Welcome to the Duke Forest Shepherd Nature Trail

The Duke Forest is always changing.

Along the Shepherd Nature Trail, you encounter the Duke Forest's past and its present. Its journey through time is shaped by both natural patterns and human activities. We invite you to discover the changing Forest and consider your role in its transformation.

DUKE FOREST
Teaching & Research Laboratory
ESTABLISHED 1931

Come discover the changing forest.

Past and Present

The Duke Forest offers a glimpse into the human and natural history of the Piedmont – from Native Americans and early European settlers to African slaves and tobacco industrialists. It helps us understand how our past shapes the Forest we know today and how our modern society will influence its future.

Since 1931, Duke University has managed the Forest as a living laboratory and outdoor classroom, providing a space for discovery and exploration across a wide range of topics. While research and teaching remain the heart of the Forest's mission, the Duke Forest also:

- *Sustains a renewable natural resource – wood!*
- *Safeguards wildlife habitat and water quality*
- *Protects unique ecosystems and historical artifacts*
- *Provides environmental education opportunities*
- *Offers natural space for outdoor enjoyment*

The Duke Forest is a perennially giving resource, offering benefits to Duke and the broader public community. Its gifts are ours to steward!

Family Matters

Families have used the Duke Forest and influenced its development for generations.

Clues to the Past

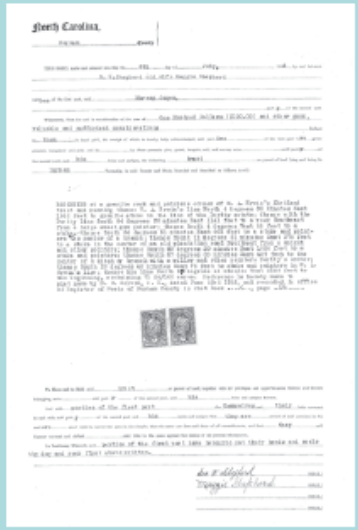
Can you find clues to the Shepherd family's use of the land?

Look for a twin tree, where two new shoots grew from a stump that was cut or grazed.

The Shepherds

The Shepherd Nature Trail gets its name from the Shepherds, a European American family that owned the property along this trail before it was the Duke Forest.

In the late 1700s, William and Suzanna Shepherd settled in what was then Orange County (now Durham County). In the 1800s, their grandson, Thomas, and his wife, Lavinia, lived nearby on a family-run farm. The property you are standing on was owned by Thomas' grandson, George William, and his wife, Maggie. In 1926, they sold this 71-acre tract to Murray Jones, an agent of Duke University, for $100.


North Carolina.


DEED

"The great mass of our population is composed of people who cultivate their own soil, owe no debt, and live within their means. It is true we have no overgrown fortunes, but it is also true that we have few beggars."

– The Fayetteville Observer, 1837

From: Clayton, T. H. (2003). Clues to the Land: North Carolina, 1820-1870. In J. A. Mobley (Ed.), The Way We Lived in North Carolina.

Forest Farmers

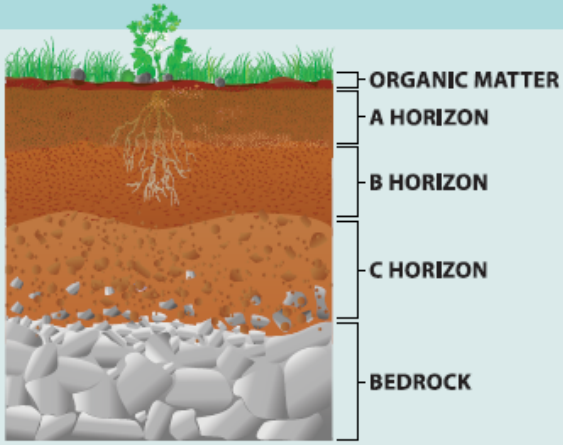
What did George and Maggie use this property for? The Shepherds may have used wood from this forested plot for fuel, fences, drying racks, and barns. They may have also used it to graze livestock, like hogs.

The Living Earth

Soils in the Duke Forest evolve and change through time.

A Rainbow of Soils

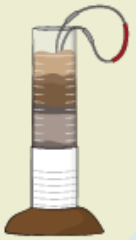
The soil below your feet is much more than just dirt. It is constantly responding to the rocks below, the air above, and the plants and animals that use it. Soils are made up of layers, called horizons, that have different colors and textures. Beneath Piedmont forests, the top horizon is darker, indicating the presence of organic matter – the decomposed remains of plants and animals. Lower horizons typically feature sticky, red clays. Across the globe, horizon colors can range from black to white, red to yellow, and tan to dark brown.



Well-developed soils can take hundreds, even thousands, of years to fully form.

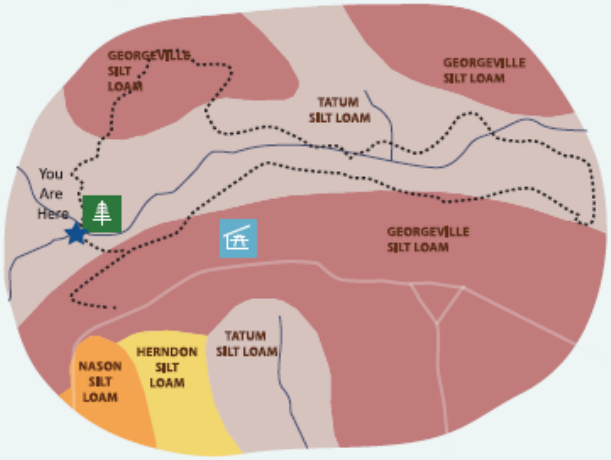
What's Underfoot?

Pull up the soil profile located just beyond this sign and check out Duke Forest's horizons.



This old farm field in the Duke Forest was left bare. Wide gullies formed as soil eroded.

Soils along the Shepherd Nature Trail

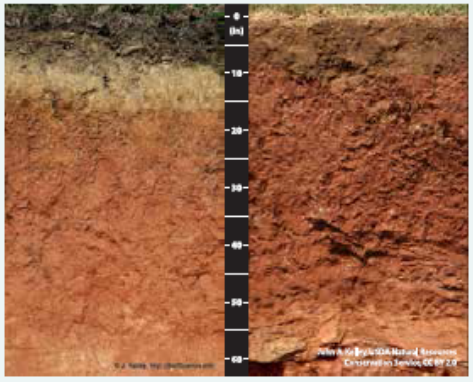


GEORGEVILLE SOIL

Profiles include a layer of decayed leaves atop bright red clay and are found along the trail's hillslopes.

TATUM SOIL

Profiles include a layer of gravelly sediment atop yellow-red silt and are found next to the creek.



Exhaustion and Exposure

In the 19th century, farming practices in the Piedmont did not protect the rich top layer of soil, leaving it vulnerable to erosion and nutrient loss. After years of cultivation, farmers often had to abandon their unproductive fields, which became too exhausted to support agriculture. In the 1920s, Duke University bought many degraded farms and woodlots to create the Duke Forest. Signs of the land's agricultural past, like erosion gullies and old-field furrows, are still visible in the Forest today.

Agents of Change

Natural and human-caused disturbances drive change within the Duke Forest.

Evidence of Fran

Check out
"The Independence Tree,"
a 200-year-old White Oak
that fell during Hurricane Fran.
Trace its life along a timeline
of important events in
United States history.

Human Disturbance: *From Farms to Forest*

Much of the Duke Forest was once farmland. In many places, Loblolly Pine trees now grow where wheat and tobacco were once cultivated. How did these farms become a forest? Pine forests slowly took over through a process called old-field succession, the regrowth of vegetation following an agricultural disturbance.

1. Grasses and wildflowers use the abundant sunlight and overtake the abandoned field. Low shrubs, like blackberry and sumac, then sprout and shade out the understory.

2. Fast-growing trees like pines outcompete the shrubs for sunlight and soil nutrients.

3. Hardwood trees, like oak and hickory, grow beneath the aging pine forest. Given hundreds of years, the pine forest can be completely replaced by hardwood trees.

Natural Disturbance: *Hurricane Fran*

Hurricane Fran remains the most devastating natural disturbance to hit the Duke Forest since its establishment in the 1930s. On September 6, 1996, Fran crashed through the Forest, flooding stream banks, splitting tree trunks, and ripping up tree roots. Those decaying tree trunks are now home to wildflowers, grasses, mosses, mushrooms, and lichens. The pits left by upturned tree roots often collect water and can provide breeding habitat for amphibians.

Tip-up mounds – the soil and upturned roots from trees downed in Fran – can still be seen along the trail.

Images of Fran's destruction, including an aerial view of trees blown down by Hurricane Fran near Highway 751.

"A few minutes ago every tree was excited, bowing to the roaring storm, waving, swirling, tossing their branches in glorious enthusiasm like worship. But though to the outer ear these trees are now silent, their songs never cease."

– John Muir

Crucial Creatures

Wildlife create and respond to changes in their Duke Forest home.

Sensitive Salamanders

Though they are small, salamanders are great indicators of change in the Duke Forest. Salamanders have moist, permeable skin and are sensitive to the warming and drying conditions posed by climate change. With increased human development, slow-moving salamanders can be isolated from one another, cut off from a water source, and subject to the heat reflecting off surfaces like pavement.


Red-backed Salamander


Marbled Salamander


Spotted Salamander

Oh dear, the deer!

Due to a lack of predators, deer are more abundant than ever in the Piedmont. In the Duke Forest, deer eat away at the diversity of native plants and stunt the regeneration of trees. Deer feed, or browse, on plants and young trees near the ground. Too much deer browse in one area can favor the spread of invasive plants, like Autumn Olive, and reduce habitat for ground-nesting birds and amphibians.

Special thanks to Brenna Forester, Nicholas School of the Environment.

Look Around You

What wildlife can you find along the Shepherd Nature Trail?

Listen to the songs of birds, search for insects beneath a rock, or watch for dragonflies zipping by.

At home in the Duke Forest:

150 species of birds


American Woodcock

80 species of butterflies


Black Swallowtail

60 species of amphibians & reptiles


Eastern Rat Snake

30 species of mammals


Bobcat

Mad for Mast

Crops of mast – the hard nuts of oaks, hickories, and beeches – create a wave of change in the Duke Forest.

Mammals, Mast, and Mayhem

Heavy mast years, known as bumper crops, create a wave of change in animal communities. Acorns and nuts provide food for mammals like mice and deer. When mast is abundant, populations of these mammals increase. Sometimes, this increase has widespread effects on other animals.

For example, with more mice around, populations of ground-nesting birds, like Veeries and Worm-eating Warblers, often decline. Mice plunder the nests of these birds for eggs and decrease the number of young birds that survive. Declines in the numbers of ground-nesting birds are usually seen two years after a bumper crop.

> ***"When the oak-tree is felled, the whole forest echoes with it; but a hundred acorns are planted silently by some unnoticed breeze."***
>
> *– Thomas Carlyle, On History (1830)*

Oak Orchards of Native Americans

Historically, Native Americans used over ten species of mast trees, including oaks, walnuts, and chestnuts, to supplement their diet. Many tribes created oak orchards and walnut woodlands by using fire to promote mast trees or by girdling undesirable trees. This strongly affected the development of Piedmont savannas and forests by promoting oaks and hickories on the landscape.

After a long process of drying, pounding, and leaching in hot water, Native Americans used acorns to make soup or bread.

A bumper crop of acorns provides food for over one hundred animals in the United States, including deer, squirrels, and birds.

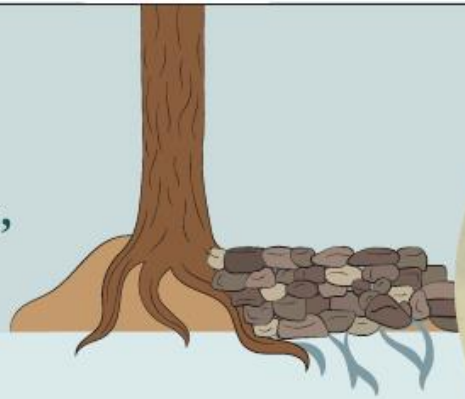
More Mast → **More Mice** → **More Plundering of Bird Nests** → **Fewer Ground-nesting Birds**

Abrams, M. D. & Nowacki, G. J. (2008). Native Americans as active and passive promoters of mast and fruit trees in the eastern USA. The Holocene, 18(7): 1123-1137.
Koenig, W. D. & Knops, J. M. H. (2005). The mystery of masting in trees. American Scientist, 93: 340-347.

Special thanks to Johnny Blackfeather Jeffries of the Occaneechi Saponi and Duke University Librarians.

An Essential Resource

Water shapes life and land in the Duke Forest, and humans alter its influence.



Who lives here?

Look into the flowing stream or peer into the puddling seep. Can you find signs of life?

Water is Life

The humble stream along this trail provides a home for a variety of lifeforms and shapes the surrounding forest. Minnows and frogs dart through its waters, and salamanders lay their eggs among the shallow rocks. Along the streambanks, trees that prefer moist soils, like American Sycamore, take root. Further uphill, trees that tolerate drier soils, like Southern Red Oak, are more common.

Upland Chorus Frog

In the past, this creek was also a water source for people. Beyond this sign is a natural seep, a location where groundwater meets the surface. In the 19th century, the Shepherd family may have built the stone wall around it to collect water for cooking and cleaning or to create a watering hole for livestock.

"Water is life. It is the briny broth of our origins, the pounding circulatory system of the world. We stake our civilizations on the coasts and mighty rivers. Our deepest dread is the threat of having too little – or too much."

– *Barbara Kingsolver, Water is Life (2010)*

American Sycamore, *Platanus occidentalis*

Southern Red Oak, *Quercus falcata*

Changing Course

Today, people build structures like roads that change natural patterns of water movement. Upstream from the trail, this creek begins in what is now a road ditch along Highway 751. How might this have changed the creek, its water quality, and the habitat it provides?

This cement culvert along Highway 751 is now the source of the creek along the trail.

Bothersome Bugs

Native and non-native pests change the composition of the Duke Forest.

Beech Blight Aphid

NATIVE

Beech Blight Aphids are native to the East Coast and have influenced forests by targeting American Beech trees. As aphids suck sap from Beeches, they excrete a sugary substance called honeydew. A specialized sooty mold, *Scorias spongiosa*, grows off this honeydew and coats tree leaves, leaving them unable to photosynthesize. This can reduce the regeneration of Beech trees in eastern forests, though there has been no noticeable impact on Duke Forest Beeches.

Be a Pest Detective!

Inspect the low branches of an American Beech tree. In late summer, you may find the cotton-white Beech Blight Aphids and black sooty mold!

Emerald Ash Borer

NON-NATIVE

One pest that is transforming forests throughout the United States is the Emerald Ash Borer (EAB), an invasive pest from Asia. The larvae of these electric-green bugs burrow into the inner bark of Ash trees, where they chew wide channels and cripple trees' ability to absorb nutrients. Though they are new to North Carolina, these brutal bugs have decimated populations of Ash trees throughout the country. As of 2016, EABs had not been found in the Duke Forest.

© Don't Move Firewood, The Nature Conservancy

Humans assist the spread of EAB by transporting infected logs. Do your part by using only local firewood!

(left) Larval galleries are the feeding paths that EAB larvae create as they eat the inner bark of an infected Ash tree.

(right) Signs of an Ash tree dying from EAB begin at the crown and move down.

Cook-Patton, S. C., Maynard, L., Lemoine, N. P., Shue, J., & Parker, J. D. (2014).
Cascading effects of a highly specialized beech-aphid-fungus interaction on forest regeneration. PeerJ, 2. doi:10.7717/peerj.442

Forestry for Today and Tomorrow

Duke Forest management responds to changing conditions to ensure the Forest's resources are available now and in the future.

The natural resources of the Duke Forest offer countless benefits to Duke University and the broader community. Its trees, water, and wildlife provide opportunity for academic exploration and carefree enjoyment of nature. Managing the Duke Forest for a variety of uses is a constant balancing act that considers – and responds when necessary – to changing human and natural conditions.

Often, a single management activity accomplishes multiple goals:

Timber Production

Timber production provides teaching and research opportunities, promotes healthy and disease-resistant trees, and creates a diversity of habitats.

Prescribed Fire

Prescribed fire replenishes soil nutrients, stimulates new forest growth, and reduces unwanted trees and plants.

Invasive Species Control

Invasive species control removes non-native, invasive plants, like Kudzu, and preserves native plant and animal habitats.

Natural Heritage Monitoring

Natural heritage monitoring protects unique plants , animals, and habitats and helps conserve North Carolina's biodiversity.

Don't take our word for it!

The management of the Duke Forest is certified to Forest Stewardship Council® guidelines, a strict set of environmental, social, and economic standards that demonstrate a commitment to responsible forestry and resource protection.

In Memory Of

DANIEL HAFER GELBERT

November 4, 1939 – April 3, 2014

Dan with loving wife, Robin.

Renowned forester dedicated to the responsible management of North Carolina's forests

Dan Gelbert devoted his career to helping North Carolina landowners responsibly manage their forests. He was a committed forester from the beginning, noting in his yearbook at age 16 that forestry would be his career. Dan attended Duke University for both his undergraduate and graduate degrees (Master of Forestry, 1962) and played on the Duke Football team that won the 1961 Cotton Bowl.

Dan established his first forestry consulting company in 1973 and later owned two forest survey companies. He passionately believed in the role of forestry consultants to support private landowners' goals to protect their land, preserve habitat and species, and generate income from responsible resource use.

Dan was an important and decorated member of the North Carolina forestry community – participating on many councils and advisory boards, publishing numerous articles in professional journals, and receiving many awards in recognition of his exemplary work. He was also committed to inspiring future foresters by employing high school and college students and serving as an adjunct professor in Duke's School of Forestry (now the Nicholas School of the Environment).

The Office of the Duke Forest recognizes Dan's extraordinary contribution to the field of forestry and his dedicated service in support of private forest landowners and the protection of North Carolina's forests.

Investigation and Inquiry

Scientific research in the Duke Forest uncovers how forests change through time.

Find the Plots

One study plot along the trail is marked with metal rods and orange flagging. It was installed by Professors Peet and Christensen in 1977.

A Long Legacy

The Duke Forest has been used by students and faculty at Duke and from across the globe to uncover secrets about our ever-changing world. The Forest's legacy of scientific discovery – from understanding how a forest regrows after agricultural abandonment to learning about how forests respond to changes in climate – is rich.

Scientific research in the Duke Forest started with its first Director, Dr. Clarence Korstian. In the 1930s, Korstian and Dr. Theodore Coile created 87 study plots to learn about the effects of forest management on tree growth. In the 1980s, Professors Norman Christensen and Robert Peet used Korstian's historic dataset plus information from 230 additional plots to describe how forests naturally thin out over time.

Students measured trees in the study plots established by Dr. Clarence Korstian.

"A scientist in his laboratory is not a mere technician: he is also a child confronting natural phenomena that impress him as though they were fairy tales."

– Marie Curie

Climate Change Research

The Forest-Atmospheric Carbon Transfer and Storage (FACTS-I) project was established in the 1990s to understand how forests respond to increasing carbon dioxide (CO_2) in the atmosphere. By pumping extra CO_2 into some Duke Forest stands but not others, the research showed that at first, Loblolly Pine trees in CO_2 enriched plots grew faster than those in control plots. However, tree growth was eventually limited by a lack of soil nutrients.

FACTS-I enrichment plots consisted of a ring of PVC pipes blowing CO_2 into a stand of trees. Over 260 researchers worldwide participated in the project. The site was decommissioned in 2010, but findings continue to be published.

Research from the FACTS-I study showed that Poison Ivy in CO_2 enriched plots contained more of the irritant, urushiol.