The TIONESTA
SCENIC AND RESEARCH NATURAL AREAS

by John C. Bjorkbom and Rodney G. Larson

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ABSTRACT

Hemlock-beech forests once covered 6 million acres of the Allegheny Plateau in Pennsylvania and New York. To preserve a remnant of this forest, the Federal Government purchased the last remaining uncut hemlock-beech forest in 1936. Four years later, half of this area was set aside in the Tionesta Scenic Area, primarily for public enjoyment; the other half was set aside in the Tionesta Research Natural Area for scientific study. Both areas are administered by the Forest Service, U. S. Department of Agriculture. A brief ecological history of the area shows the changes that have occurred in the forest. Strong winds resulting in extensive areas of blowdown have led to the regeneration of intolerant species and the development of second-growth stands in a climax forest. Deer browsing has virtually eliminated hobblebush from the understory and limits regeneration to unpalatable species such as beech. Lists of trees, shrubs, herbs, and vertebrates present in the early 1930s are included.

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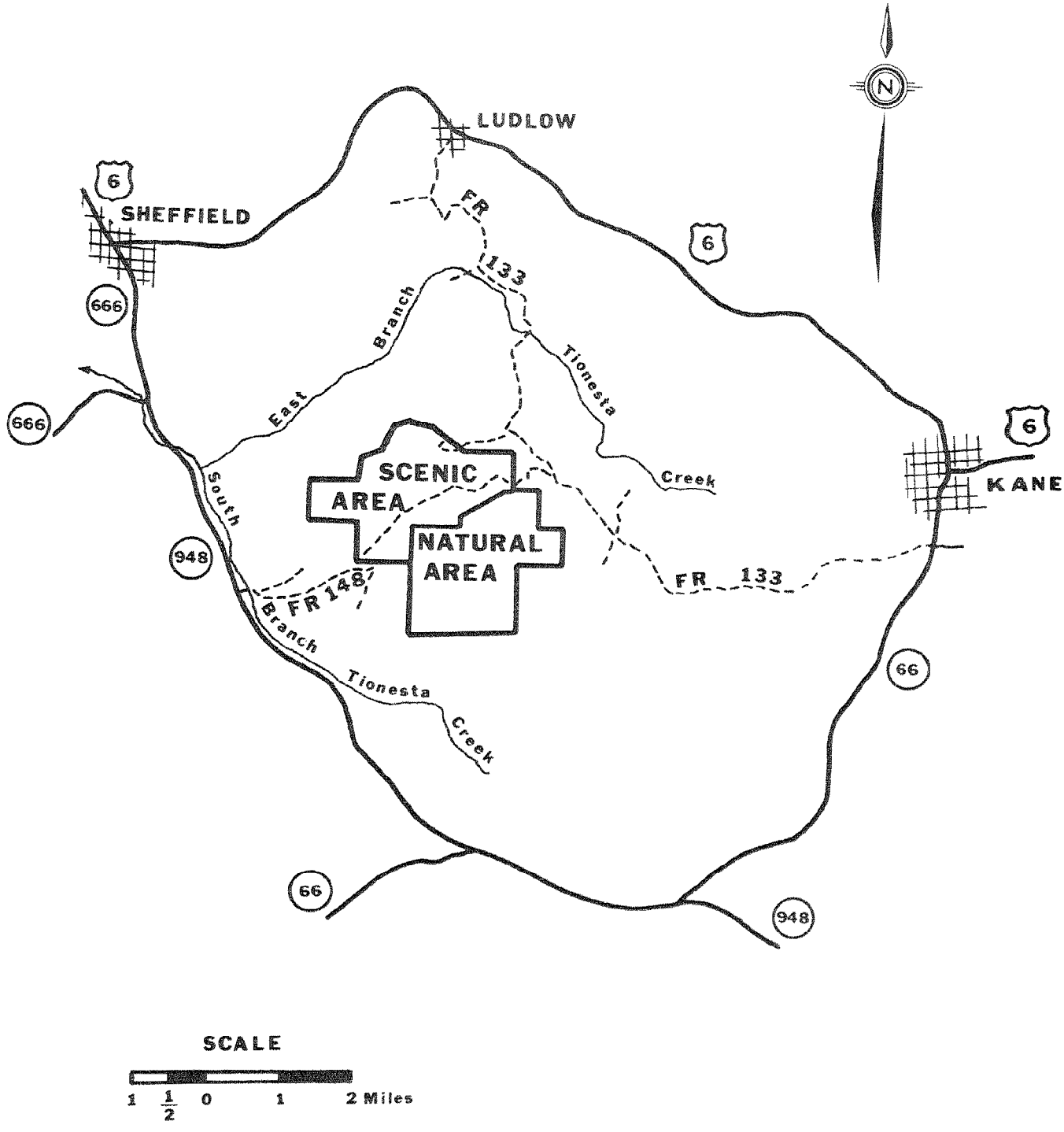


SCALE

1 1/2 0 1 2 Miles

Figure 1.—General location of the Tionesta Scenic and Natural Research Areas.

IN THE ALLEGHENY National Forest in northwestern Pennsylvania lies a unique remnant of the virgin hemlock-beech climax forest — the Tionesta Scenic and Research Natural Areas (fig. 1 and fig. 2).

Here is one of the few remaining examples of the virgin forest that once covered 6 million acres of the Allegheny Plateau in Pennsylvania and New York. Foresters call this a climax forest because it is a community of plants that represents the culminating stage of a natural forest succession for a given environment. It is a forest that slowly evolved in the course of centuries.

This report was prepared to provide a brief ecological history of the area and to record the variety of trees, shrubs, herbs, and vertebrates found here.

HISTORY

The Tionesta Areas were once part of a colonial grant to the Holland Land Company that was later held by small tanneries in Sheffield, Pennsylvania, as a reserve for hemlock tanbark. This land was later purchased by the U.S. Leather Company and subsequently was turned over to the Central Pennsylvania Lumber Company.

To preserve a remnant of this climax forest, the last remaining area of uncut hemlock-beech forest was purchased by the U.S. Government in 1936. In 1940 the northern half of this tract was formally dedicated as a scenic area; the southern half was dedicated as a research natural area. Both of these areas, the Tionesta Scenic Area and the Tionesta Research Natural Area, are administered by the Forest Service, U. S. Department of Agriculture.

On 23 July 1973, the Tionesta Scenic and Research Natural Areas were added to the National Registry of the Natural Landmarks Program. The objectives of the Natural Landmarks Program are (1) to encourage the preservation of sites illustrating the geological and ecological character of the United States, (2) to enhance the educational and scientific value of sites thus preserved, (3) to strengthen cultural appreciation of natural history, and (4) to foster a greater concern for the conservation of the Nation's natural heritage. Both the Forest Service Research Natural Areas program and the National Landmarks Program ensure that the significant ecological and historical values of both areas will be protected and preserved.

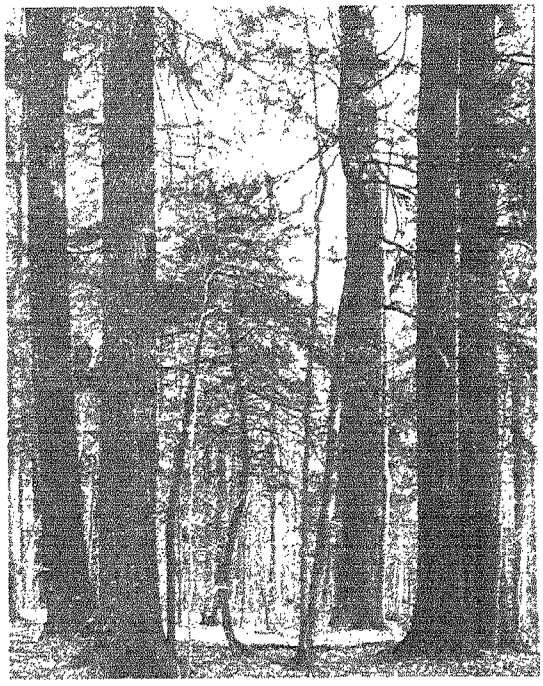
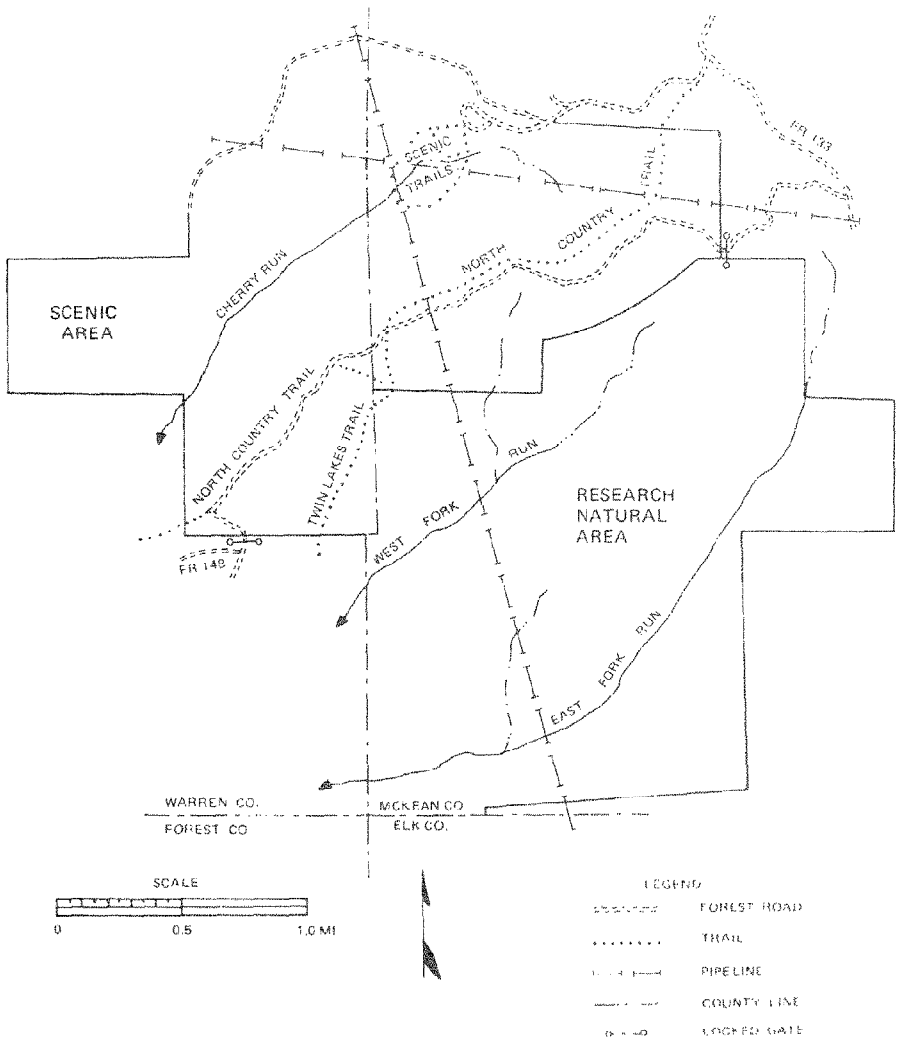


Figure 2.—Large hemlocks such as these in the Tionesta Scenic Area are common in a hemlock-beech climax forest.

Figure 3.—The Tionesta Scenic and Research Natural Area.



Management of the 2,018-acre Scenic Area (fig. 3) is designed to maintain the climax forest in an undisturbed state and to allow the public to enjoy the grandeur of the virgin forest that once covered the Allegheny Plateau. To help accomplish this objective, the entire Scenic Area has been closed to all types of camping, man-made fires, horses, and any form of motorized vehicular use.

An entrance road leading to a parking loop at the northeastern corner of the Scenic Area makes the tract accessible to the public. From the parking loop, two interpretive trails lead the visitor through a portion of the climax hemlock-beech forest. Other trails, plus numerous pipelines, open the rest of the area to hikers, hunters, and fishermen.

The 2,113-acre Research Natural Area (fig. 3) is set aside for scientific study of the ecology of a climax hemlock-beech forest. Research studies

have been conducted within this area since its dedication to that purpose. A study begun in 1942 is being continued to record the changes in understory vegetation. Other studies have been made of tree vigor, the growth and quality of the Allegheny hardwoods, and the food resources and ingestion rates of small mammals.

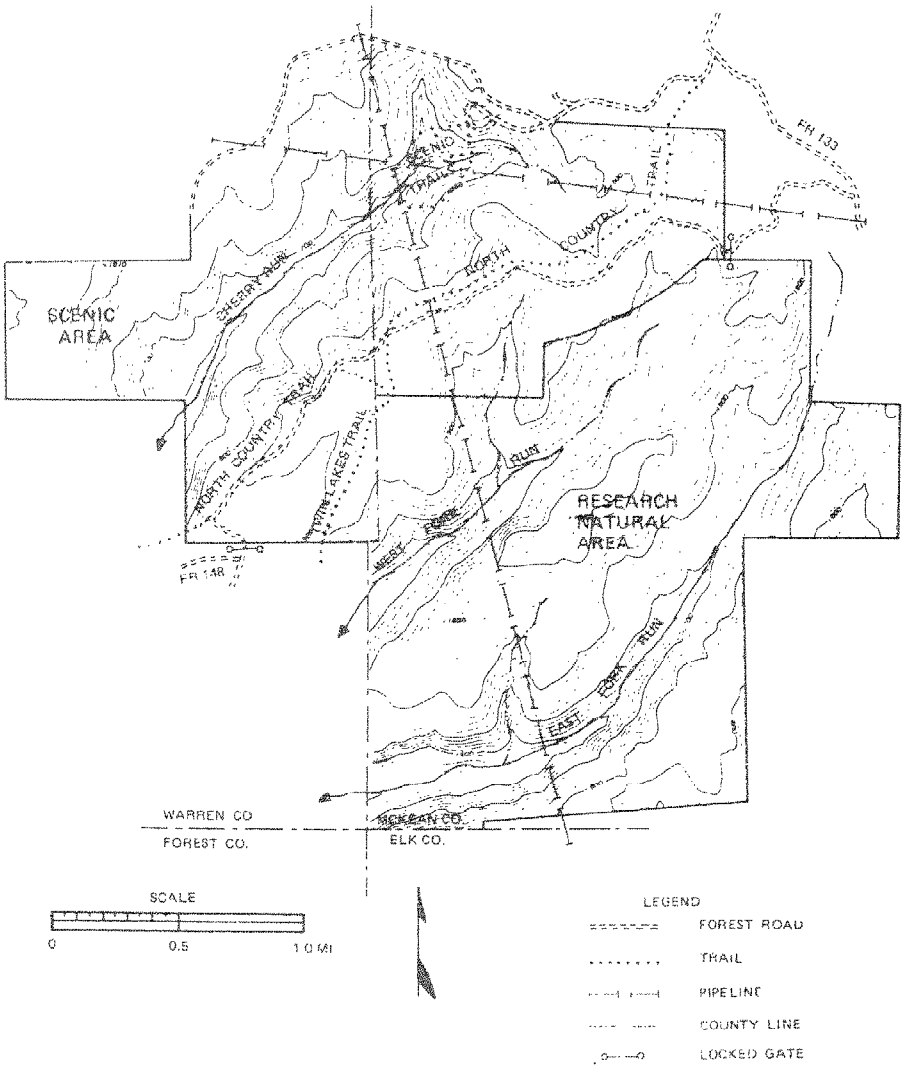
To maintain this forest in its natural state, the Research Natural Area is subject to the same use restrictions as the Scenic Area.

TIONESTA ENVIRONMENT

Climate

The climate of the Tionesta Area is cool and humid. The average annual precipitation is 42 inches, of which 16 inches falls between June and October. The average annual temperature is 46°F., and the average summer temperature is 66°F. The length of growing season is about 123

Figure 4.—The topography of the Tionesta Scenic and Research Natural Areas. The contour interval is 20 feet.



days. The average date for the last killing frost in the spring is 25 May, and the first killing frost in autumn is 25 September.

Topography

The Tionesta tract lies within the northern part of the unglaciated Allegheny Plateau. The topography is typical of plateaus: it has flat uplands and steep-sided V-shaped valleys cut by streams. Elevations range from 1,500 feet above sea level in the stream bottoms to about 1,960 feet on the plateau tops (fig. 4).

The area is drained by the Cherry Run and Fork Run branches of Tionesta Creek, which flows southwest into the Allegheny River.

Soils

The soils are derived from the Pottsville sandstone and conglomerate that cap the Plateau and from shales and sandstones on the slopes (fig. 5). In general, these are very stony and extremely stony loams or sandy loams. They are strongly acid—pH 5.1 to 5.5.

The major soil types in the Tionesta tract are

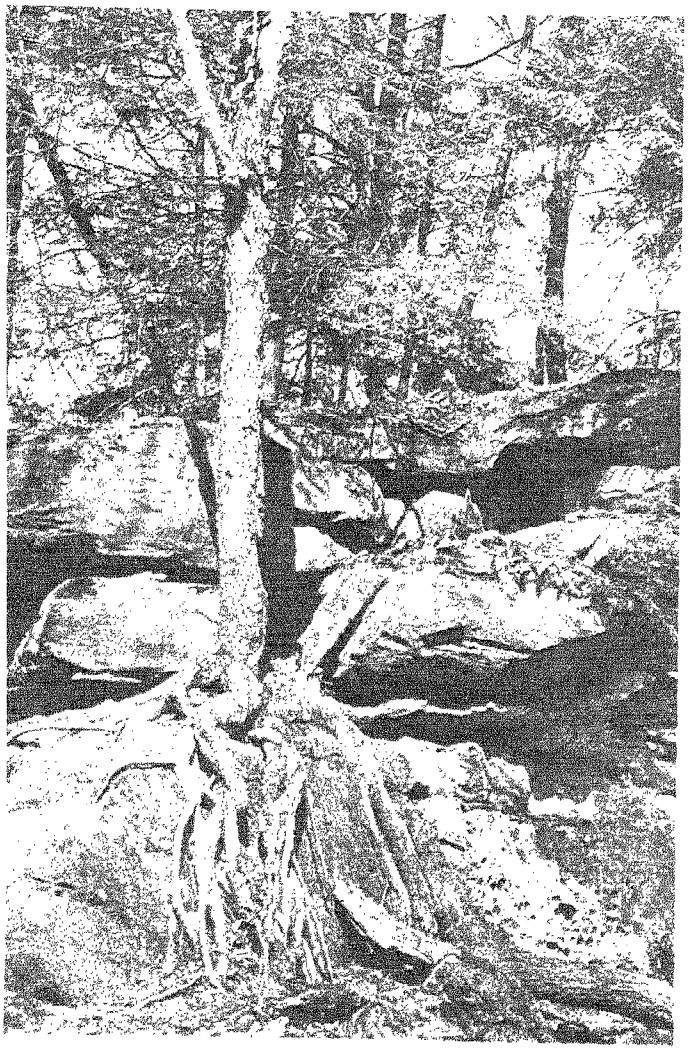


Figure 5.—This outcropping of sandstone and conglomerate rocks is in the southwest corner of the Scenic Area.

Hazelton sandy loam, Cookport sandy loam, and Cavode silt loam. These are residual soils, and all are found in both plateau and slope positions.

Hazelton series are deep (at least 40 inches to bedrock) well-drained soils developed from sandstone. The water table, where present, is normally below 4 feet.

Cookport series, formed from sandstone, are deep, moderately well drained to somewhat poorly drained. However, during wet periods, they have a seasonal high water table influenced by an impermeable layer 18 to 36 inches below the surface.

Cavode series are deep but somewhat poorly drained soils formed from acid clay shale. They have a seasonal high water table within 6 to 18 inches of the surface during wet periods.

Despite the differences in soil drainage among these soils, the forest vegetation does not differ visibly from one soil type to another.

ECOLOGICAL HISTORY

Many of the trees now present on the Tionesta Areas are several hundred years old, and we have no information about the early ecological history of the area. Forests of essentially the same type may have existed on this tract for a very long time.

However, studies of ecological succession show that the forest now present is a climax community. It consists primarily of species that are tolerant of shade, such as hemlock, beech, and sugar maple. Seedlings of these species are capable of surviving for years beneath the canopy of larger trees. Then, when an overstory tree matures, dies, and falls to the ground, it releases enough growing space for some of the tolerant seedlings present in the understory to grow and eventually reach up into the main crown canopy. In this way, a stand of shade-tolerant tree species is perpetuated.

But fire, windthrow, and other disturbances occasionally kill many trees in small areas, creating larger openings in the forest canopy than result from the natural death of scattered individual trees. When this happens, tree species that are light-demanding (shade-intolerant) are also able to get started. Since these species usually grow faster than the shade-tolerant species, they overtop the tolerants and may dominate the site for 50 to 100 or more years. Black cherry, red maple, yellow birch, black birch, white ash, cucumber-tree, yellow-poplar, and pin cherry are examples of shade-intolerant trees that originate after forest disturbances.

If left undisturbed long enough, the intolerant species will gradually be replaced by shade-tolerant species, because the intolerants cannot survive for long under their own shade. Hence large seedlings of these species are not usually present to make use of the small openings that occur from the death of scattered individual trees. Most of the Allegheny Plateau outside the Tionesta Scenic and Natural Areas is now dominated by second-growth stands of intolerant species resulting from the commercial logging operations of the 1890-1930 era. These second-growth stands will eventually revert to hemlock/beech/sugar maple types like those in the Tionesta tract if left undisturbed long enough.

Because climax forests generally contain a number of overmature low-vigor trees, natural disturbances of one kind or another can be expected occasionally. Documentation of such disturbances in the Tionesta tract is limited, but there is some information available about this and nearby areas.

Climatic effects

Strong winds occur periodically in this area, but the damage they do is usually limited to small groups of trees. Occasionally, however, wind storms damage extensive areas. About 1808, timber was blown down on the southern edge of the Research Natural Area. In 1870, many trees were uprooted on about 375 acres by a wind storm that struck the southern edge of the Scenic Area. The affected areas reverted to a secondary successional stage in which shade-intolerant second-growth species flourished along with the shade-tolerant hemlock and beech that survived.

In areas close to the Tionesta tract, many mature hemlocks, beech, and trees of other species died after the serious and widespread drought of 1930. Many other hemlocks, weakened by drought, were attacked by the hemlock borer (*Melanophila fulvoguttata* Harr.). A local but severe early summer drought occurred in 1934, and hemlock mortality was observed a year later. Important but hidden effects of these droughts are a slowdown of

Figure 6.—In the glaze storm of March 1936, trees and branches broke under the weight of the ice. Evidence of this glaze damage can still be seen in the broken tops of many trees.

growth and a slowdown of regeneration through seedling mortality or the failure of seed crops.

Ice storms are fairly common on the Allegheny Plateau. Normally they cause little damage; yet heavy and extensive damage has occurred. In the severe ice storm of March 1936, which covered most of the Allegheny Plateau, trees and branches came crashing to the ground (fig. 6). Twigs the diameter of a pencil were ringed with coats of ice 2 to 3 inches in diameter.

Black cherry was severely damaged by the ice in that storm. Red maple, beech, and the birches suffered some damage; sugar maple was damaged less. Hemlock suffered little damage, presumably because of its resilient branches and smaller upper crown.

Some small changes in species composition may have occurred because of these differences in species susceptibility. Black cherry probably represented a relatively smaller proportion of the stand after the storm, while the other species benefited at the expense of the cherry. The relative amount of hemlock increased, but the maples and birches were affected less. Individual trees of all species were deformed. Broken tops and branches left open wounds that were susceptible to insect and disease attack. These are long-term effects. Evidence of the 1936 storm is still visible after 40 years, and it will not be gone until the affected trees have died.

Fire

Although the 1870 blowdown was later swept by fire, fires have rarely occurred in the Tionesta tract—probably because of the moist nature of the forest floor, lack of inflammable undergrowth, and isolation of the area. In 1930, an examination of the area lying north of Cherry Run showed no evidence of past fires. And it appears unlikely that any part of the Fork Run drainage had ever burned.

Biological effects

Harmful insects and diseases commonly found in forest stands have always been present on the Tionesta tract. Each can damage and destroy roots, flowers, and seeds; each can injure or kill young seedlings and mature trees; and each can cause a loss of vitality and reduction of growth. But there is no evidence that either insect or disease attack has been severe enough to affect the composition of the hemlock-beech forest on this tract.

Most of the animal damage has come from two creatures—the porcupine and the white-tailed deer.

Porcupines—feeding on the bark, cambium, twigs, and leaves—kill or damage trees by girdling the stems and cutting off branches. Records from the 1930 survey showed some incidence of porcupine damage on 40 percent of the plots measured. The greatest damage was done to beech, hemlock, black cherry, sugar maple, and yellow birch, in that order. Porcupine damage, usually scattered throughout a forest stand, often occurs at hard-to-see locations such as tree tops. For this reason, the damage may not be very noticeable unless several porcupines are feeding in the same area.

Deer pose a special problem. Pennsylvania's deer herd was nearly eliminated about 1890 because of unlimited hunting. But public interest stimulated a number of positive actions in the early 1900s that favored the deer herd—notably the formation of a game commission, the restocking of the herd with out-of-state deer, and the passage of a "bucks-only" hunting law. These measures coincided with extensive timber-harvesting throughout northwestern Pennsylvania, which increased production of browse. Thus, protected and well-fed, the deer population increased rapidly.

About 1930, the young second-growth stands that developed after this timber harvesting grew up out of the reach of the deer. Available browse was very limited. Despite the limited amount of browse, the deer herd continued to increase, reaching a peak several years later. In this period, vegetation within reach of the deer was continuously overbrowsed.

Between 1932 and 1942, the understory of hemlock and hobblebush declined on all portions of the Tionesta tract because of repeated heavy browsing. Other tree species, shrubs, and herbs were also browsed. Tree species palatable to deer include hemlock, black and pin cherry, and red and sugar maple. Favored shrubs include hobblebush, the elders, wild-currant, blackberry, and raspberry. Herbs used as forage are many and varied.

Because of this intensive and selective browsing, the relative number of unpalatable beech seedlings and root suckers increased on the Tionesta tract. If such browsing is continued over a long enough period of time, the regeneration of hemlock, the maples, and black cherry may be prevented; and the species composition may be modified toward a nearly pure beech stand.

The effect of inadequate browse is noticeable on the deer too. Deer are smaller than normal; antlers are poorly developed. Weakened deer starve, and mortality is high, especially in severe winters. These conditions, along with frequent doe seasons and more hunters, reduced the deer herd to a relatively low level about 1950. But since that time, the number of deer has been increasing, and the browsing conditions of the past may be repeated. Clearly there is a need to manage the deer herd to maintain its size and well-being commensurate with the available supply of nutritious browse.

Influence of man

Although the Tionesta Scenic and Research Natural Areas have never been logged, man has had an impact on the forest. The discovery of oil near Titusville in 1859 and the opening of the Tidioute oil field in 1860 was followed a short time later by the drilling of oil and gas wells within the present boundaries of the Tionesta tract. The wells—along with the necessary pump houses, storage facilities, service roads, and pipe lines (the first one installed about 1904)—have left their mark (fig. 7). Today, some wells are still producing while others are used for gas storage. Most of these wells are on the height of land between the Cherry Run and Fork Run drainages, but some are within the drainages themselves.

Drilling and attendant activities can continue indefinitely because the oil, gas, and mineral rights are in private ownership—only the surface rights are owned by the Federal Government. However, the private owners have cooperated with the Government to reduce the effect of these activities on the Tionesta forest.

The imprint of man on this virgin forest will remain for a long, long time, because the openings created by the oil and gas operations are actively maintained and so will not revert to forest. Some of these openings have revegetated with ferns, grasses, and herbs. Although they are unnatural openings in a virgin forest, they add diversity to the plant life and are attractive to wildlife.

THE FOREST

When the present Tionesta tract was acquired in 1936, old-growth hemlock stands predominated. Hardwoods, principally sugar maple and beech, were dominant on the remaining area. Most of the hardwood stands—particularly in the Scenic Area—were younger, contained much smaller trees, and generally occurred on the old windthrow areas (fig. 8). The forest type acreages shown in table 1 are the best estimates available.

Figure 7.—Although pipe lines are artificial openings in a natural setting, they open the area to hikers and gradually take on the appearance of a forest trail.

Table 1.—*Forest types and acreages, Tionesta Scenic and Natural Areas*

Forest type	Scenic Area	Natural Area
	Acres	*Acres*
Hemlock-beech	1,213	1,883
Black cherry-sugar maple	0	47
Black cherry	0	20
Beech-sugar maple	805 [a]	163
Total	2,018	2,113

[a] Includes an unknown acreage of black cherry types.

Estimates of the forest types in the Scenic Area are based on 1936 cruise data. At that time, black cherry types were not recognized, but it is likely that such types were present then as they are now. Forest type acreages in the Research Natural Area are based on a survey of the hardwood forest types completed in 1975. Figure 9 shows the approximate boundaries of the hemlock stands and the hardwood stands as sketched from old maps, aerial photographs, and the Natural Area survey.

Surveys were made in 1930 and 1933 of the plant and animal life in a 14,000-acre tract of climax forest extending from the valley of the East Branch of Tionesta Creek south to and including the present Tionesta Scenic and Research Natural Areas. Some small areas of second-growth forest along the edges of the climax forest were also included. All the climax forests outside the Tionesta Areas have since been cut.

At the time of these surveys, hemlock and beech ranked first and second in frequency in the dominant tree cover—trees at least 70 feet tall—on the plateau and slopes. Hemlock was the most common species along Cherry Run and both branches of Fork Run. Other tree species varied according to topographic position (table 2). Species such as oak, white pine, and chestnut were of minor importance and, when present, were most likely to be found on the warmer and drier south-facing slopes. This topographic distribution is about the same today.

It is not known how many of the plants and animals listed here can be found in the remaining climax forest; but some, such as black maple and ostrich fern, are characteristic of larger valley bottoms and must have occurred only along the East Branch. Neither white pine nor red oak have ever been reported in the Tionesta

Figure 8.—Second-growth stands of sugar maple, red maple, and beech have developed in old windthrow areas. If left undisturbed for many years such stands may revert to a hemlock-beech climax forest.

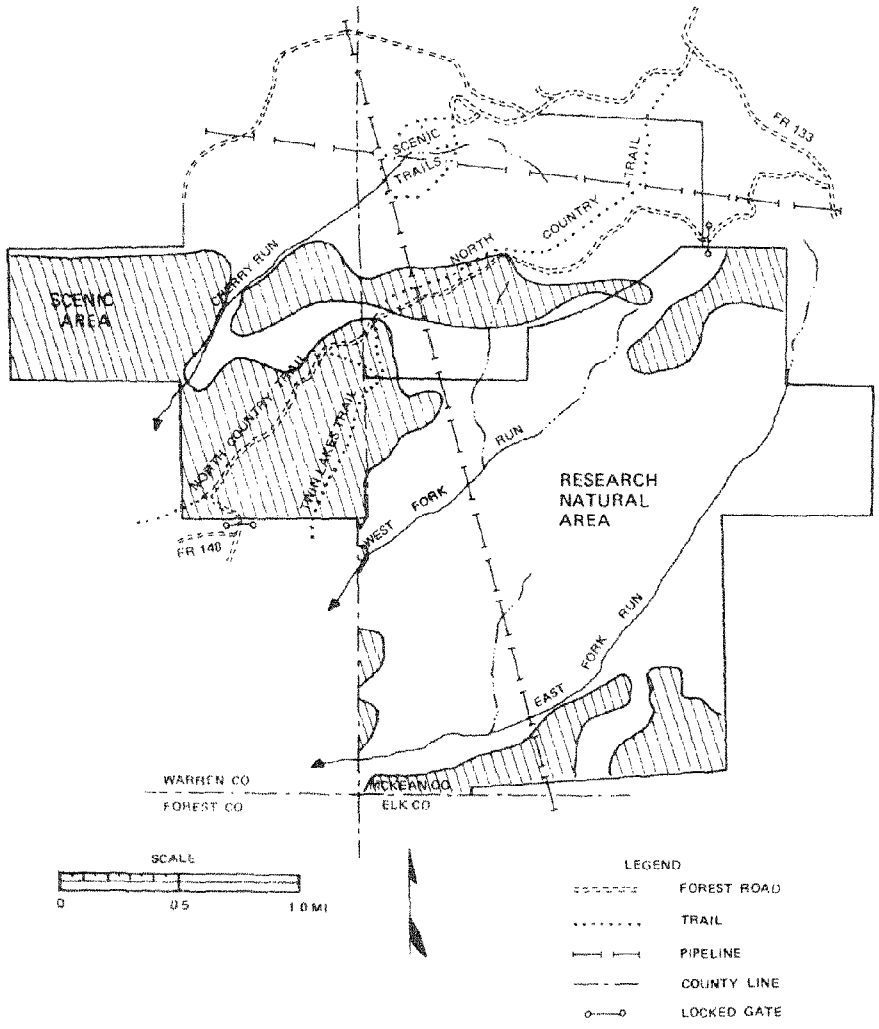
Table 2.—*Relative ranking in frequency of tree species in the dominant tree cover, by topographic position, East Tionesta climax forest, 1930*

Ranking	Plateau	Middle slope	Lower slope
1	Hemlock	Hemlock	Hemlock
2	Beech	Beech	Beech
3	Black birch	Yellow birch	Yellow birch
4	Sugar maple	Sugar maple	Sugar maple
5	Red maple	Black birch	Red maple
6	Yellow birch	Red maple	White ash
7	Black cherry	Black cherry	.
8	White ash	Basswood	.
9	Yellow poplar	—	.
10	Cucumbertree	—	.

Areas. Species observed in second-growth stands are included here because such stands existed in the Tionesta tract in 1933 and there may be some overlapping of species between the climax and second-growth forests. Species reported in second-growth stands are marked in the following lists of flora and fauna.

In the surveys, 32 tree species were recorded (table 3). A tree is defined as a woody plant having one erect perennial stem or trunk at least 3 inches in diameter at breast height (4.5 feet), a more or less definitely formed crown of foliage, and a height of at least 12 feet.

Figure 9.—The shaded areas show the locations of the hardwood stands. The remaining area is in the hemlock-beech forest type.



The principal species found were hemlock and beech. The average basal area per acre was about 140 square feet. The basal area of a tree is the area of a cross-section of a stem generally measured at breast height, and includes bark. Basal area per acre is the sum of basal areas of all the trees on the acre.

Hemlock was the dominant species in the 10-inch and larger diameter classes; beech dominated in the 4- to 9-inch classes (table 4). Sugar maple ranked second to beech in both abundance and frequency in trees less than 30 feet in height. Other species were of minor importance in all size classes.

Some acres were estimated to have as much as 50,000 board feet of sawtimber. However, the average board-foot volume per acre for the Tionesta Areas was estimated to be 15,000 board feet. Nearly three-fourths of this was hemlock.

Tree heights up to 125 feet were recorded. And many trees exceeded a diameter of 30 inches (fig. 10). The largest trees included a 53-

Table 3.—*Forest trees in the East Tionesta climax forest, 1933*

Scientific name	Common name
Acer nigrum	Black maple
Acer pensylvanicum	Striped maple
Acer rubrum	Red maple
Acer saccharum	Sugar maple
Acer spicatum	Mountain maple
Amelanchier arborea	Downy serviceberry
Aralia spinosa *	Devils-walkingstick
Betula alleghaniensis	Yellow birch
Betula lenta	Sweet birch
Carpinus caroliniana	American hornbeam
Carya cordiformis *	Bitternut hickory
Castanea dentata	American chestnut
Fagus grandifolia	American beech
Fraxinus americana	White ash
Liriodendron tulipifera	Yellow-poplar
Magnolia acuminata	Cucumbertree
Malus pumila *	Apple
Ostrya virginiana	Eastern hophornbeam
Pinus strobus	Eastern white pine
Populus grandidentata	Bigtooth aspen
Populus tremuloides	Quaking aspen
Prunus pensylvanica	Pin cherry
Prunus serotina	Black cherry
Prunus virginiana *	Common chokecherry
Quercus rubra *	Northern red oak
Robinia pseudoacacia *	Black locust
Salix alba	White willow
Sorbus americana	American mountain-ash
Tilia americana	American basswood
Tsuga canadensis	Eastern hemlock
Ulmus americana	American elm
Ulmus rubra *	Slippery elm

*Found only in second-growth forest.

Table 4.—*Basal area by species and diameter class in the East Tionesta climax forest, 1930*

Species	Diameter class	
	4- to 9- inch	10-inch and larger
	Percent	*Percent*
Hemlock	12	63
Beech	70	20
Sugar maple	5	4
Birches	3	6
Other	10 [a]	7 [b]
Total	100	100

[a] Includes 2 percent black cherry.
[b] Includes 3 percent red maple.

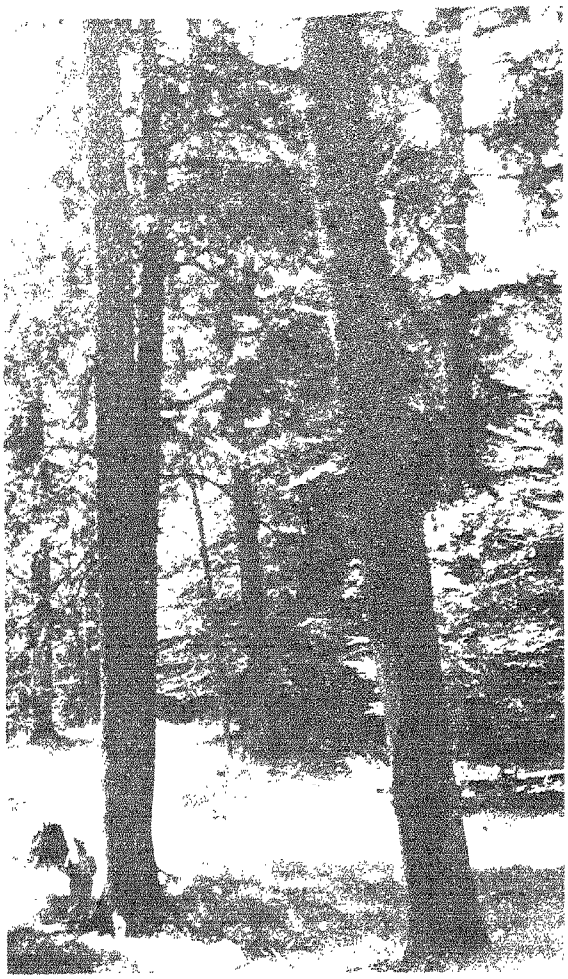


Figure 10.—The large tree on the left is a 35-inch black cherry tree. It is about 110 feet tall and about 140 years old. The large tree on the right is a hemlock of about the same size that died from natural causes.

inch hemlock, a 50-inch red maple, a 48-inch yellow-poplar, and a 40-inch black cherry. Hemlocks up to 560 years of age and a black cherry 258 years old have been recorded in the parts of the climax forest that have since been cut.

Twenty-seven shrub species have been recorded in the virgin forest (table 5). A shrub is considered a woody perennial plant differing from a perennial herb in its persistent and woody stem, and less definitely from a tree in its lower stature and general absence of a well-defined main stem. Other understory vegetation includes 4 club-mosses, 24 ferns, and 66 herbaceous plants. Of these, hobblebush, maple-leaved viburnum, spinulose wood-fern, and shining club-moss were the most common.

More than 60 species of birds were observed during the 1933 survey; probably all were nesting species. Included were predators (hawks

Table 5.—*Shrubs in the East Tionesta climax forest, 1933*

Scientific name	Common name
Clematis virginiana *	Virgin's bower
Cornus alternifolia	Alternate-leaf dogwood
Diervilla lonicera *	Bush-honeysuckle
Epigea repens *	Trailing arbutus
Gaultheria procumbens	Teaberry
Hamamelis virginiana	Witch-hazel
Ilex montana	Mountain winterberry
Kalmia latifolia	Mountain-laurel
Lonicera canadensis	Fly-honeysuckle
Mitchella repens	Partridge-berry
Parthenocissus quinquefolia *	Virginia creeper
Rhododendron maximum	Rhododendron
Rhus copallina *	Shining sumac
Rhus radicans	Poison ivy
Rhus typhina*	Staghorn sumac
Ribes cynosbati	Prickly gooseberry
Ribes glandulosum	Skunk-currant
Rubus allegheniensis	Common Blackberry
Rubus idaeus	Red raspberry
Rubus odoratus	Purple-flowering raspberry
Salix discolor *	Pussy willow
Sambucus canadensis	Common elder
Sambucus pubens	Red-berried elder
Viburnum acerifolium	Maple-leaved viburnum
Viburnum alnifolium	Hobblebush
Viburnum cassinoides	Wild-raisin
Viburnum recognitum	Arrow-wood

*Found only in second-growth forest.

and owls), water-loving birds (herons and kingfishers), woodpeckers, warblers, and song birds.

A total of 29 mammals were observed, ranging in size from shrews and mice to black bear. Abundant species included chipmunks, porcupines, and deer. Less common were such animals as mink, weasel, fox, racoon, squirrel, beaver, muskrat, and opossum. Black bears and bobcats were rare.

Fifteen species of fish were observed, but most were found only in the warmer waters of the main streams. The colder headwaters in the tract contained only native brook trout.

Of the 13 amphibians recorded, salamanders were the most common. Reptiles other than the common garter snake were rare.

In general, the trees, shrubs, herbs, mammals, and reptiles observed were those species more common to a northerly climate.

Composite lists of all the species recorded in the virgin hemlock-beech forest of the East Branch of Tionesta Creek in 1930 and 1933 are given at the end of this report. However, since the forest is constantly changing and different environments are created, some species may vanish while the populations of others rise or fall in company with the changing habitats. Other species may appear or disappear seasonally or with long-term climatic changes. These are some of the reasons why the lists of observed species can be only a guide to what might be present today.

UNDERSTORY CHANGES, 1935 to 1972

Just as the forest trees are affected by climatic and biological factors and by man's activities, so are the tree seedlings, shrubs, ferns, and herbs—the understory vegetation. Here too, the changes can be rapid or can occur slowly over a relatively long period of time. And the changes can be determined only by recording repeated observations.

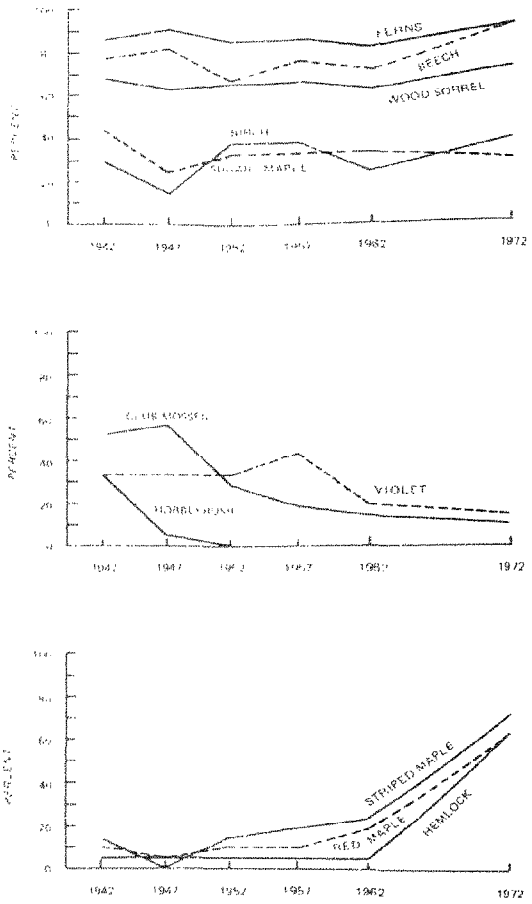
General observations on the Tionesta tract showed that the understory of hemlock and hobblebush declined between 1935 and 1942. Beginning in 1942 and continuing through 1962, the occurrence of understory vegetation on sample plots was estimated from photographs taken at 5-year intervals. In 1972, field observations were made of these same plots. These data were used to determine frequency rates by species. The frequency rate for any species is the percentage of sample plots in which a species occurs. Data for selected species—those of high frequency and those that increased or decreased substantially—are reported here.

The frequency rates for ferns, beech, wood sorrel, birch, and sugar maple remained relatively stable for the 1942-72 period. Violets, club-mosses, and hobblebush decreased in frequency during the period, while striped maple, red maple, and hemlock increased. These frequency trends are shown in figure 11.

From these data, a few suppositions can be made about the past and the future forest. It can be readily seen that ferns and beech have dominated the understory for at least the last 30 years. The high frequency of beech was brought about partly by deer browsing. Species more palatable than beech were heavily browsed; beech was left alone. If this trend continues, the amount of beech will build up in the years ahead.

The decline of hobblebush began in 1935, and

Figure 11.—Trends in understory frequency rates by species and year.



this species disappeared from the sample plots by 1952. Repeated heavy browsing was responsible for most of this decline. And, as less hobblebush was available, other species were browsed more heavily.

Between 1952 and 1972, striped maple, red maple, and hemlock increased in frequency, most of the increases occurring in the last half of the period. The reasons for these increases are not clear. More seedlings of these species may have become established because of good seed years and favorable weather conditions. Also, timber-harvesting around the Tionesta tract produced abundant browse at a time when the deer herd was below the peak levels of the 1930s. Because of this, many seedlings may have escaped browsing. If these same conditions persist, red maple and hemlock will become more abundant in the mature forest. On the other hand, if dense clumps of striped maple develop, these clumps may prevent the regeneration of other tree species.

As both understory and overstory vegetation changes occur, habitats change. This in turn may affect the animal population seeking food and shelter in an altered environment. But the trend is always toward a balanced community in which plants and animals have adapted themselves to one another as well as to their environment.

FLORA AND FAUNA

The flora and fauna listed here are those species that have been observed in the past within or near the Tionesta Scenic and Research Natural Areas. Although up-to-date lists may differ, the species shown here are indicative of what might be found in a hemlock-beech virgin forest.

The lists are arranged so that the first family listed is the one considered to be the oldest, other families following in order of decreasing age. The same system is followed for genera within families and species within genera.

Plant and bird species observed in second-growth stands are indicated. The birds included here were observed between 14 June and 10 August 1933; they include permanent and summer residents but probably no migrating species.

Authorities for the scientific names and, in most cases, for the common names, are:

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Mammals.—Walker, Ernest P. 1968. **Mammals of the world.** Vol. 1 and 2, 1500 p., illus. [revised 2nd ed.] John Hopkins Press, Baltimore.

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Ferns and club mosses

LYCOPODIACEAE: Club-Moss Family

Lycopodium lucidulum	Shining club-moss
Lycopodium clavatum	Running club-moss
Lycopodium obscurum	Ground-pine
Lycopodium complanatum	Ground-cedar

OPHIOGLOSSACEAE: Adder's Tongue Family

Botrychium dissectum	Cutleaf grape-fern
Botrychium matricariaefolium	Matricary grape-fern
*Ophioglossum vulgatum**	Adder's tongue

OSMUNDACEAE: Flowering Fern Family

Osmunda Claytoniana	Interrupted fern
Osmunda cinnamomea	Cinnamon-fern

POLYPODIACEAE: Fern Family

Woodsia obtusa	Common woodsia
*Pteretis pensylvanica**	Ostrich-fern
Onoclea sensibilis	Sensitive fern
Dryopteris Thelypteris	Marsh-fern
Dryopteris noveboracensis	New York fern
Dryopteris disjuncta	Oak-fern
Dryopteris phegopteris	Long beech-fern
Dryopteris spinulosa	Spinulose wood-fern
Dryopteris cristata	Crested wood-fern
Dryopteris marginalis	Marginal shield-fern
Polystichum acrostichoides	Christmas fern
Dennstaedtia punctilobula	Hay-scented fern
Athyrium thelypterioides	Silvery spleenwort
Athyrium Filix-femina	Lady-fern
Asplenium platyneuron	Ebony-spleenwort
Adiantum pedatum	Maidenhair-fern
*Pteridium aquilinum**	Bracken
Polypodium virginianum	Rock-polypody

Softwood trees

PINACEAE: Pine Family

Tsuga canadensis	Eastern hemlock
Pinus strobus	Eastern white pine

Grasses, sedges, and lillies

GRAMINAE: Grass Family

Brachyelytrum erectum	Bearded shorthusk

CYPERACEAE: Sedge Family

Scirpus sp.	Bulrush
Carex follicalata	Sedge

*Found only in second-growth forest.

ARACEAE: Arum Family

Arisaema atrorubens	Jack-in-the-pulpit
Arisaema triphyllum	Small jack-in-the-pulpit

LILIACEAE: Lily Family

Veratrum viride	White hellebore
Uvularia sessilifolia	Wild-oats
Allium tricoccum	Wild leek
Lilium superbum	Turk's-cap lily
Clintonia borealis	Bluebead lily
Smilacina racemosa	False Solomon's seal
Maianthemum canadense	False lily-of-the-valley
Streptopus roseus	Rosy twisted-stalk
Polygonatum biflorum	Small Solomon's seal
Polygonatum canaliculatum	Great Solomon's seal
Medeola virginiana	Indian cucumber-root
Trillium erectum	Purple trillium
Trillium grandiflorum	Large-flowered trillium
Trillium undulatum	Painted trillium

IRIDACEAE: Iris Family

Sisyrinchium angustifolium	Blue-eyed grass

ORCHIDACEAE: Orchis Family

Cypripedium acaule	Pink ladyslipper
Habenaria orbiculata	Round-leaved orchis
Habenaria psycodes	Small purple fringed orchis
Corallorrhiza maculata	Spotted coral-root

Hardwood trees, woody shrubs, and herbs

SALICACEAE: Willow Family

Salix alba	White willow
Salix discolor	Pussy willow
Populus tremuloides	Quaking aspen
Populus grandidentata	Bigtooth aspen

JUGLANDACEAE: Walnut Family

*Carya cordiformis**	Bitternut hickory

BETULACEAE: Birch Family

Ostrya virginiana	Eastern hophornbeam
Carpinus caroliniana	American hornbeam
Betula lenta	Sweet birch
Betula alleghaniensis	Yellow birch

FAGACEAE: Beech Family

Fagus grandifolia	American beech
Castanea dentata	American chestnut
*Quercus rubra**	Northern red oak

*Found only in second-growth forest.

ULMACEAE: Elm Family

*Ulmus rubra**	Slippery elm
Ulmus americana	American elm

URTICACEAE: Nettle Family

Urtica sp.	Nettle

ARISTOLOCHIACEAE: Birthwort Family

Asarum canadense	Wild ginger

POLYGONACEAE: Buckwheat Family

*Rumex crispus**	Yellow dock
Rumex acetosella	Sheep-sorrel
Polygonum persicaria	Lady's-thumb
Polygonum arifolium	Halberd-leaved tear-thumb

PHYTOLACCACEAE: Pokeweed Family

Phytolacca americana	Pokeweed

CARYOPHYLLACEAE: Pink Family

*Lychnis alba**	White campion

RANUNCULACEAE: Crowfoot Family

Ranunculus acris	Common buttercup
*Clematis virginiana**	Virgin's bower
Coptis groenlandica	Goldthread
Actea pachypoda	White baneberry

BERBERIDACEAE: Barberry Family

Caulophyllum thalictroides	Blue cohosh

MAGNOLIACEAE

Magnolia acuminata	Cucumbertree
Liriodendron tulipifera	Yellow-poplar

CRUCIFERAE: Mustard Family

Dentaria diphylla	Crinkleroot toothwort
Cardamine pensylvanica	Pennsylvania bittercress

SAXIFRAGACEAE: Saxifrage Family

Tiarella cordifolia	False miterwort
Mitella diphylla	Common miterwort
Chrysosplenium americanum	Golden saxifrage
Ribes cynosbati	Prickly gooseberry
Ribes glandulosum	Skunk-currant

HAMAMELIDACEAE: Witch-hazel Family

Hamamelis virginiana	Witch-hazel

*Found only in second-growth forest.

ROSACEAE: Rose Family

Sorbus americana	American mountain-ash
Amelanchier arborea	Downy serviceberry
Fragaria virginiana	Strawberry
Waldsteinia fragarioides	Barren strawberry
Potentilla canadensis	Oldfield cinquefoil
Rubus odoratus	Purple-flowering raspberry
Rubus idaeus	Red raspberry
Rubus alleghaniensis	Common blackberry
Dalibarda repens	Dewdrop
Agrimonia gryposepala	Tall hairy agrimony
Prunus pensylvanica	Pin cherry
Prunus serotina	Black cherry
*Prunus virginiana**	Common chokecherry

LEGUMINOSAE: Pulse Family

*Robinia pseudoacacia**	Black locust

OXALIDACEAE: Wood-Sorrel Family

Oxalis montana	Common wood-sorrel

ANACARDIACEAE: Cashew Family

*Rhus typhina**	Staghorn sumac
*Rhus copallina**	Shining sumac
Rhus radicans	Poison ivy

AQUIFOLIACEAE: Holly Family

Ilex montana	Mountain winterberry

ACERACEAE: Maple Family

Acer spicatum	Mountain maple
Acer pensylvanicum	Striped maple
Acer saccharum	Sugar maple
Acer nigrum	Black maple
Acer rubrum	Red maple

BALSAMINACEAE: Touch-Me-Not Family

Impatiens capensis	Spotted touch-me-not

VITACEAE: Vine Family

*Parthenocissus quinquefolia**	Virginia creeper

TILIACEAE: Linden Family

Tilia americana	American basswood

GUTTIFERAE: St. John's-wort Family

Hypericum perforatum	Common St. John's-wort

*Found only in second-growth forest.

VIOLACEAE: Violet Family	
Viola sororia	Wooly blue violet
Viola rotundifolia	Early yellow violet
ONAGRACEAE: Evening-Primrose Family	
Epilobium angustifolium	Fireweed
Oenothera pilosella	Meadow sundrops
Circaea alpina	Enchanter's nightshade
ARALIACEAE: Ginseng Family	
Aralia spinosa *	Devils-walkingstick
Aralia nudicaulis	Wild sarsaparilla
UMBELLIFERAE: Parsley Family	
Osmorhiza Claytoni	Sweet cicely
CORNACEAE: Dogwood Family	
Cornus alternifolia	Alternate-leaf dogwood
PYROLACAE: Wintergreen Family	
Pyrola elliptica	Shinleaf
Pyrola rotundifolia	Wild lily-of-the-valley
Monotropa unifloria	Indian-pipe
ERICACEAE: Heath Family	
Rhododendron maximum	Rhododendron
Kalmia latifolia	Mountain-laurel
Epigaea repens	Trailing arbutus
Gaultheria procumbens	Teaberry
PRIMULACEAE: Primrose Family	
Lysimachia quadrifolia	Whorled loosestrife
Trientalis borealis	Star-flower
OLEACEAE: Olive Family	
Fraxinus americana	White ash
GENTIANACEAE: Gentian Family	
Gentiana Andrewsii	Closed gentian
ASCLEPIADACEAE: Milkweed Family	
Asclepias syriaca *	Common milkweed
HYDROPHYLLACEAE: Waterleaf Family	
Hydrophyllum virginianum	Virginia waterleaf
BORAGINACEAE: Borage Family	
Myosotis scorpioides	True forget-me-not

*Found only in second-growth forest.

VERBENACEAE: Vervain Family

Verbena hastata	Blue vervain

LABIATAE: Mint Family

Scutellaria lateriflora	Mad-dog skullcap
Prunella vulgaris *	Heal-all
Monarda didyma *	Oswego tea

SCROPHULARIACEAE: Figwort Family

Mimulus ringens	Allegany monkey-flowe
Veronica officinalis	Common speedwell
Pedicularis canadensis	Wood-betony

OROBANCHIACEAE: Broom-rape Family

Epifagus virginiana	Virginia beech-drops

RUBIACEAE: Madder Family

Galium Aparine	Catchweed bedstraw
Galium asprellum	Rough bedstraw
Mitchella repens	Partridge-berry

CAPRIFOLIACEAE: Honeysuckle Family

Diervilla lonicera	Bush-honeysuckle
Lonicera canadensis	Fly-honeysuckle
Viburnum alnifolium	Hobblebush
Viburnum cassinoides	Wild-raisin
Viburnum recognitum	Arrow-wood
Viburnum acerifolium	Maple-leaved viburnun
Sambucus canadensis	Common elder
Sambucus pubens	Red-berried elder

COMPOSITAE: Composite Family

Solidago rugosa	Goldenrod
Bellis perennis	English daisy
Aster divaricatus	White wood aster
Aster cordifolius	Heartleaf aster
Aster acuminatus	Acuminate aster
Erigeron strigosus	Fleabane
Rudbeckia laciniata	Cutleaf coneflower
Prenanthes trifoliolata	Rattlesnake root

Birds

ARDEIDAE: Herons and Bitterns

Ardea herodias	Great blue heron

ACCIPITRINAE: Short-winged Hawks

Accipiter striatus	Sharp-skinned hawk

*Found only in second-growth forest.

BUTEONINAE: Buzzard Hawks	
Buteo jamaicensis	Red-tailed hawk
Buteo lineatus	Red-shouldered hawk
TETRAONIDAE: Grouse	
Bonasa umbellus	Ruffed grouse
SCOLOPACIDAE: Woodcock, Snipe, Sandpipers	
Philohela minor	Woodcock
COLUMBIDAE: Pigeons and Doves	
Zenaidura macroura *	Mourning dove
CUCULIDAE: Cuckoos	
Coccyzus americanus	Yellow-billed cuckoo
STRIGIDAE: Horned Owls, Hoot Owls	
Bubo virginianus	Great horned owl
Strix varia	Barred owl
Aegolius acadica	Saw-whet owl
APODIDAE: Swifts	
Chaetura pelagica	Chimney swift
TROCHILIDAE: Humming birds	
Archilochus colubris	Ruby-throated hummingbird
ALCEDINIDAE: Kingfishers	
Megaceryle alcyon	Belted kingfisher
PICIDAE: Woodpecker	
Colaptes auratus *	Flicker
Hylatomus pileatus	Pileated woodpecker
Sphyrapicus varius	Yellow-bellied sapsucker
Dendrocopus villosus	Hairy woodpecker
Dendrocopus pubescens	Downy woodpecker
TYRANNIDAE: Flycatchers	
Sayornis phoebe *	Eastern phoebe
Empidonax traili	Alder flycatcher
Empidonax minimus	Least flycatcher
Contopus virens	Wood peewee
Nuttallornis borealis	Olive-sided flycatcher
CORVIDAE: Crows, Jays	
Cyanocitta cristata	Blue jay
Corvus brachyrhynchos	Crow

*Found only in second-growth forest.

PARIDAE: Titmice	
Parus atricapillus	Black-capped chickadee
SITTIDAE: Nuthatches	
Sitta carolinensis	White-breasted nuthatch
Sitta canadensis	Red-breasted nuthatch
CERTHIIDAE: Creepers	
Certhia familiaris	Brown creeper
TROGLODYTIDAE: Wrens	
Troglodytes aedon *	House wren
Troglodytes troglodytes	Winter wren
MIMIDAE: Thrashers, Mockingbirds	
Dumetella carolinensis *	Catbird
Toxostoma rufum *	Brown thrasher
TURDIDAE: Thrushes, Bluebirds	
Turdus migratorius *	Robin
Hylocichla mustelina	Wood thrush
Hylocichla guttata *	Hermit thrush
Hylocichla ustulata	Olive-backed thrush
Sialia sialis *	Bluebird
BOMBYCILLIDAE: Waxwings	
Bombycilla cedrorum	Cedar waxwing
STURNIDAE: Starlings	
Sturnus vulgaris *	Starling
VIREONIDAE: Vireos	
Vireo solitarius	Blue-headed vireo
Vireo olivaceus	Red-eyed vireo
PARULIDAE: Wood Warblers	
Mniotilta varia	Black and white warbler
Parula americana	Parula warbler
Dendroica magnolia	Magnolia warbler
Dendroica caerulescens	Black-throated blue warbler
Dendroica virens	Black-throated green warbler
Dendroica fusca	Blackburnian warbler
Dendroica pensylvanica	Chestnut-sided warbler
Seiurus aurocapillus	Oven-bird
Geothlypis trichas *	Yellow-throat
Wilsonia citrina	Hooded warbler
Wilsonia canadensis	Canada warbler
Setophaga ruticilla *	American redstart

*Found only in second-growth forest.

THRAUPIDAE: Tanagers

Piranga olivacea	Scarlet tanager

FRINGILLIDAE: Grosbeaks, Finches, Sparrows, Buntings

Richmondena cardinalis *	Cardinal
Pheucticus ludovicianus	Rose-breasted grosbeak
Passerina cyanea *	Indigo bunting
Carpodacus purpureus *	Purple finch
Spinus tristis *	Goldfinch
Pipilo erythrophthalmus *	Towhee
Junco hyemalis	Slate-colored junco
Melospiza melodia *	Song Sparrow

Mammals

DIDELPHIDAE: Opossums

Didelphis marsupialis	Opossum

SORICIDAE: Shrews

Sorex fumeus	Smoky shrew
Blarina brevicauda	Short-tailed shrew

VESPERTILIONIDAE: Bats

Myotis keenii	Keen's myotis

URSIDAE: Bears

Euarctos americanus	Black bear

PROCYONIDAE: Raccoons

Procyon lotor	Raccoon

MUSTELIDAE: Weasels, Minks, Skunks

Mustela frenata	Long-tailed weasel
Mustela vison	Mink
Mephitis mephitis	Striped skunk

CANIDAE: Wolves, Foxes

Vulpes fulva	Red fox
Urocyon cinereoargenteus	Gray fox

FELIDAE: Cats

Lynx rufus	Bobcat

SCIURIDAE: Squirrels

Marmota monax	Woodchuck
Tamias striatus	Eastern chipmunk
Sciurus carolinensis	Gray squirrel
Tamiasciurus hudsonicus	Red squirrel
Glaucomys volans	Southern flying squirrel

*Found only in second-growth forest.

CASTORIDAE Beavers

Castor canadensis	Beaver

CRICETIDAE Native Rats and Mice

Peromyscus maniculatus	Deer mouse
Peromyscus leucopus	White-footed mouse
Clethrionomys gapperi	Gapper's red-backed mouse
Microtus pennsylvanicus	Meadow vole
Ondatra zibethicus	Muskrat

ZAPODIDAE Jumping Mice

Napaeozapus insignis	Woodland jumping mouse

ERETHIZONTIDAE New World Porcupines

Erethizon dorsatum	Porcupine

LEPORIDAE Rabbits and Hares

Lepus americanus	Snowshoe hare
Sylvilagus floridanus	Eastern cottontail

CERVIDAE Deer

Odocoileus virginianus	White-tailed deer

Reptiles and amphibians

COLUBRIDAE Colubrids

Storeria occipitomaculata	Red-bellied snake
Thamnophis sirtalis sirtalis	Eastern garter snake
Opheodrys vernalis	Smooth green snake
Lampropeltis triangulum	Eastern milk snake

SALAMANDRIDAE Newts

Diemictylus viridescens	Newt

PLETHODONTIDAE Lungless Salamanders

Desmognathus fuscus	Dusky salamander
Desmognathus ochrophaeus	Mountain salamander
Plethodon cinereus	Red-backed salamander
Plethodon glutinosus	Slimy Salamander
Gyrinophilus porphyriticus	Spring salamander
Eurycea bislineata	Two-lined salamander

BUFONIDAE Toads

Bufo americanus	American toad

HYLIDAE Tree Frogs

Hyla crucifer	Spring peeper

RANIDAE: True Frogs

Rana clamitans melanota	Green frog
Rana pipiens	Leopard frog
Rana palustris	Pickerel frog
Rana sylvatica	Wood frog

SUGGESTED READING

For persons interested in more detailed information about the climax forest on the East Tionesta Creek and the Allegheny hardwood forests of Pennsylvania, the following publications are recommended.

Cope, Theodora M., and Arthur S. Hawkins.
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Marquis, David A.
1975. **The Allegheny hardwood forests of Pennsylvania.** USDA For. Serv. Gen. Tech. Rep. NE-15. 32 p., illus.

Headquarters of the Northeastern Forest Experiment Station are in Upper Darby, Pa. Field laboratories and research units are maintained at:

- Amherst, Massachusetts, in cooperation with the University of Massachusetts.
- Beltsville, Maryland.
- Berea, Kentucky, in cooperation with Berea College.
- Burlington, Vermont, in cooperation with the University of Vermont.
- Delaware, Ohio.
- Durham, New Hampshire, in cooperation with the University of New Hampshire.
- Hamden, Connecticut, in cooperation with Yale University.
- Kingston, Pennsylvania.
- Morgantown, West Virginia, in cooperation with West Virginia University, Morgantown.
- Orono, Maine, in cooperation with the University of Maine, Orono.
- Parsons, West Virginia.
- Pennington, New Jersey.
- Princeton, West Virginia.
- Syracuse, New York, in cooperation with the State University of New York College of Environmental Sciences and Forestry at Syracuse University, Syracuse.
- Warren, Pennsylvania.