Asia. Adelgids feed on the base of the needles on a twig and can be seen as a white woolly mass. This feeding impedes the flow of nutrients within the tree and leads to stem dieback and death.

As a cold-loving species, hemlock is expected to decline in many Ohio forests, especially where current habitat is low quality. Here, and in other parts of Ohio, agencies are working to protect hemlocks by surveying for the spread of HWA, applying chemical treatments to trees for protection, and breeding predatory beetles that will be released to reduce HWA populations. These efforts are important to maintain high quality hemlock forests as long as possible in a warming climate.

For more information visit ohiodnr.gov

Eastern hemlock stem.



HWA on the base of hemlock leaves.

Injection of insecticide into base of tree.

Eastern hemlock killed by HWA.

In cooperation with the U.S. Department of Agriculture, Forest Service. USDA is an equal opportunity provider, employer, and lender.

Honor Camp Trail

Hocking State Forest

Division of Forestry
Ohio Department of Natural Resources

Fall Colors

Most deciduous trees in Ohio, such as oaks and maples, grow new foliage in the spring and lose their leaves in the fall. When the days begin to shorten and the nights begin to get cooler, trees take the cue to start conserving energy for the winter. Chlorophyll begins breaking down, allowing pigments to become visible. Carotenoid pigments that are present in leaves during the entire growing season now become visible. In autumn, trees begin producing anthocyanin, which protects and prolongs the life of the leaf. Carotenoids and anthocyanins are responsible for the fall colors we enjoy.

Temperature and moisture variability influence the intensity of fall colors, and a late spring or summer drought can delay the peak of fall color by a few weeks, making it more difficult to identify the timing of peak colors. As climate changes, certain species that produce brilliant fall colors, such as sugar maple and bigtooth aspen, may become less abundant in these forests.

For more information visit ohiodnr.gov

SPECIES COLOR GUIDE

May retain leaves (Beech)

Staghorn sumac	Red maple	Sugar maple	Boxelder	Black walnut	Beech	Yellow-poplar
Dogwood	Blackgum	Sassafras	Chestnut oak	Sycamore	Sugar maple	Black cherry
Scarlet oak	Red oak	Ironwood	White oak	Buckeye	White oak	Shagbark hickory

One of the last to change color (Red oak)

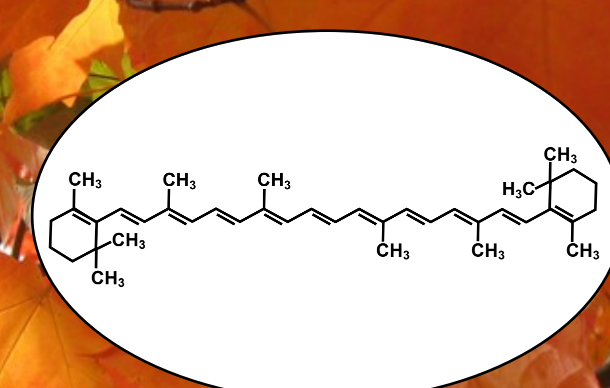
One of the first to change color (Buckeye)

Carotenoids

Always present in leaves

Absorbs green & blue light, reflects red & yellow

red + yellow = orange

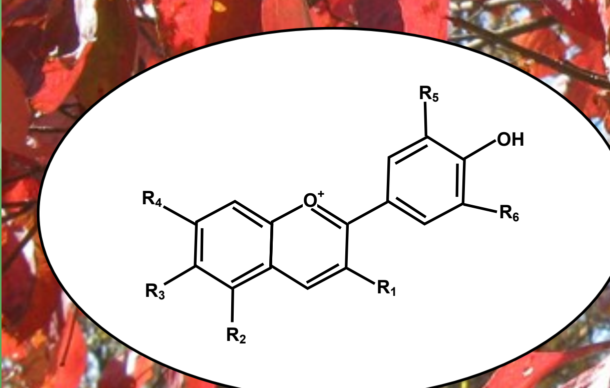


Anthocyanins

Typically produced in the autumn

Protects the leaf cells

Reds and purples

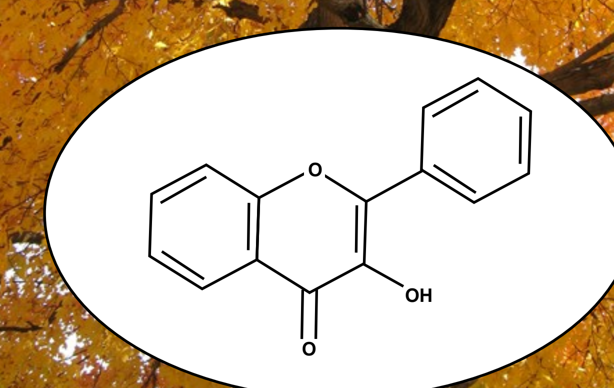


Tannins

Always present in leaves

Found in the membranes of the cells

Yellow-brown



In cooperation with the U.S. Department of Agriculture, Forest Service. USDA is an equal opportunity provider, employer, and lender.

Honor Camp Trail

Hocking State Forest

Forest Fire

In a typical year, it is estimated there are more than 1,000 wildfires statewide. According to most climate models, wildfires may become more frequent by the end of the century due to rising temperatures and increased fuels. Higher temperatures increase drying, leading to more severe fire behavior, and predicted changes in precipitation and temperatures may also lead to extended fire seasons.

Fire requires oxygen, heat, and fuel. Without any of these, fire will cease to burn. Without easily accessible water to fight fires, we focus on removing fuels (leaves, wood, grasses) with hand tools or machinery to create a "fire line" around wildfires. Prescribed fire can also help reduce the risk of severe wildfire and promote regeneration of fire-dependent and fire-tolerant species like oak and hickory, while helping to control understory vegetation. In this area, fire may be used to enhance the development of oak regeneration.

The fire triangle represents the components necessary for fire. If any of these elements are removed the fire will be extinguished.

Fire fighting tools. Hand tools such as fire rakes and Pulaski axes (*top left*), leaf blowers, and bulldozers (*bottom left*) are used to remove fuels down to bare soil. Chainsaws (*center*) are used to remove large fuels and take down dead burning trees. Fire (*top right*) can be used to burn off fuels to stop fire spread. When possible, engines with water pumps (*bottom* right) can be used to control fire and eliminate smoldering fuels.

For more information visit ohiodnr.gov

In cooperation with the U.S. Department of Agriculture, Forest Service. USDA is an equal opportunity provider, employer, and lender.

Honor Camp Trail

Hocking State Forest

Division of Forestry
Ohio Department of Natural Resources

Forest Succession

A disturbance in the forest is an event that changes the environment and influences the ecosystem. Disturbances can be natural (e.g., wildfires, ice storms, windstorms, droughts, or insect outbreaks) or can be caused by humans (e.g., timber harvests, livestock grazing, controlled burns). Disturbances are normal occurrences that are required to maintain plant and animal diversity.

Disturbances can lead to the initiation of a new forest and restart the cycle of forest succession, which is the process of gradual change in structure and species composition of a forest through time. This process also occurs when lands, such as agricultural fields or homesites, are abandoned and revert to forest cover. While this process is very complex, there are generally four stages of forest development (Figure 1).

The type of forest that develops through succession is dependent on many factors. When performing forest management, foresters try to influence this process to develop forests that meet certain goals, such as maintaining oak-hickory forests. In this stand, there are different communities of climate-adapted species. Active forest management is required in each stage of succession to maintain forests that meet objectives and can adapt to potential changes in climate.

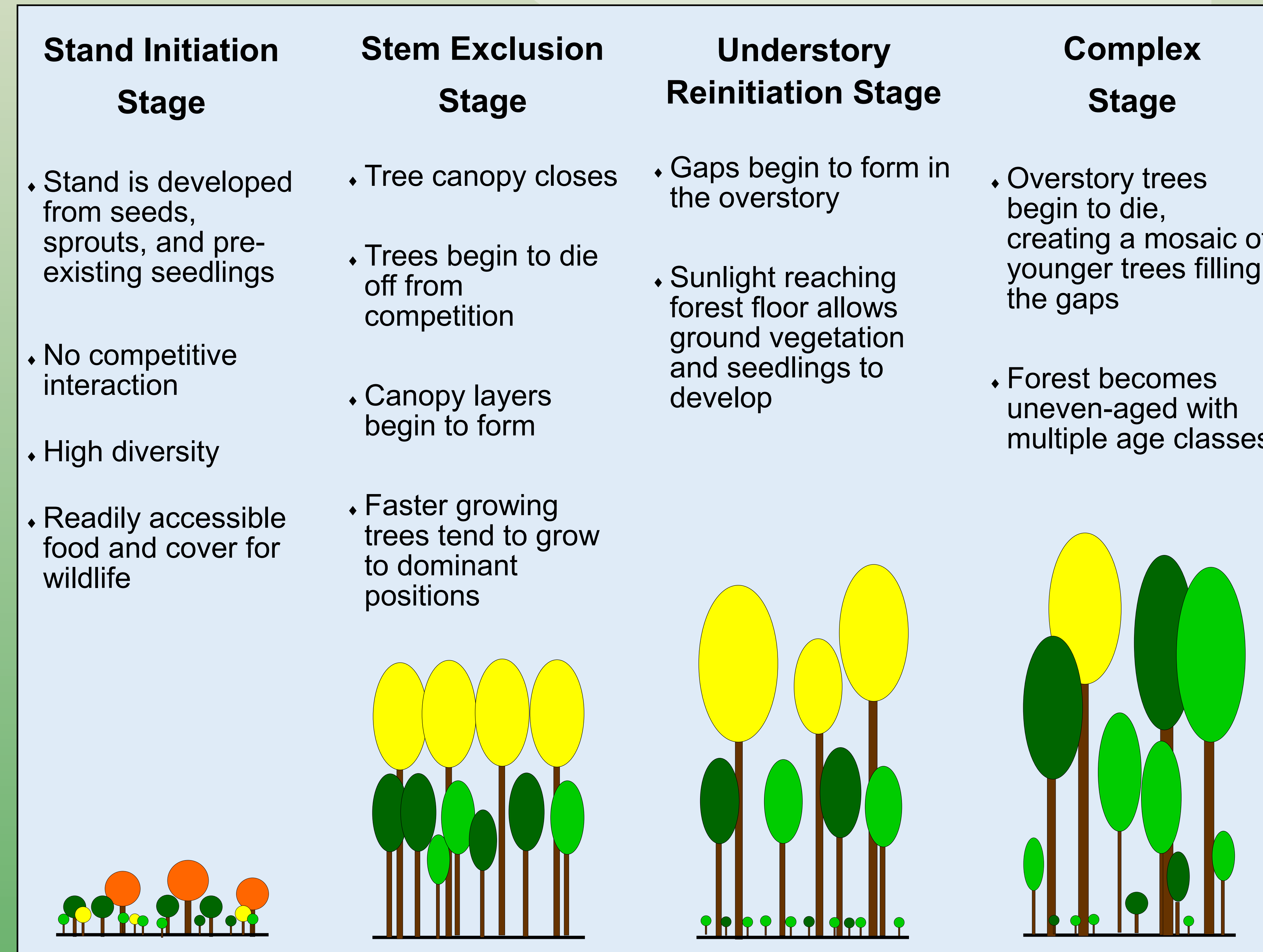


Figure 1. Diagram showing the general stages of forest succession.

Figure adapted from:

Oliver, C. D., Larson, B. C., & Oliver, C. D. (1996). *Forest stand dynamics* (p. 520). New York: Wiley

Oliver, C. D. (1997). Hardwood forest management in the United States: Alternatives for the future. In *"25 Years of Hardwood Silviculture: A Look Back and a Look Ahead," Proceedings of the Twenty-fifth Annual Hardwood Symposium [pp. 45-48].* National Hardwood Lumber Association

For more information visit ohiodnr.gov

In cooperation with the U.S. Department of Agriculture, Forest Service. USDA is an equal opportunity provider, employer, and lender.

Honor Camp Trail

Hocking State Forest

Invasive Exotic Species

Invasive exotic species (IES) are species that are not native to an ecosystem and can cause economic and environmental harm. They are a threat to biodiversity, replace native species, alter natural processes, and cost the U.S. more than $100 billion per year.

Once introduced to a new area, these species typically have rapid growth rates, few or no natural predators or competitors, high seed production, a wide range of habitats, and the ability to alter the environment to their benefit. These characteristics allow these species to grow and spread quickly to take over areas. Once established, it is difficult to eliminate IES and return the ecosystem to its natural state.

Climate change is expected to benefit IES and create even more challenges for native species. Along with the spread of present populations, warmer temperatures may allow kudzu and other IES to expand into new areas. In this area, autumn-olive and privet have been treated.

Tree-of-heaven (*Ailanthus altissima*)

Leaf: Alternate leafing pattern. Leaves are made up of many pointed leaflets. **Fruit**: Large clusters of colorful winged samaras. **Bark**: Thin, light gray. When broken, twigs exude a foul odor.

Amur honeysuckle (*Lonicera maackii*)

Leaf: Opposite leafing pattern. Smooth edges. **Fruit**: Red berries. **Bark**: Grayish brown with vertical stripes.

Royal paulownia (*Paulownia tomentosa*)

Leaf: Opposite. Very large elephant-ear shape leaf. **Fruit**: Large green egg-shaped pods that turn brown and remain through the winter. **Flowers:** Purple flowers. **Bark**: Thin gray-brown bark.

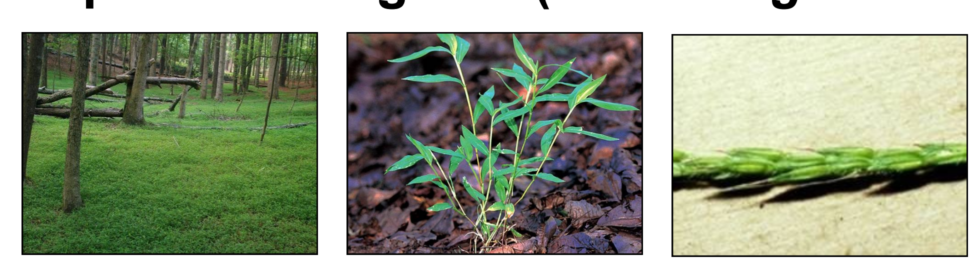
Multiflora rose (*Rosa multiflora*)

Leaf: Alternate leafing pattern with seven to nine leaflets. **Fruit**: Small red hips. **Flower:** Clusters of white flowers. **Form:** Multiple stemmed shrub with curved thorns.

Privet (*Ligustrum* spp.)

Leaf: Opposite leafing pattern with semi-evergreen leaves. **Fruit**: Blue to black drupe. **Bark**: Smooth gray brown with small, short horizontal lines throughout the bark.

Japanese stiltgrass (*Microstegium vimineum*)



Leaf: Alternate, long pointed leaf. **Fruit**: Grain. **Bark**: No bark. **Form:** Spreading grass.

For more information visit ohiodnr.gov

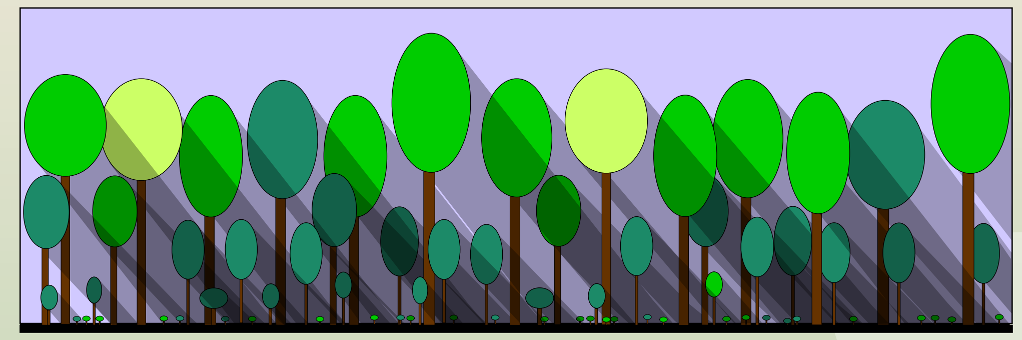
Honor Camp Trail

Hocking State Forest

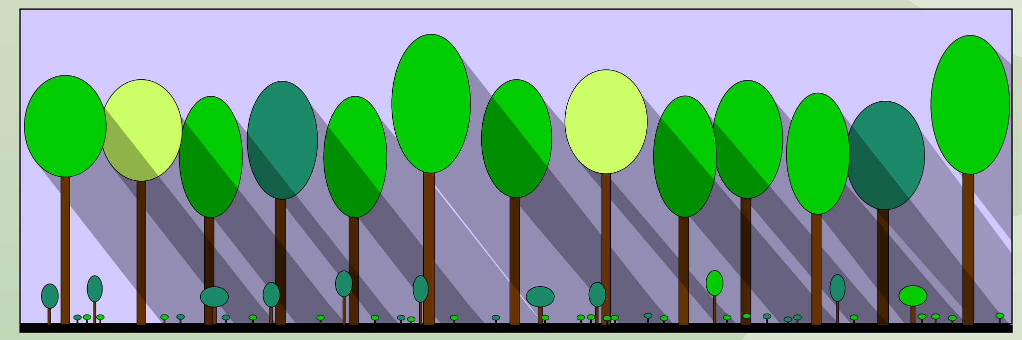
Shelterwood Treatment

Historically, repeated disturbances helped maintain oak as a dominant species in Ohio's forests. With the removal of these disturbances, particularly fire, many oak forests are being replaced by mesic forests of primarily yellow-poplars and maples. A shelterwood treatment is a multi-stage process designed to increase the probability of replacing oak forests with new oak forests. Oak-hickory forests are also expected to fare well under a warmer, drier climate, and restoring these species now will create opportunities to replace species that are expected to decline due to climate change.

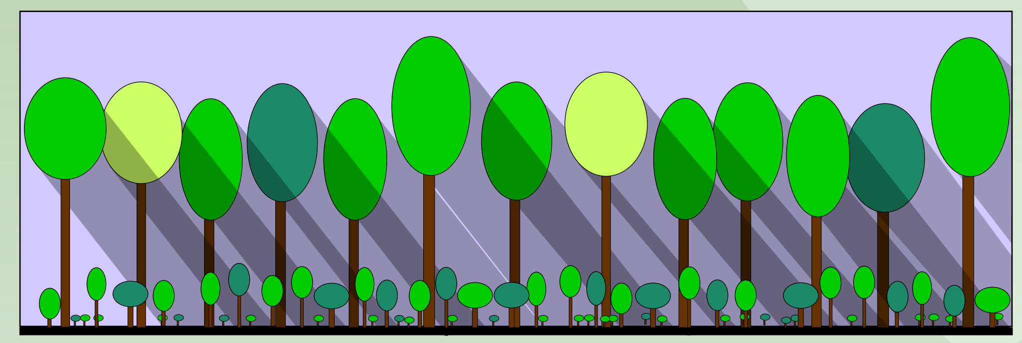
Oak seedlings have a growth strategy that focuses on building their root systems rather than height, which hurts their competitiveness against species that grow tall faster in full sunlight. A shelterwood harvest removes the overstory in stages to provide enough light to help oak seedlings grow while maintaining enough shade to inhibit competitors that require full sunlight. Once oak seedlings have a large enough "head start" they can be competitive in full sunlight. This shelterwood harvest was completed in the fall of 2017. It was inventoried, marked, and cut by Division of Forestry staff.



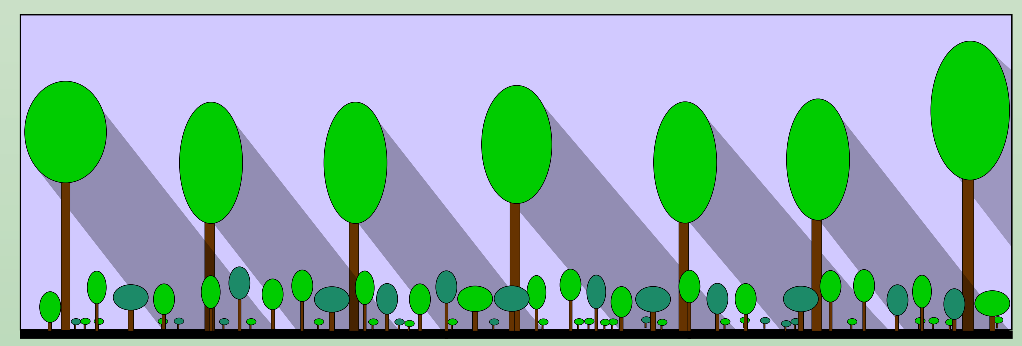
Under mature forests, a dense layer of midstory trees can develop and create deep shade. Oak seedlings may be present, but cannot survive and grow in these light levels.



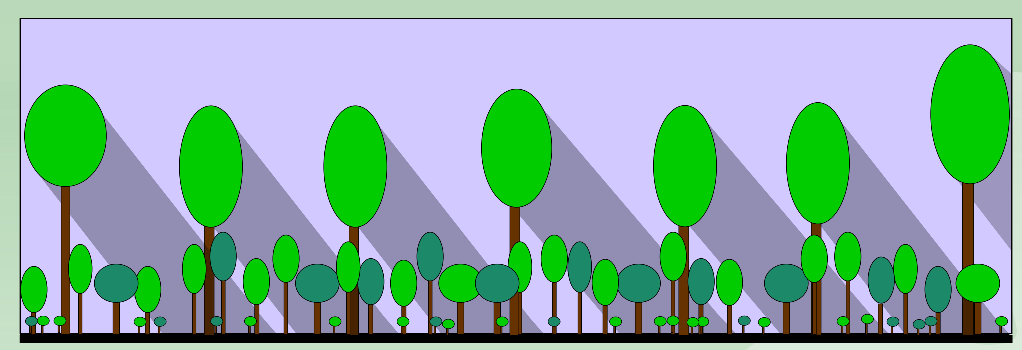
A midstory removal is one possible step in a shelterwood process. This removes the midstory to provide more light for oak seedlings while leaving the overstory intact to maintain enough shade to keep sun-loving species from growing.



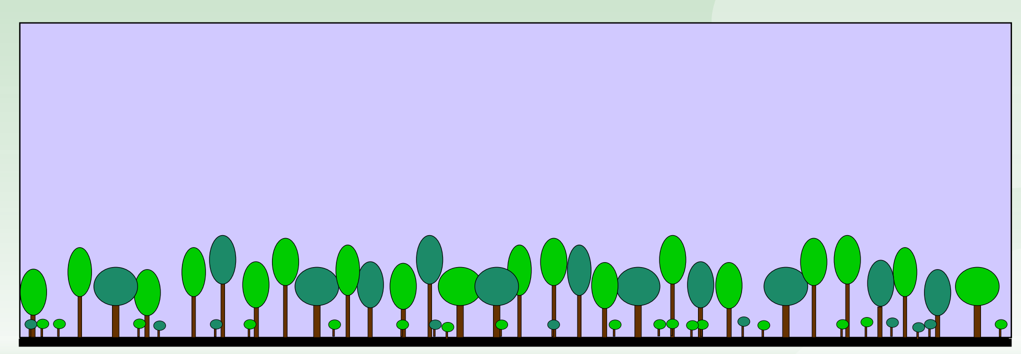
Under the midstory removal, oaks have enough sunlight to grow. While the shade slows sun-loving competitor species, shade tolerant species can still be competitors. Prescribed fires can be used in this stage to reduce competition.



Once oak seedlings are taller and in abundance, the first overstory removal can take place. In this step, about half of the overstory is removed. This further increases light, but still maintains shade to reduce competition.



After 5-15 years under a shelterwood, oak seedlings should be 3-4.5 ft tall. This is tall enough to be competitive in full sunlight. Prescribed fire may be used multiple times in this stage to reduce competition.



The remaining overstory is removed, releasing the oak seedlings. With a head start on height, chances are higher for the development of a new oak forest.

For more information visit ohiodnr.gov

In cooperation with the U.S. Department of Agriculture, Forest Service. USDA is an equal opportunity provider, employer, and lender.

Honor Camp Trail

Hocking State Forest

Thinning Treatment

Trees are constantly competing for resources (sunlight, water, nutrients) to survive and grow. Climate change is expected to affect many of the competitive relationships in forest ecosystems. Productivity may increase because of the positive effects of carbon dioxide and longer growing seasons. But not all species will be able to take equal advantage of these positive effects. Reducing competition for resources can increase the ability of ecosystems to cope with the direct effects (drought stress, temperature increases) and indirect effects (increased damage from pests and disease) of climate change.

In forest management, a thinning treatment removes trees to provide more resources for the remaining trees to grow larger. After thinning out undesirable trees, the remaining trees will grow to fill in the canopy again. By selecting which trees will be removed, foresters are able to influence the species and quality of the trees that will be dominant. This treatment can result in increased diameter growth, healthier crowns, increased seed production, increased food for wildlife, and reduced insect infestations. In this area, a thinning is planned to increase development of desirables trees.

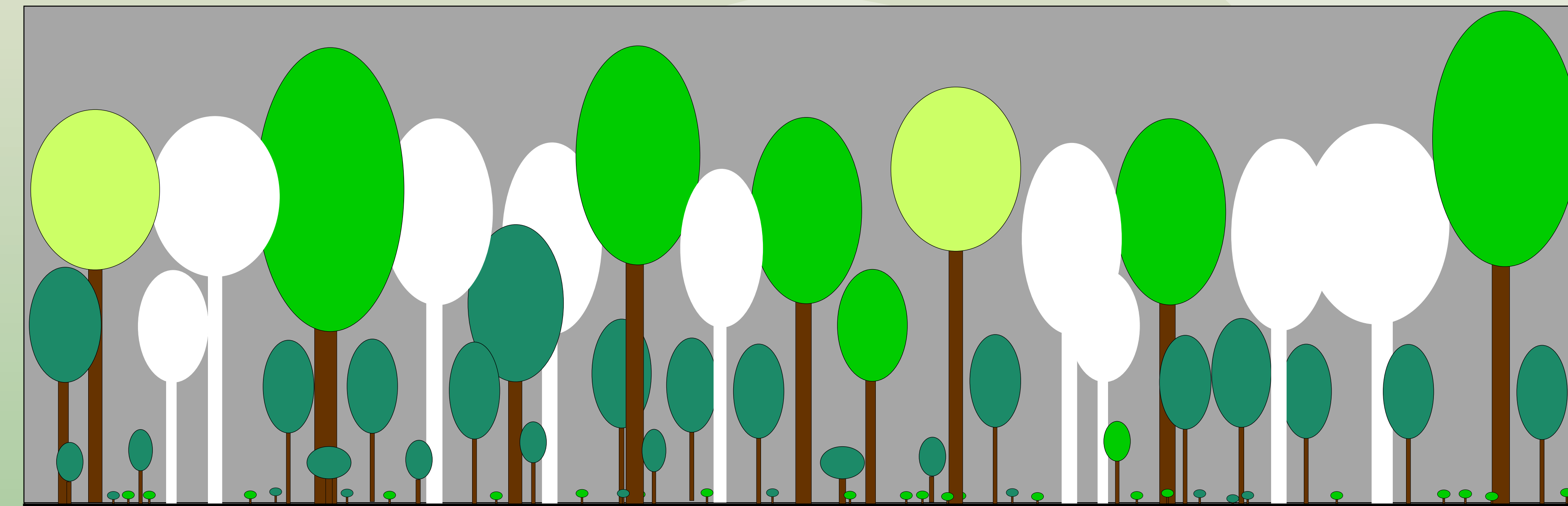


Figure 1. Horizontal view of forest with "whited out" trees selected for removal in a thinning treatment. Space created by removing trees will provide more space for the remaining dominant and codominant trees. Thinning treatments do not focus on the understory trees.

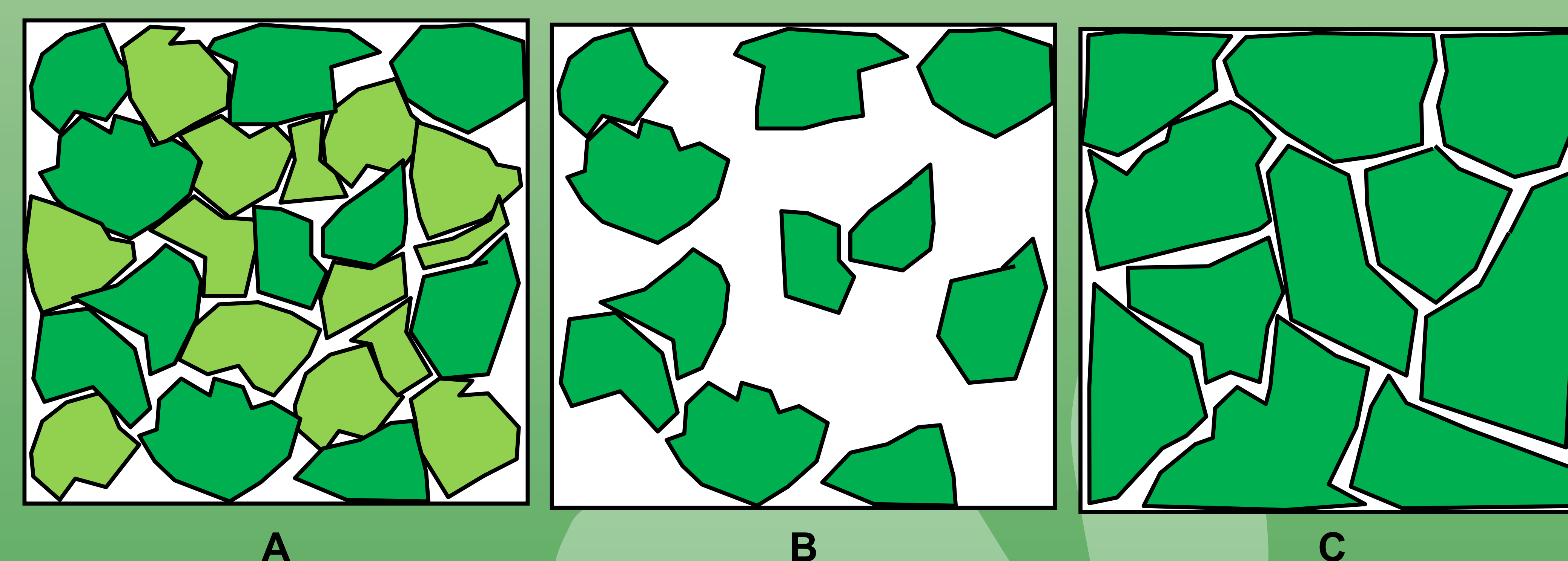


Figure 2. (**A**) An overhead view of a young forest with a closed canopy of competing trees. Desirable trees are shown in dark green. (**B**) Forest canopy immediately following thinning treatment. Only desirable trees remain, with plenty of space to grow. (**C**) Forest canopy years following thinning treatment. Trees have grown larger and reclosed the canopy.

For more information visit ohiodnr.gov

Honor Camp Trail

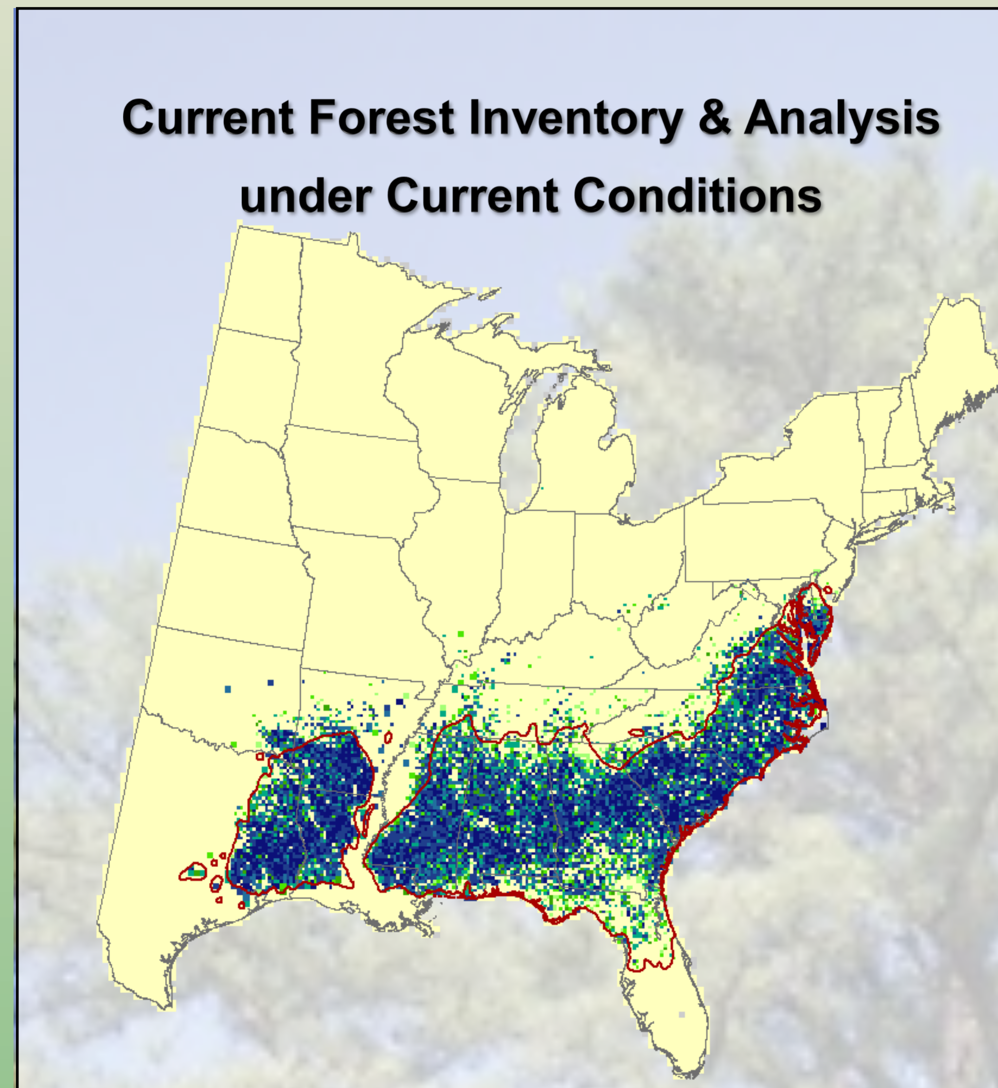
Hocking State Forest

Tree Planting

Climate change has the potential to profoundly affect the forests of Ohio. Many tree species that are currently present may fare worse with warmer temperatures and altered precipitation patterns. Other species may do better under these conditions, and some species not currently present may gain new habitat in Ohio. Climate change can also have indirect effects on forests in the region by changing the populations and dynamics of insect pests, pathogens, invasive species, and other disturbance regimes. The Climate Change Tree Atlas uses statistical techniques to model potential future changes in suitable habitat for individual species and can help forest managers make informed decisions about species composition at various locations.

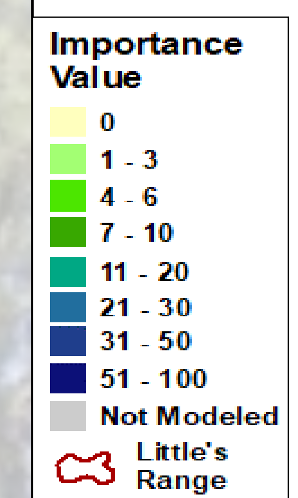
At this site, we planted a variety of species, based on available stock. Some of these species are modeled to fare well or even gain new habitat as the climate changes, including loblolly pine, cherrybark oak, Shumard oak, and water oak. Some seedlings were sourced from Tennessee, Arkansas, Georgia, and the Carolinas, which currently have climates similar to the future climate forecasted in Ohio in the coming decades.

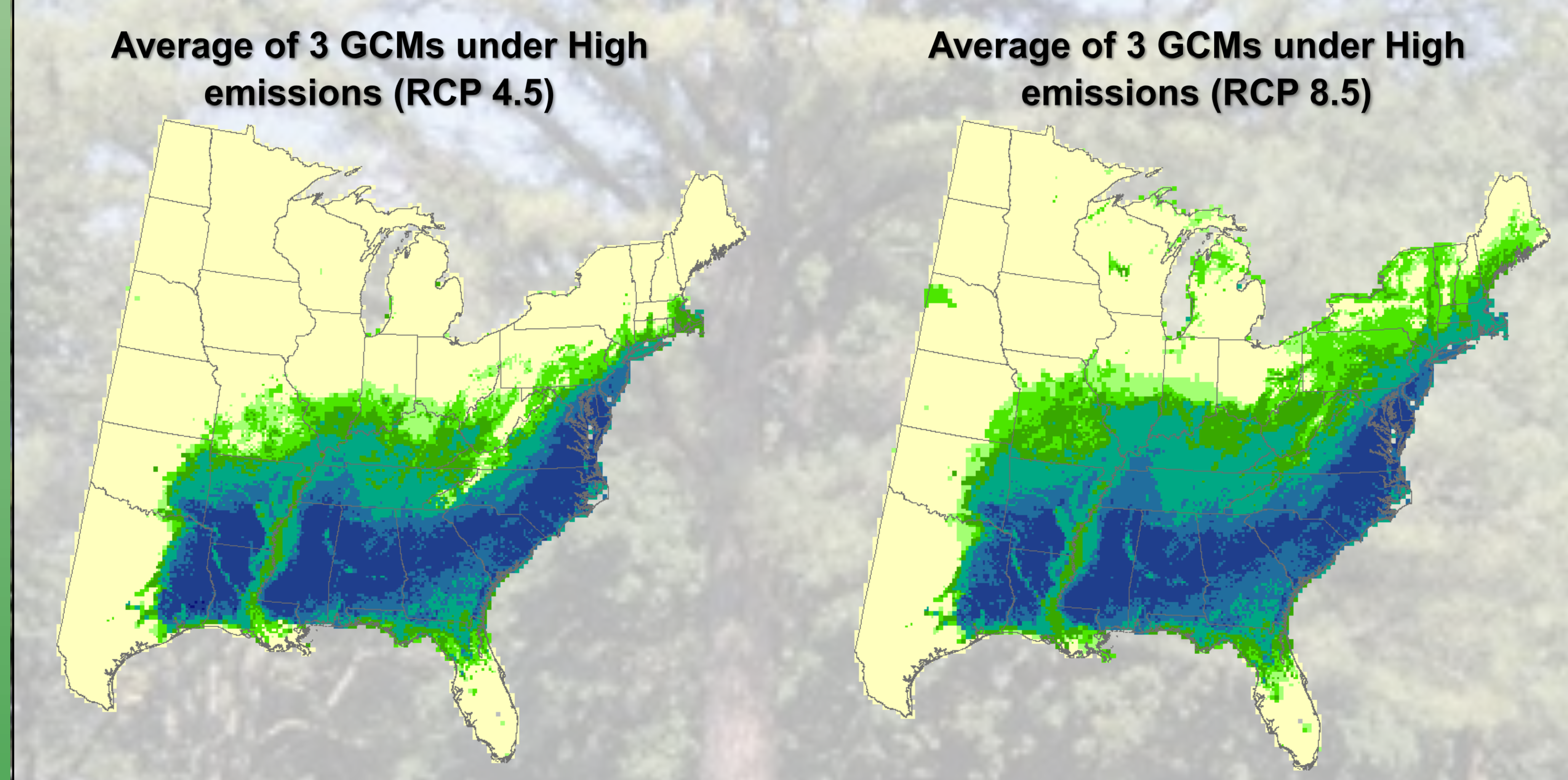
Read more about the Climate Change Tree Atlas by scanning this QR code:



Loblolly pine (*Pinus taeda*)

These maps show the current and potential future habitat for loblolly pine based on moderate and high emissions scenarios from the Climate Change Tree Atlas. Models indicate that the potential range will expand north in the next 100 years.





For more information visit ohiodnr.gov

In cooperation with the U.S. Department of Agriculture, Forest Service. USDA is an equal opportunity provider, employer, and lender.