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NOTES ON THE FISHES OF NICKAJACK RESERVOIR, TENNESSEE, NEAR THE RACCOON MOUNTAIN PUMPED-STORAGE PLANT

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Abstract

In 1976 the Raccoon Mountain Pumped-Storage Plant six miles west of Chattanooga, Tennessee, will begin pumping water from a Tennessee River impoundment, Nickajack Reservoir. Water will be pumped to Raccoon Mountain Reservoir and returned to the main reservoir, Nickajack Reservoir, during peak power demand periods. A preoperational study of the fishery was made from May, 1973 through July, 1974.

Fifty-three species of fishes from 14 families were found during 26 collections in Nickajack Reservoir near the pumped-storage plant. Fishes were collected using experimental gill nets and electrofishing.

Introduction

The Tennessee Valley Authority is presently constructing the Raccoon Mountain Pumped-Storage Plant near Chattanooga, Tennessee. When completed the plant will pump 18,500 cfs of water from Nickajack Reservoir to a storage reservoir on top of Raccoon Mountain. During peak power demand periods water will be released to produce electricity. The purpose of this investigation was to determine the species of fishes at Nickajack Reservoir near the Raccoon Mountain Pumped-Storage Plant.

Nickajack Reservoir is an unstratified mainstream impoundment of the Tennessee River and is located between Guntersville Reservoir (downstream) and Chickamauga Reservoir (upstream). The Raccoon Mountain Pumped-Storage Plant is located at Tennessee River Mile 444.6.

There have been few studies on the fishes of Nickajack Reservoir. The fish population in the lower part of the reservoir was sampled by the Tennessee Valley Authority with rotenone in 1972 (T.V.A., 1972). Early papers about the fishes from the area that is now Nickajack Reservoir were written about collections from South Chickamauga Creek and Nickajack Cave (Jordan and Brayton, 1878; Evermann and Hildebrand, 1914). South Chickamauga Creek enters Nickajack Reservoir below Chickamauga Dam. Nickajack Cave was flooded when the reservoir was impounded. Dahlberg and Scott (1971) reported on the fishes from South Chickamauga Creek in Georgia.

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Methods and Materials

Fishes were collected with experimental gill nets (247 net nights) and electrofishing from May, 1973 through July, 1974. The experimental sinking gill nets were 1.8 m deep and 45.7 m in length. Each was composed of six 7.6 m long panels. The first panel had 25 mm bar-measure mesh, the second, 32; the third, 38; the fourth, 44; the fifth, 51; and the last, 64. The electrofishing unit was a boat mounted type with three fiberglass boogs mounted on the bow. Collections were made at the pumped-storage plant and one mile above and one mile below the plant. The reported common and scientific names of the fishes collected are those approved by the American Fisheries Society (1970).

Results

Fifty-three species of fishes were found during 26 collections in Nickajack Reservoir near the pumped-storage plant. Four additional species have been reported by commercial fishermen but were not collected during this study (sturgeon, *Acipenser fulvescens?;* bowfinfi *Amia calva;* American eel, *Anguilla rostrata;* bigmouth buffalo, *Ictiobus cyprinellus*). A list of the species encountered, with brief notes, follows:

Petromyzontidae

Ichthyomyzon castaneus Girard. Chestnut lamprey. Three lamprey were attached to carp and one was attached to a white crappie. The largest lamprey collected (353 mm) approximated the maximum length recorded for the chestnut lamprey (Cross, 1967).

Polyodontidae

Polyodon spathula (Walbaum). Paddlefish. One specimen observed swimming near the surface.

Lepisosteidae

Lepisosteus oculatus (Winchell). Spotted gar. Common.
Lepisosteus osseus (Linnaeus). Longnose gar. Common.

Clupeidae

Alosa chrysochloris (Rafinesque). Skipjack herring. Common.
Dorosoma cepedianum (Lesueur). Gizzard shad. Abundant.
Dorosoma petenense (Gunther). Threadfin shad. Common.

Hiodontidae

Hiodon tergisus Lesueur. Mooneye. Two collected.

Cyprinidae

Cyprinus carpio Linnaeus. Carp. Abundant.
Hybopsis storeriana (Kirtland). Silver chub. One specimen.
Notemigonus crysoleucas (Mitchell). Golden shiner. Abundant.
Notropis atherinoides Rafinesque. Emerald shiner. Common.
Notropis buchanani Meek. Ghost shiner. One specimen.
Notropis galacturus (Cope). Whitetail shiner. Uncommon.
Notropis spilopterus (Cope). Spotfin shiner. Common.
Notropis volucellus (Cope). Mimic shiner. One specimen.
Notropis whipplei (Girard). Steelcolor shiner. Common.
Pimephales notatus (Rafinesque). Bluntnose minnow. Common.
Pimephales promelas Rafinesque. Fathead minnow. One specimen.
Pimephales vigilax (Baird and Girard). Bullhead minnow. Abundant.

Catostomidae

Carpiodes carpio (Rafinesque). River carpsucker. One specimen.
Ictiobus bubalus (Rafinesque). Smallmouth buffalo. Abundant.
Ictiobus niger (Rafinesque). Black buffalo. One specimen.
Minytrema melanops (Rafinesque). Spotted sucker. Abundant.
Moxostoma duquesnei (Lesueur). Black redhorse. One specimen.
Moxostoma erythrurum Rafinesque. Golden redhorse. One specimen.
Moxostoma macrolepidotum (Lesueur). Shorthead redhorse. One specimen.

Ictaluridae

Ictalurus furcatus (Lesueur). Blue catfish. Common.
Ictalurus melas (Rafinesque). Black bullhead. Common.
Ictalurus natalis (Lesueur). Yellow bullhead. Common.
Ictalurus punctatus (Rafinesque). Channel catfish. Common.
Pylodictis olivaris (Rafinesque). Flathead catfish. Common.

Poeciliidae

Gambusia affinis (Baird and Girard). Mosquitofish. Abundant.

Atherinidae

Labidesthes sicculus (Cope). Brook silverside. Abundant.

Percichthyidae

Morone chrysops (Rafinesque). White bass. Uncommon.
Morone mississippiensis Jordan and Eigenmann. Yellow bass. Abundant.

Centrarchidae

Ambloplites rupestris (Rafinesque). Rock bass. Common.
Lepomis auritus (Linnaeus). Redbreast sunfish. Common.
Lepomis cyanellus Rafinesque. Green sunfish. Two collected.
Lepomis gulosus (Cuvier). Warmouth. Common.
Lepomis macrochirus Rafinesque. Bluegill. Abundant.
Lepomis megalotis (Rafinesque). Longear sunfish. Common.
Lepomis microlophus (Gunther). Redear sunfish. Abundant.
Micropterus dolomieui Lacepede. Smallmouth bass. One specimen.
Micropterus punctulatus (Rafinesque). Spotted bass. Uncommon.
Micropterus salmoides (Rafinesque). Largemouth bass. Abundant.
Pomoxis annularis Rafinesque. White crappie. Common.
Pomoxis nigromaculatus (Lesueur). Black crappie. Uncommon.

Percidae

Perca flavescens (Mitchell). Yellow perch. Two collected.
Percina caprodes (Rafinesque). Logperch. Common.
Stizostedion canadense (Smith). Sauger. Two collected.
Stizostedion vitreum (Mitchell). Walleye. Two collected.

Sciaenidae

Aplodinotus grunniens Rafinesque. Freshwater drum. Abundant.

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FOREST COMMUNITIES OF THE RADNOR LAKE NATURAL AREA, DAVIDSON COUNTY, TENNESSEE

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ABSTRACT

A study was made of the tree flora (69 taxa) of the Radnor Lake Natural Area (Davidson County, Tennessee). Plot sampling was conducted in each of these five areas: ridges, dry slopes, moist slopes, ravines and lakeshore. Quantitative parameters were derived and used to delineate forest associations. In order of importance value, the most significant taxa on ridges were *Quercus Prinus, Fraxinus quadrangulata* and *Carya ovata.* Dry slope forests were dominated by *Quercus Prinus, Acer saccharum, Quercus rubra, Fraxinus quadrangulata* and *Carya ovata.* Moist slopes were occupied chiefly by *Acer saccharum, Quercus rubra, Carya cordiformis* and *Celtis occidentalis.* Ravine forests consisted mainly of *Ulmus americana, Acer saccharum, Carya cordiformis,* and *Juglans nigra.* The most important lakeshore taxa were *Ulmus americana, Salix nigra, Populus deltoides, Celtis laevigata* and *Acer saccharinum.*

INTRODUCTION

The scientific value of State Natural Areas is great, especially for ecological research, since they serve as controls for assessing man's impacts on various ecosystems. The Radnor Lake Natural Area (RLNA) in Davidson County, Tennessee, is unique in that it is the only area in the county with extensive forests that are assured of future protection by the state. It was this uniqueness and ecological importance that prompted this investigation of the RLNA forest communities.

The RLNA is located south of Nashville, Tennessee at approximately 86° 48' west longitude and 36° 03' north latitude, along the Otter Creek Road with the entrance 0.9 miles west of U.S. Highway 31 (Franklin Road). The area consists of a central lake (32.4 hectares) with a spillway elevation of 236 meters, surrounded by the hilly Otter Creek watershead (280 hectares) which is occupied predominantly by secondary forests. The narrow winding ridges (some as high as 335 meters) are separated by steep-walled valleys with rolling land on the foot slopes and narrow flood plains along drainageways. The gradient on many hillsides is greater than 50 percent. The elevational difference between the valley floors and ridgetops is generally between 61 and 84 meters.

Physiographically, the RLNA is situated on the edge of the Dissected Highland Rim (DeSelm, 1959) which is part of the Interior Low Plateau (Fenneman, 1938). Additional information on the physiography, climate and history of the area appears in Wiser (1956).

Vegetatively, RLNA lies within the Western Mesophytic Forest Region. According to Braun (1950), this region is characterized by a mosaic of unlike forest communities and is an ecotone between the eastern Mixed Mesophytic Forest Region and the western Oak-Hickory Forest Region. Nelson and Zillgitt (1969) place the Highland Rim forests in the Oak-Hickory type (forest in which 50 per cent or more of the stand is in upland oak and hickory, singly or in combination and southern pines or Red Cedar makes up less than 25 per cent).

The topography of the area is such that five distinct areas exist: ridges, dry slopes, moist slopes, ravines and lakeshore. The ridges and upper slopes have cherty, well-drained, non-fertile soil derived from the Fort Payne formation. The middle and lower slopes are underlain by the phosphate-rich Leipers and Catheys formations, largely limestones. Chattanooga Shale is exposed on the steepest slopes, and phosphorus-rich limestone outcrops occur on many of the lower slopes. In our investigation, the moist slopes are defined as those with a northern to eastern exposure, and the dry slopes are those with a southern to western exposure. The ravines are narrow valley floors with colluvial-alluvial soils which are moist, usually well-drained, deep and fertile; the underlying limestone is of the Leipers and Catheys formations. The lakeshore is defined as a narrow flood plain surrounding the lake; its poorly-drained alluvium is also underlain by the Leipers and Catheys formations. Further information on the geology of the area is given in the Geologic Map of the Oak Hill Quadrangle by Wilson and Miller (1972). These site types are hereinafter called communities.

The objectives of this paper are to (1) delimit the forest communities of the RLNA on the basis of topography, (2) describe the dominate tree species in each community in terms of importance value, (3) describe the general distribution of the unsampled tree taxa in the various community coefficients, (4) compare the five communities with each other on the basis of community coefficients, (5) compare four of the RLNA communities with four corresponding communities studied on the northwestern Highland Rim (Jensen, Schibig, Chester, in press), and (6) compare the findings of our research with those of Duncan and Ellis (1969) and Frick (1939).

METHODS AND MATERIALS

Numerous observations of the RLNA forests were made from October, 1973, through December, 1974. The area was thoroughly inspected in an effort to acquire a complete list of all the tree species. Subjective notations were made of the general importance and distribution of each species in the five communities. Voucher specimens were collected and placed in the Volunteer State Community College herbarium.

Quantative data for most of the tree species were obtained by plot sampling during the autumn of 1974. Four mature forest stands were selected to represent each community. In each stand, eight circular area plots (diameter = 7.93 meters) were established in a linear sequence. The distance between adjacent plot centers was 10.97 m. Lakeshore plots were established parallel and upslope seven m. from the water. The ravine sampling line followed the middle of the ravine bottom. In each slope stand, the plots were set at mid slope parallel to the contour. On ridges, the sampling line ran longitudinally along the middle of each ridge (Fig. 1). Only trees having a dbh (diameter at 1.37 m. above ground) of 10.2 centimeters or greater were recorded in the sampling. The thirty-two plots for each community occupied a total area of 1,579.6 square meters. Species area curves indicated the sampling was adequate.

Upon conclusion of the field work, the relative density, relative frequency, and relative basal area were calculated for each species. An importance value index was obtained by adding these relative values (Curtis and McIntosh, 1951). Community coefficients were derived from the frequency data, and used to ascertain the degree of similarity between the communities as described by Oosting (1956). A comparison of four of the RLNA forest communities was made with four topographically similar communities studied on the northwestern Highland Rim (Jensen, Schibig, and Chester, in press). Additional comparisons of our findings with those of Duncan and Ellis (1969) and Frick (1939) were made. Throughout this paper nomenclature follows Fernald (1950).

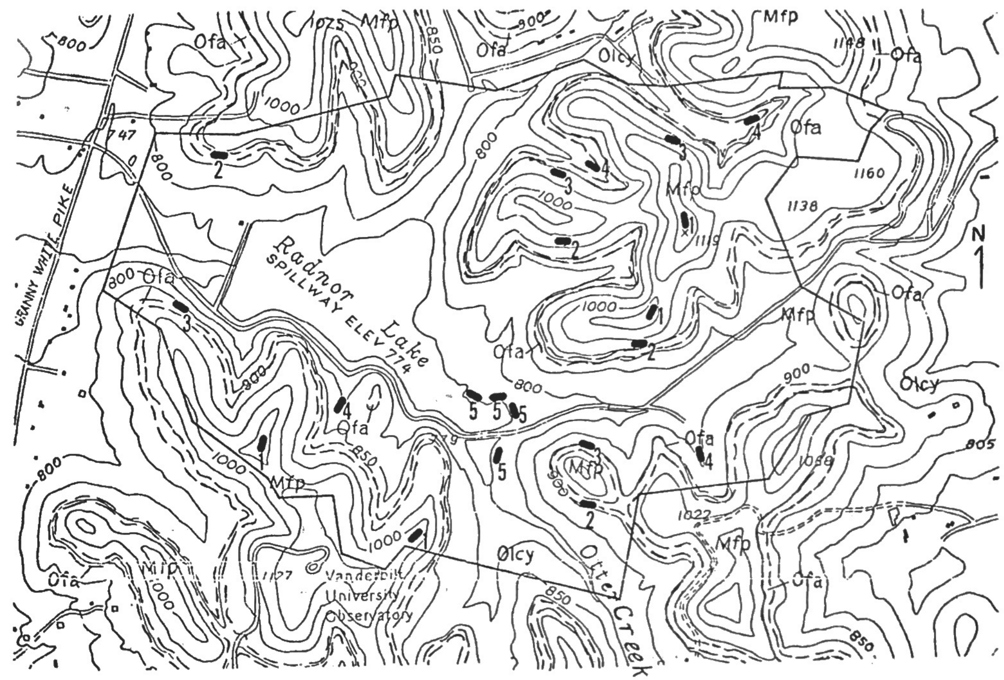

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FIG. 1: *Map of Radnor Lake Natural Area with positions of sampled areas (1 = ridge, 2 = dry slope, 3 = moist slope, 4 = ravine, 5 = lakeshore). Abbreviations include Mfp (Fort Payne and Chattanooga Formations), Ofa (Fernvale and Arnheim Formations), Olcy (Leipers and Catheys Formations). Map modified from the Geologic Map of the Oak Hill Quadrangle, Tennessee, by Charles W. Wilson, Jr., and Robert A. Miller, 1972.*

RESULTS

The importance values calculated for sampled species (45 taxa) and the places of occurrence of 24 other tree taxa are presented (Table 1). Two specimens of *Ulmus pumila* occur at an abandoned homesite. The escaped taxa *(Albizia Julibrissin, Catalpa speciosa, Maclura pomifera, Paulownia tomentosa,* and *Prunus Persica)* are rare and restricted to early successional sites. The other unsampled taxa are native to the area; they are in-significant in the canopy, but some are abundant in the understory. On a few ridges and dry slopes, *Vaccinium arboreum* and *Kalmia latifolia* form dense thickets under widely scattered oaks and hickories, while on certain mesic sites *Asimina triloba, Carpinus caroliniana* and *Staphylea trifolia* are common.

Community coefficients (Table 2) indicate the degree of floristic similarity of each possible pair of communities. Expected similarities between site-similar vegetation types occurred.

TABLE 1: *Tree Taxa, Communities, and Importance Values*

Taxa[2]	Communities and Importance Values[1]					
	DR	DS	MS	R	L	Unforested Areas[3]
Acer Negundo				3.0	23.7	
Acer Nigrum			8.4	9.9		
Acer saccharinum					32.3	
Acer saccharum	*[4]	45.5	64.7	39.2		
Aesculus octandra		11.6	11.8	3.3		
Ailanthus altissima		6.4				*
Albizia Julibrissin						*
Aralia spinosa	*	*	*			
Asimina triloba			*	*	*	
Bumelia lycioides	*		*			
Carpinus caroliniana			*	*		
Carya cordiformis			31.5	29.5		
Carya glabra	7.6	16.1	*			
Carya laciniosa			*	6.5		
Carya ovata	46.1	20.5	12.9	*		
Carya ovalis	*	4.3				
Catalpa speciosa						*
Celtis laevigata	3.6	5.2	*	2.7	34.9	
Celtis occidentalis	13.0	5.6	19.9	12.6		
Cercis canadensis	16.7	*	6.1			
Cladrastis lutea	7.8	*	5.6	3.3		
Cornus florida	*	3.2	2.6	*		
Crataegus spp.	*	*				
Diospyros virginiana				*	14.3	
Euonymus atropurpureus			*			
Fagus grandifolia			*	*		
Fraxinus americana	31.5	11.8	14.9	11.4	8.3	
Fraxinus pennsylvanica					12.5	
Fraxinus quadrangulata	49.4	26.2				
Gleditsia triacanthos	*	*	7.1	7.7		
Gymnocladus dioica	*					*
Juglans nigra		*	12.0	24.9		
Juniperus virginiana	*	*				*
Kalmia latifolia	*	*				
Liriodendron Tulipifera			*	2.7		
Maclura pomifera						*
Morus rubra			*	6.8	5.3	
Nyssa sylvatica		*	5.5			
Ostrya virginiana		*	*	2.8		
Oxydendrum arboreum	*	*				
Paulownia tomentosa			*			
Platanus occidentalis					16.2	
Populus deltoides					36.6	
Prunus Persica						*
Prunus serotina		7.1	*	15.1		
Quercus alba	*	7.2	*			
Quercus marilandica	3.5	*				
Quercus Muehlenbergii	*	14.3	11.3	9.8		

TABLE 1: *continued*

Taxa[2]	DR	DS	MS	R	L	Unforested Areas[3]
Quercus Prinus	73.6	68.5	*			
Quercus rubra	*	26.7	36.1	12.1		
Quercus Shumardii var. Schneckii			7.3	22.0		
Quercus stellata	4.1	*				
Quercus velutina	8.5	*				
Rhamnus caroliniana	*	*				*
Rhus copallina						*
Rhus glabra						*
Rhus typhina	*					*
Robinia Pseudo-Acacia	6.2	10.0	*			
Salix nigra					42.0	
Sassafras albidum		*	9.6	*		
Staphylea trifolia			*	*		
Tilia americana	7.7	*	13.5			
Ulmus alata	*	*	2.7	*		*
Ulmus americana			7.4	64.1	74.2	
Ulmus pumila						*
Ulmus rubra		3.4	2.8	*		
Ulmus serotina	20.8	6.7	6.6	11.3		
Vaccinium arboreum	*	*				
Viburnum rufidulum	*	*				
Total Tree Taxa	34	39	40	31	12	
Total Sampled Taxa	15	19	22	21	11	
Total Stems/Sample	85	83	90	92	117	

[1] DR, dry ridges; DS, dry slopes; MS, moist slopes; R, ravines; L, lakeshore.
[2] Nomenclature follows Fernald (1950).
[3] Unforested areas include abandoned homesites, fields and other open areas.
[4] Asterisk indicates known presence, but not sampled.

TABLE 2: *Similarity of Communities.*

Communities	Communities and Community Coefficients Derived from Frequency Percentages				
	DR	DS	MS	R	L
DR	—	47.6	25.1	15.7	6.2
DS	—	—	46.4	34.3	6.2
MS	—	—	—	55.3	6.9
R	—	—	—	—	28.6
L	—	—	—	—	—

DISCUSSION

Ridge forests of RLNA are dominated by *Quercus Prinus, Fraxinus quadrangulata*, and *Carya ovata*. Chief canopy species of dry slopes forests are *Quercus Prinus, Acer saccharum, Quercus rubra, Fraxinus quadrangulata*, and *Carya ovata*. Moist slope forests are characterized by *Acer saccharum, Quercus rubra, Carya cordiformis*, and *Juglans nigra*. Ravine forests closely resemble moist slope forests, but *Ulmus americana* is most important in the former. The young lake edge forest is dominated by locally typical swamp forest taxa: *Ulmus americana, Salix nigra, Populus deltoides, Celtis laevigata*, and *Acer saccharinum*.

Both total taxa and total sampled taxa peak on the moist slopes, taper abruptly to the lake margin vegetation and gradually to dry ridge totals. Extremes vary by 100 per cent (11 versus 22 in sampled taxa) and by 233 per cent (12 versus 40 in total taxa).

On the northwestern Highland Rim, Jensen, Schibig, and Chester (in press) found that both total taxa and total sampled taxa peaked in ravines and diminished across the moisture gradient (34 sampled taxa in ravines, 32 on moist slopes, 26 on dry slopes, and 16 on dry ridges); extremes varied by 113 per cent (16 versus 34 in sampled taxa) and by 68% (25 versus 42 in total taxa).

Stubblefield and Ballal (1972) studied plant communities on Davies Island, Middle Tennessee, and found the number of taxa (herbaceous and woody) in each community varied directly with the available soil moisture. These communities (in order of ascending available soil moisture) were recognized: Cedar Woods (8 total taxa), Oak-Hickory (36), Beech-Maple (49), and Old Field (75). Undoubtedly, topography influences the amount of available soil moisture, which is an important determinant of species richness.

Some taxa are well distributed throughout RLNA; *Celtis occidentalis* and *Ulmus serotina* were sampled in four of the five communities, and *Fraxinus americana* was sampled in all of the communities. Many are intermediate, and some are quite restricted; for example, *Carya laciniosa* was sampled only in the ravines and *Fraxinus pennsylvanica* var. *subintegerrima* only on the lakeshore.

Four of the northwestern Highland Rim communities (xeric ridges, xeric slopes, moist slopes, and ravines) studied by Jensen, Schibig, and Chester (in press) are topographically similar to those studied at RLNA. Based on community coefficients derived from importance values, the forest communities of Montgomery and Stewart counties are not greatly similar to the corresponding communities of RLNA. This may be due to the fact that the sample areas were much more widely distributed on the northwestern Highland Rim. The dry ridges of the northwestern Highland Rim and the RLNA have a similarity coefficient of 33.1. Sampled taxa in common are *Carya glabra, C. ovata, Quercus marilandica, Q. Prinus, Q. stellata*, and *Q. velutina*. The dry slopes of both areas have a similarity coefficient of 23.2 with these species in common: *Acer saccharum, Carya glabra, C. ovata, C. ovalis, Cornus florida, Fraxinus americana, Juglans nigra, Nyssa sylvatica, Quercus alba, Q. Muehlenbergii* and *Q. rubra*. Moist slopes of both areas have a similarity coefficient of 25.1 and these species in common: *Acer nigrum, A. saccharum, Carya cordiformis, C. ovata, Cornus florida, Fraxinus americana, Juglans nigra, Nyssa sylvatica, Quercus Muehlenbergii, Q. rubra, Sassafras albidum, Ulmus alata*, and *U. rubra*. The ravines of both areas have a similarity coefficient of 25.4 and these taxa in common: *Acer Negundo, A. saccharum, Carya cordiformis, C. laciniosa, Celtis laevigata, C. occidentalis, Fraxinus americana, Gleditsia triacanthos, Juglans nigra, Liriodendron Tulipifera, Morus rubra, Prunus serotina, Quercus Muehlenbergii, Q. rubra* and *Q. Shumardii* var. *Schneckii*.

Duncan and Ellis (1969) recognized six forest communities on the northwestern Highland Rim. Vegetatively, their White Oak-Northern Red Oak-Hickory community slightly resembles the RLNA dry slope community. Their Post Oak-Black Oak community approximates the RLNA ridge community. Their Beech-Maple community resembles the RLNA moist slope community, but *Fagus grandifolia* is rare at RLNA. Their Red Cedar-Hardwood community has no true counterpart at RLNA , but on a few early-successional slope sites, there are many small *Juniperus virginiana* mixed with various hardwoods and much *Lonicera japonica*. Their Bottomland community is roughly similar to the RLNA ravine community, and their Streambank community closely resembles the RLNA lakeshore community.

Frick (1939) conducted phytosociological studies of the vegetation of a south-facing slope in the Highland Rim section of northwestern Davidson County. Since the vegetation had been disturbed by fire, it was in an early to intermediate stage of succession. On the lower slope, these taxa were listed as dominants: *Carya tomentosa, Quercus alba, Carya glabra*, and *Quercus velutina*. At midslope the recorded taxa were *Crataegus crus-galli, Fraxinus quadrangulata, Juniperus virginiana, Ulmus alata*, and *Viburnum rufidulum*. The taxa characteristic of the upper slope were *Castanea dentata, Oxydendrum arboreum, Sassafras albidum, Quercus marilandica, Q. stellata*, and *Q. velutina*. All of these except *Carya tomentosa* and *Castanea dentata* were observed on the dry slopes of RLNA. The apparent absence of *Carya tomentosa* is puzzling, since it is common in surrounding areas. Intensive search for sprouts of *Castanea dentata* at RLNA was fruitless; if it was a previous inhabitant, it most likely was eradicated by *Endothia parasitica*.

Forests approximating the Mixed Mesophytic type occupy many of the moist slopes and ravines of RLNA. According to Braun (1950), in the eastern part of the Western Mesophytic Forest Region, mixed mesophytic forests are frequent, but westward become more limited in extent and more closely dependent on very favorable habitat conditions. The forest communities of RLNA vary from early successional stages to mature seres, and within each community there is codominance by several species. It is assumed that the diversity of vegetation patterns is due to edaphic, topographic, and other local factors; it is believed the communities are especially affected by a soil moisture gradient, which accounts for the presence of xerophytes on the ridges and dry slopes, numerous mesophytes on moist slopes and in ravines, and hydrophytes on the lakeshore.

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