Forest Ecology / Forest Health

Forest Ecology

What is the Study of Ecology? (Odum 1963)

Ecology is derived from the Greek root "oikos" meaning "house." As there are large and small houses, this aptly helps us understand that the scope of our study can be at any number of levels. Ecology includes describing: the confines of the house, the furnishings, the activities found there, and the interactions of the players and furnishings in the house.

A classical emphasis of ecology is to study the structure and function of nature. This has the benefit of allowing objective quantification, thus getting away from subjective discussion of good and bad situations (which usually reflects human self-interest).

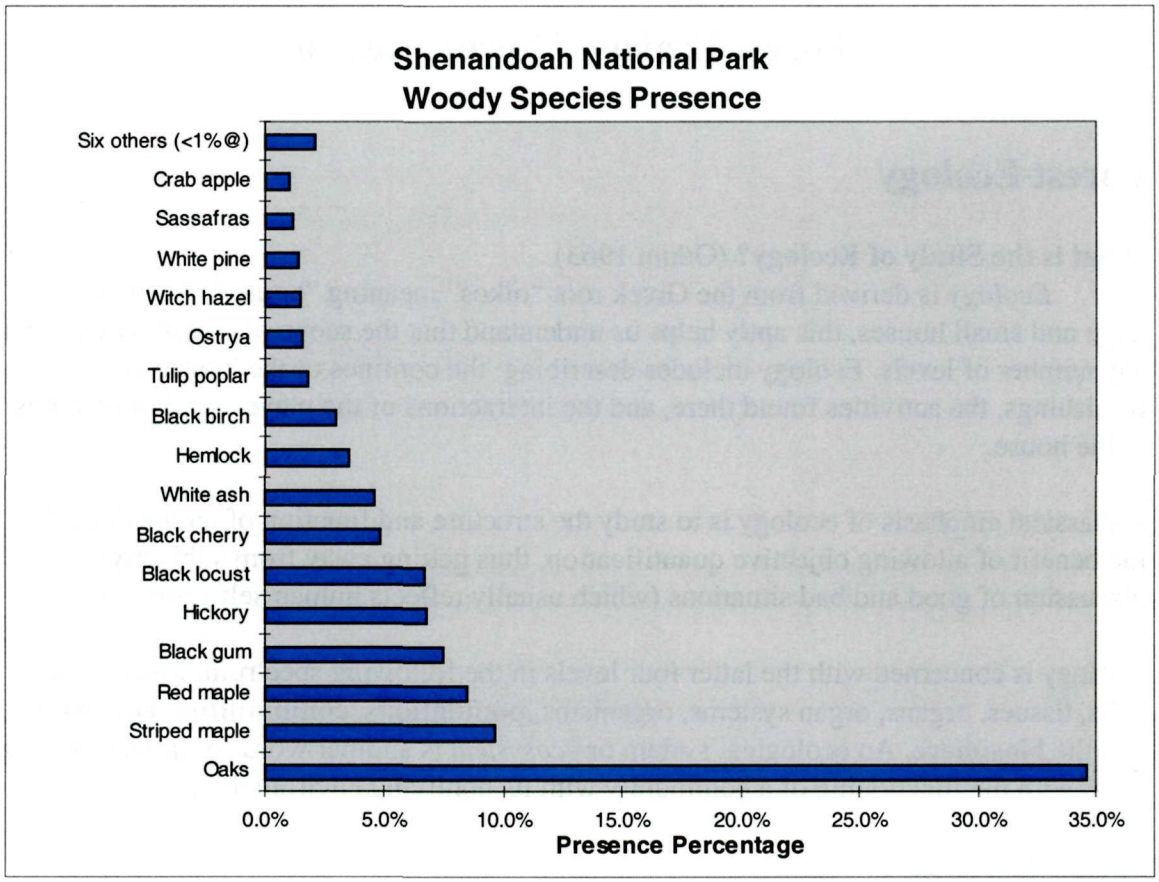
Ecology is concerned with the latter four levels in the following spectrum: protoplasm, cells, tissues, organs, organ systems, organisms, **populations**, **communities**, **ecosystems**, and the **biosphere**. An ecological system or *ecosystem* is another word for *nature*, having to do with the functioning of a community with its nonliving environment.

Species Structure

There is a strong and consistent feature of communities that they contain comparatively few species that are common and a large number of species that are rare at any given time and space (Odum 1963). Tree species found within the Park illustrate this quite well. (Refer to the following chart taken from our 1998 ice damage survey.) Three oak species plus five others represent nearly 75% of the individuals. They dominate the scene, but a host of other species also exists there and exerts their influences upon the whole.

If the eight tree species can so dominate the forests of the Park, why not manage for those eight only? What's the use of diversity? Ecologists believe that diversity is important as a response mechanism to future change of environment. Where diseases, new species, or climate and nutrient changes might negatively impact current dominant species, others within a diverse community might be able to quickly adapt and thrive, thus keeping productivity high. The minor species, then, are like stand-ins waiting backstage for their part to play. This theory was seen in action upon the demise of American chestnut -- a species which had been 10-35%$^{+}$ of our stands. Oaks quickly became the dominant species of the eastern forest as the chestnut diminished.

The following chart summarizes the relative dominance of (mostly tree) species within SNP. This data was gathered using 67 plots in 38 locations, generally along Skyline Drive, but also adjacent to fire access roads throughout the Park.



Population dispersions are generally either uniform, random, or clumped distributions. Area averages for random and clumped populations are problematic since no one area looks like another, statistically speaking. As a consequence, it takes more sampling intensity and statistical explaining to describe such stands. Most populations tend to be clumped (grouped). Random individuals are often part of a colonizing van. Truly long-term random individuals tend to be rare predators in the animal kingdom.

The Forest

Just as people show the marks of genetics and their environment, the forest stands of Shenandoah National Park exhibit the interplay between their developing genetic background with the physical environment, past & present land uses, climate, weather events, wildfire, insects, disease, and invading alien vegetation. The higher one goes on the Blue Ridge Mountains, the more intense become the environmental impacts. The higher you go, the more gnarled the trees become. In fact, only the species best able to resist those factors remain for long. What follows is a brief summary of impacts and their results.

Moisture / Available Moisture. The higher on the ridge you go, the more moisture is intercepted from the clouds. Prevailing weather comes from the west, while significant

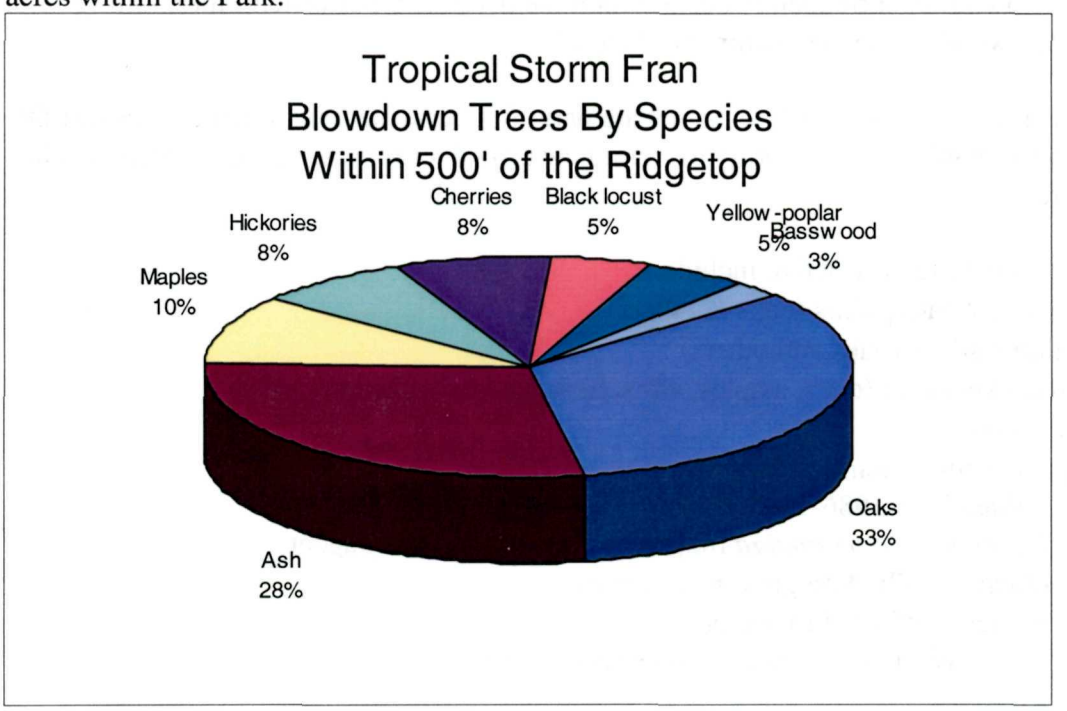
summer storms come from the south and southeast. But the higher on the ridge you go, the shallower are the soils, and they are less developed. This means that moisture tends to pass through the soil profile rapidly and not long remain available to vegetation. As a consequence, trees, shrubs and plants must be adapted to capture moisture for the droughty conditions between rains.

Air Quality. Air pollution has an effect on the vegetation of our forest. We are most concerned about the impacts of sulfates, nitrates, ozone and particulate matter. The first two cause acidification of soils and stream water. Air pollution stresses vegetation by causing chemical imbalances, adding to the suite of stresses in a given time and place.

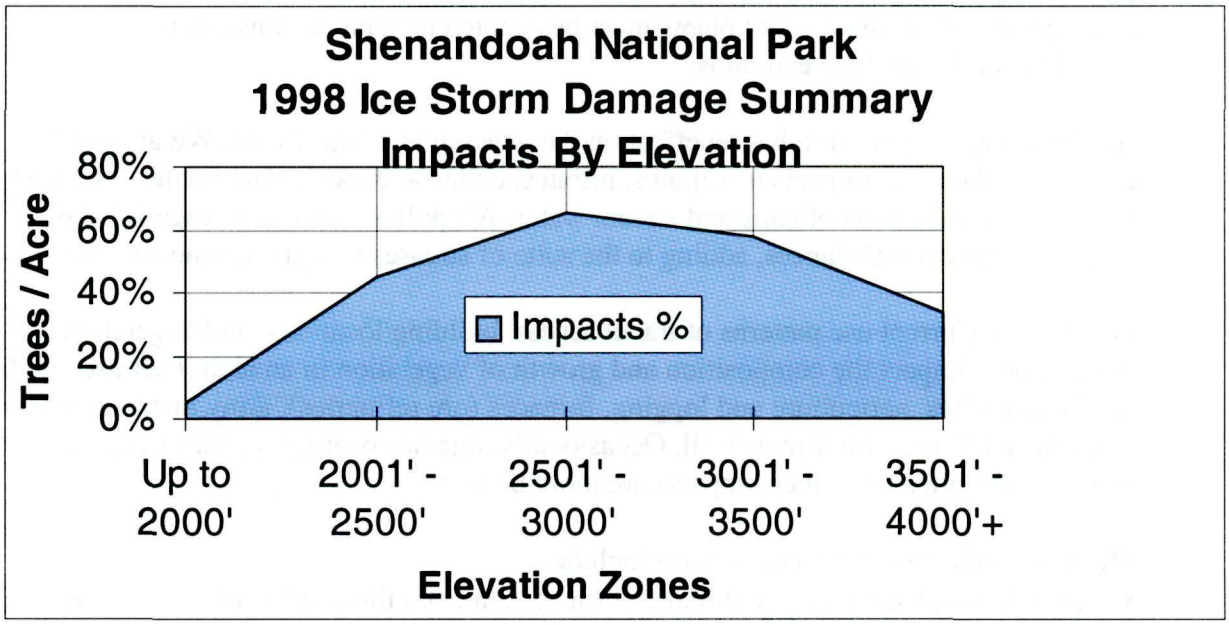
Land Uses. Current use patterns of travel access, building locations, and vegetation management impact the composition and growth of vegetation in an area. Past uses such as old homesites, agriculture and logging, furnaces (ore refineries), army installations, and roads have left their imprint as well. Occasionally, this has bearing on current forest health. More often here, their impacts are more benign.

Storm Events. Notable recent storms include:

- 1995 flood (a summertime thunderstorm system from the southeast). This caused complete deforestation and soil loss along quite a number of east side streams. Impacts were predominately in Madison and Greene Counties but were also felt in Rappahannock and Albemarle Counties.
- 1995/96 flood (a snow and quick melt, December-January). This impacted streams in all eight surrounding counties.
- Tropical Storm Fran (September 1996). This impacted forest stands and streams in all eight surrounding counties. Trees were blown down or broken over many thousands of acres within the Park.



- 1998 Ice Storm (February). Trees were tipped or broken to varying degrees virtually everywhere in the Park. Worst damage was in the elevation zone of 2000'-3500'.



Wildfire. Though fire has not played a dominant role here, there have been periodical severe impacts. The 1998 Calvary Rocks Fire blackened 1,485 acres within Paine Run watershed. Several wildfires since that time remind us that fire is a recurring problem associated with seasonal or long-term droughts. Fire is an agent for quick forest change. Berg & Moore's 1941 forest cover type report states that "forest fires occurring within the Park are mostly surface fires burning the dried leaves and other litter on the forest floor....Crown fires infrequently occur within the dry pine types (Pitch Pine), killing most of the hardwood associates within the stands."

Insects. There are a host of insects that are part of the environment, having a place at the table and valuable for their ability to cause new growth or recycle organic matter within the system.

A few of the more destructive include:

- Forest tent caterpillars (oaks & others)
- Walking sticks (oaks and others)
- Fall cankerworm (oaks, maples, elms, hickories, ash, cherry)
- Locust borer
- **Gypsy Moths** (non-native)
  Epidemic of 1986-1995
  Entomophaga maimaiga fungus became a controlling agent
- **Hemlock Woolly Adelgids** (non-native)
  Epidemic of 1988 to present
  Suppression efforts include trees accessible by road

Hemlock biodiversity research is helping us determine species that require hemlock stands, and will lead us to successfully manage for their needs.

Not considered destructive:

- Eastern tent caterpillars (cherry & others)
- Locust leafminer (locust, apple, beech, birch, cherry, elm, oak, hawthorn)
- Bagworm (arborvitae, juniper, others).

Diseases. There are many more diseases present than we have identified. Some of the most obvious include:

- American chestnut blight -- deadly to trees large enough to develop furrowed bark
- Black knot disease (cherry) -- not usually death producing
- Dogwood anthracnose -- especially troubling above 2000' in moist sites
- Nectria canker (yellow birch, black walnut, others) -- leads to death if on main stem
- Cedar apple rust (eastern redcedar, apples) -- a special problem for orchardists.

Invasive Alien Vegetation. There are over 220 non-native species within the Park (17% of total known species). Of those, there are 40 that we are targeting for monitoring, and seven we currently attempt controls(*). Some of the worst include:

Kudzu*	***Pueraria lobata***
Oriental bittersweet*	***Celastrus orbiculatus***
Japanese knotweed*	***Polygonum cuspidatum***
Johnson grass*	***Sorghum halepense***
Mullein*	***Verbascum spp.***
Princess tree*	***Paulownia tomentosa***
Tree of heaven; stink tree*	***Ailanthus altissima***
Beafsteak plant	***Perilla frutescens***
Bull-thistle	***Cirsium vulgare***
Canada thistle	***C. arvense***
Common burdock	***Atrium minus***
Garlic mustard	***Alliaria petiolata***
Gill-over-the-ground	***Glechoma hederacea***
Japanese barberry	***Berberis thunbergii***
Japanese grass; stilt grass	***Microstegium vimineum***
Japanese honeysuckle	***Lonicera japonica***
Multiflora rose	***Rosa multiflora***

Forest Management

Mission & Intent. Forest health and IPM field activities support the following Park goals.

- Long term goal 1.1 -- By 2002, park resources are sustained through an understanding of ecosystem processes, status and trends, and protected from an unacceptable level of impacts of human activities inside and outside the park.
- Long term goal 1.4 -- By 2002, habitats containing high diversity; endemic or threatened species; required by migratory species; or of social, economic, scientific or cultural importance; have been identified and 50% are protected from avoidable degradation.
- Long term goal 1.7 -- By 2002, the distribution and abundance of all exotic species that threaten park resources or public health are known and all high priority populations exist at levels below defined damage thresholds.

- Long term goal 2.6 -- By 2002, 70% of facilities, employees' quarters, work activities and public services are in compliance with health and safety standards.
- Long term goal 4.1 -- By 2002, 40% of all historic structures on the List of Classified Structures are in a "good" condition.
- Long term goal 4.2 -- By 2002, the care of the park's curatorial collection meets NPS standards.
- Long term goal 4.3 -- By 2002, Camp Hoover has been restored to the standards established by the Secretary of the Interior and are maintained to such standards.
- Long term goal 4.5 -- By 2002, those significant cultural resources and landscapes that do not need restoration are not degrading.

Are there overriding legal or policy considerations?

The 1916 Organic Act establishing the NPS clearly states that we are "to conserve the scenery, and the natural and historic objects and wild life therein...." The 1988 NPS-77 states, "The NPS will manage the natural resources of the national park system to maintain, rehabilitate, and perpetuate their inherent integrity." Director's Order 55 states, "...the Park Service must leave park resources and values unimpaired..."

Landowner Objectives. These citations establish our land management objectives. How would the objectives of other owners differ from our own? Compare the following: timber tract business v. farmstead v. homeowner v. SNP.

Forest Health

Definition of Tree Health (Åkerson)

- Freedom from maladies. A fully functioning organism. A condition of optimal well-being.

Definition of Forest Health (USDA, Forest Service)

- Forest health is achieved when biotic and abiotic influences do not threaten management objectives now or in the future. (circa 1990s)

- Forest health is a condition wherein a forest has the capacity across the landscape to vigorously renew itself, to recover from a wide range of disturbances, and to retain its ecological resiliency while meeting current and future needs of people for desired levels of values, uses, products, and services. (June 1996 interagency task force)

Both forest health definitions above are human centered. Indeed, it is difficult to look at the health of an area without having the underlying assumption of "healthy for my needs." When looking through the largest scope possible, health has less relevance since even a deteriorating stock of trees is good for insects, fungi and others -- they have a place at the table.

In this largest context, all creatures have their place and function. What are some of the creatures we normally choose to ignore? (fungi, algae, insects, etc.)

Discussion of Ecosystem Stability (Wicklum and Davies. 1995.)

- "Health and integrity are not inherent properties of an ecosystem..."

The authors contend that human definitions reflect our demand for order and stability, and place us outside the environment instead of putting us in it. Change, they say, is part of an environment. Change may not look healthy as the new *reality* takes over.

Is anything Sacred or Taboo?

If disruption, decay, and instability are acceptable, is anything unacceptable? What remains?

In a park setting, where we must preserve and protect our resources, we can still resist degradation and longterm-to-permanent change. Indeed, we must protect against impairment and degradation brought on by factors that would hinder the abundance of life and biodiversity. Such factors include accelerated soil erosion, increased air-borne depositions, repeated man-caused wildfire, and the introduction of invasive non-native species.

Literature

Berg, L.Y. and R.B. Moore. 1941. *Forest cover types of Shenandoah National Park, Virginia.* USDI, National Park Service, Region One. 66 p. plus illustrations & appendices.

Odum, Eugene P. 1963. *Ecology.* Holt, Rinehart and Winston, Inc. New York. 152 p.

USDA-FS. 1996. *Congressional field briefing: forest health protection in the East, June 3, 1996.* Interagency task force sponsored by USDA-Forest Service, Washington, DC; USDI-National Park Service, Shenandoah National Park, Luray, VA; and Virginia Department of Forestry, Charlottesville, VA.

Appendix

Silvical characteristics[a] and value of some commercial central Appalachian hardwood tree species.
Miller, Gary W., and James N. Kochenderfer. 1998. *Journal of Forestry* (96:7); "Maintaining species diversity in the Central Appalachians." Society of American Foresters, Bethesda, MD. P. 29.

Shade tolerance	Seed longevity	Seed periodicity	Tree Age At first seed	Primary regeneration mechanism: Seeds	Advanced Seedlings	Sprouts	Relative product market value[b]	Relative wildlife food value[c]
		..... years						
Very intolerant								
Black locust	Several	1-2	6			x[d]	4	14
Intolerant								
Black cherry	3	1-5	10	x	x	x	100	96
Yellow poplar	8	1	15	x		x	26	14
Hickories	1	1-3	25-40		x		5	23
Intermediate								
White ash	3	3-5	20	x	x	x	34	22
Sweet birch	1	1-2	40	x	x		4	41
White oak	0	4-10	20		x	x[e]	27	100
Red oak	0	2-5	25		x	x[e]	60	100
Chestnut oak	0	4-5	20		x	x[e]	21	100
Tolerant								
Red maple	1	1	4	x	x	x	21	51
Very tolerant								
Sugar maple	2	2-5	40		x		28	51
American beech	1	2-8	40			x[d]	2	46

[a] *From Trimble and Tryon 1967; Trimble 1975; Beck 1988; Kelty 1988; Burns and Honkala 1990.*

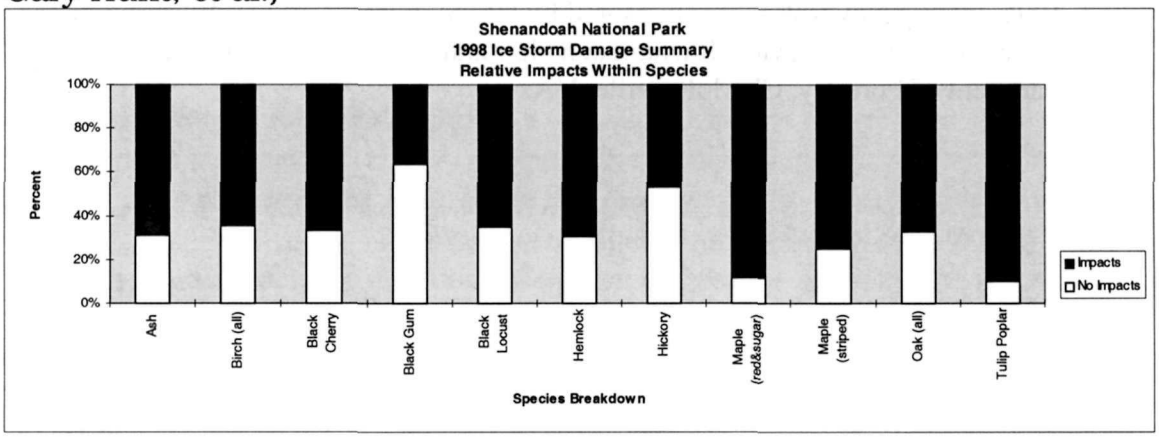
[b] *Value relative to black cherry computed from Monongahela National Forest quarterly transaction evidence prices for January, 1998.*

[c] *Value relative to oaks computed from Martin et al., 1951.*

[d] *Sprouts from wounded roots and root suckers.*

[e] *Oak sprouting becomes more important as site index declines.*

Forest damage caused by the 1998 ice storm at Shenandoah National Park. (Field data gathered March-May 1998 by Rolf Gubler, Gary Hunt, et al.)



Forest damage caused by Tropical Storm Fran (September 1996).

(Field data gathered September 1996 by Gary Hunt, Biological Technician, SNP.)

Tropical Storm Fran Damage Summary								
Within 500' of the Blue Ridge Ridgeline								
	----- Standing -----		---------- Blowdown ----------					
	DBH/Ac	BA/Ac	Trees/Ac	Predom Spec.	DBH-All species	BA/Ac	Percent of Original Stand BA	Estimated Blowdown in Area
All	12.9	106.7	10.8	oak/ash	14.2	11.9	10.0%	13%
North Dist	13.8	105.2	6.7	oak/ash	11.9	5.2	4.7%	8%
Central Dist	12.8	107.2	12.5	ash	16.2	17.8	14.2%	13%
South Dist	12.3	107.7	13.3	oak	18.0	23.5	17.9%	18%
Eastside	12.9	106.7	10.7	oak/ash	14.3	11.8	10.0%	12%
Westside	13.1	112.3	5.3	maple	14.1	5.8	4.9%	6%
Ridgetop	12.7	92.5	23.3	oak/ash	14.1	25.4	21.5%	32%
<2500'	12.9	95.4	7.7	oak/others	17.2	12.4	11.5%	10%
>2500'	13.0	104.3	12.6	ash/oak	13.1	11.9	10.2%	15%
			Trees/Ac	%	DBH	Total Count		
All Blowdown in Plots			10.8	100%	14.2	39.0		
Oaks			3.6	33%	14.3	13.0		
Ash			3.1	28%	16.5	11.0		
Maples			1.1	10%	5.3	4.0		
Hickories			0.8	8%	14.0	3.0		
Cherries			0.8	8%	11.3	3.0		
Black locust			0.6	5%	10.0	2.0		
Yellow-poplar			0.6	5%	26.0	2.0		
Basswood			0.3	3%	16.0	1.0		

WHAT WE SEE IS NOT WHAT WAS!

(SNP Forest Development)

Surveys in 1940 and 1990 show that the forests of Shenandoah National Park have changed dramatically in 50 years. The changes included the percentage of forested lands, and the ages, sizes, and species of trees.

In 1940 Shenandoah was a young park. It was authorized by act of Congress in 1926 and established in 1935. For almost 200 years people had harvested and used the resources of these mountains. Timbering, grazing, hunting, and cultivation ceased when the lands became a national park.

In 1940 the park was 85% forested, with many areas showing signs of timber or bark harvesting. The rest of the park was open ground, including grasslands, cultivated fields, and fields becoming reforested. There were more young tree stands growing in old grazing areas, including bear oaks and pitch pines. By 1990, 95% was forested. In the more mature forest bear oak stands had disappeared and pitch pine numbers had dwindled.

In 1940 there were no yellow poplar stands; cove hardwoods covered only 6% of the area. By 1990 yellow poplar stands covered 16% of the park and cove hardwoods covered 15%. These trees grow in moist sites. Their increase is evidence of more organic matter in the soil and more protective forest canopy cover.

In 1940 chestnut oaks and northern red oaks covered 72% of the park. In 1990 their numbers were down to 59%. Since 1990 repeated defoliation by non-native gypsy moth caterpillars contributed to the deaths of even more oaks.

What do these changes mean? The answer is not simple. For example, fewer oaks mean fewer acorns. Acorns are food for deer, bear, wild turkey, and other animals. Fewer oaks also mean greater diversity of species in the forest. Insects and diseases that target oaks will not have as great an effect on the forest overall.

ENDURANCE AMIDST CHANGE

Travelers through the park have opportunities to begin their own observations as they consider forest changes. Have you seen any of these?

-American chestnut saplings.
American chestnut trees once dominated the Blue Ridge Mountains. The non-native chestnut blight killed them in the 1920s and 30s. Saplings emerge from still-living roots, only to be killed by the blight.

-Standing dead oaks.
Repeated defoliation by non-native gypsy moth caterpillars, 1986-1995, in combination with periodic droughts, killed thousands of oaks and other species.

-Broken and fallen trees.
The 1998 ice storm, 1996's Tropical Storm Fran, and countless weather events made their marks.

-Fading eastern hemlocks.
The non-native hemlock woolly adelgid, an aphid-like insect, is killing hemlocks throughout the park. First identified here in 1989, it has quickly spread to all stands. There may be no hemlock stands in 10 years.

-Spotted milkweed.
Spots on milkweed leaves indicate high ozone levels in our air.

-Non-native plants.
Tree of heaven, oriental bittersweet, and Japanese honeysuckle are some of the many plants that are changing the face of our forest.

Change is disruptive and causes us unease. But Shenandoah's forests will continue to change as they endure.

/work/misc/speeches/Uva-SWAS.doc