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 hickorybush from the undergrowth 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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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.
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 2,118-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 days.

**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

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*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, big leaf maple, 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 (Meloxyphila fulvovittata 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 huckleberry 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 huckleberry, 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 Titusville oil field in 1869 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>
<thead>
<tr>
<th>Forest type</th>
<th>Scenic Area</th>
<th>Natural Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acres</td>
<td>Acres</td>
<td></td>
</tr>
<tr>
<td>Hemlock-beech</td>
<td>1,211</td>
<td>1,883</td>
</tr>
<tr>
<td>Black cherry-sugar maple</td>
<td>0</td>
<td>47</td>
</tr>
<tr>
<td>Black cherry</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>Beech-sugar maple</td>
<td>505 a</td>
<td>163</td>
</tr>
<tr>
<td>Total</td>
<td>2,918</td>
<td>2,418</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Plateau</th>
<th>Middle slope</th>
<th>Lower slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hemlock</td>
<td>Hemlock</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Beech</td>
<td>Beech</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Black birch</td>
<td>Yellow birch</td>
<td>Yellow birch</td>
</tr>
<tr>
<td>4</td>
<td>Sugar maple</td>
<td>Sugar maple</td>
<td>Sugar maple</td>
</tr>
<tr>
<td>5</td>
<td>Red maple</td>
<td>Red maple</td>
<td>Red maple</td>
</tr>
<tr>
<td>6</td>
<td>Yellow birch</td>
<td>Red maple</td>
<td>White ash</td>
</tr>
<tr>
<td>7</td>
<td>Black cherry</td>
<td>Black cherry</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>White ash</td>
<td>Rosierwood</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Yellow poplar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Cucumber tree</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.
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

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acer negundo</td>
<td>Black maple</td>
</tr>
<tr>
<td>Acer pensylvanicum</td>
<td>Striped maple</td>
</tr>
<tr>
<td>Acer rubrum</td>
<td>Red maple</td>
</tr>
<tr>
<td>Acer saccharinum</td>
<td>Sugar maple</td>
</tr>
<tr>
<td>Acer spicatum</td>
<td>Mountain maple</td>
</tr>
<tr>
<td>Amelanchier arborea</td>
<td>Downy serviceberry</td>
</tr>
<tr>
<td>Aralia spinosa</td>
<td>Devils-walkingstick</td>
</tr>
<tr>
<td>Betula alleghaniensis</td>
<td>Yellow birch</td>
</tr>
<tr>
<td>B. lenta</td>
<td>Sweet birch</td>
</tr>
<tr>
<td>Carpinus caroliniana</td>
<td>American hornbeam</td>
</tr>
<tr>
<td>Carya ovata</td>
<td>Water oak</td>
</tr>
<tr>
<td>Castanea dentata</td>
<td>American chestnut</td>
</tr>
<tr>
<td>Fagus grandifolia</td>
<td>American beech</td>
</tr>
<tr>
<td>Fraxinus americana</td>
<td>White ash</td>
</tr>
<tr>
<td>Liriodendron tulipifera</td>
<td>Yellow-poplar</td>
</tr>
<tr>
<td>Magnolia acuminata</td>
<td>Cucumber tree</td>
</tr>
<tr>
<td>Malus pumila</td>
<td>Apple</td>
</tr>
<tr>
<td>Ostrya virginiana</td>
<td>Eastern hop hornbeam</td>
</tr>
<tr>
<td>Pinus strobus</td>
<td>Eastern white pine</td>
</tr>
<tr>
<td>Populus grandidentata</td>
<td>Eighteenth aspen</td>
</tr>
<tr>
<td>Populus tremuloides</td>
<td>Quaking aspen</td>
</tr>
<tr>
<td>Prunus pensylvanica</td>
<td>Pin cherry</td>
</tr>
<tr>
<td>Prunus serotina</td>
<td>Black cherry</td>
</tr>
<tr>
<td>Prunus virginiana *</td>
<td>Common chokecherry</td>
</tr>
<tr>
<td>Quercus rubra *</td>
<td>Northern red oak</td>
</tr>
<tr>
<td>Rubus penscinoircus *</td>
<td>Black burs</td>
</tr>
<tr>
<td>Saxaul</td>
<td>White willow</td>
</tr>
<tr>
<td>Sorbus americana</td>
<td>American mountain-ash</td>
</tr>
<tr>
<td>Tsuga canadensis</td>
<td>American hemlock</td>
</tr>
<tr>
<td>Ulmus americana</td>
<td>Eastern elm</td>
</tr>
<tr>
<td>Ulmus rubra *</td>
<td>Slippery elm</td>
</tr>
</tbody>
</table>

*Found only in second-growth forest.

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

<table>
<thead>
<tr>
<th>Species</th>
<th>Diameter class</th>
<th>4-inch to 9-inch</th>
<th>10-inch and larger</th>
<th>Percent</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemlock</td>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>63</td>
</tr>
<tr>
<td>Beech</td>
<td></td>
<td></td>
<td></td>
<td>70</td>
<td>29</td>
</tr>
<tr>
<td>Sugar maple</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Birches</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Includes 2 percent black cherry.

Includes 3 percent red maple.

inch hemlock, a 50-inch red maple, a 48-inch yellow-poplar, and a 40-inch black cherry. Hemlocks up to 500 years of age and a black cherry 238 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, spinachose 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>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clematis virginiana</td>
<td>Virginia's lily</td>
</tr>
<tr>
<td>Cornus alternifolia</td>
<td>Alternate-leaved dogwood</td>
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<tr>
<td>Derris trifoliata</td>
<td>Bush-honeysuckle</td>
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<tr>
<td>Epigaea repens</td>
<td>Trailing arbutus</td>
</tr>
<tr>
<td>Gaultheria procumbens</td>
<td>Teaberry</td>
</tr>
<tr>
<td>Humulus virginicus</td>
<td>White-hazel</td>
</tr>
<tr>
<td>Ilex montana</td>
<td>Mountain winterberry</td>
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<tr>
<td>Kalina latifolia</td>
<td>Mountain-laurel</td>
</tr>
<tr>
<td>Lonicera canadensis</td>
<td>Five-honeysuckle</td>
</tr>
<tr>
<td>Mitchellia repens</td>
<td>Partridge-berry</td>
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<td>Parthenocissus quinquefolia</td>
<td>Virginia creeper</td>
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<td>Rhus copallina</td>
<td>Shining sumac</td>
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<td>Rhus radicans</td>
<td>Poison ivy</td>
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<td>Rhus typhina</td>
<td>Staghorn sumac</td>
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<td>Ribes cynosbati</td>
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<td>Ribes glandulosum</td>
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<td>Rubus alleghenensis</td>
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<td>Rubus idaeus</td>
<td>Red raspberry</td>
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<td>Rubus odoratus</td>
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<td>Salix discolor</td>
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<td>Sambucus pubens</td>
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<td>Viburnum dilatatum</td>
<td>Hebbeleash</td>
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<td>Viburnum cassinoides</td>
<td>Wild-rabbi</td>
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<tr>
<td>Viburnum recognitum</td>
<td>Arran-rose</td>
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</tbody>
</table>

*Found only in second-growth forest.*

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

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, raccoon, 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 northern climate.

Composite lists of all the species recorded in the virgin hemlock-beech forest of the East Branch of Tionesta Creek in 1930 and 1932 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 1952, 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 1955, and
Figure 11.—Trends in understory frequency rates by species and year.

this species disappeared from the sample plots by 1932. Repeated heavy browsing was responsible for most of this decline. And, as less huckleberry 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:

Forest tree species.—Little, Elbert L Jr. 1953.
Check list of native and naturalized trees of the United States. USDA For. Serv. Agric. Handb. 41, 472 p.


**Ferns and club mosses**

LYCOPODIACEAE: Club-Moss Family

- *Lycopodium lucidulum*  
- *Lycopodium clavatum*  
- *Lycopodium obscurum*  
- *Lycopodium complanatum*

Shining club-moss  
Running club-moss  
Ground-pine  
Ground-cedar

OPHIOGLOSSACEAE: Adder's Tongue Family

- *Botrychium dissectum*  
- *Botrychium matricariifolium*  
- *Ophioglossum vulgatum* *

Cattle grape fern  
Matricary grape-fern  
Adder's tongue

OSMUNDACEAE: Flowering Fern Family

- *Osmunda Claytoniana*  
- *Osmunda cinnamomea*

Interrupted fern  
Cinnamon-fern

POLYPODIACEAE: Fern Family

- *Woodia obtusa*  
- *Pteris pensylvanica* *  
- *Onoclea sensibilis*  
- *Dryopteris Thelypteris*  
- *Dryopteris norvegicaensis*  
- *Dryopteris disjuncta*  
- *Dryopteris phlebopiperis*
- *Dryopteris spinulosa*  
- *Dryopteris cristata*  
- *Dryopteris marginalis*  
- *Polystichum acrostichoides*  
- *Polystichum munitum*  
- *Athrygium filix-femina*  
- *Asplenium platyneuron*  
- *Adiantum pedatum*  
- *Pteridium aquilinum* *  
- *Polypodium virginianum*

Common woodsia  
Ostrich-fern  
Sensitive fern  
Marsh-fern  
New York fern  
Oak-fern  
Long beech-fern  
Spinulose wood-fern  
Crested wood-fern  
Marginal shield-fern  
Christmas fern  
Hay-scented fern  
Silvery spleenwort  
Lady-fern  
Ebony-spleenwort  
Maidenhair-fern  
Bracken  
Rock-polypody

**Softwood trees**

PINACEAE: Pine Family

- *Tsuga canadensis*  
- *Pinus strobus*

Eastern hemlock  
Eastern white pine

**Grasses, sedges, and lilies**

GRAMINAE: Grass Family

- *Brachyelytrum ericinum*

Bearded shortusk

CYPERACEAE: Sedge Family

- *Scirpus sp.*  
- *Carex folliculata*

Bulrush  
Sedge

*Found only in second-growth forest.*
ARACEAE: Arum Family

Arisaema atrorubens
Arisaema triphyllum

LILIACEAE: Lily Family

Veratrum viride
Uvularia sessilifolia
Allium triiscocum
Lilium superbum
Clintonia borealis
Solanum nigrum
Maianthemum canadense
Streptopus robus
Polygonatum biflorum
Polygonatum canaliculatum
Medeola virginiana
Trillium erectum
Trillium grandiflorum
Trillium undulatum

IRIDACEAE: Iris Family

Sisyrinchium angustifolium

ORCHIDACEAE: Orchid Family

Cypripedium acaule
Habenaria orbeculata
Habenaria pygmaea
Corallorhiza maculata

Hardwood trees, woody shrubs, and herbs

SALICACEAE: Willow Family

Salix alba
Salix discolor
Populus tremuloides
Populus grandidentata

JUGLANDACEAE: Walnut Family

Carya cordiformis*

BETULACEAE: Birch Family

Betula lenta
Betula alleghamenasis

FAGACEAE: Beech Family

Fagus grandifolia
Fagus crenata
Quercus rubra*

*S. Found only in second-growth forest.
ULMACEAE: Elm Family

Ulmus rubra *
Ulmus americana

POLYGONACEAE: Buckwheat Family

Rumex crispus *
Rumex acetosella
Polygonum persicaria
Polygonum arifolium

PHYTOLACCACEAE: Pokeweed Family

Phytolacca americana

CARYOPHYLLACEAE: Pink Family

Lychnis alba *

RANUNCULACEAE: Crowfoot Family

Ranunculus acris
Clematis virginiana *
Coptis groenlandica
Actaea pachypoda

BERBERIDACEAE: Barberry Family

Caulophyllum thalictroides

MAGNOLIACEAE

Magnolia acuminata
Liriodendron tulipifera

CRUCIFERAE: Mustard Family

Poastrum diphyllum
Cardamine pennsylvanica

SAXIFRAGACEAE: Saxifrage Family

Tussilago farfara
Mitella diphylla
Chrysosplenium americanum
Ribes corymbosum
Ribes procumbens

HAMAMELIDACEAE: Witch-hazel Family

Hamamelis virginiana

*Found only in second-growth forest.
**ROSAEAE: Rose Family**

Sorbus americana
Acer saccharum
Fragaria virginiana
Walnutia fragarioides
Potentilla canadensis
Rubus odoratus
Rubus idaeus
Rubus allegheniensis
Dulbarba repens
Agrimonia parviflora
Prunus pensylvanica
Prunus serotina
Prunus virginiana

American mountain-ash
Burr oak
Lowbush cranberry
Strawberry
Barren strawberry
Oldfield cinquefoil
Purple-flowering raspberry
Red raspberry
Common blackberry
Dewdrop
Tall hairy agrimony
Pin cherry
Black cherry
Common chokecherry

**LEGUMINOSAE: Pulse Family**

*Robinia pseudacacia*

Black locust

**OXALIDACEAE: Wood-Sorrel Family**

Oxalis montana

Common wood-sorrel

**ANACARDIACEAE: Cashew Family**

Rhus typhina
Rhus copallina
Rhus radicans

Staghorn sumac
Shining sumac
Poison ivy

**AQUIFOLIACEAE: Holly Family**

Ilex montana

Mountain winterberry

**ACERACEAE: Maple Family**

Acer spicatum
Acer pensylvanicum
Acer saccharum
Acer nigrum
Acer rubrum

Mountain maple
Striped maple
Sugar maple
Black maple
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
Viola rotundifolia

Wooly blue violet
Early yellow violet

ONAGRACEAE: Evening-Primrose Family

Epilobium angustifolium
Oenothera pilosella
Circaea alpina

Fireweed
Meadow sundrops
Enchanter's nightshade

ARALIACEAE: Ginseng Family

Aralia spinosa *
Aralia nudicaulis

Devils-walkingstick
Wild sarsaparilla

UMBELLIFERAE: Parsley Family

Osmorhiza Claytoni

Sweet ceely

CORNACEAE: Dogwood Family

Cornus alternifolia

Alternate-leaf dogwood

PYROLACEAE: Wintergreen Family

Pyrola elliptica
Pyrola rotundifolia
Monotropa uniflora

Shinleaf
Wild lily-of-the-valley
Indian-pipe

ERICACEAE: Heath Family

Rhododendron maximum
Kalina latifolia
Epigaea repens
Gaylussacia prescambrosa

Rhododendron
Mountain-laurel
Trailing arbutus
Teaberry

PRIMULACEAE: Primrose Family

Lysimachia quadrifolia
Trientalis borealis

Whorled loosestrife
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
Prunella vulgaris
Monarda didyma*

Mad-dog skullcap
Heal-all
 Oswego tea

SCROPHULARIACEAE: Figwort Family

*Mimulus ringens
Veronica officinalis
Pedicularis canadensis*

Alegany monkey-flowe
Common speed well
Wood-betony

OROBANCHACEAE: Brown-root Family

Epifagus virginiana

Virginia beech-drops

RUBIACEAE: Madder Family

Galium Aparine
Galium asprellum
Mitchella repens

Catchweed bedstraw
Rough bedstraw
Partridge-berry

CAPRIFOLIACEAE: Honeysuckle Family

*Dierovilla lonicerata
Lonicera canadensis
Viburnum abalblum
Viburnum cassinoides
Viburnum recognitum
Viburnum acerifolium
Sambucus canadensis
Sambucus pubens*

Bush-honeysuckle
Fly-honeysuckle
Hobblebush
Wild-raisin
Arrow-wood
Maple-leaved viburnum
Common elder
Red-berried elder

COMPOSITAE: Composite Family

Solidago rugosa
Bellis perennis
Aster divaricatus
Aster cordifolius
Aster acuminatus
Erigeron strigosus
Rudbeckia laciniata
Bacnanthes trifoliolata

Goldenrod
English daisy
White wood aster
Heartleaf aster
Acuminate aster
Fleabane
Cutleaf coneflower
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.
<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUTEONINAE: Buzzard Hawks</td>
<td>Buteo lineatus</td>
<td>Red-tailed hawk</td>
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<tr>
<td></td>
<td>Buteo lineatus</td>
<td>Red-shouldered hawk</td>
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<td>TETRAONINAE: Grouse</td>
<td>Bonasa umbellus</td>
<td>Ruffed grouse</td>
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<tr>
<td>SCOLOPACIDAE: Woodcock, Snipe, Sandpipers</td>
<td>Philohela minor</td>
<td>Woodcock</td>
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<tr>
<td>COLUMBIDAE: Pigeons and Doves</td>
<td>Zenaida macroura*</td>
<td>Mourning dove</td>
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<td>CUCULIDAE: Cuckoos</td>
<td>Coccyzus americus</td>
<td>Yellow-billed cuckoo</td>
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<td>STRIGIDAE: Horned Owls, Hoot Owls</td>
<td>Bubo virginianus</td>
<td>Great horned owl</td>
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<td>Strix varia</td>
<td>Barred owl</td>
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<td>Aegolius acadica</td>
<td>Saw-whet owl</td>
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<td>APOIDAE: Swifts</td>
<td>Chaetura pelagica</td>
<td>Chimney swift</td>
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<td>TROCHILIDAE: Humming birds</td>
<td>Archilochus colubris</td>
<td>Ruby-throated hummingbird</td>
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<td>ALCEDINIDAE: Kingfishers</td>
<td>Megaceryle alcogyn</td>
<td>Belted kingfisher</td>
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<td>PICIDAE: Woodpecker</td>
<td>Cactpus montanus *</td>
<td>Flicker</td>
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<td>Hyloptila pileatus</td>
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<td>Sphyrapicus varius</td>
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<td>Dendrocopos villosus</td>
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<td>Dendrocopos pubescens</td>
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<td>TYRANNIDAE: Flycatchers</td>
<td>Segois phoebe *</td>
<td>Eastern phoebe</td>
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<td>Empidonax traillii</td>
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<td>Nottallornis borealis</td>
<td>Olive-sided flycatcher</td>
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<td>CLOVIDAE: Crows, Jays</td>
<td>Cyanocitta cristata</td>
<td>Blue jay</td>
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<td>Corvus brachyrhynchos</td>
<td>Crow</td>
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*Found only in second-growth forest.
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<td><strong>Paridae: Titmice</strong></td>
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<tr>
<td><em>Parus atricapillus</em></td>
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<td><strong>Sittidae: Nuthatches</strong></td>
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<td><em>Sitta carolinensis</em></td>
<td>White-breasted nuthatch</td>
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<td><em>Sitta canadensis</em></td>
<td>Red-breasted nuthatch</td>
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<td><strong>Certhiidae: Creepers</strong></td>
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<tr>
<td><em>Certhia familiaris</em></td>
<td>Brown creeper</td>
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<td><strong>Troglodytidae: Wrens</strong></td>
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<td><em>Troglodytes aedon</em></td>
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<td><em>Troglodytes troglodytes</em></td>
<td>Winter wren</td>
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<td>** Mimidae: Thrashers, Mockingbirds**</td>
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<td><em>Dumetella carolinensis</em></td>
<td>Cathbird</td>
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<td><em>Toxostoma rufum</em></td>
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<td><strong>Turdidae: Thrushes, Bluebirds</strong></td>
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<td><em>Turdus migratorius</em></td>
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<td><em>Stilia sialis</em></td>
<td>Bluebird</td>
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<td><strong>Rombychillidae: Waxwings</strong></td>
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<td><em>Bombycilla cedrorum</em></td>
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<td><strong>Vireonidae: Vireos</strong></td>
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<td><em>Vireo solitarius</em></td>
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<td>Red-eyed vireo</td>
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<td><strong>Parulidae: Wood Warblers</strong></td>
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<tr>
<td><em>Mniotilta varia</em></td>
<td>Black and white warbler</td>
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<td><em>Parula americana</em></td>
<td>Parula warbler</td>
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<td>Magnolia warbler</td>
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<td>Blackburnian warbler</td>
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<td><em>Seiurus auricapillus</em></td>
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<td><em>Geothlypis trichas</em></td>
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<tr>
<td><em>Wilsonia citrina</em></td>
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<td><em>Wilsonia canadensis</em></td>
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<tr>
<td><em>Setophaga ruticilla</em></td>
<td>American redstart</td>
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</table>

*Found only in second-growth forest.*
**THRAUCIDAE: Tanagers**

<table>
<thead>
<tr>
<th><strong>Piranga olivacea</strong></th>
<th>Scarlet tanager</th>
</tr>
</thead>
</table>

**Fringillidae: Grosbeaks, Finches, Sparrows, Buntings**

<table>
<thead>
<tr>
<th><strong>Pyrrhula numazou</strong></th>
<th>Cardinal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pyrrhula lutea</strong></td>
<td>Red-breasted grosbeak</td>
</tr>
<tr>
<td><strong>Passerina cyanea</strong></td>
<td>Indigo bunting</td>
</tr>
<tr>
<td><strong>Carduelis petrosa</strong></td>
<td>Purple finch</td>
</tr>
<tr>
<td><strong>Sparrow prisca</strong></td>
<td>Goldfinch</td>
</tr>
<tr>
<td><strong>Pipilo erythrophthalmus</strong></td>
<td>Tufted titmouse</td>
</tr>
<tr>
<td><strong>Junco hyemalis</strong></td>
<td>Slate-colored jay</td>
</tr>
<tr>
<td><strong>Melospiza melodia</strong></td>
<td>Song sparrow</td>
</tr>
</tbody>
</table>

**Mammals**

**Hidricidae: Oppossums**

<table>
<thead>
<tr>
<th><strong>Didelphus marsupialis</strong></th>
<th>Oppossum</th>
</tr>
</thead>
</table>

**Soricidae: Shrews**

<table>
<thead>
<tr>
<th><strong>Sorex cinereus</strong></th>
<th>Smoky shrew</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blarina brevicauda</strong></td>
<td>Short-tailed shrew</td>
</tr>
</tbody>
</table>

**Vespertilionidae: Bats**

<table>
<thead>
<tr>
<th><strong>Myotis lucifugus</strong></th>
<th>Keen's myotis</th>
</tr>
</thead>
</table>

**Ursidae: Bears**

<table>
<thead>
<tr>
<th><strong>Procyon lotor</strong></th>
<th>Black bear</th>
</tr>
</thead>
</table>

**Procyonidae: Raccoons**

<table>
<thead>
<tr>
<th><strong>Procyon lotor</strong></th>
<th>Raccoon</th>
</tr>
</thead>
</table>

**Mustelidae: Weasels, Minks, Skunks**

<table>
<thead>
<tr>
<th><strong>Mustela frenata</strong></th>
<th>Long-tailed weasel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mustela erminea</strong></td>
<td>Mink</td>
</tr>
<tr>
<td><strong>Meles meles</strong></td>
<td>Striped skunk</td>
</tr>
</tbody>
</table>

**Canidae: Wolves, Foxes**

<table>
<thead>
<tr>
<th><strong>Vulpes fulva</strong></th>
<th>Red fox</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vulpes v. concolor</strong></td>
<td>Gray fox</td>
</tr>
</tbody>
</table>

**Felidae: Cats**

<table>
<thead>
<tr>
<th><strong>Leopardus wiedii</strong></th>
<th>Bobcat</th>
</tr>
</thead>
</table>

**Sciuridae: Squirrels**

<table>
<thead>
<tr>
<th><strong>Tamias striatus</strong></th>
<th>Woodchuck</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soropus carolinensis</strong></td>
<td>Eastern chipmunk</td>
</tr>
<tr>
<td><strong>Scriurus carolinensis</strong></td>
<td>Gray squirrel</td>
</tr>
<tr>
<td><strong>Tamias striatus</strong></td>
<td>Red squirrel</td>
</tr>
<tr>
<td><strong>Chondestes diana</strong></td>
<td>Southern flying squirrel</td>
</tr>
</tbody>
</table>

*Found only in second-growth forest.*
CASTORIDAE, Beavers
Beaver

URFETIDAE, Native Rats and Mice
Deer mouse
White-footed mouse
Gapper's red-backed mouse
Meadow vole
Muskrat

ZAPUDEA, Jumping Mice
Woodland jumping mouse

ERZHIZONTIDAE, New World Porcupines
Porcupine

LEPORIDAE, Rabbits and Hares
Snowshoe hare
Eastern cottontail

CERVIDAE, Deer
White-tailed deer

Reptiles and Amphibians

COLUMBIDAE, Columbids
Red-bellied snake
Eastern garter snake
Smooth green snake
Eastern milk snake

SALAMANDRIDAE, Newts

PLETHIODONTIDAE, Lungless Salamanders
Husky salamander
Mountain salamander
Red-backed salamander
Shiny Salamander
Spring salamander
Two-lined salamander

BISONIDAE, Toads
American toad

HYLIDAE, Tree Frogs
Spring peeper
RA N I D A E: True Frogs

Rana clamitans melanolota
Rana pipiens
Rana palustris
Rana sylvatica

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.

Downs, Albert A. 1936. Glaze damage in the birch-beech-maple-hemlock type of Pennsylvania and New York. For. 36: 63-70
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.
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- Princeton, West Virginia.
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