

A STUDY IN FOREST WILDLIFE RELATIONSHIPS

By

W.R. DeGarmo

Major Thesis Submitted to the Faculty

Of

The Virginia Polytechnic Institute

Department of Biology

For the Degree of

MASTER OF SCIENCE

In

WILDLIFE CONSERVATION

Approved

Dean of School

Approved

Dean of Agriculture

Approved

Head, Department of Biology

Approved

Supervisor

August 1941



MAP OF
BIG LEVELS GAME REFUGE
AUGUSTA CO. VIRGINIA



Clearing No. C-16, an old clearing with
its growth of sumac and grapes

Acknowledgements

The writer wishes to express his sincere appreciation to _____ for the many services rendered throughout the course of this investigation, and for his invaluable guidance and patience. To Professor A. B. Massey goes the credit for all matters pertaining to the plant studies conducted under the project and for his assistance and cooperation in preparing the plant catalog of the Big Levels Game Refuge and Mountain Lake Demonstration Area.

The writer is also indebted to _____ of the U. S. Forest Service for his splendid cooperation and assistance in all matters pertaining to work on the Big Levels. To _____, Supervisor of the George Washington National Forest, appreciation is expressed for making the Big Levels available for the study. A special note of thanks is reserved for the interest, assistance and friendship of _____ of Stuarts Draft, Virginia. For the many long hours spent in preparing the manuscript, the writer is indebted to _____.

For the material borrowed from the thesis submitted by _____, the writer extends his gratitude and apologies.

Table of Contents

Acknowledgements	1
Introduction	
Description of Project	1
Review of Literature	3
Review of previous report on project	14
Descriptions of Areas	
Big Levels Game Refuge	
Location	25
Climate	26
Life Zones	26
Mt. Lake Wildlife Demonstration Area	
Location	27
Topography	27
Climate	27
Life Zones	28
Soil	28
Soil Fertility	29
Water Content	29
Vegetation of the Area	30
Investigation and Results	
Procedure	
Big Levels Game Refuge	
Seasonal Studies	32
Population Studies	32
Grouse Brood Studies	33

Food Habit Studies	34
Mt. Lake Wildlife Demonstration Area	34
Haven's State Game Refuge	35
Results	
Seasonal Studies	
Ruffed Grouse	
Pre-nesting Period	37
Nesting Period	40
Grouse Brood Studies	42
Late Summer and Early Fall	43
Fall and Winter	43
Table I Record Sheet for Grouse Broods	46
Table II Distribution of Ruffed Grouse Flushed on Big Levels in Relation to Openings	49
Table III Distribution of Ruffed Grouse Flushed by Months and Cover Types	50
Table IV Field Observations on Grouse Feeding Habits on Big Levels	51
Bob-white	55
Wild Turkey	59
Table V Bob-white Feeding Habits on Big Levels	65
White-tailed Deer	68
Table VI Feeding Habits of Deer	72
Predators	78
Use Made of Various Types of Clearings	80
Population Studies	79

Mt. Lake Demonstration Area	85
Haven's State Game Refuge	88
Summary and Conclusions	91
Appendices	
I List of Plants on Forest and Clearing Quadrats	99
II Quadrat Data Sheet	108
III Catalog of Plants on Big Levels and Mt. Lake	109
IV Distribution of Grouse Flushed on Game Census Areas	142
V Distribution of Timber Cover Types on Game Census Areas	147
VI Bibliography	152
VII Aerial Photo of Big Levels	160 (<i>Franklin Pierce</i>)
VIII Map of Mt. Lake Area	161
IX Map of Haven's State Game Refuge	162

INTRODUCTION

The Big Levels Game Refuge, as established by presidential proclamation on July 6, 1936, included some 30,000 acres in an area in the southeast corner of Augusta County, Virginia. Formerly there had been a refuge of 4,000 acres, established by the Virginia Commission of Game and Inland Fisheries, on what was then the Natural Bridge National Forest. Subsequently, with the inclusion of the Natural Bridge National Forest in the George Washington National Forest, the Big Levels Game Refuge, now known as a national game refuge, is administered by the U. S. Forest Service under Federal supervision.

In a reconnaissance of the area in 1935 by members of the Bureau of Biological Survey, it was recognized that the unbroken even-aged timber stands on the area were not suitable as wildlife range. It was therefore recommended that at least five per cent of the total acreage be opened up by intensive clearing within a two year period, and that within the next four years another five per cent be cleared. On the basis of these recommendations work was initiated, in 1936, on a series of clearings. Approximately 175 clear-cut areas and 200 slashings have been established since that time. The clearings were of various sizes, exposures and shapes. Treatment of the clear-cut areas was aimed at maintaining them as permanent openings.

With the exception of cursory examinations by personnel of the Forest Service and of the Biological Survey, no systematic study of the clearings was undertaken. Accordingly, a Pittman-Robertson project,

designed to make a detailed study of the clearings was begun in April 1939. As originally titled "The Effect of Cleared Areas on Wildlife Populations," the study was to determine the practicability and utility of clearings of various sizes, shapes and locations, to ascertain facts on the ecology and maintenance of such developments, and to determine their roll in the management of forest wildlife species. Work was to have been done on the Big Levels and North River Refuges of the George Washington National Forest by conducting a study of the clearings on the Big Levels and by comparing the area with the North River Refuge where there were no clearings.

In July 1939 the project was re-submitted and retitled, "A Study of Forest Wildlife Relationships." Under the project a study was to have been made of the clearings on the Big Levels. Information gained on this study was then to have been used as a basis for establishing experimental clearings on two state game refuges; the Mountain Lake Wildlife Demonstration Area in Giles County and the Haven's State Game Refuge in Roanoke County.

The project was terminated by the Virginia Commission of Game and Inland Fisheries on June 30, 1940. Accordingly a report is made of work done under the project during the period April 4, 1939 to June 30, 1940. Inasmuch as the work on the project had been planned on a five-year basis, the scope of this report must of necessity be largely limited to presenting data obtained during the period of study.

REVIEW OF LITERATURE

The problem of instituting effective and practical environmental controls for the improvement of wildlife range in forested areas has long been an obstacle in the path to successful management of forest wildlife. It is recognized that the problem is essentially one of avoiding large tracts of uniform cover types, either by providing widespread openings, young growth, or an interspersion of timber types. Wildlife management as such is a manipulation designed to obtain the maximum edge effects.

Just as every sportsman knows that a mature forest with a closed canopy furnishes poor hunting, so he knows that a brushy open forest containing a series of open grassy areas is good wildlife cover. In such areas are to be found a greater abundance and variety of food in the form of increased succulence and greater abundance of fruit. It therefore appears that any practical procedure in the provision of increased sources of food and cover must provide some means of breaking the light-restraining effect of the forest canopy. Wildlife authors have expressed numerous ways in which this may be accomplished. In general such efforts have been made to conform to accepted methods of silviculture. Likewise they have been varied in an effort to meet the demands of the major game species under consideration.

In forested areas of Pennsylvania (58) cuttings of four kinds were undertaken: release cuttings, slashings, thinnings, and felling timber for sale; most of which were designed to increase browse for deer. In slashing plots of approximately one-half acre, it was found that unless the areas were given temporary protection by felling brush over them, deer destroyed

potential grouse food by browsing all young growth as fast as it appeared. On the basis of such experience, it was believed that the most practical method lay in cutting zigzag strips 50-90 feet wide and from 300 to 600 feet long. More sprout growth was obtained by cutting the stumps six to twelve inches high than by cutting at heights of eighteen to twenty-four inches.

In thinning it was found that the more severe the thinning the longer the period before such an operation would again become necessary. As much as 50-75 per cent thinning was practiced around mast producing trees. At least a 50 per cent crown removal was considered necessary to insure growth of an adequate understory. In remote areas where slashings or thinnings were conducted, a great increase in the number of snowshoe hares was reported, due in part to influx from surrounding areas.

In thinning for browse in New York (17), 25 per cent of the stems, chiefly grey birch and soft maple were removed. No noticeable increase in grass and coarse annuals was noted, but an abundance of small sprouts of high palatability resulted. Cooke believes that a system of frequent thinnings in younger hardwood stands has great promise.

On the Santa Barbara National Forest (60) a series of truck trails and firebreaks was cut along the crests of ridges through dense stands of oak, sugar bush and chamise. This, of course, resulted in a changed vegetative condition, in the form of annual weeds and grasses. Deer were quick to take advantage of the change. Well defined deer trails were soon found along the sides or middle of these lanes. Browsing of tender shoots of oak, sugar bush and chamise was striking. There has also been close browsing of forage species within easy distance of the new openings.

Gabrielson (32), recognizing the value of timber cutting advocates a cutting cycle based on a period of eighty years in which 25 per cent of the units will have been cut over within periods of twenty years. This amount of cut-over land should furnish suitable range by providing favorable shelter and food conditions for the game found on the total unit. Such annual cut-over areas need to be as small as can be economically logged. Ehrhart (29) disagrees with such a plan, stating that deer could not get to these areas in winter, the critical period over most deer ranges.

Increasing the productivity of forest units for game species in which there is not a concentration of deer presents a slightly different problem. "In species like grouse the covert theorem may probably be stated in very simple terms: producing capacity is proportional to the sum of the peripheries of the necessary environmental types." (47) Leopold also believes that maximum production is attained where there is an interspersion of the necessary environmental types, all of which should be within the cruising radius of the species.

"Analysis of types in which 13,553 grouse were flushed on an area in New York (12) indicates that:

- (1) The most important characteristic of winter grouse cover is the presence of a substantial number of conifers.
- (2) Concentrations of grouse in coniferous types becomes less noticeable as spring advances, the more open hardwood and overgrown land types rising progressively in utilization.
- (3) Coniferous types are largely abandoned in summer, in favor of open wooded, slashed, and overgrown areas containing an abundance of herbaceous growth.

(4) "Edge" types furnishing fall food and coniferous types offering shelter becomes increasingly important as fall progresses. Dr. Bump presents the following analysis of data on 1,270 grouse nests:

- (1) A preponderance of grouse nests are located in second growth hardwoods.
- (2) There is a slight preference for slashings in contrast with overgrown lands.
- (3) There is indication of a slight preference for slashings over overgrown lands.

On the basis of 1515 brood contacts it is believed that:

- (1) Predominant use is made of those types containing extensive overgrown land or woodland herbaceous cover.
- (2) Second growth hardwoods prove nearly as attractive as all other woodland cover combined.
- (3) In proportion to available data, slashing types are also heavily favored.
- (4) In slashing types desirability increases with age.

Edminster (26) presents a similar classification of cover preferences for New York. In addition he states that the most desirable proportion of these types is as follows: winter shelter 30 per cent, spring nesting grounds 30 per cent, fall feeding grounds 20 per cent, summer feeding grounds 10 per cent and open land 10 per cent. It is also important that these types be arranged and distributed properly before maximum production can be expected. On the Connecticut Kill area a scarcity of grouse above 300 feet from an opening was noted. He therefore recommends opening up

areas by a systematic slashing plan whereby every point in the forest is within 300 feet of an opening. Slashing units are to be distributed over a period of 20 to 30 years. Two acre plots have been arbitrarily accepted, but it is not known whether or not such an opening is of the optimum size. An attempt is being made to increase the extent of the edges. In Michigan (31) preferences of grouse for different degrees of stocking was noted: 39 per cent for good, 42 per cent for medium, 19 per cent for poor. Again it was found that 77 per cent of all grouse flushed were within 300 feet of the margin of a cover type.

King (43) describes in considerable detail the value of openings in Ruffed Grouse management. He points out that the female grouse is attracted to openings because they are a source of a number of things that enter into her daily life: dry mineral soil for dusting, gravel, succulent vegetation and greater insect populations. It is stated that small openings can be made in heavily wooded areas without sacrificing valuable timber. Such openings need not be wider than twice the height of the bordering trees. Recommendations include burning brush piles at the edges to provide dusting places; the provision of small mounds of mineral soil, and seeding the clearings to alsike or white clover.

In connection with forest openings, cover is just as essential as food. Several kinds are necessary in proper grouse range: drumming cover, nesting cover, brooding cover, molting cover, and winter cover. King believes that "cover areas need not be extensive, and the more effective the plant growth is as cover the more important it is to see that these areas

are broken up and interspersed with open areas; otherwise there will be little or no food produced at the ground surface, and food in this location is essential to the young birds and highly important to the old ones." It is important that nesting cover include a number of openings as nests are almost invariably located near the edges of openings, so the greater the number of openings, the less the danger of nest concentration. In late summer and fall months, when water supplies grow weak, grouse resort to openings to obtain succulent vegetation in an effort to satisfy their need of water.

Cahalane (14) believes that the silvicultural practice of most value to wildlife is the selection system whereby the forest canopy is broken up, thus allowing the continuance of abundant ground cover. Then "clear-cutting in small blocks or in narrow strips is probably the next best practice, inasmuch as it does not clear extensive areas."

On the Buck Creek Plantation in the Huron National Forest in Michigan (36) two types of areas were studied: planted areas and natural stands. Census drives indicated that small game and fur-bearer populations were not greatly different in planted and unplanted areas. However, more rabbits and squirrels were found in areas where slash and salvage material had been piled than where disposal had resulted in a scarcity of such slash. Three times as many dens of burrowing animals were found in the plantation as compared with the unplanted area. Leopold (47) urges the use of caution in creating too large plantations.

The bob-white is considered to be a farm game species, best adapted to areas of open grassland or broken farmland. Stoddard (65) however, states

that, while a maximum crop of timber and maximum crop of quail can seldom, if ever, be produced on the same ground, some quail can, by careful management, be produced on land handled primarily for timber. This has subsequently been demonstrated in New Jersey, Maryland and New York.

In the "Pine Barrens" of New Jersey (57) food was found to be the limiting factor for small game. Hence, an effort was made to break up the widespread uniformity of cover by the creation of an interspersion of forest and openings: i.e. to create additional "habitable range" a number of twenty-five foot strips are being cleared of trees, plowed and sowed to native food producing species. Small clearings of one-half to two acres are being laid out at intervals along the strips. They are designed to provide nesting and breeding centers. The developments under way entail an expenditure of approximately 400 man days per mile, exclusive of plowing.

The economics of such operations and some of the results obtained are presented by Burlington (15). On the Glassboro Public Shooting Grounds, an area of 2,000 acres, an increase was obtained from three coveys of 31 birds in 1936 to 11 coveys and 173 birds in 1938 by the installation of nine food areas. In an area in Cumberland County 5 coveys in 1935 increased to sixteen coveys in 1939. In clearing the areas, cutting by hand, pulling stumps by tractors, required 132 man hours and 30.1 tractor hours per acre. The total expenditure in getting a seed bed started was 146.9 man hours and 41.9 tractor hours per acre. Brush cutters and brush breakers were then put into use. There were indications that this permitted an acre to be cleared with one-twelfth the man hours and one-sixth the tractor hours

formerly required by cutting and stump-pulling.

In New York (11) management was undertaken of 3,700 acres of scrub oak - pitch pine cover type. In 1934 a survey indicated a population of 250 quail, 20 grouse and an undetermined number of deer on the area. Strips 50 feet wide and averaging about 600 feet apart were cleared by CCC below and planted to a green soiling crop. These were later planted to grains. Other developments included evergreen plantings, forest stand improvement, water holes and predator controls. In December and January a careful census showed a population of 2,000 quail, 45 grouse and 75 pheasants. Liberations had amounted to 225 quail in 1934 and 525 in 1935; and 100 pheasants in 1934. Expenses for maintaining food strips, seed, patrol, regulation of shooting, upkeep and maintenance of equipment amounted to \$1,275 annually, or a cost of \$1.27 per bird.

In Maryland (71) it was found that the following proportions of submarginal land are capable of supporting a winter population of one quail for each seven acres: pine and mixed hardwoods, 72 per cent; swamp woodlands, 10 per cent; broomsedge field, 8 per cent; brushland, 5 per cent; and fallow land, 5 per cent.

Cutting, burning, or thinning a forest stand marks the beginning of an ever-changing relationship in the make-up of the "biotic community." As pointed out by Horn (37) following cutting on a sugar pine-fir type, ground cover increased rapidly, resulting in an improved habitat for small rodents and mice. Later, as the cutting grows into browse deer utilize it as summer range. It is thought that the proper ratio between summer and winter deer range could therefore be regulated by continued logging and opening of adjacent timber areas.

Woodcock management in Maine (1-2) has taken account of the scarcity of suitable singing grounds in areas of unbroken woodland. The nesting population, it was thought, could be increased by the construction of a number of artificial clearings. Of nine such clearings established in 1937 five were found to have been occupied by singing males.

A number of census counts by Lay (46) of birds in relation to cleared areas resulted in finding 41 per cent more species and 95 per cent more birds being found in the margins than the adjacent woodland interiors. Again it is pointed out that the influence of a clearing usually extends less than a hundred yards into the interior of the woodland, consequently the maximum development of an area for wildlife required numerous well-located clearings.

Carpenter in studying the bird populations of forest edge communities in Illinois found that there was a marked selection by the majority of birds in regard to the exposure directions of the habitat selected. In both tracts studied it was found that birds selected exposures on the "lee" sides of the woods. In late spring this discrimination appears to become less noticeable. A notable exception was found in the case of Juncos, as late spring and summer birds of this species exhibited a marked preference for North exposures. In all seasons, the east side ("lee" side) had by far the greatest bird population. Insect population studies conducted during the same period gave no indication of similar habitat selection in regard to exposure.

Considerable variation is to be found in recommended sizes for forest clearings. Montgomery (56), King, R. T. (44), and Couch (19) advocate that

~~that~~ the width of the clearing be about twice the height of the surrounding canopy. In New Jersey pine barrens (57) the artificial fields are roughly rectangular (150 x 400 feet), while the narrow strips are approximately twenty-five feet wide. In New York (11), strips 50 feet wide were cut in the scrub oak - pitch pine forest. Deems (24) states that the "proper size of cutting areas cannot be stated definitely as it is a local problem."

In Pennsylvania, Herbert P. Kaufman is at present conducting as a Pittman-Robertson project, a study of forest wildlife problems. Studies are being made of cutting operations covering a five-year period, in an effort to correlate game management and timber production practices. Kaufman states that it is important not to open an area too much by thinning because ice and wind storms will do serious damage. It is likewise pointed out that too much sunlight allows the bracken fern, "Pteris aquilina" to get started. Areas cut in 1934 are in need of being cut again if sprout growth is to be provided for deer. It is stated that it is preferred to spread the cuttings over a large area rather than to concentrate the work in one vicinity, because deer will either browse the sprout growth too heavily and kill it, or the sprouts will not be utilized, so will soon get beyond reach of the deer.

Wight (70) conducted a quantitative study of the effect of various forest improvement practices on the wildlife environment of the Huron National Forest. A series of sample plots was established in both treated and untreated timber stands. Physical factors, including light, temperature, wind velocity, and relative humidity were studied on each of the plots. Biotic factors, including concealment, visibility, the quantity, quality, and availability of food and timber stocking were measured. Natural checks were chosen

from unimproved areas for each plot located on the areas that had been improved.

Findings were numerous, of which a few may be mentioned. Grass showed a slightly increased frequency on improved areas, as did mixed herbaceous plants, sand cherry, bearberry, blueberry, and the pines, except jack pine. "It is apparent that there is a more luxuriant growth on the improved areas, due to the effect of the forest practices. Thus it is evident that the prevailing forestry practices increase the average yield of food plants, increase the frequency of some valuable food species, but possibly seriously reduce the frequency of others, and the ultimate effect of an extensive planting program will greatly reduce the food supply both in respect to quantity, variety, and possibly in quality."

Wight believes that the ideal conditions in a mixed hardwood and evergreen stand would require average visibility and concealment ranging between 40 and 60 per cent, and with the total per cent of light also within this range. It is suggested that numerous areas of from one acre up to twenty-five acres in size be maintained either as openings or be developed into park-like areas.

In a thesis submitted to the faculty of Virginia Polytechnic Institute, Department of Biology, for the degree of Master of Science in Wildlife Conservation, James E. Thornton included a portion of the work done under the present project as "An Ecological Study of Forest Clearings on the Big Levels Game Refuge." (68) Inasmuch as the work reported in this thesis was an integral part of the entire study, it is essential that portions of it be included within this report. The order of presentation will vary little from that of Thornton's report.

INVESTIGATION

Procedure

The study has been developed along the following lines:

Quadrat Studies

A total of twenty clearings was selected for the study, representing approximately ten per cent of the clearings of the refuge. Detailed plant studies of each of these clearings was conducted by the use of a combination of the belt and line transects. These transect lines were usually two chains long (132 feet), one chain extending into the cleared area and one chain extending into the forested area. Unless conditions warranted otherwise, four transects were established in each clearing.

Along each transect three quadrats were located. These quadrats were of two sizes: those in the clearings being three feet, three inches square; and those along the forest transects six feet, six inches square. In all a total of 476 quadrats was established: 232 along the clearing transects, and 224 in the forest surrounding the clearings. A combination list and chart method was used in recording the vegetation of the quadrats. Notes on the edaphic factors were likewise taken. Each clearing was type-mapped and descriptions obtained of the vegetation surrounding the clearings.

Plant Collections

As complete^a collection as possible of the plants of the area was made in connection with the quadrat studies and other work involved in the project.

Food Availability Studies

Throughout the winter of 1939-1940, studies were made of the availability

of food believed to be of value to wildlife in the clearings.

Type Mapping

Notes were taken on the various representative forest types found on the refuge, mainly with the idea of correlating the ground and shrub cover with the forest cover.

Soil Sample Collections and Studies

Soil samples were taken from the depths of 0-3 inches, and several from 12-18 inches, on all clearings on which quadrat studies were made. Analyses were made by the Agronomy Department of Virginia Polytechnic Institute.

Results:

Edaphic Factors

Soil Origin

The greater portion of the soil of the Big Levels may be classed as a steep phase of the Muskingham stony fine sandy loam. The subsoil is yellow, brownish yellow, or light brown friable sandy clay which extends to a depth of ten to fifteen inches below the surface. A limited portion of the soil on the refuge is classed as the stony phase of Muskingham fine sandy loam and extends to a depth of seven to ten inches below the surface. Buried beneath the sandstone and shale soils of the lower slopes and flat sections is a layer of limestone; which however is nowhere in evidence.

Soil Acidity

Soil samples from the clearings were tested for acidity by the quinhydrode method. The results show that the average pH of the soils tested was 4.9 at a depth of 0-3 inches, 5.0 at a depth of 3-6 inches, and 5.1 at a depth of 12-18 inches. The highest pH for any clearing listed was 5.4. The lowest pH value, one of 4.6, was found on a comparatively new clearing.

Soil Fertility

The results of rapid soil tests indicated that phosphorus, calcium and potassium are relatively low as compared with the amount of aluminum and magnesium present in the soil. This relatively high amount of available magnesium is highest in samples collected from clearings of long standing, ie from clearings in which the soil has not been disturbed for a number of years.

Water Content

The sandy, well-drained soils of the higher slopes and tops of the mountains, has as a whole a relatively low water content. This is not so noticeable on the lower slopes and flat portions of the refuge, which as a whole are rather poorly drained. That the water-retaining capacity of the soils of the area is considerable^{is} evidenced by the fact that the streams on the refuge are remarkably uniform throughout the summer and fall months.

Biotic Factors

Vegetation

It is said that the greater portion of the Big Levels was once covered with a dominant growth of pitch pine. Lumbering operations removed this late in the nineteenth century; an operation which was followed by the completion of timber exploitation in the form of charcoal burnings. Numerous scars marking sites of former charcoal pits are still in evidence. There then followed the usual series of annual burns for a period of something like twenty-five years; a process that must have had a great influence on the present composition and growth rate of the vegetative cover.

At present something like two-thirds of the refuge supports a dense growth of bear oak (Quercus ilicifolia) interspersed with scattered stands of chestnut oak (Q. Prinus), pitch pine (Pinus rigida), and table mountain pine (P. pungens). On the lower slopes and valleys there is a rather thick growth of mixed pine and hardwoods.

Five timber types or associations are recognized as occurring within the refuge: bear oak, mixed oak, chestnut oak, yellow pine-hardwood, and hemlock.

Bear Oak Association:

This type is dominant over the greater portion of the ridges, ridge tops and higher slopes of the refuge. It is estimated that approximately 60 per cent of the refuge area is occupied by this vegetative type. Bear oak (Quercus ilicifolia) is of course the dominant species, but with associates of Q. Prinus, Pinus rigida, P. pungens, Carya glabra, Nyssa sylvatica, Robinia Pseudo-Acacia and Sassafras albidum. Shrub cover includes Kalmia latifolia, Rhododendron catawbiense, Vaccinium spp., Gaylussacia sp., Lyonia ligustrina, Myrica asplenifolia, Hammamelis virginiana, Chionanthus virginica and Andromeda floribunda. The ground cover is largely Gaultheria procumbens which grows in dense mats throughout this type. Other ground species include Pteris aquilina, Iris verna, Smilax glauca, Solidago spp., Lycopodium spp., Baptisia tinctoria, and Epigea repens.

Mixed Oak Association:

The lower "flat woods" section at the bases of the ridges, or about 20 per cent of the refuge area, is covered by what may be classed as this type. It intergrades with the yellow pine-hardwood type over the greater part of the area. Next to the bear oak type, it is the most extensive type on the refuge. It is made up largely of mixed oaks with a few other hardwoods and coniferous species. Species within the type include: Quercus Prinus, Q. coccinea, Q. velutina, Q. alba, and Pinus rigida as co-dominants; and Robinia Pseudo Acacia, Pinus virginiana, P. Strobus, Liriodendron Tulipifera, Nyssa sylvatica, Acer rubrum, Fraxinus americana, Cornus florida, Carya glabra, and Betula lenta. The understory is rather thin and is made up largely of Kalmia latifolia, Sassafras albidum, Vaccinium spp., Gaylussacia sp. and in spots Rhododendron maximum and R. catawbiense.

Ground and herbaceous cover is as a whole thin and is made up principally of Epigea repens, Tephrosia virginiana, Osmunda cinnamomea, Dryopteris novaboracensis, Pteris aquilina and Gaultheria procumbens.

Chestnut Oak Association:

As might be expected, this type, occupying approximately ten per cent of the area, is to be found just under the tops of the higher ridges, thus bordering on the bear oak type. As a whole it occupies the more rugged and rocky portions of the refuge. The principal species is Quercus Prinus; but the association contains considerable numbers of Quercus coccinea, Q. alba, Pinus rigida, and P. pungens, Carya glabra, Nyssa sylvatica, Acer rubrum, and Robinia Pseudo-Acacia. The undergrowth is rather thin, and is composed largely of miscellaneous hardwood reproduction with Kalmia latifolia, Rhododendron spp., Smilax glauca, Vaccinium spp., Gaylussacia sp., Myrica asplenifolia, and other species. The principal species of ground cover are Epigea repens, Pteris aquilina, Tephrosia virginiana, and Lycopodium spp.

Yellow Pine-Hardwood Association:

Something like five per cent of the refuge may be said to be occupied by this type, though it is often difficult to distinguish from the mixed oak type. In general it is found on the lower slopes and at the mouths of the valleys, with scattered stands on the upper slopes and lower ridges. The principal species of the type is pitch pine, Pinus rigida, with other important coniferous species being Pinus virginiana and Pinus pungens. For the most part the stands of coniferous trees contain considerable hardwoods. Important hardwood species found within the association include Quercus coccinea, Q. Prinus, Q. velutina, Acer rubrum, Carya glabra, and Nyssa sylvatica.

The undergrowth is made up largely of hardwood reproduction with Vaccinium spp. Smilax glauca, and Kalmia latifolia. Herbaceous ground cover is made up largely of Gaultheria procumbens, Epigea repens, Pteris aquilina, Aster linariifolius, Antennaria Parlirii, Chimaphylla maculata, and Chrysopsis mariana.

Hemlock Associations:

With the exception of one or two north slopes this type is confined to the coves at the heads of the valleys. Not more than five per cent of the refuge is occupied by the type. Tsuga canadensis is the dominant species with the following associates: Tilia glabra, Acer rubrum, Pinus Strobus, Betula lenta, Fraxinus americana, Nyssa sylvatica and Juglans cinerea.

The shrubby undergrowth is made up of patches of Kalmia latifolia, Rhododendron sp., Alnus rugosa, Rubus spp., Acer spicatum, and hardwood reproduction. The herbaceous cover is limited, being made up of Mitchella repens, Osmunda cinnamomea, Polystichum acrostichoides, and numerous other ferns.

Description of Clearings

A detailed description of each of the twenty clearings on which quadrat studies were conducted is presented by Thornton. Inasmuch as later descriptions of the use made by wildlife of various clearings will include some of these, it is not considered necessary to take note of each of the clearings at this point.

Comparison of Old and New Clearings

It is believed that the newly-created clearings on the refuge will, in time, develop conditions roughly similar to those found in several old clearings still to be found on the refuge. The most important of these old clearings were established by mining operations about 1917. A comparison of

the two types of clearings is desirable.

Insofar as concerns soil nutrients of the old and new clearings, there is no striking difference. There is a slightly higher proportion of available phosphorus and calcium in the older clearings, but not enough so to be of any significance. However, there is a marked difference in the pH of the soils of the two types of clearings. The average pH for the new clearings is 4.9 while the older clearings have a pH of 5.3. It appears that, as the vegetation in the clearings becomes stabilized, there is an increase in the pH of the soil.

There is a significant difference in the vegetation of the old and new clearings; twenty-two more species of plants having been found on the older clearings than on those of recent origin. It is also noticeable that there is a greater abundance of the majority of the plants on the clearings of long standing.

A few of those plants occurring in greater abundance on the older clearings are as follows:

Fragaria virginiana
Andropogon spp.
Potentilla canadensis
Rumex Acetosella
Rubus spp.
Gramineae spp.
Lespedeza frutescens (and other native *Lespedezas*)
Smilax glauca
Rhus spp.
Aster spp.
Prunella vulgaris

Most of the above series of plants may be found on at least a few of the new clearings, but their occurrence is limited. "In most cases these newly-established clearings are dominated by the artificially planted vegetation and ground species common to the forests, such as *Vaccinium* spp. and *Pteris*

aquilina. There is apparently a conspicuous decline in the number of these two species as the age of the clearing increases."

An examination of the older clearings reveals a much greater abundance of available food than can be found in the new clearings. They have acquired a more or less natural border fringe, that contains sufficient ground and shrub cover to offer concealment; the lack of which is a serious limiting factor in the use being made, by wildlife, of the new clearings.

COMPARISON OF SOIL ON OLD AND NEW CLEARINGS

Available Nutrients

<u>Old Clearings</u>		<u>New Clearings</u>	
C-18		C-22	
Phosphorus	---	Phosphorus	---
Calcium	-----	Calcium	---
Magnesium	-----	Magnesium	-----
Potassium	-----	Potassium	-----
Aluminum	-----	Aluminum	-----
C-18		C-64	
Phosphorus	-----	Phosphorus	---
Calcium	-----	Calcium	---
Magnesium	-----	Magnesium	-----
Potassium	-----	Potassium	-----
Aluminum	-----	Aluminum	-----
C-18		C-73	
Phosphorus	---	Phosphorus	---
Calcium	---	Calcium	---
Magnesium	-----	Magnesium	-----
Potassium	-----	Potassium	-----
Aluminum	-----	Aluminum	-----

Average Available Nutrients for
Above Clearings, Old and New

<u>Old</u>		<u>New</u>	
Phosphorus	-----	Phosphorus	---
Calcium	-----	Calcium	---
Magnesium	-----	Magnesium	-----
Potassium	-----	Potassium	-----
Aluminum	-----	Aluminum	-----



Nest of ruffed grouse in typical site
under rotten log.
Both views are of same nest.



DESCRIPTIONS OF AREAS

Big Levels Game Refuge

Location: The Big Levels Game Refuge, an area of some 30,000 acres, is located on a side arm of the main axis of the Blue Ridge Mountains in the southeastern corner of Augusta County. A part of the George Washington National Forest, it is in the Pedlar River district of that forest. The Big Levels Refuge is so named because of the presence within the area of a flat-topped ridge. This Big Levels area has an average elevation of from 3,000 to 3,500 feet. The refuge area itself ranges in elevation from approximately 1,600 feet throughout its lower portions to 3,500 feet on Bald Mountain.

The degree of slope on the refuge varies considerably. The Big Levels area is flat topped, nearly level in spots, gently rolling in others. Between the top and the mouths of the valleys the land is marked by a series of parallel ridges between which are rough rocky slopes and craggy valleys bordered by numerous rock slides and talus slopes.

Toward the mouths of the valleys these ridges and stream beds expand into a broad comparatively level area known locally as the "flat woods." The numerous small streams are on a whole remarkably uniform in flow throughout the year. Two drainage systems are represented on the refuge. The greater portion of the streams empty into the South River and thence into the Shenandoah River, which in turn empties into the Potomac River. One stream, Saint Mary River,

with its tributaries empties into the James River.

Climate: The nearest Weather Bureau station from which data can be obtained for the area is in Staunton, Virginia, nearly twenty miles distant. However, it is probable that conditions here are roughly similar to those of a portion of the Big Levels. The following data were obtained from records in Staunton:

Average annual rainfall	37.75 inches
Average annual snowfall	29.2 inches
Average temperature	57.7 degrees
Average maximum temperature	66.8 degrees
Average minimum temperature	43.9 degrees
Highest annual temperature	106.0 degrees
Average length growing season	173 days
Average date of last killing frost	April 25
Average date of first killing frost	October 18

The wide range in elevation within the boundaries of the Big Levels Refuge would lend support to the belief that there is considerable variation in weather conditions between the lower elevations and the higher mountain tops. Throughout the duration of the present study it was noted that conditions varied remarkably on the higher slopes from those lower in the valleys. In winter sleet and snow are both severe at higher elevations.

Life Zones: That portion of the refuge between 1,800 and 3,500 feet in elevation may be said to be within the Transition or Alleghanian Zone. The greater part of the refuge may thus be said to occur within this zone. The flat woods border of the refuge may be said to approach conditions found in Carolinian Zones. With the

exception of one or two plant species and a similar number of birds, none of the area approaches a Canadian Zone element. Yellow birch is said to be a Canadian Zone plant, as are the rose-breasted grosbeak and Canadian warbler. All three are found within the confines of the refuge, but such occurrence is an insufficient basis for consideration of any of the area as being within this life zone.

Mountain Lake Wildlife Demonstration Area

Location: The Mountain Lake Wildlife Demonstration Area is located in the Alleghany Plateau of Giles County in Southwest Virginia. With the exception of a small portion of the Johns Creek watershed the greater part of the area is that included within the upper part of the watershed of Little Stony Creek.

Topography: The two extremes of elevation for the area under consideration are not so far apart, ranging from 3,600 feet in the northeast corner to approximately 4,200 feet in the extreme southern corner which adjoins Salt Pond Mountain with its peak, Bald Knob, attaining an elevation of 4,563 feet. Between Salt Pond and Big Mountains, and within the confines of the Mt. Lake area, Little Stony Creek has its origin from two forks, both of which arise from small bogs resulting from poor drainage.

Climate: Complete records of climatic conditions on the Mt. Lake are not available. Civens (34) presents data covering the period from July 1936 to December 1937:

Annual rainfall	58.2 inches
Annual snowfall	61.8 inches
Average annual temperature	46.5 degrees
Average maximum temperature	72.5 degrees

Average minimum temperature 20.1 degrees

Highest annual temperature 89.0 degrees

No dates are available on first and last killing frosts but only June, July and August are considered as months escaping freezing temperatures at this elevation.

Life Zones: Though it is said that areas attaining an elevation of 4,000 feet or over in Virginia may be considered as being within the Canadian Life Zone, the greater portion, if not all, of the Mountain Lake Area must be classed as being in the Transition Zone, but approaching Canadian Zone. A number of plants and animals representative of Canadian Zone flora and fauna are found above elevations of 3,500 feet on the Area. These include the Cloudland white-footed mouse (Perognathus maniculatus umbiliferus), red-backed mouse (Onychomys leucogaster gapperi), the carolina junco (Junco hyemalis carolinensis), yellow-bellied sapsucker (Sphyrapicus varius varius); and such plants as northern red oak, (Quercus borealis), red spruce (Picea rubra) and stiff clubmoss (Lycopodium annotinum).

Soil: With few exceptions the soils of the area have their origin in sandstones of four types: Clinton, Clinch, Cacapon, and the shaly Juniata. While the Martinsburg shale is represented along portions of the Little Stony Creek valley, it is doubtful if soils from the source occur within the confines of the area included in this study. The soil of the area has an average pH of 4.6, with a variation of only an 0.8 point between the lowest and highest pH value of any representative sample for any of the plant associations. The boggy areas at the heads of Little Stony Creek are lowest with an average pH of 4.5. Cleared areas of the region have a pH of 5.1. Of the sandstone groups, the red "Cacapon" sandstone has a pH of 5.0

higher than those of the white sandstones (Glinch 4.7 and Clinton 4.7).

The various plant associations of the area present some slight variation in pH values:

Oak-chestnut association	4.8
Oak-chestnut-hickory association	5.0
White pine-hemlock association	4.9
Bear oak association	4.5
Spruce-hemlock-bog association	4.3
Meadow-shrub association	4.5
Grassland association	5.1
Streambank association	4.5
Shrubby-ericaceous-bald association	4.5
Cliff association	4.5
Average pH	4.6

Soil Fertility: Soil tests of representative samples from each of the plant associations show that the aluminum and manganese content of the soil is high; while calcium, potassium, phosphorus, ammonium, magnesium, and nitrates are relatively low. In general the tests indicate that the soils are very infertile.

Water Content: With the exception of the poorly drained swampy areas, the water retaining capacity of the sandstone soils of the area is probably relatively low. The well drained mountain tops, such as found on Salt Pond and Big Mountains, represent an extreme in low water holding power. In spite of this, the streams of the area have a very uniform flow throughout average years. The poorly drained areas and heavily timbered slopes are doubtlessly responsible for much of this condition.

Vegetation of the Area: Givens (34) in his examination of the Mt. Lake area recognized ten associations as being represented: (1) oak-chestnut, (2) oak-chestnut-hickory, (3) white pine-hemlock, (4) bear oak, (5) spruce-hemlock-bog, (6) meadow-shrubs, (7) grassland, (8) streambank-aquatic, (9) shrubby-ericaceous-bald, and (10) cliff association. Of these the oak-chestnut and oak-chestnut-hickory make up the greater portion of the area, and represent the climax vegetation of the region; while the other associations together with the numerous consociations, societies and clans may be considered as successional stages in the formation of one or the other climax types. This probably applies to a less extent to the spruce-hemlock-bog association which is more or less distinct in origin and composition.



Grouse nest at base of dead stub
among sprouts.
The two photos are of the same
nest.



INVESTIGATION AND RESULTS

PROCEDURE

A brief account of the lines of investigation undertaken in connection with the present phase of the project follows:

Big Levels Game Refuge

Seasonal Studies: Throughout the period of study efforts were made to obtain data on the seasonal distribution and activity of each game species on the area, as influenced by the presence of the various types of forest clearings. Of the 170-odd clearings 45 were selected for more detailed studies than could have been possible had an attempt been made to conduct surveys over each of the clearings. Surveys of wildlife in relation to the clearings included those of mating and nesting studies of ruffed grouse, bobwhite and wild turkey; numerous field observations of food habits, studies of broods of grouse to determine insofar as possible, cover preferences, proximity to forest clearings or slashings; and a study of the selection of cover types by seasons for each of the major species.

Population Studies: Five census areas were established in various cover types on the refuge. The standard rectangular area usually used where Civilian Conservation Corps enrollees are available could not be used for these drives as the number of man days was limited. The areas were therefore established along a linear course, following a road, trail or refuge boundary as a guiding line

along which to conduct the drives. Stations were then set up along each of these guide lines at one hundred yard intervals and numbered consecutively for each of the drive areas. The lines were plotted on maps, together with all clearings, slashings, and other openings.

Due to the nature of the drive areas it was impossible to station men on the margins, so all personnel participating in the drives served as beaters. They varied in number from fifteen to twenty men. Each man in the drive was given a number. With sufficient supervision it was possible to maintain a uniform line, with each participant keeping at a prearranged distance from the center of the line.

Data obtained, such as flush records, tracks or signs of predation, were noted in relation to the nearest station number and the number of the observer. It was thereby possible to plot with fair accuracy the location of such records as grouse flushes, around which the drives were centered. Drives were conducted over each of these areas in January, February and April 1940.

Grouse Brood Studies: In studying the habits and activities of young grouse, efforts were made to locate as many broods as possible during the months of June and July. Examinations were made of clearings, roadways, trails, dry pond areas, and of the various vegetative types found on the refuge.

In attempts to census representative areas, drives were conducted with enrollees of the Civilian Conservation Corps, using as many as could be successfully managed, usually 15 to 20 men, spaced at intervals of 30 feet. When broods of grouse were found

the line was stopped until an examination of the vicinity had been made.

Six such drives were conducted over the following areas: (1) along Mill Creek from clearing M-8 to the Coal Road and along this road to Patterson Field; (2) from Black Shaft, along the Coal Road over a two mile area to Tuckehoe Trail; (3) along Mill Creek road from Coal Road to first stream crossing on Mill Creek above clearing M-8; (4) one and three-quarter miles of Kennedy Ridge Trail; (5) one mile of Coles Run above Coal Road; and (6) from Tuckehoe Camp along south side of Coal Road to Johns Run.

Food Habits Studies: Throughout the course of the investigation numerous observations were made on food habits of all game species. In addition to field studies, stomachs of seven grouse and one bob-white were collected on the refuge, and their contents sent to the Food Habits Section of the Fish and Wildlife Service.

Mountain Lake Wildlife Demonstration Area

During the severe winter of 1939-1940 a study was made of wildlife conditions on the Mountain Lake Area. Field observations on food habits, distribution, and daily movements of ruffed grouse constituted the greater part of the study. A study was also made of two coveys of quail that were being given careful attention during the period.

In the spring months additional studies were made of grouse in relation to the limited number of clearings on the area. Efforts were made to study the distribution of wild turkeys released on the area.

Development was begun of six clearings in May 1940. Clumps of sumac (Rhus glabra) were planted in two corners of each of these and their edges planted in apple trees. A total of 550 apple trees was planted over the clearings, along the trails, roadways, and other openings on the area.

Havens State Game Refuge

A brief reconnaissance of the area was conducted early in the spring of 1940 in an effort to gain information on the distribution of the deer herd on the refuge and to study the food and cover resources of the area with a view toward selecting areas in which to establish experimental clearings.

In May 1940, 150 apple trees were planted on the refuge where suitable openings could be found.



Laurel bush
nearly de-
foliated by
ruffed grouse



Greenbrier, one
of the leading
grouse foods
during fall and
winter months.

RESULTS

Seasonal Studies

A large portion of the study conducted on the Big Levels Refuge and Mountain Lake Demonstration Area centered around the seasonal activities of the various game species. The wildlife populations of the two areas, while not high, were sufficient to offer numerous sources of information. The material presented must of necessity be limited due to the fact that the wide and varied scope of the study prevented emphasis being placed on any one phase of the study.

Ruffed Grouse

Pre-nesting period: With the advent of warmer weather following the dormancy of winter, vegetation quickly responds to the changes in temperature. New growth appears; the dormant rosettes of such plants as asters, plantains, everlasting and panic grasses attain a new succulence. The ruffed grouse soon takes advantage of this condition in its preparation for the nesting season. It has been suggested that there is a change in the diet of the birds to include a higher percentage of green plant materials at this season. At any rate it was found that with the disappearance of the heavy snows, beginning in February, grouse resorted to clearings, venturing into the open, comparatively unprotected open areas offered by such clearings.

Field observations, as indicated in Table IV, are insufficient basis for a complete interpretation of the early spring food habits, but it is apparent that the role of cleared areas assumes a greater importance at this season than at any other. Here, with a

greater amount of sunlight, the snow melts more rapidly than in the surrounding forest; as a result the vegetation soon takes on new growth. Then there is a greater abundance of such plants as furnish food for grouse at this season: cinquefoil, panic grasses, everlasting, plantains, trailing arbutus, goldenrods, asters, and golden asters.

Throughout the height of the drumming season, it was noted that the male grouse commonly selected certain sites from which to send forth his challenges to rival males. Clearings on the Big Levels and Mountain Lake Areas apparently had considerable influence in the selection of drumming sites. While drumming males were seldom heard in the immediate vicinity of clearings, they were consistently noted at distances of 100 to 300 feet. The large number of birds found at such distances from clearings, as shown in Table II, suggests the probability of their being chosen in relation to open areas.

That openings in the forest may sometimes be used as grounds for courtship displays is indicated by an observation on March 30, 1941, in clearing number C-64. Upon entering the clearing along its lower edge, three grouse were observed in the clearing. Two appeared to be females, the third a male. The latter was facing the other two birds in full display, tail spread, ruff extended and strutting proudly. Before additional observations could be made, the writer's presence was detected and all three birds flew.

Again on October 10, 1939, three grouse, two males and a female, were observed along the Coal Road. One male was strutting in the road, the other demonstrating at the edge of the road. The display of the latter was very active; consisting in part of a clearly audible whirr of his ruff. The female appeared to pay little heed to the efforts of either bird. No aggressive actions of intimidation were noted.



Azalea buds,
an important
winter grouse
food.



Sumac, though
reported to be
a poor grouse
food, was taken
by grouse and
quail.

Nesting period: Nesting data of ruffed grouse obtained during the period of study are meagre. In spite of concerted efforts throughout the Spring of 1939 and 1940 to locate nests in the vicinity of clearings, only three nests were found, one of which was on the Mountain Lake Area.

In April, just prior to the nesting season, as shown in Table II, there was a sharp rise in the number of grouse flushed from the margins of clearings. In most cases these appeared to be females, selecting sites for nest construction. It was often noted that the birds even uttered brief notes of alarm when flushed. It was at first believed that such occurrences furnished clues as to the location of nests, but in only one case did this hold true, as thorough searches were made in the vicinity of clearings in which grouse were flushed during this period.

Data on each of the nest is as follows:

Nest No. I

Big Levels Refuge

Location: Eighteen yards from the edge of clearing numbered G-12, near Orebank Creek.

Timber Type: Mixed Oak with *Quercus coccinea*, *Q. Prinus*, *Q. marilandica*, *Q. ilicifolia*, and *Pinus rigida* making up the greater portion of the tree cover.

Description of nest site: Base of dogwood tree over which grows a large grape vine. The forest canopy was fairly dense.

Nearest source of water: 100 feet to small stream.

History of nest: First discovered on April 24, 1939, when the female was flushed from the nest which contained four eggs.

May 2, 11:30 A. M., bird not on nest. Seven eggs, poorly

covered with one oak leaf and a few pine needles. The nest had an appearance of having been deserted.

May 3, 11:45 A. M. Eight eggs. Better covered than on May 2, but most of eggs still partially visible.

May 4, 12:45 M. Grouse on nest. Did not flush.

May 5, 7:30 A. M. Grouse not on nest, but flushed nearby. Nine eggs, poorly covered.

May 5, 11:40 A. M. Bird still off nest. Nine eggs.

May 6, 8:40 A. M. Grouse on nest.

May 9, 3:15 P. M. Grouse on nest.

May 16, 5:00 P. M. Grouse off nest; ten eggs uncovered.

May 23, 7:30 A. M. Grouse on nest.

May 27, 7:30 A. M. Grouse on nest.

Date of hatch not recorded. Eight of ten eggs hatched.

Low temperature prior to the beginning of incubation may have frozen a portion of the eggs.

Nest No. II

Big Levels Refuge

Location: Thirty yards from edge of Patterson Field, a small natural opening by Refuge boundary on Orebank Creek.

Timber type: Yellow pine-hardwood with nearly pure stand of *Pinus virginiana* and *Pinus rigida*.

Description of nest site: Under rotten log, surrounded by cut brush. Grape vine growing over brush. Woods fairly ^{open} in immediate vicinity of nest.

Nearest source of water: 200 feet to Orebank Creek.

History of nest: May 2, 1939-nest discovered by W. L. Smith, 10:00 A. M.

May 2, 11:55 A. M. Grouse on nest. Did not flush.

May 4, 7:05 A. M. Grouse on nest.

May 9, 3:30 P. M. Grouse on nest. Flushed her to determine number of eggs. She was sitting very close, as it was necessary to shake grape vine over her before she flushed. She ran for about six feet before flying. Flew silently. There were 12 well-incubated eggs.

May 20, nest had hatched on May 19. Six of the twelve eggs hatched.

Nest No. III

Mountain Lake Demonstration Area

Location: On War Spur ridge, 100 yards below last clearing. Forty yards from trail.

Timber type: Mixed Oak, with *Quercus alba*, *Q. borealis*, *Betula lenta*, *Acer rubrum*, and *Castanea dentata* making up the forest canopy. Understory of *Betula lenta*, *Viburnum dentatum*, *Viburnum cassinoides*, *Amelanohier* sp., *Sassafras*, *Ribes* and *Pyrus*. Ground cover of *Menziesia*, *Asalea*, *Rubus* and *Aralia nudicaulis*.

Description of nest site: At base of rocks among series of large boulders, under fallen log.

Nearest source of water: 120 yards to a spring, 140 yards to a small pond.

History of nest: Found by Lowell Porterfield. When checked on May 25 found that ten of eleven eggs had hatched on May 23 or the 24th. The egg failing to hatch was pipped, but the chick had died in the shell.

Grouse brood studies: During the summer of 1939 twenty-five broods of young grouse were found on the Big Levels. Table I presents data on each of these broods as to number of young, estimated age, location, cover type, in which it was found, relation to openings, and of weather conditions at the time the brood was found.

Little information is available on food habits of young grouse on the Big Levels. During the month of June, 1939, five young

birds were collected for R. E. Gensch of the Fish and Wildlife Service. The stomachs of only two of these were examined at the time. One collected on June 7, contained immature specimens of the oak-leaf hopper (Platycotis vittata var. quadrivittata) of which there was a heavy infestation during the summer and fall months. Another, collected by T. E. Clarke at the edge of the Patterson Field on June 7 contained one strawberry (Fragaria virginiana).

Late summer and early fall: During this period the amount of time spent in checking clearings was limited, due to the emphasis being placed on the plant succession studies. However, it was apparent that during the months of August and September grouse retired from the vicinity of the forest clearings, probably to more dense vegetative growth such as the tangles of greenbrier along the stream beds. As will be noted in Tables II and III no grouse were flushed during the months of August and September.

Fall and winter: Early in October, grouse began to appear in or near clearings, first being found on October 7 in clearing number C-18, an old natural clearing. Three were flushed, one from a cluster of grape vines in the center of the clearing, another at the edge of the clearing, and a third fifty feet from the edge. The latter was collected. Its crop contained the following: *Lespedeza frutescens*, seeds and leaves; *Quercus ilicifolia*, 3 acorns; *Gerardia sp.*, seed capsules taken whole; few berries of *Gaultheria procumbens*; few seeds of *Vitis sp.*; one seed capsule of *Viola sp.*, one specimen of *Phytocotis vittata var. quadrivittata*; and one ant. Its stomach contained chiefly seeds of *Smilax*, with some seeds of *Lespedeza*, *Gaultheria*, and capsules of *Gerardia*. The bird had obviously been feeding in the clearing.

On October 18, a bird was collected on Loves Run at the

edge of a trail. Though collected at 2:00 P. M. the crop was entirely empty. The stomach contained chiefly remains of *Mitchella repens*, seeds and stems of *Smilax*, with a few seeds of *Vitis*.

On November 3, a female, one of four birds flushed at the edge of a grape slashing on Falling Rock Creek, was collected at 9:25 A. M. The crop of the bird was filled with fresh fruit of *Vitis*. The stomach contained chiefly berries of *Gaultheria procumbens*.

On the same date, two birds were flushed from the edge of clearing C-9 which had been planted to Korean lespedesa. One was collected. An examination of its crop and stomach revealed that it had been feeding extensively on Korean lespedesa and bush clover (*Lespedeza frutescens*.)

With the beginning of the winter it was possible to gain considerable information on feeding habits of grouse. Table IV contains a list of observations made of plants being taken in and near the clearings on the Big Levels. It does not include those items found in the stomachs of the birds collected. It will be noted that buds of azalea make up an important item in the winter food of the grouse. Greenbrier (*Smilax*), considered to be the leading winter grouse food of the region, is probably more important than field observations indicate.

Tables II and III present data relative to flush records of grouse on the Big Levels as to cover types and distance from clearings and other openings. In Table II any grouse flushed within 50 feet of the margin is considered as occurring at the edge of the clearing. Other distance groupings vary with the distance from the clearing, at which the birds were flushed along trails or roadways leading to the clearings. These are listed under both the distance from the clearing at which they were flushed, and again as to whether or not they were found at the border of a trail or roadway.



Tracks of grouse
in clearing on
War Spur, Mt. Lake
Area.

Entrance and exit
of ruffed grouse
from deep snow.



TABLE I

RECORD SHEET FOR TWENTY-FIVE

GROUND BROOD CONTACTS

Date	No. birds in brood	Estimated age	Location	Vegetative type	Distance from opening	Weather	Remarks
6-1-39	Female 6 young	4-5 days	Grebank Creek	Mixed Oak	Roadside; 100 feet from C-4	Fair, warm.	Reported by W. L. Smith.
6-2-39	Female 2 young	10 days	St. Mary River	Mixed Oak	Roadside	Cloudy, warm vegetation wet.	Ground cover largely herbaceous 04
6-2-39	Female 3 young	4-5 days	$\frac{1}{2}$ mile E. Kennedy Mt. Trail	Mixed Oak	Roadside	Cloudy, warm vegetation wet.	Believed not all young found.
6-5-39	Female 7 young	7 ?	Edge Orchard	Mixed Oak	20 feet	Clear, warm vegetation damp.	No young seen though must have been present.
6-6-39	Female 4-5 young	1 week	Loves Run	Mixed Oak	200 yards from C-40	Clear, warm dry.	Ground cover slight, some laurel, greenbrier.
6-7-39	Female 3 young	1 week	Edge Coal Road Near Sherando Pike	Mixed Oak	Roadside	Clear, warm dry.	Two collected for R.E. Gensch.

TABLE I (Con'd)

Brood No.	Date	No. birds in brood	Estimated age	Location	Vegetative type	Distance from opening	Weather	Remarks
7.	6-7-39	Female 2 young	1 week	Edge Patterson Field	Mixed Oak	Edge of clearing	Clear, warm dry.	Reported by T.E. Clarke, 1 collected stomach contained 1 strawberry
8.	6-7-39	Female 8 young	1 week	Edge, C-22	Bear Oak	Edge of clearing	Clear, warm dry.	Reported by T.E. Clarke one collected.
9.	6-8-39	Female 4 young	1 week	Edge, slashing No. 29	Mixed Oak	50 feet from slashing	Clear, warm dry.	Located on C.C.C. drive.
10.	6-8-39	Female 3 young	1 week	Near C-9	Mixed Oak	300 feet from C-9	Clear, warm dry.	Located on C.C.C. drive.
11.	6-9-39	2 adults 5 young	10 days	100 yards from brood No. 10	Mixed Oak	200 feet from Coal Road	Clear, warm dry.	Located on C.C.C. drive.
12.	6-9-39	Female 5 young	10 days	200 feet from No. 11	Mixed Oak	400 feet from Coal Road	Clear, warm dry.	Located on C.C.C. drive.
13.	6-9-39	Female 8 young	1 week	Near clearing H-3	Mixed Oak	200 yards south H-3	Clear, warm dry.	Located on C.C.C. drive.
14.	6-9-39	Female 3 young	1 week	Orebank Creek	Mixed Oak	200 feet from C-15 at roadside	Clear, warm dry.	Reported by R.E. Gensch.
15.	6-12-39	Female 1 young	2 weeks	St. Mary River	Mixed Oak	Roadside; 300 feet from refuge boundary	Clear, warm dry.	May have been other young.
16.	6-12-39	Female 5 young	2½ weeks	Red Mt. Mine	Mixed Oak	In old field opening	Clear, warm dry.	Cover largely herbaceous.

TABLE I (Con'd)

Brood No.	Date	No. birds in brood	Estimated age	Location	Vegetative type	Distance from opening	Weather	Remarks
17.	6-13-39	Female 4 young	10 days	Mill Creek Road	Mixed Oak	Roadside	Raining very hard.	Female flew from chicks at roadside. Had been covering young.
18.	6-14-39	Female 7 young	?	Coal Road, Edge C-17	Mixed Oak	Edge C-17	Clear, warm dry.	Actions of female indicated presence of young, but unable to locate.
19.	6-14-39	Female 14 young	?	North Fork Back Creek	Mixed Oak	120 feet	Clear, warm dry.	One young heard, unable to locate any of brood.
20.	6-16-39	Female 7 young	?	Near clearing C-4	Mixed Oak	200 feet from Coal Road; 250 feet from C-4	Clear, warm dry	Located on C.C.C. drive. In small opening 400 feet in diameter.
21.	6-20-39	Female 3 (or 4) young	2½ weeks	Stony Run Trail	Mixed Oak	200 feet from refuge boundary at trails edge	Cloudy, warm	Had been dusting in trail, vegetation approaching yellow pine-hardwood.
22.	6-24-39	Female 7 young	4 weeks	Green Pond	Bear Oak	50 feet from edge Green Pond	Nearly clear, warm.	Flushed from thick growth of greenbrier and black gum
23.	6-29-39	Female 7 young	?	Falling Rock Creek	Chestnut Oak	100 feet from slashing	Clear, warm.	Female flushed, apparently had young but unable to locate.
24.	7-18-39	Female 7-8 young	7-8 weeks	Edge C-18	Yellow Pine Hardwood	Upper edge clearing No. C-18	Clear, warm dry.	Well feathered, able to fly well.
25.	7-24-39	Female 2 young	6 weeks	Falling Rock Creek	Chestnut Oak	200 feet from C-9 at edge of trail.	Clear, hot vegetation moist.	In open spot along edge of stream bed.

TABLE II

DISTRIBUTION OF 577 RUFFED GROUSE FLUSHED ON BIG LEVELS REFUGE

	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
In clearing	0	0	9	0	0	0	5	4	7	5	22	11	63
Edge of clearing	17	2	16	7	0	0	6	16	11	3	3	1	81
50-100 ft. from edge	0	2	2	0	0	0	3	0	6	6	9	3	31
100-200 ft. from edge	6	1	16	0	0	0	4	7	3	6	3	0	48
200-300 ft. from edge	18	1	22	3	0	0	7	2	12	3	3	0	71
Over 300 ft. from edge	3	0	16	0	0	0	0	6	0	8	10	1	44
Near Slashing	(1)	0	9	0	0	0	(4)	(4)	0	0	0	(1)	(16) 9
Roadside	0	0(7)	18	0	0	0	(8)	0	(2)	0	0	0	(17)18
Trail	(1)	0	12	(3)	0	0	(2)	(1)	(7)	0	(2)	0	(16)12
TOTAL	44	6	122	10	0	0	25	34	39	31	50	16	577

() Counted elsewhere in totals

TABLE III

FLUSH RECORDS OF HOPPED GROUSE ON BIG LEVELS REFUGE
BY MONTHS AND COVER TYPES

	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Mixed Oak	36	6	119	7	0	0	25	23	20	53	57	13	369
Chestnut Oak	0	0	1	3	0	0	0	4	0	0	10	0	18
Bear Oak	10	0	25	0	0	0	0	3	10	2	0	1	51
Yellow Pine-Hardwood	10	0	0	8	0	0	0	4	8	4	39	2	76
Healock	1	0	0	0	0	0	0	2	0	0	0	0	3
TOTAL	57	6	141	18	0	0	25	36	38	59	106	16	506

TABLE IV

FIELD OBSERVATIONS ON HIPPED GROUSE FEEDING HABITS

ON BIG LEVELS ISPUON

Species Taken	Date	Location	Relation to Opening	Remarks
Aster	2-27-40	C-5	In clearing	Rosettes being eaten.
Asalen	2-19-40	C-2	In clearing	Buds removed from plants.
Asalen	2-26-40	C-65	In clearing	Tracks of two birds over clearing; birds feeding on buds of asalen sprouts.
Asalen	2-27-40	C-2	In clearing	Most of buds on plants in clearing have been removed.
Asalen	2-27-40	C-6	In clearing	Buds removed from large patch of sprouts.
Asalen	2-27-40	E-5	In clearing	Buds eaten from few plants in clearing
Asalen	2-28-40	C-12	In clearing	Buds eaten from plants in clearing.
Asalen	2-6-40	C-56	In clearing	One bird flushed in clearing; buds eaten from plants.
Asalen	2-28-40	E-8	In clearing	Buds taken from sprouts.
Asalen	4-1-40	C-14	In clearing	Buds removed from sprouts growing in south corner of clearing.

TABLE IV (Con'd)

Species Taken	Date	Location	Relation to Opening	Remarks
Asalea	11-21-39	C-71	Along edge of clearing	Eight flushed along edge, where has been feeding.
Asalea	12-29-39	C-12	In clearing	Tracks along edge of clearings; bird feeding on buds of asalea.
Fagopyrum (buckwheat)	10-16 to 11-16-39	C-73	In clearing	Grouse flushed from clearing on numerous occasions.
Kalmia	2-28-40	C-3	In clearing	Two birds flushed; feeding on leaves.
Kalmia	12-29-39	Kennedy Mt. Trail	200 feet from C-9	Five birds, feeding largely on Kalmia.
Kalmia	12-29-39	C-12	In woods between C-3, C-12	Four birds, feeding extensively on leaves.
Lespedeza stipulacea	2-27-40	C-10	In clearing	Birds flushed from clearing; may have been feeding on L. stipulacea.
Lespedeza stipulacea	3-26-40	Orchard (C-15)	In feed strip	Bird observed feeding on L. stipulacea for several minutes.
Malus	3-30-40	Orchard (C-15)	Upper edge	Four flushed. Buds eaten on trees.
Panicum	2-27-40	C-3	In clearing	Rosettes being eaten.
Panicum	3-6-40	C-3	In clearing	Rosettes being eaten.

TABLE IV (Con'd)

Species Taken	Date	Location	Relation to Opening	Remarks
<i>Plantago lanceolata</i>	2-27-40	C-5	In clearing	Rosettes being eaten.
<i>Rosa</i>	2-6-40	O-9	In clearing	One rose hip eaten by grouse in clearing.
<i>Smilax</i>	10-7-39	C-17	Edge of clearing	Two birds flushed from thicket.
<i>Smilax</i>	11-17-39	M-1	Edge of clearing	Bird flushed from clump containing good crop of fruit.
<i>Smilax</i>	11-21-39	C-71	Edge of clearing	Eight birds flushed, feeding along edge of clearing during snow storm.
<i>Smilax</i>	11-21-39	C-17	Edge of clearing	Three flushed from thicket during snow storm.
<i>Smilax</i>	12-27-39	Coal Road	Along roadside	Apparently feeding on leaves and buds of <i>Smilax</i> .
<i>Smilax</i>	12-29-39	O-12	Between O-12 and O-5	Four birds notes feeding on leaves and fruit.
<i>Vaccinium</i>	2-26-40	C-63	In clearing	Tracks of two birds over clearing; feeding on buds of <i>Vaccinium</i> .
<i>Vaccinium</i>	11-21-39	C-71	Along edge	Eight flushed, feeding along edge during snow storm.
<i>Vitis</i>	10-7-39	C-18	Grape cluster in clearing	One bird flushed from grape cluster.
<i>Vitis</i>	10-10-39	C-18	Grape cluster in clearing	Two birds flushed from cluster.
<i>Vitis</i>	10-18-39	Loves Run	None	Several birds flushed from tangles of <i>Vitis</i> .



Wintergreen, an
important grouse food in the
mountains of Virginia

BOB-WHITE

It is believed that, prior to the beginning of clearing operations on the Big Levels Refuge, there were no more than three or four coveys of quail to be found in such old openings as the workings at the Kennedy Mountain and Tory Mountain mines. During the winter of 1939 an effort was made to determine the quail population of the area, at least insofar as concerned the number of coveys. Due to the fact that several coveys often visited the same or adjacent clearings, considerable difficulty was experienced in determining the exact number of coveys.

Some information relative to the number of birds in each of the coveys and of their distribution on the refuge follows. The numbering of the coveys is arbitrary.

Covey No. 1. First flushed on October 19, 1939, in clearing number C-7. There were twelve birds in the covey. They were feeding on Korean lespedeza. On December 29, two day old tracks of what was probably the same covey, still containing twelve birds, were found in the clearing. In clearing number C-6, a part of which was planted to Korean lespedeza, fresh tracks of a covey of twelve birds was found on December 29. A covey of twelve or thirteen had been feeding in the clearing on January 10, 1941.

Covey No. 2. When first found on November 21, this covey was in clearing number C-8 which had been planted to buckwheat and cow-peas. They were seen in and adjacent to this clearing until late in the following spring, and insofar as known, suffered the loss of but one bird. When first seen feeding in the clearing during a snow storm there

were eight birds; when last seen there were seven.

Covey No. 3. On November 5, fourteen birds were flushed from C-8. During the snow storm of November 21, thirteen birds were counted in the covey, as it was feeding near covey number 2. On December 13, a covey was flushed that was presumably this covey. No count was obtained. On December 29, tracks of a covey of fourteen birds were found in the clearing. The covey had apparently borrowed a bird, possibly from covey number 2. On January 16, the covey was flushed at the edge of the clearing by C. C. C. enrollees. A rough count of 12 birds was made. On this date feathers of a bird were found in the middle of the clearing. On March 26, a covey of ten or twelve birds was flushed in the clearing so this figure represents the known survival of the covey.

Covey No. 4. Only two records are available for this covey. On November 6, tracks of eleven birds were found in clearing number C-14 where they were feeding on sericea lespedeza. Then on December 29, tracks of what was probably the same covey of eleven birds were found in clearing K-2 on the opposite side of Kennedy Creek. Here they had been feeding on Korean lespedeza. One loss is known to have occurred in this covey as feathers were found last in January.

Covey No. 5. On January 3, 1940, a covey of 12 birds was found in the orchard where they had been working over the feed strips planted to Korean lespedeza and soybeans. This covey was found on three other dates: January 8, January 9 and February 6. On the latter date 9 birds were counted in the covey. Feathers of one were found in the field.

Covey No. 6. The range of this covey was never determined. On two occasions they were found near clearing C-16; first on January 13

when tracks of only four birds could be distinguished. Later tracks of six were found near the same clearing. It is surprising that the covey did so little feeding in this clearing.

Covey No. 7. Though the clearing was well supplied with native quail foods this covey was found in the clearing on only two dates: January 3 and January 9. On both occasions there were ten birds in the covey.

Covey No. 8. On only one date was this covey seen, January 5 when 10 birds were observed feeding in clearing No. C-47 near Loves Run. It may have had its origin in a covey seen in C-50 on April 5, 1939. One bird was collected from the covey for food habits study.

Covey No. 9. On January 3, 1940, a covey of eight quail was found to have visited three clearings, C-64, C-65 and C-67, though little feeding was observed. The normal range of the covey was never determined, as it was not found again in this vicinity. The distances to other clearings in which coveys of this number were known to range appear too great for this covey to have been included elsewhere in this account.

Covey No. 10. On January 3, a second covey was found to have been feeding in clearing number C-64. There were tracks of twelve birds. A covey of twelve was flushed from the edge of C-63 on January 10, and again on February 15, C. C. C. enrollees flushed ten or twelve birds during a game drive.

Covey No. 11. Three clearings on Mill Creek, M-1, M-2 and M-3, were all visited by a covey of thirteen on January 2. They had fed on Korean lespedeza, sericea lespedeza, cowpeas, buckwheat, and

diodia. The covey was never flushed.

Covey Nos. 12-17. The greatest concentration of quail on the Refuge was found in a group of clearings bordering on Orebank Creek trail. The majority of the clearings in which the birds were found had been planted to Korean lespedeza. The numbers of birds in each of these coveys was never determined and it appeared as though there was considerable shifting of a few birds from covey to covey. According to available information, the six coveys contained the following number of birds: seven, fifteen or sixteen, two, thirteen, six or seven, and ten or eleven.

Covey No. 18. Found only twice, once in O-16 (November 7) and again in O-19 (January 10.) There were six birds.

Covey No. 19. On December 7, a covey of eight or nine birds was flushed in clearing number O-19.

Covey No. 20. On November 7, tracks of six birds were seen at the edge of the clearing. They were tracked to the edge of Mill Creek where they were lost.

Covey No. 21. Tracks of six quail were found on Kennedy Mountain Trail half way between the base of the mountain and Green Pond on December 28. So far as known the covey was never flushed.

Covey No. 22. Thornton reports flushing a covey of six or seven in C-73 early in the winter. The clearing had been planted to buckwheat.

Thus a total of 22 coveys and, insofar as known, 202 birds was noted for the Big Levels Refuge during the winter of 1939-1940. The clearings visited most frequently were those planted to

Korean lespedeza and buckwheat, both excellent quail foods.

The spring and summer months are notable for the lack of definite information on the nesting activities of the birds on the Big Levels with the exception of an occasional unmated male, no evidence of quail during the summer months could be found. Thorough searches of the woods in the Orebank Creek area throughout the summer of 1939 were made in an effort to locate nests, but all to no avail nor were any young birds ever seen. It would appear as though there was a seasonal migration from the forested sections to open areas outside the Refuge. No evidence could be obtained to substantiate such a theory other than the complete disappearance of paired birds from the clearings.

Wild Turkey

Throughout the period of study the normal distribution and activities of this shy bird were being constantly affected by road construction by C. C. C. personnel. A road, the Coal Road, was being rebuilt through the Refuge, so the birds were kept on the move as the course of the road progressed. Thus the information obtained on the use of clearings by turkeys is limited and in some cases somewhat unreliable.

Of the turkey studies conducted, the most interesting were those made during the mating season, that is, April and May, 1939. A few brief notes are of particular interest.

On April 19, two hens were followed toward a gobbler. Both hens continued to yelp until they were within thirty or forty feet of the male who remained stationary and continued to gobble. Each of the hens then flew into a tree. It was therefore impossible for the writer to move. Four hens were heard yelping but none

appeared to be with the gobbler. Finally the writer's presence was discovered by one of the hens in the trees. She putted briefly, then flew to the gobbler. In a few minutes both the hen and the gobbler walked slowly and silently past the writer, then proceeded around the hillside.

On April 20, a male was first heard gobbling on the roost atop a ridge overlooking Cellar Run at 4:50 A. M. At 5:00 he ceased gobbling for ten minutes, then flew and soared across Cellar Run to the opposite hillside, a distance of nearly one-half mile. Upon alighting he began gobbling, proceeding eastward. The writer followed him for an hour, but saw no hens. Ridge tops were usually chosen on which to pause to gobble.

On the same morning a very large gobbler was seen in a cut-over area one-half mile from where the first gobbler had spent the night. Before any observations could be made, the wary bird saw the writer and took to his heels in the direction of Cellar Run.

On April 27, the writer was able to get within thirty-five or forty feet of a gobbler without being seen. A hen was heard yelping nearby. When a train in the valley began whistling the gobbler became very excited, and began to gobble rapidly. For a few moments he remained on his gobbling ground; but soon he appeared to have gone completely crazy. Leaving the hen, he ran past the writer without giving him any heed, then gobbling excitedly, he ran off through the woods, answering the train whistle for all he was worth. When last heard he was nearly a half-mile away. The hen had nothing more to say.

On April 26, a gobbler was heard near Loves Run. Upon investigating, the writer found him busily engaged in strutting and gobbling in the cleared area along the Forest boundary. The writer was able to watch him for a half hour before a slight movement warned the bird of his presence. He ceased gobbling, advanced cautiously to within twenty-five feet of the writer; then, deciding not to take any chances, he moved slowly, but did not fly. His suspicions were sufficiently aroused to prevent him from resuming his display. No hens were heard.

On May 10, while beginning to work toward a gobbler near Cellar Run, the bird began approaching the writer, who concealed himself as well as possible in a clump of trees. The gobbler approached to within thirty feet before finding anything amiss, but then he turned and ran for about 100 yards, then flew. He had been gobbling while in a fairly dense woods. As nearly as could be learned, his procedure consisted of gobbling, listening for a few seconds, then moving on rapidly for a short distance. No strutting was observed.

Turkey nest

One turkey nest was reported during the period of study. The following information was gained from an examination of the nest after it had hatched.

Discovered by Archie Darcus, Stuarts Draft, Virginia about June 1, while going to get an axe he had been using in cutting pulp wood in February. He relates that the bird left the nest when he was within 15 feet, hissing at him as she left.

Location: Below Big Levels Refuge near chalk mines.

Nest site: Bird was apparently facing south from under

the edge of a pitch pine top which had been cut in pulp wood operations. Not more than two per cent slope at nest. It was in an open area with a few oak, (*Quercus alba* and *Q. borealis*), remaining. There was very little concealing vegetation around the nest. The nest was about 125 feet from a large clearing; and apparently quite a distance from water.

Eggs: Darcus reports that there were ten or twelve eggs. All apparently hatched. Egg fragments were found fifteen and fifty feet from the nest.

Nest: Fifteen by twelve inches; three and one-quarter inches deep. Lined with leaves and a few pine needles.

Visits: W. L. Smith visited the nest site on May 16. The writer visited it on the following day.

Broods of young: On only one occasion was a brood of young turkeys found in a cleared area: on June 20, 1939, when C. O. Handley and the writer flushed a large flock of young along the forest boundary. There were at least twenty young, and two hens. They were approximately two weeks old, enough so to fly into the trees when flushed.

Fall and winter: With the exception of clearings planted to Korean lespedeza, buckwheat or cowpeas, use of the clearing by turkeys during these seasons appear to have been limited. It was repeatedly noted that turkeys approached clearings to their margins, but seldom ventured into the middle unless in search of food. In one instance a group of four were flushed from a clearing planted to orchard grass (*Dactylis glomerata*), and young shoots of

the grass were found to have been eaten by the turkeys. Of the planted foods buckwheat and cowpeas were favored.



Sumac planting
in clearing on Mt. Lake



TABLE V
FIELD OBSERVATIONS ON BOB-WHITE
FEEDING HABITS ON BIG LEVELS REFUGE

Species Taken	Clearing No.	Months
<i>Ambrosia artemisiifolia</i>	C-15	January
<i>Ambrosia artemisiifolia</i>	O-13	January
<i>Ceanothus americana</i>	C-15	January
<i>Ceanothus americana</i>	C-43	January
<i>Desmodium</i> sp.	C-15	January
<i>Desmodium</i> sp.	O-7	January
<i>Desmodium</i> sp.	O-9	January
<i>Desmodium</i> sp.	O-13	January
<i>Desmodium</i>	O-18	November
<i>Dicliptera</i>	M-2	January
<i>Fagopyrum esculentum</i>	C-8	Nov., Dec., Jan., Feb., Mar.,
<i>Fagopyrum esculentum</i>	C-50	April
<i>Fagopyrum esculentum</i>	M-2	January
<i>Fagopyrum esculentum</i>	C-73	November
<i>Lespedeza frutescens</i>	C-15	January
<i>Lespedeza frutescens</i>	C-18	January
<i>Lespedeza frutescens</i>	O-13	January
<i>Lespedeza hirta</i>	C-15	January
<i>Lespedeza hirta</i>	C-18	January
<i>Lespedeza sericea</i>	C-14	November
<i>Lespedeza sericea</i>	M-2	January

TABLE V (Con'd)

Species Taken	Clearing No.	Months
<i>Lespedeza stipulacea</i>	C-6	Dec., Jan.
<i>Lespedeza stipulacea</i>	C-7	Oct., Dec.
<i>Lespedeza stipulacea</i>	C-15	January
<i>Lespedeza stipulacea</i>	C-18	January
<i>Lespedeza stipulacea</i>	C-43	January
<i>Lespedeza stipulacea</i>	K-2	December
<i>Lespedeza stipulacea</i>	M-1	January
<i>Lespedeza stipulacea</i>	O-4	Nov., Dec., Jan.
<i>Lespedeza stipulacea</i>	O-5	Dec., Jan.
<i>Lespedeza stipulacea</i>	O-7	Dec., Jan., Feb.
<i>Lespedeza stipulacea</i>	O-7	April
<i>Lespedeza stipulacea</i>	O-9	January
<i>Lespedeza stipulacea</i>	O-14	February
<i>Lespedeza stipulacea</i>	O-19	Dec., Jan.
<i>Lespedeza stipulacea</i>	O-22	November
<i>Lespedeza virginica</i>	C-18	January
<i>Pinus rigida</i>	near O-15	December
<i>Rhus typhina</i>	C-18	January
<i>Secale cereale</i> (rye)	C-64	January
<i>Secale cereale</i>	C-65	January
<i>Soja max</i> (soybean)	C-15	January
<i>Vigna sinensis</i> (cowpea)	M-3	January



Deer caught feeding
in young buckwheat
clearing No. C-7

Orchard (C-15) where
deer were most often
seen.



White-tailed Deer

The center of the rapidly expanding deer herd on the Big Levels Refuge corresponded with the concentration of clearings in the Orebank and Mill Creek sections. There was thus ample opportunity to study the seasonal distribution of deer in relation to the clearings of the area. Table VI presents a list of plant species which were found to have been taken by deer in the various forest clearings on the Big Levels. In it will be noted the higher frequency of orchard grass (Dactylis glomerata) taken in the late winter and early spring months. It was at this season that deer really made use of the clearings which contained growths of fresh young grass. In the vicinity of Mill and Orebank Creeks any clearings planted to orchard grass were visited regularly by deer at this season. Another favorite spot was the twenty-five acre field in which there was a small orchard (C-15). Throughout the spring of 1939 eleven deer frequented this clearing where they could be found almost daily. Needless to say they did some browsing of the lower limbs of the apple trees. However, the herbaceous vegetation of the field proved equally attractive.

During the summer months the group of small clearings (MG-1 to MG-5) near the head of Mill Creek received heavier use than any other clearings at this season. The abundance of young second-growth browse proved to be very attractive,

as can be noted from an examination of Table VI.

During the fall and early winter months, deer resorted to feeding on some of the planted foods. Buckwheat of course was very much favored. Deer began feeding on the young plants prior to their flowering, and continued to feed on the mature plants long after the seed had matured. In the case of cowpeas, they usually waited until the pods were nearly ripe before beginning. But once the deer began feeding on the pods, they seldom ceased until the entire crop had been removed. Considerable difficulty was experienced in obtaining enough mature seed for the following year's seed supply.

Soybeans were not eaten so extensively, though they were taken more often in the early winter months, following the exhaustion of the supply of buckwheat and cowpeas.

Korean lespedesa is not considered to be a suitable deer food for planting. However, on at least one clearing on the Big Levels deer fed very heavily on the plant. The clearing in which this occurred is K-2 on Kennedy Creek. In the late winter months of January and February several deer began feeding on the dense growth of Korean lespedesa in the clearing. Before long the effects of the grazing became very noticeable. However, the value of the lespedesa as a source of quail food continued to be excellent.

In the Mill Creek area deer were often found loafing in the clearings during the hot summer months. On one occasion, on June 7, 1959, five were seen in K-2, of which

two were lying in the middle of the clearing. When alarmed they left the clearing and went on to M-3 where they remained. Most of them lay down in the shaded portion of the clearing. They did no feeding while they were under observation.

Then during the fall months numerous signs of fights between rival bucks were found in a number of the clearings. The writer was never fortunate enough to witness one of these struggles.

Use of the clearings during winter months was limited, though their tracks were often seen in the clearings. There was very little feeding in any of the clearings with the exception of those planted to buckwheat or soybeans. However, the clearings appeared to possess some attraction. In one case, on January 10, while the writer was making an examination of clearing number C-64, a large buck came through the clearing. He showed no alarm when he saw the writer, but after proceeding for another fifty yards, he left the clearing. While he was being watched he fed on two items: a dead stalk of fireweed (*Erechtites hieracifolia*) and a small vine of greenbrier (*Smilax glauca*). Upon retracing its tracks, it was learned that it had come from the orchard (C-15) from where it had gone to C-67, C-65, C-63 and finally to C-64.



Clearing No. C-71,
with its border
vegetation well
under development.

Clearing No. C-16,
with border mosaic
well formed.



TABLE VI

FIELD OBSERVATIONS ON FEEDING HABITS
OF DEER IN CLEARINGS ON
BIG LEVELS REFUGE

Species Taken	Clearing No.	Months
<i>Acer rubrum</i>	MG-2	June, July
<i>Agrostis alba</i>	C-14	October
<i>Agrostis alba</i>	MG-3	March
<i>Amelanchier</i> sp.	MG-4	July
<i>Angelica villosa</i>	C-15	June
<i>Angelica villosa</i>	C-64	July
<i>Angelica villosa</i>	M-4	July
<i>Aster</i> sp.	C-64	July
<i>Aster</i> sp.	C-68	July
<i>Aster</i> sp.	M-4	July
<i>Aster</i> sp.	MG-2	July
<i>Aster</i> sp.	MG-3	July
<i>Aster</i> sp.	MG-4	June, July
<i>Aster</i> sp.	C-3	July
<i>Aster</i> sp.	C-12	July
<i>Carex</i> sp.	MG-3	March
<i>Ceanothus americanus</i>	C-15	May
<i>Cornus florida</i>	C-15	November
<i>Cornus florida</i>	MG-2	July
<i>Dactylis glomerata</i>	C-15	May
<i>Dactylis glomerata</i>	C-29	April

TABLE VI (Con'd)

Species Taken	Clearing No.	Months
<i>Dactylis glomerata</i>	C-30	April
<i>Dactylis glomerata</i>	C-34	April
<i>Dactylis glomerata</i>	C-52	April
<i>Dactylis glomerata</i>	C-67	January
<i>Dactylis glomerata</i>	C-72	February
<i>Dactylis glomerata</i>	M-5	June
<i>Dactylis glomerata</i>	M-7	April
<i>Dactylis glomerata</i>	O-2	May
<i>Dactylis glomerata</i>	O-4	March
<i>Dactylis glomerata</i>	O-6	April
<i>Dactylis glomerata</i>	O-11	April, July
<i>Dactylis glomerata</i>	O-12	March
<i>Dactylis glomerata</i>	O-14	March
<i>Erechtites hieracifolia</i>	C-64	January
<i>Erechtites hieracifolia</i>	O-4	January
<i>Eupatorium sessilifolium</i>	C-15	November
<i>Fagopyrum esculentum</i>	C-8	Oct., Nov.
<i>Fagopyrum esculentum</i>	C-9	July
<i>Fagopyrum esculentum</i>	C-15	July, August
<i>Fagopyrum esculentum</i>	C-72	July
<i>Fagopyrum esculentum</i>	C-73	June
<i>Fagopyrum esculentum</i>	K-2	July
<i>Fagopyrum esculentum</i>	M-2	July
<i>Fagopyrum esculentum</i>	O-22	June, July

TABLE VI (Con'd)

Species Taken	Clearing No.	Months
<i>Pagopyrum esculentum</i>	S-3	July, August
Gramineae	C-22	March
Gramineae	MS-4	March, June, July.
<i>Kalmia latifolia</i>	C-2	February
<i>Lactuca</i> sp.	MS-4	July
<i>Lespedeza stipulacea</i>	K-2	Dec., Feb.
<i>Lespedeza stipulacea</i>	O-14	December
<i>Liriodendron Tulipifera</i>	MS-2	July, August
<i>Malus</i> sp.	C-15	May
<i>Nyssa sylvatica</i>	MS-1	July
<i>Nyssa sylvatica</i>	MS-2	July
<i>Nyssa sylvatica</i>	MS-3	July, Nov.
<i>Nyssa sylvatica</i>	O-3	July
<i>Nyssa sylvatica</i>	S-3	August
<i>Panicum</i> sp.	C-22	March
<i>Panicum</i> sp.	O-13	March
<i>Plantago lanceolata</i>	C-64	March
<i>Plantago lanceolata</i>	C-71	March
<i>Prunus serotina</i>	C-16	July
<i>Pteris aquilina</i>	O-22	June
<i>Quercus borealis</i> var. <i>maximam</i>	MS-2	June, July
<i>Quercus borealis</i> var. <i>maximam</i>	MS-4	June
<i>Quercus Prinus</i>	C-65	March
<i>Quercus Prinus</i>	MS-1	July

TABLE VI (Con'd)

Species Taken	Clearing No.	Months
Quercus Prinus	MG-2	July
Quercus Prinus	C-2	Feb., Oct.
Quercus Prinus	O-17	March
Rhododendron catawbiense	C-7	December
Robinia Pseudo-Acacia	C-2	February
Robinia Pseudo-Acacia	S-3	August
Sassafras albidum	C-2	February
Sassafras albidum	C-13	February
Sassafras albidum	C-15	May
Sassafras albidum	C-64	July
Sassafras albidum	MG-2	March, June, July
Sassafras albidum	MG-3	July
Sassafras albidum	MG-4	July
Smilax sp.	C-64	January
Smilax sp.	K-2	July
Smilax sp.	MG-1	July
Smilax sp.	MG-2	June, July
Smilax sp.	MG-3	July
Smilax sp.	MG-4	July
Smilax sp.	O-22	June
Soja max	C-15	July, August, November
Soja max	C-72	Nov., Dec.
Vigna sinensis	C-8	November
Vigna sinensis	C-15	July, August

TABLE VI (Con'd)

Species Taken	Clearing No.	Months
Vigna sinensis	C-72	July
Vigna sinensis	M-5	July
Vitis sp.	C-15	May



Clearing No. C-14,
a large clearing
with clump of trees
in middle.



Clearing No. O -13,
on which quadrat
studies were
conducted.

Predators

In spite of the many hours spent in the field during the period of study, comparatively few data were obtained on the effect of clearings on the success or failure of predatory species to capture and kill their prey.

One of the most conspicuous actions of such predatory species as the fox and bobcat was to make routine trips around the edges of all clearings to which they came during the course of their travels. It is possible that they too were aware of the fact that grouse and rabbits frequented the margins of these clearings, and that their chances for success were greater in these spots.

Definite evidence of predatism was obtained for four grouse, three quail, and two rabbits. All four grouse were adjacent to clearings and were apparently killed by foxes. Their remains, usually nothing but a pile of feathers, were found at the edges of clearing numbers MG-1, MG-5, W-4, and S-9.

All three quail were apparently weakened by the period of heavy snow and cold weather of late January. Their remains failed to indicate that they had been killed by hawks. Feathers of the birds were found in clearing numbers C-15, C-16, and K-2.

Both rabbits were killed in the vicinity of Green Pond. One was pursued for a short distance by a New York weasel, captured, its blood drained, and then released, only to crawl for ten feet, where it was found lying outstretched in

the snow. The other had been caught in clearing number S-23, carried to the edge and eaten. A feather found at the spot was believed to be that of a barred owl, which gives a good indication as to the responsible predator.

Red-tailed hawks sometimes used the clearings as hunting grounds, particularly the larger areas such as C-14, C-15, and C-3. They were often seen sitting in dead tree tops overlooking various clearings. Though several were kept under observation, they were never seen attempting to capture prey.

Population Studies

The modified strip census method employed in the game drives proved to be of value only in recording flush records of ruffed grouse. Appendix III includes maps of each of these areas in which the timber types are plotted. Appendix IV presents the information relative to the distribution of grouse flushed during the drives of January, February and April.

Throughout the course of each of these drives two factors greatly influenced their degree of success. One of these was the type of enrollees employed in the drive. During the first two drives boys experienced as woodsmen were available. However, in the last drive, it was necessary to use recruits and inexperienced leaders. This explains in a large measure the apparent scarcity of grouse flushed on the drive.

Another factor governing the degree of success of the

drives was the amount of responsible supervision which could be obtained. Considerable difficulty was had in maintaining a straight, uniformly spaced line of enrollees. It was found advisable to have at least one responsible leader for each five enrollees used.

Use Made of Various Types of Clearings

To list the merits of each of the clearings studied on the Big Levels would require many pages of somewhat unrelated facts. A general discussion of their role is therefore more in order. It appears that the value of recently created openings in the forest corresponds roughly to the amount of available native and planted food. It is believed that when a natural fringe of border vegetation develops and the flora of the clearing itself reaches a stage corresponding to a natural forest opening, the true value of the clearing will not be realized. That means that their value should increase with the age of the clearing.

The value of narrow clearings, such as C-71, in rapidly growing timber may soon become limited due to overtopping by forest trees and encroachment of the border fringe. In general it appears as though clearings roughly square and of approximately one acre offers the best solution to the problem of size selection.

The series of clearings established in the vast expanse of bear oak on the Big Levels plateau has thus far

proved to be very disappointing. For one thing the vegetation of each of the clearings has been limited by the removal of the thin top soil in the process of clearing the vegetation from the areas with a trail builder. In winter it was found that, with the exception of one or two protected areas adjacent to evergreen cover of rhododendron and laurel, grouse were seldom found in the vicinity of the clearings. Their use by deer was very much limited. Though members of the Biological Survey have reported finding signs of use of some of these clearings by turkeys in the late summer months, no such indications were found in the summer of 1939. A few deer continued to visit the greater portion of the clearings, particularly those in the vicinity of Green Pond.

Clearings planted to Korean lespedeza received the greatest use of any studied. As has been noted, ruffed grouse, quail, turkey and deer resorted to such clearings. Without a doubt, it is the best of the game foods planted on the area. With the exception of limited availability buckwheat proved to be valuable for annual planting. As the deer herd increases, considerable difficulty may be experienced in getting buckwheat to attain maturity, as deer will probably remove most of their flowers long before seed can mature.

The practice of planting clearings to orchard grass appears to be sound insofar as long-time planning is concerned. Of the grasses planted in the clearings, orchard

grass was obviously superior to red top or timothy. The abundant spring growth assures an early supply of green food for deer, at which season clearings are of most value to this species. As the clearings become older natural vegetation will probably gradually replace the orchard grass.

It is believed that, as this natural vegetation develops, the quail population of the area will greatly increase if a reliable source of food can be provided until that time. A conservative estimate of fifteen years will probably elapse before this phase of the ecological succession will have developed.

It is with some hesitancy that the writer approaches the somewhat intangible problem of suggesting desirable locations for clearings of the type found on the Big Levels Refuge. Several factors tend to obscure this phase of the study. In general those clearings in the Orebank and Mill Creek areas were most heavily used. The entire area is one of mixed oak, with portions approaching a yellow pine-hardwood cover type. This damp, poorly drained, and comparatively level section has long been recognized as having a higher wildlife population than surrounding parts of the Refuge. So the effects of the clearing operations in this area may not in reality have been as spectacular as one might suppose from a survey of the area in its present condition. However, it is believed that the real value of the clearings is greatest in the winter and early spring months. Field observations throughout the year spent on the Big

Levels indicated that there was a tendency for wildlife to move into these lower "flatwoods" during extended periods of severe weather. This was particularly noticeable at higher elevations where there was a scarcity of evergreen cover.

Therefore, it would appear that clearings, to be of the most value should be placed in the relatively protected ravines bordering the dry and somewhat barren ridge tops. To locate them in areas naturally chosen by wildlife species appears to be a better game management practice than attempting to create wildlife range in biological deserts.



Clearing No. C-19,
planted to red top
but with abundance
of sprout growth.

Clearing No. C-2,
which was never treat-
ed. Note abundance
of blueberries.



Mountain Lake Demonstration Area

In a brief study of ruffed grouse under winter conditions on the Mountain Lake Demonstration Area considerable information was obtained on feeding habits of the birds while the ground was covered with from fourteen to eighteen inches of snow. Of twenty-eight observations in which grouse were flushed while feeding, or were tracked in the snow, twelve were feeding on laurel (*Kalmia latifolia*), four were feeding on azalea (*Azalea* spp.), three on sumas (*Rhus typhina*), three on greenbrier (*Smilax* spp.), two on menziesia (*Menziesia pilosa*), two on rhododendron (*Rhododendron maximum*), one on buds of blueberry (*Vaccinium* sp.), and one on buds of blackberry (*Rubus* sp.)

One clearing was found to have been visited by three grouse on January 28. Two had spent the night at the edge of the clearing, then had worked over the greater part of the clearing, feeding largely on buds of *Vaccinium*.

For the first time the writer found grouse diving beneath the surface of the snow to roost. In one instance one was found while still buried in the snow. The bird did not flush until it had been probed with a stick.

Throughout the investigation of this area, grouse were found to be concentrated along the stream beds where the snow was deeper, but where there was more protection from the severe weather. It has been suggested that a fairly accurate census of the grouse population of the

area could be obtained during such a period by conducting a systematic survey of these ravines, as there were times in which ninety-five per cent of the grouse of the Area must have been along these streams.

During the fall of 1939 three coveys of quail were found on the Area. All three attempted to spend the winter there. One covey perished; the other two were found and feed was kept by them during the greater part of the winter. Though the birds were weakened considerably, the greater part of both coveys survived. However, it is understood that they have not been seen on the Area since the spring of 1940.



Clearing No. M-8,
in winter, with
lack of concealing
cover along its
margin.

Clearing No. 3 on
War Spur, Mt. Lake.
Two-thirds of clear-
ing planted to
buckwheat in summer
of 1940



Haven's State Game Refuge

In March 1941 a brief reconnaissance was made of the Haven's State Game Refuge near Salem in Roanoke County, Virginia. Located on Fort Lewis Mountain, the drainage of the greater part of the area is to the north and into Mason's Creek. With the exception of a narrow strip of woodland between Mason's Creek and the foot of Fort Lewis Mountain, the terrain is extremely rough. While numerous small stream beds drain the area, it is probable that most of them furnish little water during summer months.

Wildlife populations of the area are low. Most of the grouse, at the time the study was made, were found at the base of the mountain and appeared to be very scarce. A few deer range along the top of the mountain and into the land owned by the Mountain Brook Orchard Company, where they had been causing some damage to fruit trees.

The examination of the area was made in an effort to choose possible locations for future development in the form of experimental clearings. Along the top of the mountain a number of semi-open areas were found with a southern exposure and were surrounded by an abundance of grapes. It was suggested that these areas, one of which was an old orchard site, and another an old house site, be maintained as openings.

Elsewhere, it was considered impractical to attempt to establish clearings, with the exception of the

comparatively level area bordering on Mason's Creek. Then, it was also considered advisable to refrain from locating clearings less than a half mile from the land of the Mountain Brook Orchard Company, as they may serve as an attraction causing deer to concentrate in this vicinity.



Apple tree, planted
on Mt. Lake Area,
and wrapped to pre-
vent peeling by
rabbits.

Arrangement of apple
plantings in clearing
on Mt. Lake Area.



Summary and Conclusions

The study was initiated on April 4, 1939, as Virginia Pittman - Robertson Project 4-R entitled "The Effect of Clearings on Wildlife Populations." On June 30 the project was temporarily discontinued but was resumed on July 16 as project 6-R entitled "A Study of Forest Wildlife Relationships." Under the latter project work was continued until June 30, 1940. This is a final report of data obtained under this study.

In a separate report, James E. Thornton presented the results of an ecological study of the forest clearings on the Big Levels Game Refuge, a part of the George Washington National Forest in Augusta County. Free use has been made of the information presented in Thornton's report.

Members of the Biological Survey conducted a reconnaissance of the area in 1935. Recommendations were made for a series of clearings representing approximately five per cent of the refuge area within the next two years; and that another five per cent be cleared within the next four years. These areas were to be maintained as permanent openings. As a result of these recommendations, approximately 175 clearings have been established on the Big Levels Refuge by the United States Forest Service. Many of the areas were more or less experimental, so included those of various designs and in varied locations. In the ecological study of the plant succession of the forest clearings twenty

of those on the Big Levels were selected for detailed plant studies. In order to obtain quantitative data on the flora of the clearings permanent transect lines were established on each of the twenty clearings. Along each of these, permanent quadrats were located. The normal number of transects per clearing was four along each of which three forest and three clearing quadrats were located. A combination list and chart form was used in recording the vegetation of each quadrat (Appendix II).

Of the twenty-two clearings two were old clearings dating back to about 1917. A comparison was thus available of these and the newly-created clearings established by the U. S. Forest Service. This comparison showed in general that there was no significant difference in the amount of available nutrients in the soil for the two groups. However, the older clearings possessed an average p H of 5.3 while the more recently cleared areas had an average p H of 4.9.

On the average twenty-two more species of plants were found on the older clearings than on the new. Of those species occurring in both types of clearings, those in the older clearings were in most instances more abundant, native species of value as wildlife food increased with the age of the clearings. There was a conspicuous difference in the border fringe of the two types of clearings, as that of the older clearings has become well filled with a protective border or "mosaic". Fruiting capacity of such plants as

wintergreen (*Gaultheria procumbens*), grape (*Vitis*), and wild strawberry (*Fragaria virginiana*) increased as a result of the establishment of the forest openings.

The present phase of the study includes a report of the role of forest openings in the distribution and management of game species occurring on the Big Levels Refuge. A large part of the study was of the seasonal use of clearings by ruffed grouse, bob-white, wild turkey and white-tailed deer.

Population studies were conducted on a series of five game drive areas in which a modified strip census method was employed by C.C.C. enrollees. The five game census areas were located in typical portions of the forest so as to include cover types represented on the refuge; and areas in which were located typical groups of clearings, slashings, trails, and other openings.

Throughout the study data were assembled on the role of various types of clearings in the life of the major game species. An effort was made to arrive at some conclusions as to the desirable type of clearing for use in the management of each of the game species.

On the basis of field observations it may be said that ruffed grouse resort to clearings or their vicinity for a number of reasons, but primarily because they are a source of food. This is particularly true during the months of February and March. During the nesting season males were commonly heard drumming within 100 - 300 feet of clearings,

while females were flushed from their margins where they were apparently searching for nesting sites. Of three nests found during the study two were within 100 feet of the edge of a clearing while the other was near a trail and within 300 feet of a clearing. One instance was noted in which a clearing was used in a courtship affair between a male and two females.

Of twenty-five grouse brood contacts, twenty were in mixed oak, two in chestnut oak, two in bear oak, and one in yellow pine-hardwood. All but three were within 300 feet of openings such as a clearing, road, trail, slashing, or refuge boundary. Thirteen were within 300 feet of a clearing.

Observations of winter feeding habits indicated that of native foods azalea, greenbrier, and laurel were most often taken. Of the planted foods Korean lespedeza and buckwheat were taken. Of 506 grouse flush records, 359 were flushed from mixed oak, seventy-five were in yellow-pine hardwood, fifty-one in bear oak, eighteen in chestnut oak, and only three in hemlock. These figures do not actually represent a true picture of the distribution of grouse as the studies of the clearings were largely in those portions of the refuge covered by mixed oak.

Insofar as could be determined, twenty-two coveys of quail were found on the Big Levels during the winter months. The winter population was estimated to be 202 birds. With few exceptions quail were found in or adjacent to clearings

on the refuge. Those clearings planted to Korean lespedeza were most often utilized. Of native foods, legumes were taken most often. Bush clovers (*Lespedeza* spp.) were the leading quail foods, though buckwheat appeared to be of considerable value as late as April.

With the exception of an occasional unmated cock, no quail were found on the refuge between the months of April and October. It would appear as though there is some seasonal movement of the species.

Data on wild turkeys were limited, due to the disturbing influence of road construction on the refuge. During the mating season gobblers were found to select open areas in which to strut and gobble. A turkey nest, reported after the eggs had hatched, was near a large clearing, and in an area recently cut over for pulpwood. Young turkeys were found in an open area on the forest boundary. During fall and winter months, clearings planted to buckwheat or Korean lespedeza were most heavily utilized.

White-tailed deer were found in clearings during all months of the year, but those clearings planted to orchard grass or containing a new growth of hardwood sprouts were most popular. Deer fed heavily on young orchard grass in the early spring months.

Predators commonly hunted the edges of clearings during their travels. Data on the killing of four grouse, three quail and two rabbits were obtained. Foxes were apparently responsible for the death of all grouse, and

possibly of the quail.

On three game drives over each of the five areas eighty-three grouse were flushed. Of these sixty-three, or 73.7 per cent were flushed within 300 feet of a clearing, trail, slashing, refuge boundary, or dry pond area.

The degree of success of the game drives by the modified strip census method used was dependent on the amount of supervision and previous experience of the C.C.C. enrollees. It was found advisable to have at least one responsible leader for each five enrollees.

The value of recently created openings corresponds roughly to the amount of available food, largely that planted in the clearings; and that of old clearings, the amount of native food present. The value of the new clearings should increase from year to year.

It is believed that the value of narrow clearings in young timber will become limited in a few years by the overtopping of the clearing, and by the encroachment of the border fringe. In general it is believed that clearings roughly square and approximately one acre in size are best in wooded areas such as the Big Levels, as clearings in the bear oak stands received only limited use by game species. The clearings in the Mill Creek and Grebank Creek areas received the most use during the period of study. It is believed that the most desirable location for clearings is in the more protected portions of an area;

and that little can be gained from clearing areas in what is recognized as poor game range.

Of the clearings studied, those planted to Korean lespedeza were used most often and by all game species on the area. Buckwheat likewise proved to be a valuable annual planting, though deer sometimes seriously reduced the seed crop by eating the flowers and young seed from the plants. For deer, clearings planted in orchard grass appeared best.

On the Mountain Lake Demonstration Area, laurel, azalea, sumac, greenbrier and menziesia were found to be the main winter grouse foods. Grouse were found to be concentrated in the sheltered ravines, so it is believed that clearings at this elevation would be of most value if made in such locations. Grouse seldom roost under the snow at the latitude of the Mountain Lake Area, but during the investigation they were often found buried beneath twelve or fifteen inches of snow.

Quail on the Area cannot be expected to survive during severe winters unless given close attention, or some provision is made for a source of food from wildlife plantings. In this connection, two corners in each of four clearings were planted to sumac in the spring of 1940.

In a brief reconnaissance of the Haven's State Game Refuge it was found that limited possibilities existed for the establishment of experimental clearings

along the top of the Fort Lewis Mountain, and along the base of this mountain, bordering on Mason's Creek. The wildlife population of the area was low, due largely to the limited amount of suitable wildlife range.

APPENDIX I

List of Plants Occurring on Forest and Clearing Quadrats on the Big Levels Game Refuge
with Their Relative Abundance and Relative Food Value
for Deer, Turkey and Grouse

Plant Name	Clearing Number																				Wildlife Value						
	0-3	0-13	0-18	0-22	0-23	C-2	C-16	C-18	C-57	C-64	C-71	C-72	C-73	M-1	M-6	MG-2	MG-4	S-6	S-9	S-22	Deer	Turkey	Grouse				
	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F						
<i>Pteris aquilina</i>	-	-	-	R	CA	-	-	CC	-	-	R	OO	CC	CA	AA	CC	CC	CC	-	-	-	CA	OO	CA	-	-	-
Other Ferns	-	-	-	O	-	-	-	-	O	-	O	-	-	-	-	-	-	CC	RR	-	-	O	-	-	E	F	E
<i>Lycopodium</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	O	-	F	-	F
<i>Pinus rigida</i>	RR	RO	RR	-R	RR	OO	-O	RR	RR	RR	RR	RR	-R	-O	-RRR	-	-	-	-	-	O	-RR	-	-	-	F	
<i>Pinus virginiana</i>	-	-	-	-	-	-	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	
<i>Juniperus virginiana</i>	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Panicum</i> spp.	CR	CR	RR	OR	OO	OR	OR	R	-	CO	OC	CA	OC	CO	A	OC	R	-	O	-	-	RO	OO	-	G	F	
<i>Andropogon</i> spp.	-	-	A	R	-	-	R	-	R	OR	AR	R	-	RR	RO	-R	-R	R	-	OO	RO	-	-	-	-	-	
<i>Sorghastrum nutans</i>	-	-	-	-	-	-	-	-	-	-	-	O	-	-	R	-	RR	-	-	-	-	-	-	-	-	F	
<i>Digitaria Sanguinalis</i>	-	-	RR	R	-	O	-	-	R	-	O	-	-	R	-	O	-	-	-	-	O	-	C	O	-	F	F
<i>Danthonia spicata</i>	R	OC	CO	-	-	CR	-	-	CO	AO	-	-	R	-	-	-	-	OR	R	-	-	R	-	-	-	-	
<i>Agrostis</i> spp.	A	-	OR	OR	-	-	-	-	R	-	RR	-	-	-	-	-	RR	-	-	O	-	-	R	-	F	-	F
<i>Daetylis glomerata</i>	-	-	-	-	R	-	-	-	-	A	-	O	-	A	-	C	-	A	-	-	-	-	A	-	-	-	F
Gramineae (spp.)	-	-	-	CR	O	-	-	-	OO	CO	R	-	-	R	-	-	-	O	-	-	R	OR	O	-	F	G	F
Cyperaceae	-	-	OR	OR	-	-	R	-	R	-	OR	RR	-	RR	-	R	RR	R	-	RRR	-	R	RR	-	-	F	F

Plant Name	O-8	O-13	O-18	O-22	O-23	C-2	C-16	C-18	C-57	C-64	C-71	C-72	C-73	M-1	M-6	MG-2	MG-4	S-6	S-9	S-22																	
	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F																
<i>Oakesia sessilifolia</i>	-	R	R	-	-	-	R	-	-	-	R	-	R	R	R	-	R	-	R	-	-	R															
<i>Medeola virginiana</i>	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	R	-	-	-	O	-															
<i>Smilax glauca</i>	C	A	C	A	C	C	R	O	C	C	-	O	O	O	O	C	R	R	A	C	C	A	C	C	-	-	R	O	-	-							
<i>Smilax rotundifolia</i>	-	-	-	-	-	-	R	O	-	-	-	-	-	-	-	A	-	-	-	-	O	-	-	-	-	-	-	-	-	-							
<i>Smilax herbacea</i>	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-							
<i>Dioscorea villosa</i>	-	-	R	-	-	O	-	-	-	-	-	-	-	-	-	-	-	-	R	O	-	R	-	R	-	R	-	-	-	-							
<i>Hypoxis hirsuta</i>	-	R	-	-	-	-	R	-	R	-	-	O	R	-	R	R	-	R	R	O	R	R	R	-	R	O	-	-	-	-	-						
<i>Iris verna</i>	-	R	-	R	-	-	R	O	-	-	O	O	-	-	R	O	R	R	R	O	R	O	R	R	R	-	-	-	R	O	-	R					
<i>Pogonia spp.</i>	-	-	-	-	-	R	-	-	-	-	-	-	-	-	R	-	-	-	-	-	O	-	-	-	-	-	-	-	-	-	-						
<i>Cypripedium acaule</i>	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	R	-						
<i>Myrica asplenifolia</i>	-	-	-	R	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	O	R	R	R	R					
<i>Carya glabra</i>	R	O	R	O	-	-	R	C	-	-	-	R	R	R	-	R	-	-	-	-	-	-	-	-	-	R	-	R	-	-	-	-					
<i>Alnus rugosa</i>	-	-	-	O	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	-					
<i>Quercus alba</i>	R	O	-	R	-	-	O	-	-	O	-	-	-	-	-	-	-	-	-	C	-	R	R	R	R	-	-	-	-	-	-	-					
<i>Q. coccinea</i>	R	O	R	O	-	O	-	O	R	O	-	O	-	O	R	O	-	O	R	R	O	O	R	O	O	O	O	R	O	-	-	-	-				
<i>Q. velutina</i>	R	O	R	R	-	-	O	-	O	-	R	-	O	-	O	-	O	R	R	O	R	O	R	O	R	O	-	O	-	-	-	-	-				
<i>Q. marilandica</i>	-	-	-	-	-	-	R	-	-	R	O	-	-	O	-	R	-	R	-	R	-	R	-	-	-	-	-	-	-	-	-	-	-				
<i>Q. ilicifolia</i>	-	O	R	O	R	R	R	A	R	O	-	O	R	O	-	O	R	R	O	-	O	R	R	O	-	-	R	R	R	-	-	-	C	R	C	O	A

Wildlife Value		
Deer	Turkey	Grouse
-	-	-
-	-	-
G	E	F
G	E	E
-	-	G
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
G	-	F
-	-	-
F	-	F
G	E	G
G	E	G
G	E	G
G	E	G
G	E	G

Plant Name	0-8	0-13	0-18	0-22	0-23	C-2	C-16	C-18	C-57	C-64	C-71	C-72	C-73	M-1	M-6	MG-2	MG-4	S-6	S-9	S-22	
	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F
<i>Quercus montana</i>	-	-	R	R	O	-	O	-	-	R	O	-	-	O	-	O	-	-	-	-	-
<i>Castanea pumila</i>	R	-	-	-	-	R	-	-	R	-	R	-	R	-	R	-	O	-	-	-	-
<i>Castanea dentata</i>	-	-	R	-	-	-	-	O	-	R	-	R	-	R	-	O	-	R	O	-	-
<i>Celtis occidentalis</i>	-	-	-	-	-	-	-	R	R	-	-	-	-	-	-	-	-	-	-	-	-
<i>Aristolochia Serpent.</i>	-	R	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Rumex Acetosella</i>	-	-	O	-	O	-	O	-	-	A	C	O	R	C	-	O	-	O	-	-	R
<i>Polygonum scandens</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O
<i>Polygonum spp.</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R
<i>Fagopyrum sp.</i>	-	-	-	-	O	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	A
<i>Dianthus Armeria</i>	-	-	-	-	-	-	-	R	R	R	-	-	-	-	-	-	-	-	-	-	-
<i>Cerastium vulgatum</i>	-	-	-	-	-	-	-	R	R	R	R	-	-	-	-	-	-	-	-	-	-
<i>Liriodendron tulip.</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R
<i>Benzoin aestivale</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R
<i>Sassafras sp.</i>	-	C	O	O	O	O	R	O	R	O	C	C	-	O	C	C	O	C	O	A	O
<i>Robinia Pseudo-Ac.</i>	R	R	R	O	-	-	-	O	R	R	-	R	R	R	O	R	O	R	R	O	R
<i>Vicia caroliniana</i>	O	O	-	-	-	-	C	-	-	-	-	-	-	-	-	-	-	-	-	-	O
<i>Tephrosia virginiana</i>	-	-	-	-	R	O	-	-	O	R	-	-	-	R	R	-	O	-	O	R	O
<i>Oxalis spp.</i>	R	-	R	R	O	-	-	-	R	-	-	O	R	-	-	-	-	-	-	-	R
<i>Geranium sp.</i>	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Deer	Wildlife Value	
	Turkey	Grouse
-	F	F
E	-	E
E	-	E
-	-	-
-	-	-
-	F	E
G	F	G
-	F	-
E	G	G
-	-	-
-	-	-
G	-	-
F	F	F
G	F	F
-	F	F
F	F	F
-	-	-
-	-	-
-	-	-

Plant Name	C-8	C-13	C-18	C-22	C-25	C-2	C-18	C-18	C-57	C-64	C-71	C-72	C-73	M-1	M-8	M-2	M-4	C-6	S-9	S-22	Wildlife Value			
	C-8	C-13	C-18	C-22	C-25	C-2	C-18	C-18	C-57	C-64	C-71	C-72	C-73	M-1	M-8	M-2	M-4	C-6	S-9	S-22	Deer	Turkey	Grouse	
<i>Polygala</i> spp.	-	-	-	-	-	-	-	-	R	RR	-	-	R	-	-	-	-	-	-	-	-	-	-	-
<i>Euphorbia corollata</i>	RRRR	-	-	-	-	R	R	R	-	-	-	-	R	-	-	-	-	-	RR	-	-	-	-	-
<i>Rhus typhina</i>	-	-	R	-	-	-	CR	R	-	-	-	-	-	-	-	-	-	-	-	-	-	E	F	E
<i>Rhus glabra</i>	-	R	R	-	-	-	C	RR	-	-	-	-	-	-	-	-	-	-	-	-	-	R	G	E
<i>Ilex monticola</i>	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-	F	F
<i>Acer rubrum</i>	-	RR	O	-	R	-	R	O	O	-	-	-	RR	-	-	R	O	C	R	O	-	E	-	E
<i>Ceanothus americ</i>	O	O	O	-	R	-	CA	-	-	R	O	O	R	O	RR	-	R	O	RRRR	-	-	O	-	F
<i>Psedera quinq.</i>	-	RR	-	-	-	-	-	NO	-	-	-	-	-	-	-	R	-	R	O	O	-	-	G	G
<i>Vitus</i> sp.	-	RR	O	R	RR	-	R	R	-	O	-	R	-	-	-	R	RRRR	RR	O	-	-	O	E	E
<i>Ascyrum</i> sp.	R	RR	R	-	-	-	-	R	R	-	-	-	R	R	RR	-	-	-	-	-	-	-	-	-
<i>Hypericum</i> sp.	RRR	-	RR	-	-	-	R	O	RR	-	-	R	R	-	R	-	-	-	-	RR	-	-	-	-
<i>Lochea racemulosa</i>	-	-	O	-	-	R	-	R	RR	-	-	R	-	-	-	O	-	-	-	-	-	-	-	-
<i>Viola pedata</i>	-	-	RR	-	-	-	R	-	-	-	-	-	R	RR	-	R	-	-	-	-	-	-	-	-
<i>Viola sagittata</i>	RR	R	R	-	-	-	-	O	RR	-	-	R	RR	-	R	-	O	RR	-	-	R	-	-	-
<i>Viola</i> spp.	RRRR	RR	-	-	RR	-	RR	RR	R	R	-	-	R	C	O	R	-	RR	-	R	O	-	-	-
<i>Aralia</i> sp.	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	RR	-	-	-	O	-	-	-	-
<i>Hammelis virg.</i>	-	-	R	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	R	-	G	G
<i>Spiraea latifolia</i>	-	O	R	-	-	-	O	R	-	-	RR	-	R	C	-	RR	-	R	-	-	R	F	-	-
<i>Spiraea latifol.</i>	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-	RR	RR	R	-	RR	RRR	-	F	-

Wildlife Value

Deer Turkey Grouse

Plant Name	O-8	O-13	O-18	O-22	O-23	C-2	C-18	C-18	C-57	C-64	C-71	C-72	C-73	M-1	M-6	MG-2	MG-4	S-6	S-9	S-22	
	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	C-F	
<i>Pyrus arbutifolia</i>	-	-	R	-	R	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	R
<i>Amelanchier can.</i>	-	-	R	-	R	-	-	-	R	R	-	-	R	-	-	R	R	R	-	-	R
<i>Crataegus sp.</i>	R	-	R	-	-	-	-	-	O	O	-	-	-	-	-	-	-	-	-	-	-
<i>Fragaria virg.</i>	-	-	O	R	C	R	-	-	-	A	O	C	O	-	-	-	-	-	-	-	-
<i>Potentilla can.</i>	O	O	O	C	R	R	-	O	R	O	R	A	O	O	R	-	R	R	R	R	R
<i>Rubus alleg.</i>	R	R	O	-	R	O	-	-	-	-	-	-	-	R	R	-	-	-	-	-	R
<i>Rubus spp.</i>	O	O	O	A	O	-	R	R	-	C	A	O	O	-	-	R	-	-	O	O	R
<i>Rosa spp.</i>	R	R	R	R	R	-	R	R	-	-	-	-	-	R	-	-	-	R	-	-	-
<i>Prunus americana</i>	-	R	-	-	-	-	-	-	-	O	-	-	-	-	-	-	-	-	-	-	-
<i>Prunus serotina</i>	-	-	R	R	R	-	-	-	R	R	-	R	-	-	-	R	-	R	R	R	-
<i>Cassia nicotiana</i>	-	-	O	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Baptisia tinot.</i>	-	-	R	-	-	R	R	-	-	R	-	-	-	O	R	-	-	R	-	-	R
<i>Desmodium spp.</i>	R	-	O	R	O	R	R	-	-	R	-	R	-	-	-	-	R	-	-	-	-
<i>Lesp. sericea</i>	-	-	-	-	A	-	-	-	-	-	-	-	-	R	-	-	-	A	-	-	C
<i>Lesp. stip.</i>	R	-	R	C	O	-	-	-	R	R	-	-	-	-	-	-	-	O	-	-	R
<i>Lesp. hirta</i>	-	-	-	O	-	-	-	-	-	-	-	-	-	R	R	O	R	-	-	-	-
<i>Lesp. repens</i>	R	R	O	C	-	-	-	R	R	-	O	R	R	R	-	-	-	R	-	R	-
<i>Lesp. procumbens</i>	-	-	-	-	-	-	-	-	R	R	-	-	-	-	-	-	-	-	-	-	-
<i>Lesp. frutescens</i>	-	-	O	R	C	-	-	O	R	-	-	-	-	R	R	-	-	-	-	-	-

103

Wildlife Value

Deer Turkey Grouse

Plant Name	C-6	C-13	C-16	C-22	C-23	C-2	C-16	C-16	C-57	C-64	C-71	C-72	C-73	M-1	M-3	M-3	M-4	S-3	S-9	S-22		
<i>Stylosanthes sp.</i>	-	R	-	-	-	-	RR	-	-	-	-	-	R	-	-	R	-	-	-	-	-	
<i>Angelica villosa</i>	-	R	-	-	-	-	RR	-	-	R	RR	-	R	-	R	R	H	-	-	RRR	RR	
<i>Daucus Carota</i>	-	-	-	-	-	-	OR	OR	-	-	R	-	-	-	R	-	-	-	-	ORR	-	
<i>Cornus florida</i>	-	R	O	-	R	RO	-	R	-	-	-	-	R	-	-	-	RR	O	-	-	-	
<i>Nyssa sylvatica</i>	O	O	O	-	O	R	O	R	O	O	O	R	O	O	-	R	O	O	O	O	O	O
<i>Chimaphila macul.</i>	-	O	C	-	-	-	O	O	O	-	O	R	R	-	-	R	O	-	-	-	-	
<i>Rhododendron spp.</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	O	
<i>R. nudiflorum</i>	C	C	R	O	-	O	O	-	R	A	-	-	C	-	R	R	-	O	-	R	O	
<i>Kalmia latifolia</i>	-	-	-	-	-	-	R	O	-	-	O	R	-	-	R	-	-	-	-	RR	C	
<i>Menziesia pilosa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	O	-	
<i>Lyonia ligustrina</i>	R	O	O	R	O	R	O	R	R	-	-	R	R	O	O	O	C	R	R	-	-	
<i>Epigaea repens</i>	-	-	-	-	R	-	O	O	-	-	-	-	R	-	-	RR	RRR	-	-	-	R	
<i>Gaultheria proc.</i>	-	-	-	R	O	-	-	-	R	-	-	-	-	-	-	-	RR	R	O	O	O	
<i>Gaylussacia spp.</i>	-	R	-	-	O	O	-	-	R	-	-	-	-	-	-	-	R	-	-	R	-	
<i>Vaccinium spp.</i>	A	A	O	C	R	C	O	A	C	A	A	A	C	R	C	A	A	A	A	A	A	
<i>Lysimachia quad.</i>	C	C	O	O	O	R	-	R	O	-	-	-	-	-	-	-	-	-	-	C	R	
<i>Diospyros virg.</i>	-	R	-	-	-	-	-	OR	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Chionanthus virg.</i>	-	-	-	-	R	-	-	R	-	-	-	R	-	-	R	-	R	-	-	R	R	
<i>Asclepias spp.</i>	R	R	-	R	-	R	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	

Deer	Turkey	Grouse
-	-	F
-	-	-
-	-	-
F	E	G
F	E	G
-	-	-
E	-	G
E	-	G
-	-	G
-	-	-
-	-	E
G	F	G
G	G	G
G	G	F
-	-	-
-	G	-
-	-	-
-	-	-

Wildlife Value

Plant Name	O-8	O-13	O-18	O-22	O-25	C-2	C-16	C-19	C-57	C-64	C-71	C-72	C-73	M-1	M-6	MG-2	MG-4	S-6	S-9	S-22	Wildlife Value			
	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	Deer	Turkey	Grouse
<i>Ipomoea sp.</i>	R	R	R	R	-	-	-	-	-	-	R	R	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cuscuta sp.</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	F
<i>Scutellaria sp.</i>	-	-	-	-	R	-	-	R	-	-	-	-	-	-	-	R	-	-	-	-	-	-	-	-
<i>Fumella vulgaris</i>	O	R	O	R	-	-	-	C	H	A	O	-	-	R	-	-	-	O	R	R	-	F	-	E
<i>Hedeoma pulegioides</i>	R	R	O	-	-	-	-	-	R	-	R	-	-	-	-	O	-	-	O	-	-	-	-	-
<i>Veronica officianalis</i>	-	-	R	R	O	-	-	-	-	C	O	-	-	-	-	-	-	R	-	-	-	-	-	F
<i>Gerardia spp.</i>	-	R	-	-	R	-	R	-	R	O	R	R	-	R	-	O	R	-	R	R	R	-	F	F
<i>Symphoricarpus orb.</i>	-	-	-	-	-	-	-	O	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F
<i>Chelone glabra</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-	-
<i>Plantago lanceolata</i>	R	R	O	-	O	-	C	-	-	O	R	O	-	O	-	H	-	C	-	-	H	E	-	-
<i>Plantago virginica</i>	-	-	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	-	-	-	-	-
<i>Galium sp.</i>	R	R	-	R	O	-	-	-	O	-	-	-	-	-	-	-	-	-	-	-	-	-	F	O
<i>Biodia toros</i>	-	-	R	-	-	-	-	-	O	-	C	-	-	-	-	-	-	-	-	-	-	-	F	-
<i>Houstonia sp.</i>	-	-	R	R	-	R	-	-	-	-	O	-	R	-	-	-	-	-	-	-	-	-	-	-
<i>Lonicera sp.</i>	-	-	-	R	-	-	-	-	-	O	-	-	-	-	-	-	-	-	-	-	-	-	O	-
<i>Viturnum spp.</i>	-	-	O	-	R	-	-	-	-	-	-	-	-	-	-	O	-	R	R	O	-	F	F	O
<i>Taraxacum off.</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Chrysanthemum Leuc.</i>	-	-	R	-	R	-	-	-	-	-	C	R	C	-	-	-	-	-	-	-	-	-	-	F
<i>Solidage spp.</i>	A	C	R	O	O	R	R	O	R	C	R	R	O	R	-	R	C	O	R	C	O	-	-	O

Wildlife Value

Deer Turkey Grouse

O-8 O-13 O-18 O-22 O-25 C-2 C-16 C-18 C-57 C-64 C-71 C-72 C-73 M-1 M-6 MG-2 MG-4 S-6 S-9 S-22
 C-F

Plant Name	O-8	O-13	O-18	O-22	O-25	C-2	C-16	C-18	C-57	C-64	C-71	C-72	C-73	M-1	M-6	MG-2	MG-4	S-6	S-9	S-22	Deer	Turkey	Grouse	
Solidago bicolor	R	--R	--	-R	--	OR	--	--	--	--	--	--	--	R	--	--	--	--	R	--	--	-	-	G
Aster linariifolius	RR	--	--	--	--	RR	--	--	R	RR	--	-R	RR	RR	-R	--	--	--	--	--	--	-	-	-
Aster spp.	OR	OR	OO	-R	AO	OR	CR	CR	-R	OR	R	-R	OR	OR	OR	RR	AO	R	--	--	--	-	G	E
Erigeron canadensis	CR	R	-R	--	--	O	OO	R	--	R	O	--	--	O	-R	--	--	--	RR	-R	--	-	-	-
Erigeron spp.	--	R	-R	--	--	--	R	R	--	--	--	--	--	O	--	--	--	--	R	--	--	-	-	-
Aster multiflorus	R	-RR	O	-R	--	--	CR	CO	--	--	--	--	--	--	--	--	--	--	R	--	--	F	G	E
Antennaria spp.	RO	-R	R	--	OC	--	RR	RR	--	--	R	-R	-R	--	--	--	--	--	--	--	--	-	-	E
Gnaphalium spp.	RR	--	R	--	R	-RR	--	R	-R	RR	--	--	R	--	--	--	--	--	--	--	--	-	-	G
Parthenium integ.	O	-R	--	--	-R	--	--	-R	--	-R	--	--	--	R	--	--	--	--	--	--	--	-	-	-
Ambrosia artem.	--	O	-R	--	--	--	-R	RR	--	--	--	--	--	R	--	--	O	--	--	--	--	-	-	F
Achillea Millefolium	R	--	R	--	--	--	RR	OO	--	--	--	--	--	--	--	--	O	--	-R	--	--	-	-	-
Coreopsis vert.	RR	O	--	-R	--	--	--	R	--	RO	-R	--	--	OR	-R	--	R	--	--	--	--	-	-	-
Coreopsis majus	--	--	--	--	--	--	--	OC	--	--	--	--	--	--	R	--	--	--	--	--	--	-	F	-
Erechtites sp.	RR	--	--	RR	--	--	--	R	-R	--	R	--	--	--	--	R	-R	--	-R	-R	--	-	-	-
Prenanthes spp.	R	--	--	--	--	R	--	--	--	--	-R	--	--	--	--	--	R	-R	--	-R	--	-	-	-
Bidens sp.	--	RR	--	--	--	--	RR	--	--	--	--	--	--	--	--	--	RR	--	-R	--	--	-	F	F
Helianthus sp.	RR	--	--	--	--	-R	--	OR	R	RR	--	-R	-R	RR	--	--	--	--	--	--	--	-	F	-
Lactuca sp.	OR	RR	R	--	-R	R	-RR	RR	R	-RR	R	--	R	-R	--	R	--	-R	--	--	--	-	F	-

Plant Name

	O-6	O-13	O-18	O-22	O-25	C-2	C-15	C-18	C-37	C-64	C-71	C-72	C-73	N-1	N-4	MI-2	MI-4	S-6	S-9	S-22	
	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1	C-1
<i>Hieracium</i> spp.	R	R	R	-	-	-	-	R	R	-	-	R	R	-	-	R	R	-	-	-	-
<i>H. paniculatum</i>	-	-	-	-	-	C	-	-	-	-	-	R	R	O	R	-	R	R	-	-	-
<i>Sensula</i> spp.	-	-	R	-	-	-	R	R	-	R	-	-	-	-	-	R	R	-	-	-	-
<i>Vigna sinensis</i>	-	-	-	-	-	-	-	-	-	-	-	A	-	-	-	-	-	-	R	-	-
(Soy Bean)	-	-	-	-	-	-	-	-	-	-	-	C	-	-	-	-	-	-	-	-	-
(Rye)	-	-	-	-	-	-	-	-	O	-	-	-	-	-	-	-	-	-	R	-	-

Wildlife Value

	Deer	Turkey	Grouse
<i>Hieracium</i> spp.	-	0	F
<i>H. paniculatum</i>	-	0	F
<i>Sensula</i> spp.	-	-	F
<i>Vigna sinensis</i>	R	R	R
(Soy Bean)	0	0	0
(Rye)	0	-	0

Date _____ recorder _____

Clearing Number _____

Quadrat Number _____

Size of quadrat _____

Location _____

Edaphic Factors

Moisture Content-

Dry, Moist, Wet, Saturated

Origin-

Sandstone, Granite, Shale,
Limestone

Humus-

None, Slight, Medium, Deep

Structure-

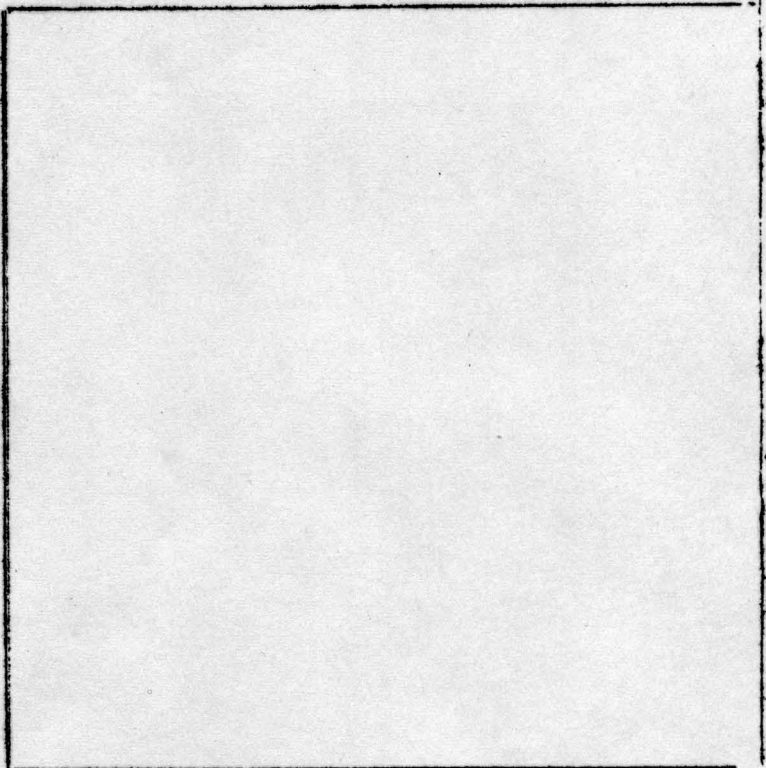
Sand, Gravel, Stone, Rock,
Clay, Loam

Surface-

Level, Medium, Slight, Steep

Exposure-

N S E W



Vegetation

Type- Herbs, Grass, Trees, Shrubs, Sprouts. _____.

Density- Ground _____ Shrub _____ Tree _____ Slash _____.

Total Cover- Evergreen _____ % Deciduous _____ %

Tally of plants:

Ground:	Shrub:	Tree:
1.	16.	31.
2.	17.	32.
3.	18.	33.
4.	19.	34.
5.	20.	35.
6.	21.	36.
7.	22.	37.
8.	23.	38.
9.	24.	39.
10.	25.	40.
11.	26.	41.
12.	27.	42.
13.	28.	43.
14.	29.	44.
15.	30.	45.

Present food value to wildlife (Fruit or seed present)

Remarks: - Observations and signs observed - (Use other side if needed)

APPENDIX III
 CATALOG OF PLANTS OCCURRING ON BIG LEVELS
 GAME REFUGE AND MT. LAKE DEMONSTRATION AREA

POLYPODIACEAE

	Big Levels	Mt. Lake
<i>Adiantum pedatum</i> L.	X	X
<i>Asplenium ebencoides</i>	X	
<i>Asplenium Felix-femina</i> (L.) Bernh.		X
<i>Asplenium montanum</i> Willd.	X	X
<i>Asplenium platyneuron</i> (L.) Oakes		X
<i>Asplenium resiliens</i> Kunze	X	
<i>Asplenium Trichomanes</i> L.		X
<i>Athyrium angustum</i> (Willd.) Presl.		X
<i>Athyrium asplenioides</i> (Michx.) Desv.		X
<i>Camptosorus rhizophyllus</i> (L.) Link.	X	
<i>Cystopteris bulbifera</i> (L.) Bernh.		X
<i>Cystopteris fragilis</i> (L.) Bernh.		X
<i>Dematoedtia punctilobula</i> (Michx.) Moore		X
<i>Dryopteris Bottii</i> Tuckerm.		X
<i>Dryopteris campyloptera</i>		X
<i>Dryopteris cristata</i> (L.) A. Gray		X
<i>Dryopteris hexagonoptera</i>		X
<i>Dryopteris marginalis</i> (L.) A. Gray		X
<i>Dryopteris noveboracensis</i> (L.) A. Gray	X	X
<i>Dryopteris spinulosa</i> var. <i>americana</i> (Fisch.) Fern.		X
<i>Dryopteris spinulosa</i> var. <i>intermedium</i> (Dahl.) D. C. Eaton	X	X
<i>Dryopteris Thelypteris</i> (L.) A. Gray		X
<i>Onoclea sensibilis</i> L.	X	X

	Big Levels	Mt. Lake
<i>Pellaea atropurpurea</i> (L.) Link	X	
<i>Polypodium virginianum</i> L.	X	X
<i>Polystichium acrostichoides</i> (Michx.) Schott	X	X
<i>Pteridium latiusculum</i> (Desv.) Hieron	X	X
<i>Woodsia ilvensis</i> (L.) R. Br.		X
<i>Woodsia obtusa</i> (Spreng.) Torr.	X	X
<i>Woodwardia virginica</i> (L.) Sm	X	
OSMUNDACEAE		
<i>Osmunda cinnamomea</i> L.	X	X
<i>Osmunda Claytoniana</i> L.	X	X
<i>Osmunda regalis</i> L.	X	X
<i>Osmunda regalis</i> var. <i>spectabilis</i> (Willd.) A. Gray		X
OPHIOGLOSSACEAE		
<i>Botrychium dissectum</i> Spreng.		X
<i>Botrychium obliquum</i> Muhl.	X	X
<i>Botrychium virginianum</i> (L.) Sw.		X
EQUISETACEAE		
<i>Equisetum arvense</i> L.		X
LYCOPODIACEAE		
<i>Lycopodium annotinum</i> L.		X
<i>Lycopodium clavatum</i> L.		X
<i>Lycopodium complanatum</i> var. <i>dendroideum</i> (Michx.) D. C. Eaton		X
<i>Lycopodium complanatum</i> var. <i>flabelliforme</i> Parnald	X	X
<i>Lycopodium lucidulum</i> Michx.	X	X
<i>Lycopodium obscurum</i> L.	X	X
<i>Lycopodium tristachyum</i> Pursh.	X	X

	Big Levels	Mt. Lake
ISOETACEAE		
<i>Isoetes Engelmanni</i> A. Br.		X
<i>Isoetes virginica</i>	X	
PINACEAE		
<i>Juniperus virginiana</i> L.	X	X
<i>Picea rubra</i> (DuRoi) Distr.		X
<i>Pinus echinata</i> Mill.	X	
<i>Pinus pungens</i> Lamb	X	X
<i>Pinus rigida</i> Mill.	X	X
<i>Pinus Strobus</i> L.	X	X
<i>Pinus virginiana</i> Mill.	X	X
<i>Tsuga canadensis</i> (L.) Carr.	X	X
TYPHACEAE		
<i>Typha latifolia</i> L.	X	X
HAJADACEAE		
<i>Potamogeton Oakesianus</i> Robbins	X	
ALISMACEAE		
<i>Alisma Plantago-aquatica</i> L.	?	X
GRAMINEAE		
<i>Agropyron repens</i> (L.) Beauv.		X
<i>Agrostis alba</i> L.	X	X
<i>Agrostis hyemalis</i> (Walt.) B S P.	X	X
<i>Agrostis perennans</i> (Walt.) Tuckerm.		X
<i>Agrostis tenuis</i> Sibth.		X
<i>Andropogon Elliottii</i> Chapm.	X	
<i>Andropogon furcatus</i> Michx.		X
<i>Andropogon glomeratus</i> (Walt.) B S P.	X	X

	Big Levels	Mt. Lake
<i>Andropogon scoparius</i> Michx.	X	X
<i>Andropogon virginicus</i> L.	X	
<i>Aristida dichotoma</i> Michx.	X	
<i>Arrhenatherum elatius</i> (L.) Beauv.	X	X
<i>Bromus comutatus</i> Schrad.		X
<i>Calamagrostis cirsioides</i> (Muhl.) Barton		X
<i>Dactylis glomerata</i> L.	X	X
<i>Danthonia compressa</i> Austin		X
<i>Danthonia spicata</i> (L.) Beauv.	X	X
<i>Deschampsia caespitosa</i> (L.) Beauv.		X
<i>Deschampsia flexuosa</i> (L.) Trin.		X
<i>Digitaria humifusa</i> Pers.	X	X
<i>Digitaria sanguinalis</i> (L.) Scop.	X	X
<i>Echinochloa crusgalli</i> (L.) Beauv.	X	
<i>Eragrostis capillaris</i> (L.) Nees.		X
<i>Eragrostis pectinacea</i> (Michx.) Nash	X	
<i>Festuca capillata</i> Lam.		X
<i>Festuca obtusa</i> Spreng.		X
<i>Festuca ovina</i> L.		X
<i>Glyceria canadensis</i> (Michx.) Trin.	X	
<i>Glyceria grandis</i> Wats.		X
<i>Glyceria mollicaria</i> (Michx.) F. T. Hubb.		X
<i>Glyceria septentrionalis</i> Hitchc.		X
<i>Glyceria striata</i> (Lam.) Hitchc.		X
<i>Glyceria Torreyana</i> (Spreng.) Hitchc.		X
<i>Holcus lanatus</i> L.	X	X

	Big Levels	Mt. Lake
<i>Hystrix patula</i> Moench.		X
<i>Leersia oryzoides</i> (L.) Sw.	X	X
<i>Lolium multiflorum</i> Lam.		X
<i>Muhlenbergia Schreberi</i> J. F. Gmel.	X	X
<i>Panicum clandestinum</i> L.		X
<i>Panicum dichotomum</i> L.		X
<i>Panicum latifolium</i> L.		X
<i>Panicum microcarpon</i> Muhl.		X
<i>Panicum</i> spp.	X	
<i>Paspalum hemitocum</i> Schultes	X	
<i>Paspalum</i> spp.	X	
<i>Phleum pratense</i> L.	X	X
<i>Poa autumnalis</i> Muhl.		X
<i>Poa compressa</i> L.		X
<i>Poa palustris</i> L.		X
<i>Poa pratensis</i> L.	X	X
<i>Setaria italica</i> (L.) Beauv.		X
<i>Setaria lutescens</i> (Weigel) F. T. Hubb.	X	
<i>Sorghastrum nutans</i> (L.) Nash	X	

CYPERACEAE

<i>Carex aestivalis</i> M. A. Curtis		X
<i>Carex brunneocens</i> Poir.		X
<i>Carex communis</i> Bailey		X
<i>Carex crinita</i> var. <i>gyandra</i> (Schwein.)		X
<i>Carex debilis</i> Michx.		X
<i>Carex foenea</i> var. <i>perplexa</i> Bailey		X
<i>Carex folliculata</i> L.	X	
<i>Carex Grayii</i> Carey		X

	Big Levels	Mt. Lake
<i>Carex intumescens</i> Ridge		X
<i>Carex leptalea</i> Wahlenb.		X
<i>Carex lurida</i> Wahlenb.		X
<i>Carex lurida</i> var. <i>gracilis</i> (Scott) Bailey		X
<i>Carex pennsylvanica</i> Lam.		X
<i>Carex prasina</i> Wahlenb.		X
<i>Carex radiata</i> (Walt.) Small		X
<i>Carex scoparia</i> Schumbr.		X
<i>Carex stricta</i> Lam.		X
<i>Carex stipata</i> Muhl.		X
<i>Carex wrightii</i> (Fern.) Bickn		X
<i>Carex tribuloides</i> var. <i>reducta</i> Bailey		X
<i>Carex triperora</i> Dewey		X
<i>Carex virescens</i> Muhl.		X
<i>Carex vulpinoidea</i> Michx.		X
<i>Dulichium arundinaceum</i> (L.) Britton	X	
<i>Kleocharis acicularis</i> (L.) R & S	X	
<i>Kleocharis obtusa</i> (Willd.) Schultes		X
<i>Kleocharis Robbinsii</i> Coker	X	
<i>Kleocharis tenuis</i> (Willd.) Schultes		X
<i>Eriophorum virginicum</i> L.	X	X
<i>Rynchospora glomerata</i> (L.) Vahl		X
<i>Scirpus cyperinus</i> (L.) Kunth		X
<i>Scirpus polyphyllus</i> Vahl.		X
<i>Scirpus subterminalis</i>	X	
ANACRACAE		
<i>Arisaema triphyllum</i> (L.) Schott		X
<i>Oxypetalum aquaticum</i> L.	X	

	Big Levels	Mt. Lake
<i>Symplocarpus foetidus</i> (L.) Nutt.	X	X
ERIOCAULACEAE		
<i>Eriocaulon articulatum</i> (Huds) Morong.	X	
<i>Eriocaulon septangulare</i> With.	X	
XYRIDACEAE		
<i>Xyris caroliniana</i> Walt.	X	
COMMELINACEAE		
<i>Commelina communis</i> L.	X	
<i>Tradescantia montana</i> Shuttlew.		X
<i>Tradescantia virginiana</i> L.		X
JUNCACEAE		
<i>Juncus canadensis</i> J. Gay	X	
<i>Juncus debilis</i> Gray		X
<i>Juncus effusus</i> L.		X
<i>Juncus tenuis</i> Willd.	X	X
<i>Luzula campestris</i> var. <i>multiflora</i> (Nutt) Celak		X
LILIACEAE		
<i>Alstroemeria farinosa</i> L.	X	X
<i>Allium cernuum</i> Roth	X	
<i>Anemone hepatica</i> (Walt.) Gray	X	X
<i>Chamaelirium luteum</i> (L.) Gray	X	X
<i>Clintonia borealis</i> (Ait.) Raf.		X
<i>Clintonia umbellulata</i> (Michx.) Morong	X	X
<i>Clintonia alleghaniensis</i> Horned.		X
<i>Convallaria majalis</i> L.		X
<i>Disporum lanuginosum</i> (Michx.) Nichols		X
<i>Helonias bullata</i> L.	X	
<i>Lilium canadense</i> L.		X

	Big Levels	Mo. Lake
<i>Lilium philadelphicum</i> L.	X	X
<i>Lilium superbum</i> L.		X
<i>Maianthemum canadense</i> Desf.		X
<i>Medeola virginiana</i> L.	X	X
<i>Melanthium latifolium</i> Deor.		X
<i>Melanthium virginicum</i> L.		X
<i>Oakesia sessifolia</i> (L.) Sats.	X	X
<i>Polygonatum biflorum</i> (Walt.) Ell.	X	X
<i>Polygonatum commutatum</i> (R. & S.) Bistr.		X
<i>Smilacina racemosa</i> (L.) Desf.	X	X
<i>Smilax glauca</i> Walt.	X	X
<i>Smilax herbacea</i> L.	X	X
<i>Smilax hispida</i> Michx.		X
<i>Smilax rotundifolia</i> L.	X	X
<i>Stenanthium gramineum</i> (Nes) Kunth		X
<i>Streptopus roseus</i> Michx.		X
<i>Trillium cernuum</i> L.		X
<i>Trillium erectum</i> L.		X
<i>Trillium grandiflorum</i> (Michx.) Salisb.		X
<i>Trillium undulatum</i> Willd.		X
<i>Uvularia grandiflora</i> Ga.		X
<i>Uvularia perfoliata</i> L.	X	X
<i>U. puberula</i> Michx.		X
<i>Veratrum viride</i> Ait.	X	X
<i>Xerophyllum asphodeloides</i> (L.) Nutt.	X	

HEXAMONACEAE

<i>Lachnanthes tinctoria</i> (Walt.) Ell.	X	
---	---	--

DIOSCOREACEAE

	Big Levels	Mt. Lake
<i>Dioscorea villosa</i> L.	X	X
<i>Dioscorea quaternata</i> var. <i>glauca</i> (Muhl.) Fernald		X

AMARYLLIDACEAE

<i>Hypoxis hirsuta</i> (L.) Coville	X	X
-------------------------------------	---	---

IRIDACEAE

<i>Iris verna</i> L.	X	
<i>Sisyrinchium gramineum</i> Curtis		X

ORCHIDACEAE

<i>Aplectrum hyemale</i> (Muhl.) Torr	X	
<i>Arethusa bulbosa</i> L.	X	
<i>Calopogon pulchellus</i> (Sw.) R. Br.	X	X
<i>Corallorrhiza maculata</i> Raf.		X
<i>Corallorrhiza odontorrhiza</i> Nutt.	X	X
<i>Cypripedium acaule</i> Ait.	X	X
<i>Cypripedium parviflorum</i> var. <i>pubescens</i> (Willd.) Knight		X
<i>Epipactis pubescens</i> (Willd.) A. A. Eaton		X
<i>Epipactis repens</i> (L.) Griseb. var. <i>ophioides</i> (Fernald) Eaton		X
<i>Habenaria blephariglotis</i> (Willd.) Torr.		X
<i>Habenaria ciliaris</i> (L.) R. Br.	X	X
<i>Habenaria clavellata</i> (Michx.) Spreng.	X	X
<i>Habenaria fibriata</i> (Ait.) R. Br.		X
<i>Habenaria peruviana</i> Gray		X
<i>Habenaria psycodes</i> (L.) Sw.		X
<i>Listera cordata</i> (L.) R. Br.		X
<i>Microstylis unifolia</i> (Michx.) T. & G. P.	X	X

	Big Levels	Nt. Lake
<i>Pogonia ophioglossoides</i> (L.) Ker	X	
<i>Pogonia verticillata</i> (Willd.) Nutt.	X	X
<i>Spiranthes Beckii</i> Lindl.	X	
<i>Spiranthes cernua</i> (L.) Richard		X
<i>Spiranthes gracilis</i> (Bigel.) Beck		X
<i>Spiranthes praecox</i> (Walt.) Wats. & Coult.		X
SALICACEAE		
<i>Populus grandidentata</i> Michx.	X	X
<i>Salix humilis</i> Marsh.	X	X
<i>Salix nigra</i> Marsh.		X
<i>Salix sericea</i> Marsh.		X
<i>Salix tristis</i> Ait.		†
MYRICACEAE		
<i>Myrica asplenifolia</i> L.	X	
JUGLANDACEAE		
<i>Carya alba</i> (L.) K. Koch	X	X
<i>Carya cordiformis</i> (Wang.) K. Koch		X
<i>Carya glabra</i> (Mill.) Spach	X	X
<i>Carya ovata</i> (Mill.) K. Koch	X	X
<i>Juglans cinerea</i> L.	X	X
<i>Juglans nigra</i> L.	X	X
BETULACEAE		
<i>Alnus crispa</i> (Ait.) Pursh		X
<i>Alnus rugosa</i> (Du Roi) Spreng.	X	X
<i>Betula lenta</i> L.	X	X
<i>Betula lutea</i> Michx. f.	X	X

	Big Levels	Wt. Lake
<i>Carpinus caroliniana</i> Walt.		X
<i>Corylus americana</i> Walt.		X
<i>Corylus rostrata</i> Ait.		X
<i>Ostrya virginiana</i> (Mill.) K. Koch		X

FAGACEAE

<i>Castanea dentata</i> (Marsh.) Borkh.	X	X
<i>Castanea pumila</i> (L.) Mill.	X	X
<i>Fagus grandifolia</i> Ehrh.	X	X
<i>Quercus alba</i> L.	X	X
<i>Quercus alba</i> var. <i>latiloba</i> Sarg.		X
<i>Quercus coccinea</i> Muench.	X	X
<i>Quercus ilicifolia</i> Wang.	X	X
<i>Quercus marilandica</i> Muench.	X	
<i>Quercus borealis</i> var. <i>maxima</i> (Marsh) Ashe	X	X
<i>Quercus palustris</i> Muench.	X	
<i>Quercus prinus</i> L.	X	X
<i>Quercus stellata</i> Wang.	X	
<i>Quercus velutina</i> Lam.	X	X

URTICACEAE

<i>Boehmeria cylindrica</i> var. <i>scabra</i> Parler		X
<i>Celtis occidentalis</i> L.	X	
<i>Celtis occidentalis</i> var. <i>crassifolia</i> (Lam.) Gray		X
<i>Laportea canadensis</i> (L.) Gaud.	X	X
<i>Morus rubra</i> L.	X	
<i>Filix pumila</i> (L.) Gray	X	X
<i>Ulmus americana</i> L.		X
<i>Urtica dioica</i> L.	X	

SANTALACEAE

Big Levels Mt. Lake

Pyrularia pubera Michx.

X

LORANTHACEAE

Phoradendron flavescens (Pursh) Nutt.

X

ARISTOLOCHIACEAE

Aristolochia macrophylla Lam.

X

Aristolochia Serpentaria L.

X

Asarum canadense L.

X

Asarum virginicum L.

X

X

POLYGONACEAE

Polygonum esculentum Moench

X

Polygonum Convolvulus L.

X

Polygonum hydropiperoides Michx.

X

Polygonum Muhlenbergii (Meisn.) Wats.

X

Polygonum pennsylvanicum L.

X

X

Polygonum Persicaria L.

X

Polygonum sagittatum L.

X

X

Polygonum scandens L.

X

X

Rumex Acetosella L.

X

X

Rumex conglomeratus Murr.

X

Rumex obtusifolius L.

X

CHENOPODIACEAE

Chenopodium album L.

X

X

PHYTOLACCACEAE

Phytolacca decandra L.

X

X

ILLINOIBRACEAE

Paronychia argyrocoma (Michx.) Nutt.

X

CARYOPHYLLACEAE

	Big Levels	Mt. Lake
<i>Agrostemma Githago</i> L.	X	
<i>Cerastium vulgatum</i> L.	X	
<i>Dianthus Armeria</i> L.	X	X
<i>Saponaria officinalis</i> L.	X	
<i>Silene antirrhina</i> L.	X	
<i>Silene dichotoma</i> Ehrh.		X
<i>Silene stellata</i> (L.) Ait. f.	X	X
<i>Silene virginica</i> L.	X	X
<i>Stellaria media</i> (L.) Cyrill	X	X
<i>Stellaria pubera</i> Michx.	X	X

NYMPHAEACEAE

<i>Brasenia Schreberi</i> Gmel.	X	
<i>Nymphaea advena</i> Ait.	X	

RANUNCULACEAE

<i>Acetosa alba</i> (L.) Mill.		X
<i>Anemone trifolia</i> L.	X	X
<i>Anemone virginiana</i> L.	X	X
<i>Anemonella thalictroides</i> (L.) Spach	X	
<i>Aquilegia canadensis</i> L.	X	
<i>Caltha palustris</i> L.		X
<i>Cimicifuga racemosa</i> (L.) Nutt.		X
<i>Clematis virginiana</i> L.	X	X
<i>Hepatica acutiloba</i> DC.		X
<i>Hepatica triloba</i> Chaix	X	X
<i>Ranunculus abortivus</i> L.	X	

	Big Levels	Mt. Lake
<i>Ranunculus allegheniensis</i> Britton		X
<i>Ranunculus hispidus</i> Michx.		X
<i>Thalictrum dioicum</i> L.		X
<i>Thalictrum polygamum</i> Muhl.	X	X
<i>Thalictrum revolutum</i> DC.		X
<i>Trautvetteria carolinensis</i> (Walt.) Vail.		X
MAGNOLIACEAE		
<i>Liriodendron tulipifera</i> L.	X	X
<i>Magnolia acuminata</i> L.	X	X
ANONACEAE		
<i>Asimina triloba</i> Dunal	XX	
MENISPERMACEAE		
<i>Menispermum canadense</i> L.	X	
BERBERIDACEAE		
<i>Caulophyllum thalictroides</i> (L.) Michx.		X
<i>Podophyllum peltatum</i> L.	X	X
LAURACEAE		
<i>Benzoïn aestivale</i> (L.) Nees	X	X
<i>Sassafras albidum</i> (Nutt.) Nees	X	X
PAPAVERACEAE		
<i>Chelidonium majus</i> L.	X	
<i>Sanguinaria canadensis</i> L.	X	X
FUMARIACEAE		
<i>Corydalis sempervirens</i> (L.) Pers.		X
<i>Dicentra eximia</i> (Ker) Torr.	X	

CRUCIFERAE

	Big Levels	Mt. Lake
<i>Arabis canadensis</i> L.		X
<i>Capsella Bursa-pastoris</i> (L.) Medic.	X	X
<i>Dentaria laciniata</i> Muhl.		X
<i>Lepidium caespitose</i> (L.) R. Br.	X	X
<i>Lepidium virginicum</i> L.	X	X
<i>Sisymbrium officinale</i> var. <i>leiocarpum</i> DC.		X

DROSERACEAE

<i>Drosera rotundifolia</i> L.	X	X
--------------------------------	---	---

GRASSULACEAE

<i>Sedum Nevii</i> Gray		X
<i>Sedum ternatum</i> Michx.	?	X

SAXIFRAGACEAE

<i>Boykinia aconitifolia</i> Nutt.		X
<i>Heuchera americana</i> L.		X
<i>Heuchera villosa</i> Michx.		X
<i>Hydrangea arborescens</i> L.	X	X
<i>Parnassia acarifolia</i> Vent.	X	X
<i>Hibes rotundifolium</i> Michx.		X
<i>Saxifraga leucanthemifolia</i> Michx.		X
<i>Tiarella cordifolia</i> L.		X

HAMAMELIDACEAE

<i>Hammamelis virginiana</i> L.	X	X
---------------------------------	---	---

PLATANACEAE

<i>Platanus occidentalis</i> L.	X	X
---------------------------------	---	---

ROSACEAE

<i>Agrimonia gryposepala</i> Wallr.	X	X
-------------------------------------	---	---

	Big Levels	Mt. Lake
<i>Amelanchier canadensis</i> (L.) Medic	X	X
<i>Amelanchier laevis</i> Waig.		X
<i>Amelanchier</i> sp.?	X	
<i>Aruncus sylvestris</i> Kosteletsky		X
<i>Crataegus Crus-galli</i> L.	X	X
<i>Crataegus rotundifolia</i> Moench		X
<i>Fragaria virginiana</i> Duchesne	X	X
<i>Geum flavum</i> (Porter) Micknell	X	
<i>Geum virginianum</i> L.	X	
<i>Gillenia trifoliata</i> (L.) Moench	X	X
<i>Potentilla intermedia</i> L.	X	
<i>Potentilla mansueti</i> L.		X
<i>Potentilla pusilla</i> Poir.	X	
<i>Potentilla recta</i> L.		X
<i>Potentilla simplex</i> Michx.	X	X
<i>Prunus americana</i> Marsh.	X	X
<i>Prunus pennsylvanica</i> L.f.	X	X
<i>Prunus serotina</i> Ehrh.	X	X
<i>Prunus virginiana</i> L.	?	
<i>Pyrus americana</i> (Marsh.) DC.		X
<i>Pyrus arbutifolia</i> (L.) L.f.	X	X
<i>Pyrus arbutifolia</i> var. <i>atropurpurea</i> (Britton) Robinson	X	X
<i>Pyrus cornaria</i> L.		X
<i>Pyrus Malus</i> L.	X	X
<i>Pyrus melanocarpa</i> (Michx.) Willd.		X
<i>Rosa canina</i> L.		X
<i>Rosa carolina</i> L.	X	X
<i>Rosa palustris</i> Marsh.	X	X

	Big Levels	Mt. Lake
<i>Rosa rubiginosa</i> L.		X
<i>Rosa virginiana</i> Mill.	?	
<i>Rubus allegheniensis</i> Porter	X	X
<i>Rubus hispidus</i> L.	X	X
<i>Rubus occidentalis</i> L.	X	X
<i>Rubus odoratus</i> L.	X	X
<i>Spiraea latifolia</i> Borkh.	X	X
<i>Spiraea salicifolia</i> L.		X
<i>Spiraea tomentosa</i> L.		X

LEGUMINOSAE

<i>Amphicarpa monoica</i> (L.) Ell.	X	X
<i>Apios tuberosa</i> Moench.		X
<i>Astragalus canadensis</i> L.	X	
<i>Baptisia tinctoria</i> (L.) R. Br.	X	X
<i>Cassia Chamaecrista</i> L.	X	
<i>Cassia nictitans</i> L.	X	
<i>Clitoria mariana</i> L.	X	
<i>Desmodium Dellenii</i> Darl.		X
<i>Desmodium laevigatum</i> (Mutt.) D C.		X
<i>Desmodium marilandicum</i> (L.) D C.		X
<i>Desmodium nudiflorum</i> (L.) D C.	X	X
<i>Desmodium obtusum</i> (Muhl.) D C.		X
<i>Desmodium paniculatum</i> (L.) D C.		X
<i>Desmodium rigidum</i> (Ell.) D C.		X
<i>Desmodium rotundifolium</i> (Michx.) D C.	X	X
<i>Lespedeza capitata</i> Michx.	X	
<i>Lespedeza frutescens</i> (L.) Britton	X	X

	Big Levels	Mt. Lake
<i>Lespedeza hirta</i> (L.) Hornem	X	X
<i>Lespedeza procumbens</i> Michx.	X	X
<i>Lespedeza repens</i> (L.) Pers.	X	
<i>Lespedeza sericea</i> (Introduced)	X	
<i>Lespedeza stipulacea</i> (Introduced)	X	
<i>Lespedeza virginica</i> (L.) Britton	X	
<i>Lupinus perennis</i> L.	X	
<i>Melilotus alba</i> Desr.	X	X
<i>Melilotus officinalis</i> (L.) Lam.	X	
<i>Robinia Pseudo-Acacia</i> L.	X	X
<i>Stylosanthes biflora</i> (L.) B S P.	X	
<i>Tephrosia virginiana</i> (L.) Pers.	X	X
<i>Trifolium agrarium</i> L.	X	
<i>Trifolium hybridum</i> L.	X	
<i>Trifolium pratense</i> L.	X	X
<i>Trifolium procumbens</i> L.	X	X
<i>Trifolium repens</i> L.	X	X
<i>Vicia americana</i> Muhl.	X	
<i>Vicia angustifolia</i> (L.) Reichard		X
<i>Vicia caroliniana</i> Walt.	X	
<i>Vicia Cracca</i> L.	X	
LINACEAE		
<i>Linum striatum</i> Walt.		X
OXALIDACEAE		
<i>Oxalis Acetosella</i> L.		X
<i>Oxalis europaea</i> Jord.		X
<i>Oxalis filipes</i> Small	X	X

	Big Levels	Mt. Lake
<i>Omalis montana</i> Raf.		X
<i>Omalis stricta</i> L.	X	
GERANIACEAE		
<i>Geranium maculatum</i> L.	X	X
POLYGALACEAE		
<i>Polygala ambigua</i> (Nutt.) Wood	X	
<i>Polygala cruciata</i> L.	?	
<i>Polygala paucifolia</i> Willd.	X	X
<i>Polygala polygama</i> Walt.	X	
<i>Polygala sanguinea</i> L.	X	X
<i>Polygala verticillata</i> var. <i>ambigua</i> (Nutt.) Wood	X	
EUPHORBACEAE		
<i>Acalypha gracilens</i> Gray	X	
<i>Euphorbia corollata</i> L.	X	X
<i>Euphorbia Preslii</i> Guss.	X	X
CALLITRICHACEAE		
<i>Callitriche heterophylla</i> Pursh		X
ANACARDIACEAE		
<i>Rhus copallina</i> L.	X	
<i>Rhus glabra</i> L.	X	X
<i>Rhus Toxicodendron</i> L.	X	X
<i>Rhus typhina</i> L.	X	X
<i>Rhus Vernix</i> L.	X	
AQUIFOLIACEAE		
<i>Ilex monticola</i> Gray	X	X
<i>Ilex verticillata</i> (L.) Gray	X	X
CELASTRACEAE		
<i>Celastrus scandens</i> L.		X

Evonymus americanus L.

X

ACTINACEAE

Acer pennsylvanicum L.

X

X

Acer rubrum L.

X

X

Acer saccharinum L.

X

Acer saccharum Marsh.

X

Acer spicatum Lam.

X

X

SAPINDACEAE

Aesculus octandra Marsh.

X

BALSAMIFERAE

Impatiens pallida Nutt.

X

X

RHAMNACEAE

Ceanothus americanus L.

X

X

VITACEAE

Paedera quinquefolia (L.) Greene

X

X

Paedera quinquefolia var. hirsuta (Donn) Rehder.

X

Vitis aestivalis var. argentifolia (Bunson) Fernald

X

X

Vitis riparia Michx.

X

Vitis vulpina L.

X

TILIACEAE

Tilia americana L.

X

Tilia heterophylla Vent.

X

Tilia neglecta Spach

X

MALVACEAE

Hibiscus Moscheutos L.

X

HYPERICACEAE

Ascyrum hypericoides L.

X

Hypericum gentianoides (L.) B. & P.

X

Hypericum graveolens Buckley

X

Hypericum mutilum L.

X

X

Hypericum perforatum L.

X

X

Hypericum prolificum L.

X

Hypericum punctatum Lam.

X

X

Hypericum virginicum L.

X

CISTACEAE

Lechea racemulosa Lam.

X

VIOLACEAE

Viola blanda Willd.

X

X

Viola canadensis L.

X

Viola cucullata Ait.

X

X

Viola fimbriatula Sm.

X

X

Viola hastata Michx.

X

Viola hirsutula Brainerd

X

Viola lanceolata L.

X

Viola pedata L.

X

X

Viola pedata var. *lineariloba* D. C.

X

Viola prismatifolia L.

X

X

Viola pubescens Ait.

X

Viola Rafinesqui Greene

X

Viola rotundifolia Michx.

X

Viola sagittata Ait.

X

X

Viola sororia Willd.

X

LYTHRACEAE

Cuphea petiolata (L.) Koehne

X

X

	Big Levels	Mt. Lake
<i>Decodon verticillatus</i> (L.) Ell.	X	
MELASTOMACEAE		
<i>Rhexia mariana</i> L.	X	
ONAGRACEAE		
<i>Circaea intermedia</i> Ehrh.		X
<i>Circaea lutetiana</i> L.	X	X
<i>Epilobium angustifolium</i> L.	X	X
<i>Ludivigia palustris</i> (L.) Ell.	X	
<i>Oenothera biennis</i> L.	X	X
<i>Oenothera fruticosa</i> L.		X
EALORAGIDACEAE		
<i>Proserpinaca palustris</i> L.	X	
ARALIACEAE		
<i>Aralia hispida</i> Vent.	X	
<i>Aralia nudicaulis</i> L.	X	X
<i>Aralia racemosa</i> L.		X
<i>Panax quinquefolium</i> L.	X	X
UMBELLIFERAE		
<i>Angelica Curtisi</i> Buckley		X
<i>Angelica villosa</i> (Walt.) B S P.	X	X
<i>Cicuta maculata</i> L.	X	X
<i>Cryptotaenia canadensis</i> (L.) DC.		X
<i>Daucus Carota</i> L.	X	X
<i>Ligusticum canadense</i> (L.) Britton		X
<i>Osmorhiza Claytoni</i> (Michx.) Clarke		X
<i>Osmorhiza longistylis</i> (Torr.) DC.		X
<i>Sanicula canadensis</i> L.	X	
<i>Sanicula gregaria</i> Sickenell	X	

	Big Levels	Mt. Lake
<i>Sanicula marilandica</i> L.		X
<i>Thaspium barbinode</i> (Michx.) Nutt.		X
<i>Thaspium pinnatifidum</i> (Buckley) Gray		X
<i>Eisia aurea</i> (L.) Koch	X	X
<i>Eisia Hebbii</i> (Coul. & Rose) Britton		X
<i>Eisia cordata</i> (Walt.) DC.	X	
CORNACEAE		
<i>Cornus alternifolia</i> L. f.		X
<i>Cornus Amomum</i> Mill.		X
<i>Cornus asperifolia</i> Michx.		X
<i>Cornus circinata</i> L'Her.		X
<i>Cornus florida</i> L.	X	X
<i>Cornus Priceae</i> Small		X
<i>Cornus stricta</i> Lam.		X
<i>Nyssa sylvatica</i> Marsh.	X	X
ERICACEAE		
<i>Andromeda floribunda</i> Pursh	X	
<i>Chimaphila maculata</i> (L.) Pursh	X	X
<i>Epigaea repens</i> L.	X	X
<i>Gaultheria procumbens</i> L.	X	X
<i>Gaylussacia baccata</i> (Wang.) C. Koch	X	X
<i>Gaylussacia baccata</i> f. <i>glaucocarpa</i> (Robinson)		X
<i>Gaylussacia baccata</i> f. <i>leucocarpa</i> (Porter) Fernald Mackenzie		X
<i>Gaylussacia dumosa</i> (Andr.) T. & G.		X
<i>Gaylussacia frondosa</i> (L.) T. & G.	X	
<i>Kalmia latifolia</i> L.	X	X
<i>Leucothoe recurva</i> (Buckley) Gray		X
<i>Lychia ligustrina</i> (L.) DC.	X	X

	Big Levels	Mt. Lake
<i>Menziesia pilosa</i> (Michx.) Pers.	X	X
<i>Monotropa hypopitys</i> L.	X	X
<i>Monotropa uniflora</i> L.	X	X
<i>Oxydendrum arboreum</i> (L.) DC.	X	X
<i>Pyrola americana</i> Sweet	X	X
<i>Rhododendron arborescens</i> (Pursh) Torr.		X
<i>Rhododendron calendulaceum</i> (Michx.) Torr.		X
<i>Rhododendron canescens</i> (Michx.) G. Don		X
<i>Rhododendron catawbiense</i> Michx.	X	
<i>Rhododendron maximum</i> L.	X	X
<i>Rhododendron nudiflorum</i> (L.) Torr.	X	X
<i>Rhododendron viscosum</i> (L.) Torr.	X	X
<i>Vaccinium corymbosum</i> L.		X
<i>Vaccinium dubbinii</i> Burnham		X
<i>Vaccinium erythrocarpum</i> Michx.		X
<i>Vaccinium maroccanum</i> Ait.	X	
<i>Vaccinium neglectum</i> (Small) Fernald		X
<i>Vaccinium Oxycoccus</i> var. <i>intermedium</i> Gray		X
<i>Vaccinium pennsylvanicum</i> Lam.		X
<i>Vaccinium stamineum</i> L.	X	X
<i>Vaccinium vacillans</i> Kalm	X	X
DIAPYNSIACEAE		
<i>Galax aphylla</i> L.	X	X
PRIMULACEAE		
<i>Lysimachia ciliata</i> L.		X
<i>Lysimachia quadrifolia</i> L.	X	X

	Big Levels	Ht. Lake
<i>Lysimachia terrestris</i> (L.) B S P.	X	
<i>Trientalis americana</i> (Pers.) Pursh		X
BIBACACEAE		
<i>Diospyros virginiana</i> L.	X	
OLNACEAE		
<i>Chionanthus virginica</i> L.	X	
<i>Fraxinus americana</i> L.	X	X
GENTIANACEAE		
<i>Gentiana Andrewsii</i> Griseb.		X
<i>Gentiana quinquefolia</i> L.	X	X
<i>Gentiana Saponaria</i> L.		X
<i>Gentiana villosa</i> L.	X	
<i>Sabatia angularis</i> (L.) Pursh		X
<i>Sabatia gracilis</i> (Michx.) Salisb.	X	
APOCYNACEAE		
<i>Apocynum androsaemifolium</i> L.	X	X
<i>Apocynum cannabinum</i> L.	X	X
ASCLEPIADACEAE		
<i>Asclepias incarnata</i> L.	X	
<i>Asclepias phytolaccoides</i> Pursh		X
<i>Asclepias purpurascens</i> L.	X	
<i>Asclepias syriaca</i> L.		X
<i>Asclepias tuberosa</i> L.	X	X
<i>Asclepias variegata</i> L.	X	
<i>Asclepias verticillata</i> L.		X
CONVOLVULACEAE		
<i>Convolvulus sepium</i> L.		X

Convolvulus spithameus L.

X

Ipomoea pandurata (L.) G. P. W. Mey.

X

HYDROPHYLLACEAE

Hydrophyllum virginianum L.

X

BORAGINACEAE

Echium vulgare L.

X

X

Lithospermum canescens (Michx.) Lohm.

X

VERBENACEAE

Verbena urticifolia L.

X

LABIATAE

Agastache scrophulariaefolia (Willd.) Ktze.

X

Collinsonia canadensis L.

X

X

Hedeoma pulegioides (L.) Pers.

X

X

Lycopus uniflorus Michx.

X

Lycopus virginicus L.

X

Monarda olinopodia L.

X

Monarda fistulosa L.

X

Monarda mollis L.

X

Nepeta Cataria L.

X

X

Nepeta hederacea (L.) Trevisan

X

X

Prunella vulgaris L.

X

X

Pycnanthemum incanum (L.) Michx.

X

Pycnanthemum leptodon Gray

X

Salvia lyrata L.

X

Satureja vulgaris (L.) Pritsch

X

Scutellaria lateriflora L.

X

Scutellaria pilosa Michx.

X

X

	Big Levels	Mt. Lake
<i>Scutellaria serrata</i> Andr.		X
<i>Scutellaria vernicolor</i> Nutt.		X
<i>Stachys hyscopifolia</i> Michx.	Y	X
<i>Teucrium canadense</i> L.		X

SOLANACEAE

<i>Datura Stramonium</i> L.	X	X
<i>Solanum carolinense</i> L.	X	X
<i>Solanum nigrum</i> L.	X	

SCROPHULARIACEAE

<i>Castilleja coccinea</i> (L.) Spreng.		X
<i>Chelone glabra</i> L.	X	X
<i>Gerardia flava</i> L.	X	
<i>Gerardia laevigata</i> Raf.	X	X
<i>Gerardia pedicularis</i> L.	X	X
<i>Gerardia setacea</i> Walt.	X	
<i>Gerardia virginica</i> (L.) B S P.	X	X
<i>Gratiola neglecta</i> Torrey		X
<i>Linaria vulgaris</i> Hill	X	
<i>Himelus gringens</i> L.		X
<i>Pedicularis canadensis</i> L.	X	X
<i>Pentstemon canescens</i> Britton	Y	
<i>Verbascum blattaria</i> L.	X	
<i>Verbascum thapsus</i> L.	X	X
<i>Veronica officinalis</i> L.	X	X
<i>Veronica serpyllifolia</i> L.	X	X
<i>Veronica virginica</i> L.		X

LESTINULARIACEAE

<i>Utricularia fibrosa</i> Walt.	X	
----------------------------------	---	--

Utricularia gibba L.

X

Utricularia radiata

X

OROBANCHACEAE

Conopholis americana (L. f.) Wallr.

X

Orobancha uniflora L.

X

BIGNONIACEAE

Cassia radicans (L.) Scop.

X

PLANTAGINACEAE

Plantago arista Michx.

X

Plantago lanceolata L.

X

X

Plantago major L.

X

X

Plantago rugelii Don.

X

Plantago virginica L.

X

RUBIACEAE

Cephalanthus occidentalis L.

X

Diodia teres Walt.

X

Galium concinnum T. & G.

X

Galium lanceolatum Torr.

X

Galium latifolium Michx.

X

Galium parisiense L.

X

Galium pilosum Ait.

X

Galium triflorum Michx.

X

Houstonia caerulea L.

X

Houstonia lanceolata (Poir.) Britton

X

X

Houstonia longifolia Gaertn.

X

X

Houstonia patens Ell.

X

Mitchella repens L.

X

X

CAPRIPODIACEAE

Diervilla lonicera Mill.

X

	Big Levels	Ht. Lake
<i>Lonicera japonica</i> Thunb.	X	X
<i>Sambucus canadensis</i> L.	X	X
<i>Sambucus racemosa</i> L.	X	X
<i>Symphoricarpos orbiculatus</i> Moench	X	
<i>Symphoricarpos racemosus</i> Michx.		X
<i>Viburnum acerifolium</i> L.	X	
<i>Viburnum alaiifolium</i> Marsh.		X
<i>Viburnum cassinoides</i> L.	X	X
<i>Viburnum dentatum</i> L.	X	
<i>Viburnum lentago</i> L.		X
<i>Viburnum nudum</i> L.	X	
<i>Viburnum prunifolium</i> L.	X	X
<i>Viburnum rufidulum</i> Raf.		X
<i>Viburnum scaberrimum</i> (V. & C.) Chapm.		X
CAMPANULACEAE		
<i>Campanula americana</i> L.		X
<i>Campanula sparsinoides</i> Pursh		X
<i>Campanula divaricata</i> Michx.	X	X
<i>Specularia perfoliata</i> (L.) A. DC.	X	X
LOBELIACEAE		
<i>Lobelia cardinalis</i> L.	X	X
<i>Lobelia inflata</i> L.	X	X
<i>Lobelia spicata</i> Lam.		X
COMPOSITAE		
<i>Achillea Millefolium</i> L.	X	X
<i>Ambrosia artemisiifolia</i> L.	X	X
<i>Ambrosia trifida</i> L.	X	X
<i>Antennaria medicinis</i> Greene	?	X

	Big Levels	St. Lake
<i>Antennaria Forlinii</i> Fernald	X	
<i>Antennaria plantaginifolia</i> (L.) Richards	X	X
<i>Anthemis Cotula</i> L.	X	X
<i>Arctium minus</i> Bernh.	X	X
<i>Aster acuminatus</i> Michx.		X
<i>Aster cordifolius</i> L.		X
<i>Aster divaricatus</i> L.		X
<i>Aster infirmus</i> Michx.		X
<i>Aster laevis</i> L.		X
<i>Aster lateriflorus</i> (L.) Britton		X
<i>Aster linearifolius</i> L.	X	X
<i>Aster Lowrieanus</i> Porter		X
<i>Aster macrophyllus</i> L.	X	X
<i>Aster multiflorus</i> Ait.	X	X
<i>Aster novae-angliae</i> L.	X	
<i>Aster paniculatus</i> Lam.		X
<i>Aster patens</i> Ait.	X	
<i>Aster pilosus</i> L.		X
<i>Aster radula</i> Ait.		X
<i>Aster salicifolius</i> Ait.		X
<i>Aster umbellatus</i> Mill.		X
<i>Aster undulatus</i> L.	X	X
<i>Aster virginicus</i> Lam.		X
<i>Bidens bipinnata</i> L.	X	X
<i>Bidens discoides</i> (T. & G.) Britton	X	
<i>Bidens frondosa</i> L.	X	X
<i>Boltonia asteroides</i> (L.) L'Her.	X	
<i>Cacalia atriplicifolia</i> L.		X

	Big Levels	Mt. Lake
<i>Carduus acanthoides</i> L.		X
<i>Centaurus maculosa</i> Less.	X	
<i>Chrysanthemum Leucanthemum</i>	X	X
<i>Chrysogonum virginianum</i> L.	X	
<i>Chrysopsis mariana</i> (L.) Nutt.	X	X
<i>Cichorium Intybus</i> L.	X	
<i>Cirsium discolor</i> (Muhl.) Spreng.		X
<i>Cirsium lanceolatum</i> (L.) Hill	X	X
<i>Coreopsis major</i> Walt.	X	X
<i>Coreopsis verticillata</i> L.	X	X
<i>Erechtites hieracifolia</i> (L.) Raf.	X	X
<i>Erigeron annuus</i> (L.) Pers.	X	
<i>Erigeron canadensis</i> L.	X	X
<i>Erigeron philadelphicus</i> L.		X
<i>Erigeron pulchellus</i> Michx.		X
<i>Erigeron ramosus</i> (Walt.) B S P.		X
<i>Eupatorium alba</i> L.	X	
<i>Eupatorium arvense</i> L.	X	
<i>Eupatorium coelestinum</i> L.	X	X
<i>Eupatorium fistulosum</i> Barret		X
<i>Eupatorium perfoliatum</i> L.		X
<i>Eupatorium purpureum</i> L.	X	X
<i>Eupatorium rotundifolium</i> L.	X	
<i>Eupatorium sessilifolium</i> L.	X	
<i>Eupatorium urticaefolium</i> Reichard		X
<i>Eupatorium verbenafolium</i> Michx.		X
<i>Gnaphalium obtusifolium</i> L.		X
<i>Gnaphalium polycephalum</i> Michx.	X	X

	Big Levels	Mt. Lake
<i>Helianthus autumnale</i> L.	X	X
<i>Helianthus virginicus</i> Blake	X	
<i>Helianthus strobiliferus</i> L.	X	
<i>Helianthus divaricatus</i> L.	X	X
<i>Helianthus giganteus</i> L.		X
<i>Helianthus hirsutus</i> Raf.		X
<i>Helianthus laevigatus</i> T. & G.		X
<i>Helianthus mollis</i> Lam.		X
<i>Helianthus strumosus</i> L.		X
<i>Helianthus</i> spp.	X	
<i>Hieracium paniculatum</i> L.	X	X
<i>Hieracium filiosella</i> L.		X
<i>Hieracium pratense</i> Tausch		X
<i>Hieracium scabrum</i> Michx.	X	
<i>Hieracium venosum</i> L.	X	X
<i>Hypochaeris radicata</i> L.		X
<i>Krigia virginica</i> (L.) Willd.	X	
<i>Lactuca canadensis</i> L.		X
<i>Lactuca hirsuta</i> Muhl.	X	
<i>Lactuca spicata</i> (Lam.) Hitchc.		X
<i>Lapsana occanalis</i> L.		X
<i>Liatris graminifolia</i> (Walt.) Willd.		X
<i>Liatris spicata</i> (L.) Willd.	X	
<i>Mikania scandens</i> (L.) Willd.	X	
<i>Parthenium integrifolium</i> L.	X	
<i>Polygonia canadensis</i> L.		X
<i>Prenanthes alba</i> L.		X

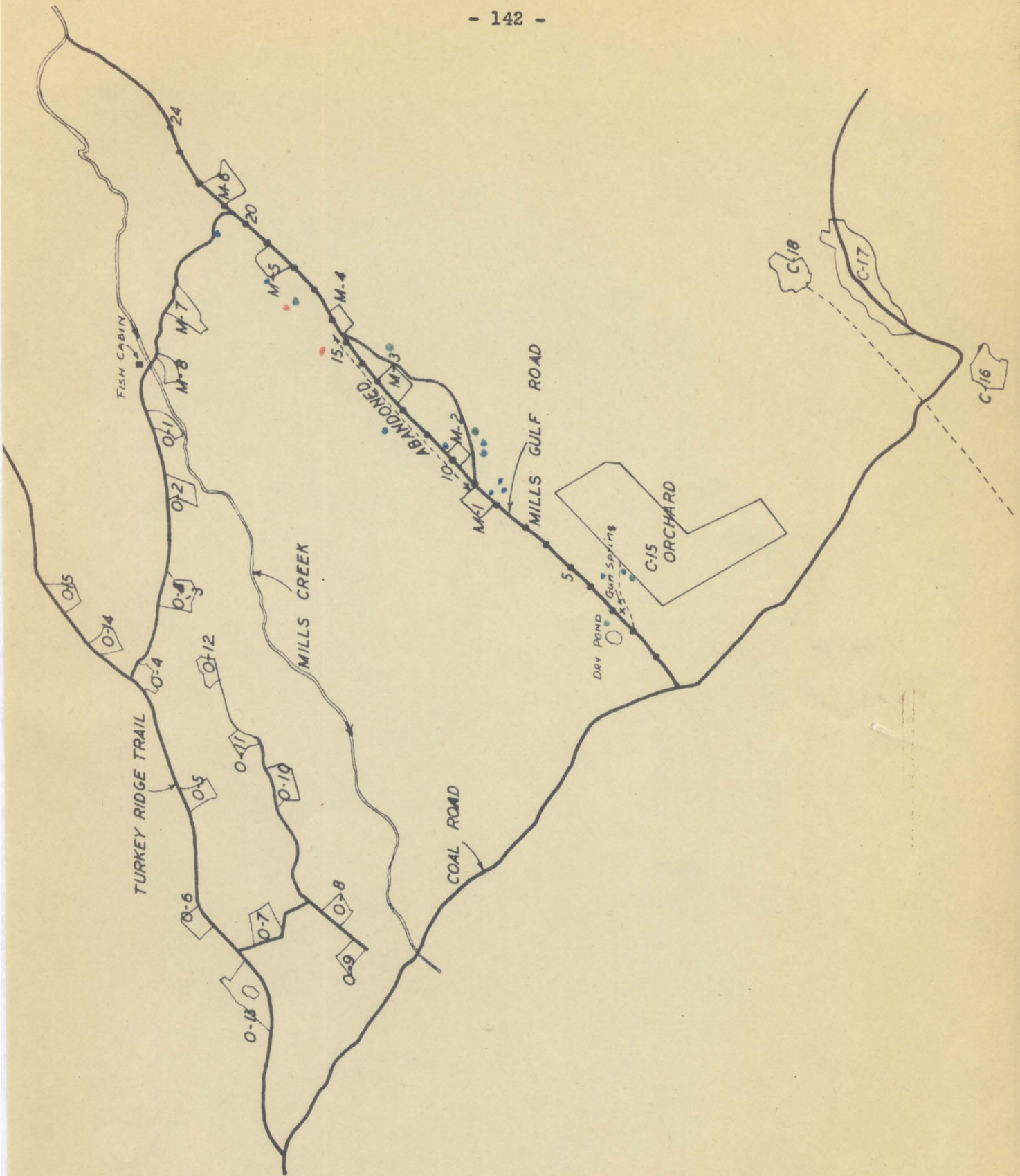
	Big Levels	Wt. Lake
<i>Prenanthes altissima</i> L.	X	
<i>Prenanthes trifoliolata</i> (Cass.) Fernald	X	
<i>Rudbeckia hirta</i> L.	X	X
<i>Rudbeckia triloba</i> L.		X
<i>Senecio aureus</i> L.		X
<i>Senecio tomentosus</i> Michx.	X	
<i>Sericocarpus asteroides</i> (L.) B S P.		X
<i>Solidago bicolor</i> L.	X	X
<i>Solidago caesia</i> L.	X	X
<i>Solidago curtisii</i> T. & G.	X	X
<i>Solidago graminifolia</i> (L.) Salicb.		X
<i>Solidago hispida</i> Muhl.		X
<i>Solidago monticola</i> T. & G.		X
<i>Solidago odora</i> Ait.		X
<i>Solidago puberula</i> Nutt.		X
<i>Solidago rugosa</i> Mill.		X
<i>Taraxacum officinale</i> Weber	X	X
<i>Vernonia noveboracensis</i> Willd.	X	X
<i>Xanthium canadense</i> Mill.	?	X

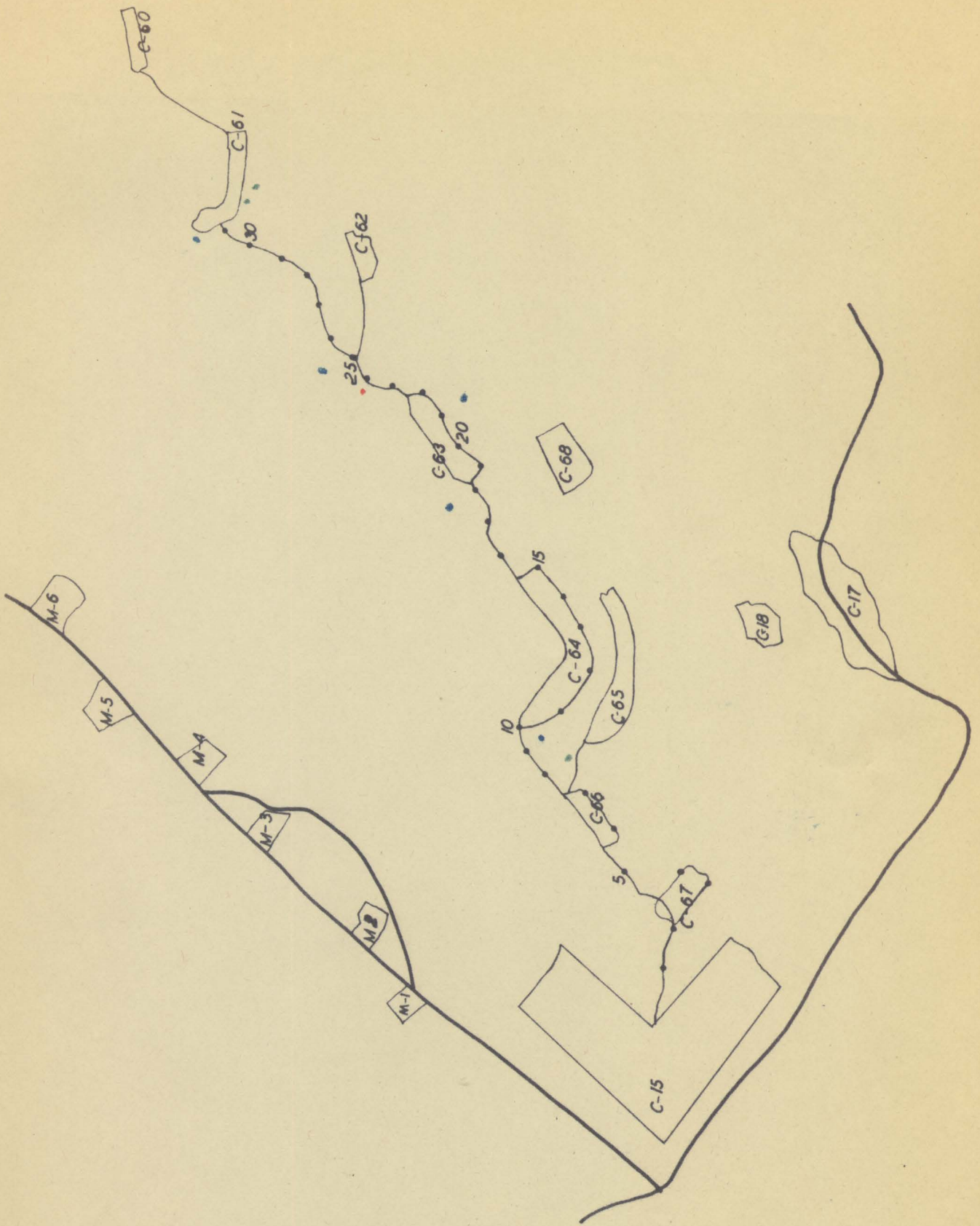
Appendix IV

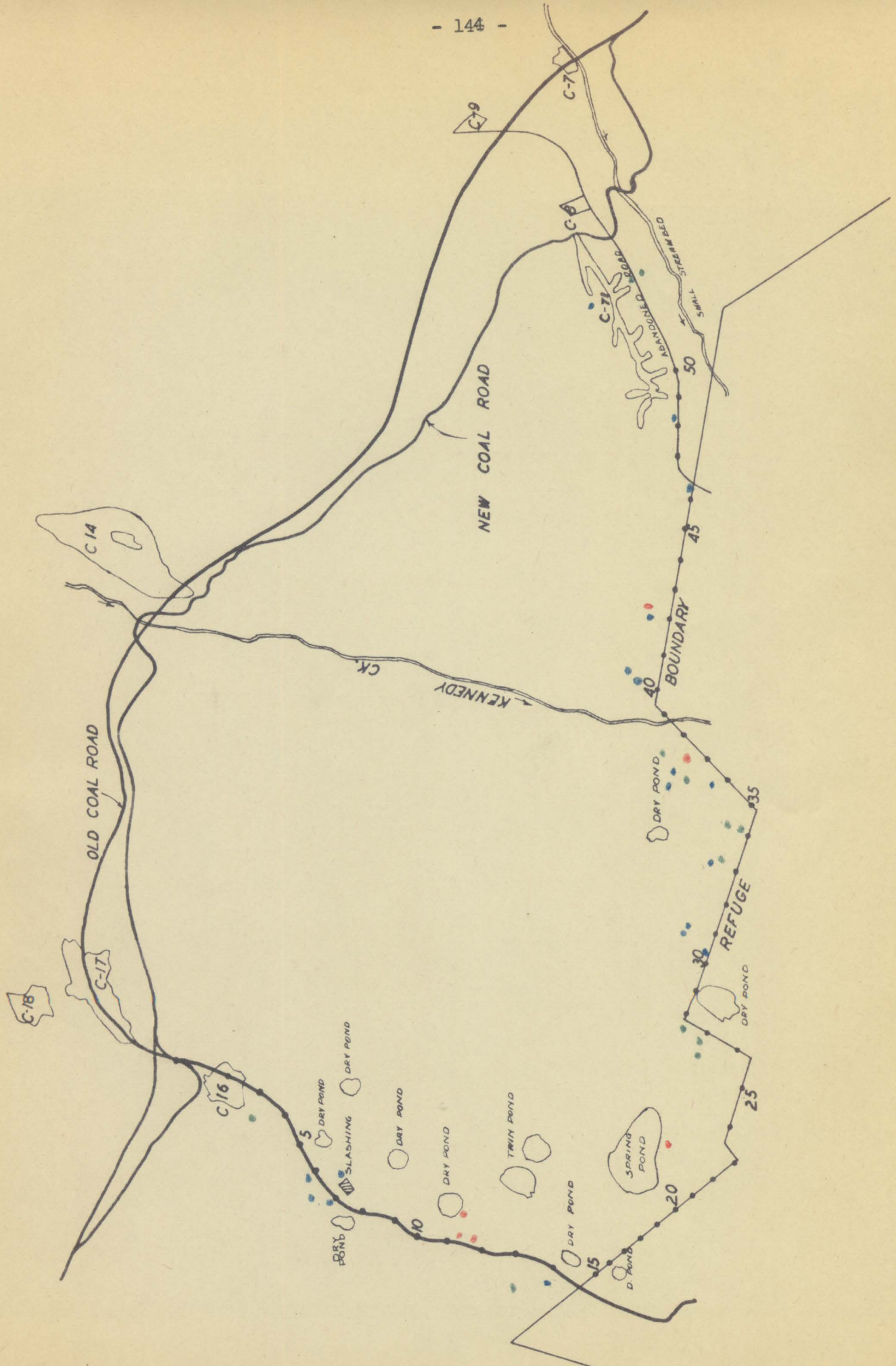
Distribution of Ruffed Grouse Flushed
on
Game Census Areas

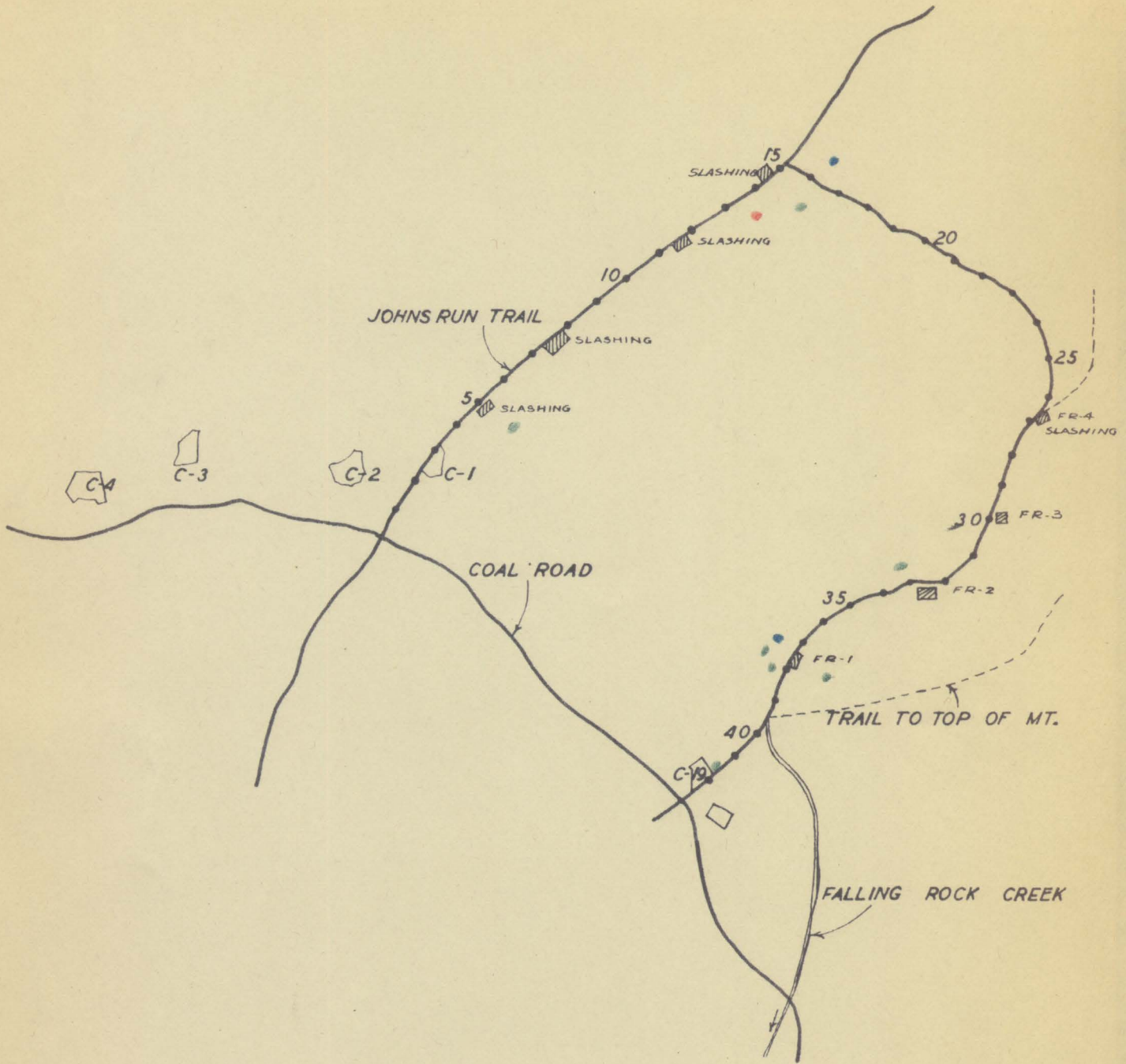
Key

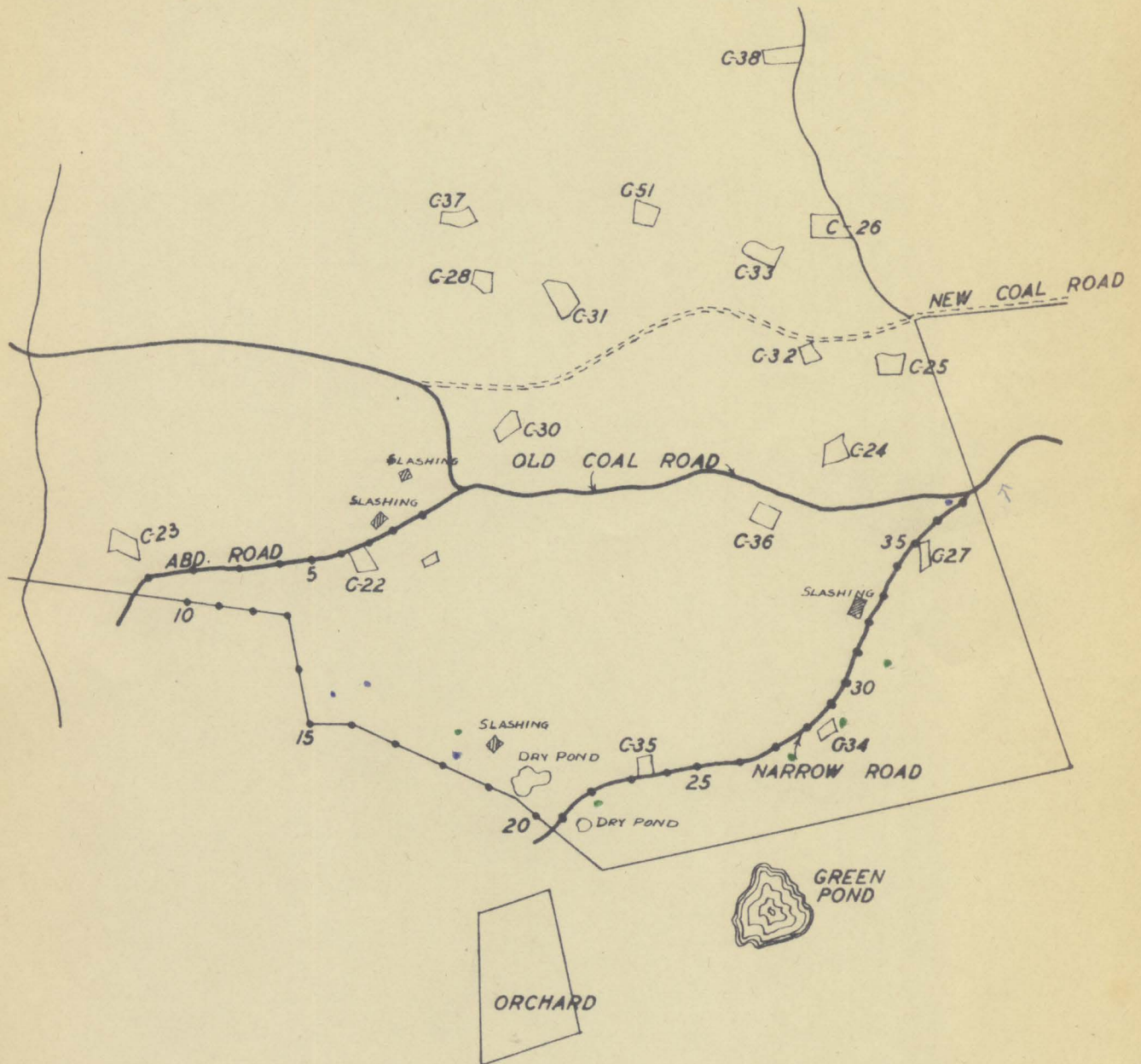
- Birds Flushed In January
- Birds Flushed In February
- Birds Flushed In April











Appendix V

Distribution of Timber Cover Types
on
Game Census Areas

Key



Mixed Oak



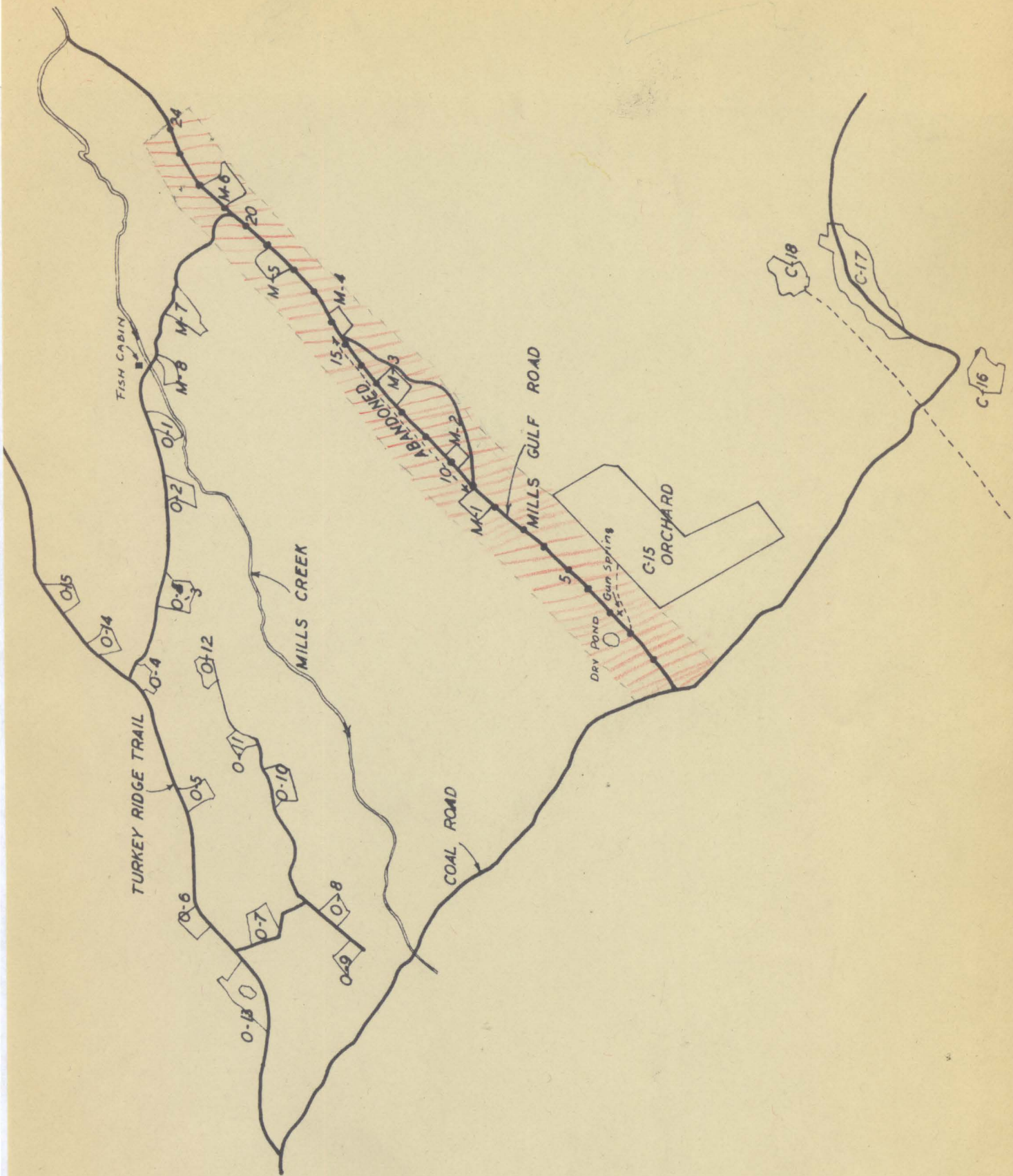
Yellow Pine - Hardwood

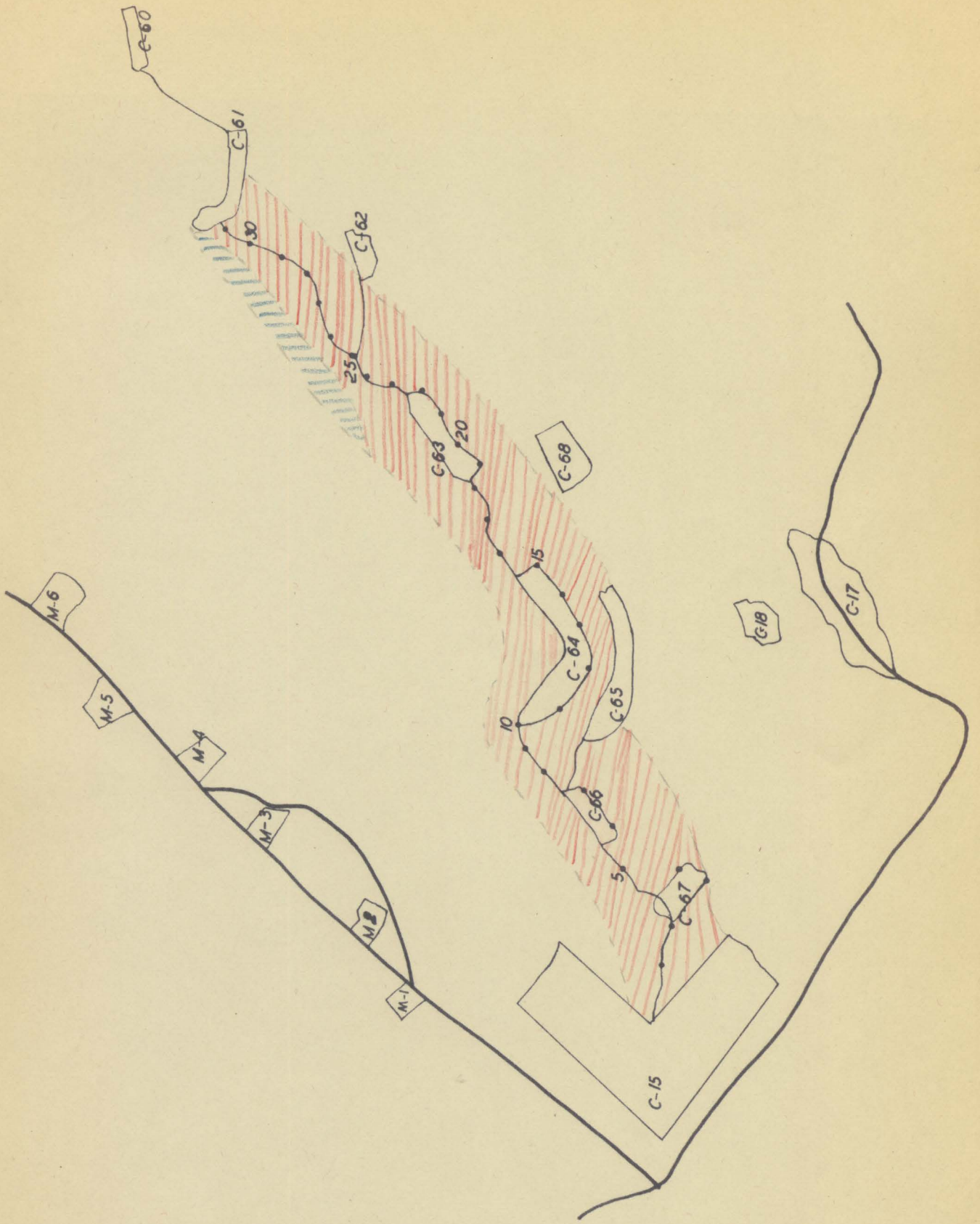


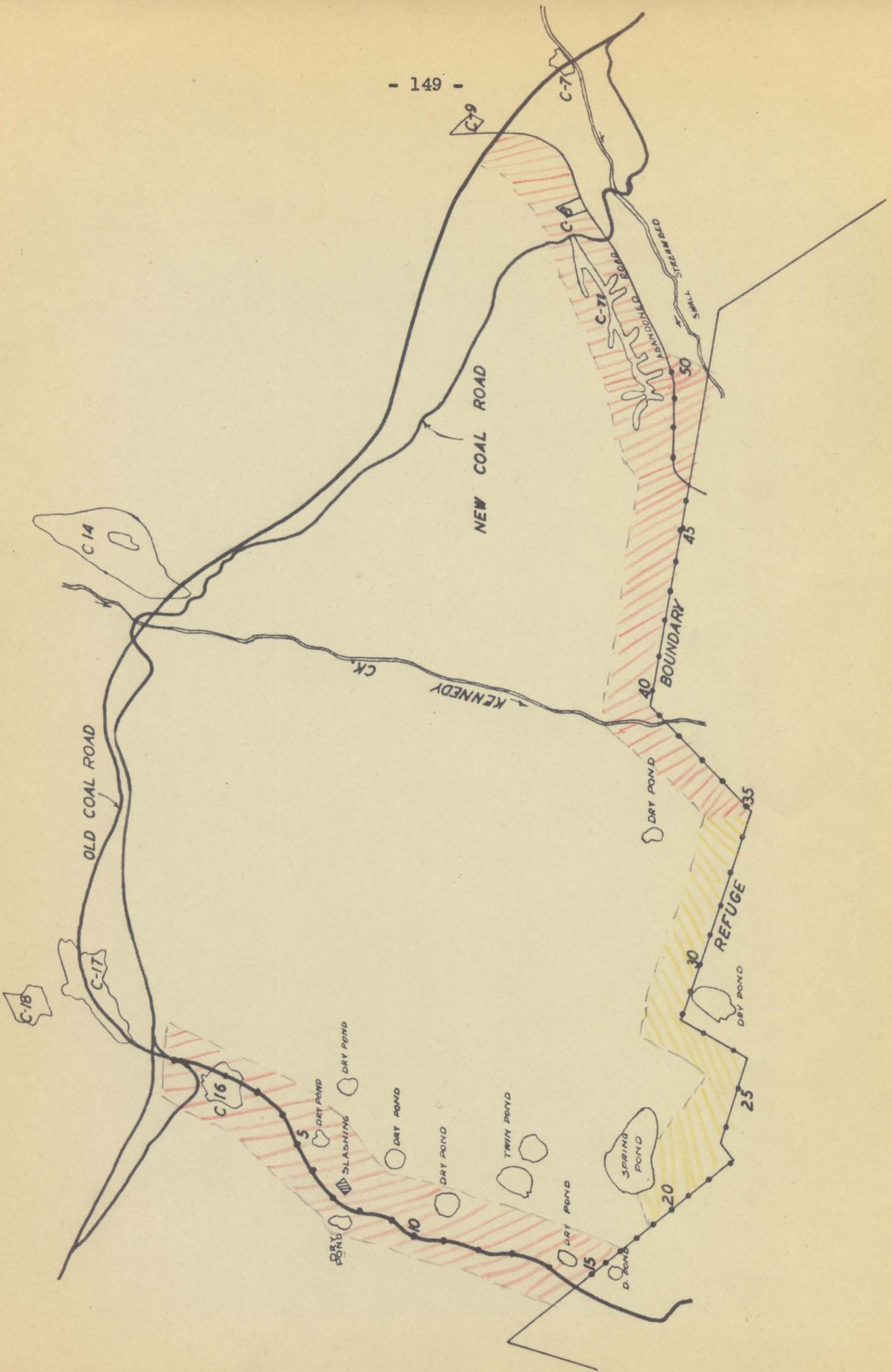
Chestnut Oak

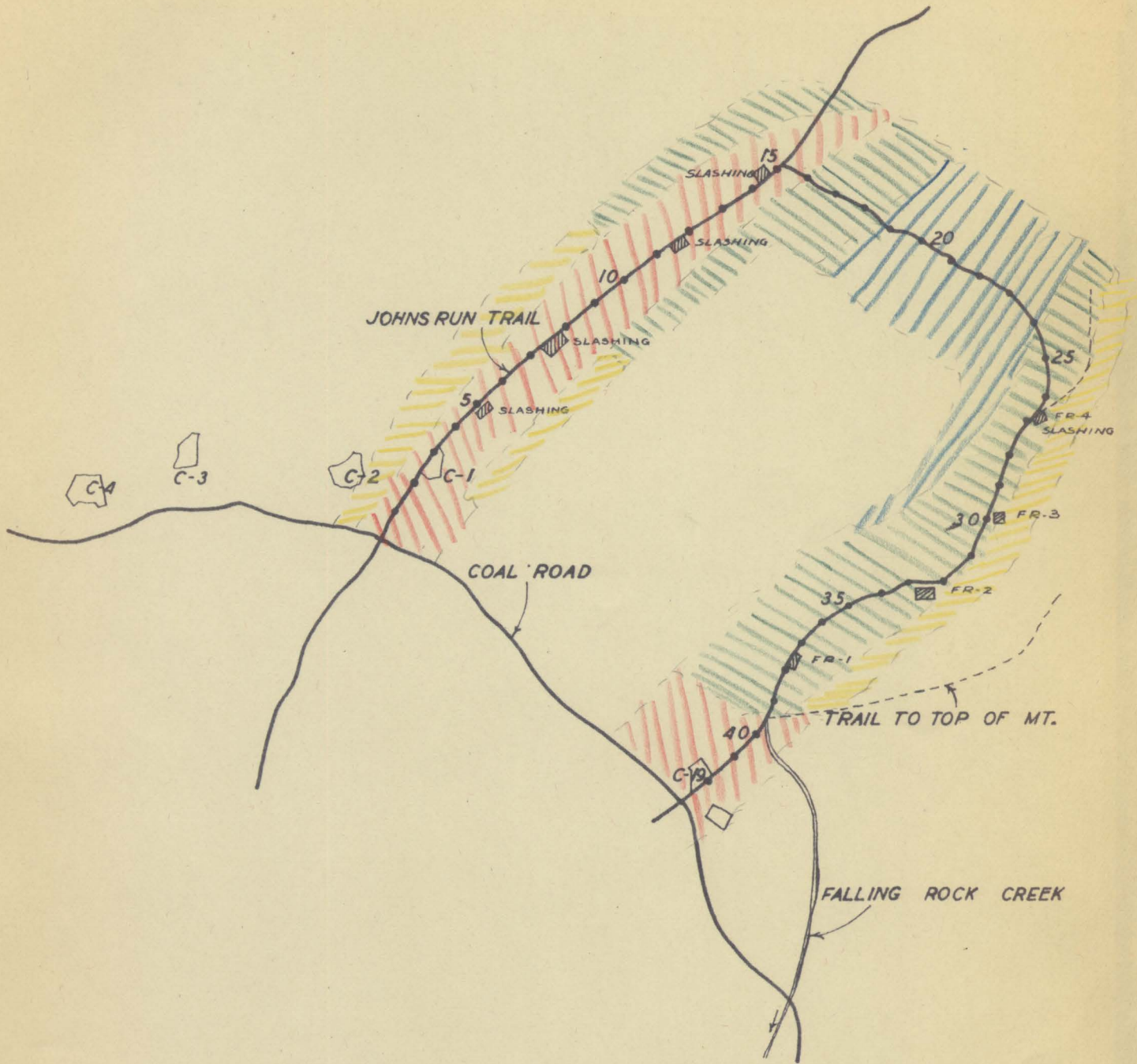


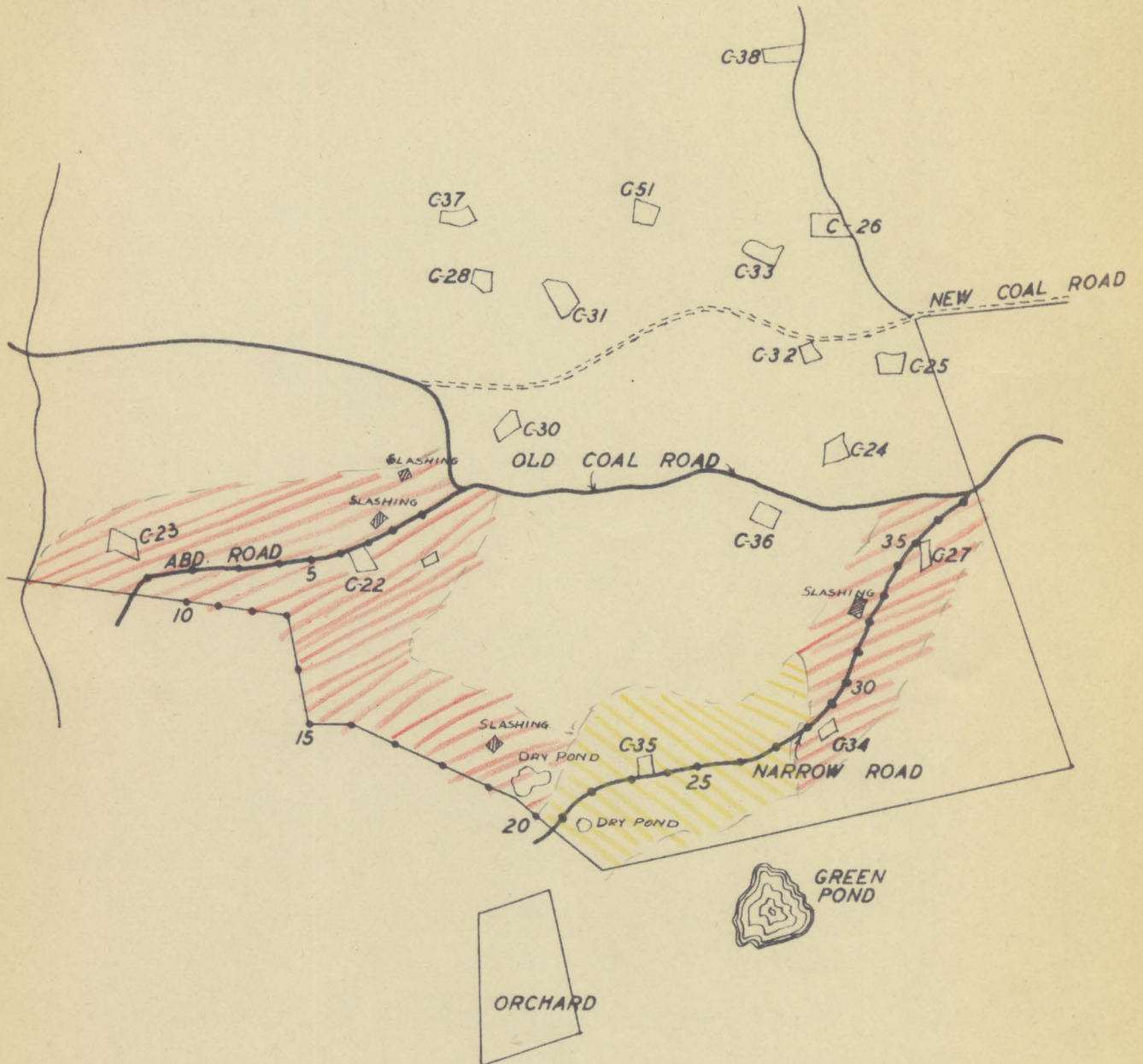
Bear Oak











APPENDIX VI

BIBLIOGRAPHY OF TITLES ON
FOREST WILDLIFE RELATIONSHIPS.

1. Aldous, C. M. - "Woodcock Management Studies in Maine 1937,"
Transactions Third North American Wildlife Conference,
1938, pp. 839-846.
2. Aldous, C. M. - "Studies on Woodcock Management in Maine 1938,"
Transactions Fourth North American Wildlife Conference,
1939, pp. 437-441.
3. Allen, D. L. - "Some Observations on Fall and Winter Food
Patches for Birds in Southern Michigan," The Wilson
Bulletin, Vol. 50, No. 1, March 1939, pp. 42-46.
4. Barlett, M. E. - "Ruffed Grouse and Fruit Trees," Bul. Amer.
Game Protective Assn., January 1924, pp. 15-16, 19.
5. Barret, Leonard, - W. C. Branch and P. F. W. Prater, "Stand
Improvement Work in Southern Appalachians," Journal
Forestry, Vol. 34, August 1936.
6. Blake, I. H. - "Further Studies on Deciduous Forest Animal
Communities," Ecology, Vol. 12, 1931, pp. 508-527.
7. Bradbury, H. M. - "Management of Apple Trees in Massachusetts,"
Journal Wildlife Management, July 1939, pp. 240.
8. Breckenridge, W. J. - "A Bird Census Method," Wilson Bul., Vol. 46,
September 1935, pp. 195-197.

9. Bump, Gardiner - "The New York Ruffed Grouse Survey," Seventeenth American Game Conference, 1930, pp. 207-210.
10. Bump, Gardiner - "The New York Ruffed Grouse Survey," Nineteenth American Game Conference, 1932, pp. 388-403.
11. Bump, Gardiner - "From Scrub Oak and Pitch Pine to Quail," Proc. First American Wildlife Conference, 1936, pp. 599-603.
12. Bump, Gardiner - "Analysis of Certain Cover Requirements of the Ruffed Grouse in New York State," Proc. Third North American Wildlife Conference, 1938, pp. 618-624.
13. Burlington, H. J. - "Land Clearing for Wildlife in Southern New Jersey," Transactions Fourth North American Wildlife Conference, 1939, pp. 546-548.
14. Cahalane, Victor H. - "Integration of Wildlife Management With Forestry," Journal Forestry, Vol. 37, No. 2, February, 1939, pp. 162-166.
15. Chapman, H. H. - "Forestry and Game Management," B. S. '33, Yale School of Forestry, Journal 1936.
16. Clements, F. E. - "Experimental Ecology in the Public Service," Ecology, July 1936, pp. 342-363.
17. Cook, D. B. - "Thinning for Browse," Journal of Wildlife Management, July 1939, pp. 201-202.
18. Cooper, W. S. - "Seventeen Years of Successional Changes Upon Isle Royal, Lake Superior," Ecology, Vol. 9, 1928, pp. 1-5.

19. Couch, Leo K. - "Forest Wildlife Relationship Research," Journal of Forestry, Vol. 36, September, 1938, pp. 913-915.
20. Dalke, P. D. - "The Cover Map in Wildlife Management," Journal Wildlife Management, October, 1937, pp. 100.
21. Darrow, Robert - "Seasonal Food Preferences of Adult and of Young Grouse in New York State," Transactions Fourth North American Wildlife Conference, 1939, pp. 585-590.
22. Davison, Verne E. - "A Field Method of Analyzing Game Bird Foods," Journal Wildlife Management, Vol. 4, April, 1940, pp. 105.
23. Deen, J. L. - "Methods of Studying Browse Preferences of Deer," Transactions Third North American Wildlife Conference, 1938, pp. 256-260.
24. Deen, J. L. - "Forest Practices Affecting Wildlife," Perma. Game News, March, 1938, pp. 12-13.
25. Edminster, F. C. et. al. - "The First Fifteen Months of the New York State Ruffed Grouse Investigation," Eighteenth American Game Conference, 1931, pp. 196-201.
26. Edminster, F. C., Jr. - "Developing Ruffed Grouse Areas," Transaction Twentieth American Game Conference New York, 1934.
27. Edminster, F. C. - "The Effect of Reforestation on Game," Twenty-First American Game Conference, 1935, pp. 313-318.
28. Edminster, F. C. - "The Effect of Predator Control on Ruffed Grouse Population in New York," Journal Wildlife Management, October, 1939, pp. 345.

29. Ehrhart, E. O. - "Forest Management and Deer Requirements on Alleghany National Forest," Journal Forestry, Vol. 34, May, 1936, pp. 472-474.
30. English, P. F. - "Seed Mixture for Food Patches for Wildlife," Michigan Department Conservation Game Management Circular No. 1, 1935, pp. 2.
31. Fisher, Lee, Williams - "Studies of the Eastern Ruffed Grouse in Michigan," Michigan State College Agr. Exp. Station, Tech. Bul. 186, June, 1939.
32. Gabrielson, I. A. - "The Correlation of Forestry and Wildlife Management," Journal Forestry, Vol. 34, February, 1936, pp. 98-106.
33. Gerstell, R. and Long, W. H. - "Physiological Variations in Wild Turkeys and Their Significance in Management," Pennsylvania Game Commission Research Bul. No. 2, 1939, pp. 1-iii, 1-60.
34. Givens, L. S. - "A Preliminary Ecological Survey to Determine the Potentialities of the Mountain Lake Region for Wildlife Production," A thesis for M.S. degree, Virginia Polytechnic Institute, May, 1938, (unpublished).
35. Grange, Wallace - "Some Observations on the Ruffed Grouse in Wisconsin," Wilson Bulletin, Vol. 48, No. 2, June, 1936, pp. 104-110.
36. Gray, D. V. and Hermal, Louis G., - "A Study of Game Cover and Openings in the Buck Creek Plantation, Huron National Forest, Michigan," Transactions Fourth North American Wildlife Conference, 1939, pp. 554-559.

37. Horn, E. E. - "Some Wildlife-Forest Relationships," Transactions Third North American Wildlife Conference, 1938, pp. 376-380.
38. Hosley, N. W., Ziebarth, R. K. - "Some Winter Relations of the White-tailed Deer to the Forests in North Central Massachusetts," Harvard Forest, Petresham, Mass. Unpublished memo. 1934.
39. Hosley, N. W., Ashman, R. I. et. al. - "The Essentials of a Management Plan for Forest Wildlife in New England," Journal Forestry, Vol. 33, 1935, pp. 985-989.
40. Hosley, N. W. - "Some Inter-relation of Wildlife and Forest Management," Journal Forestry, Vol. 35, July, 1937, pp. 674-678.
41. Howard, M. C. - "Use of Power in Making Small Clearings in Bear Oak Brush for Wildlife," Journal Wildlife Management, October, 1938, pp. 179-180.
42. Jackson, H. H. T., Nelson, A. L., Bailey, V. - "Consideration for the Improvement of the Game Resources on the Big Levels Game Refuge," Unpublished report.
43. King, A. J. - "Ruffed Grouse Management," Journal Forestry, Vol. 35, No. 6, June, 1937, pp. 523-532.
44. King, R. T. - "The Essentials of a Wildlife Range," Journal Forestry, Vol. 36, May, 1938, pp. 457-464.
45. Kramer, W. B. - "Game Management in Western North Carolina with Particular Reference to Deer," Minutes of Annual Meeting of the Appalachian Section, Society of American Foresters, Columbia, S. C., 1933, Mimeographed pp. 3-5.

46. Lay, Daniel W. - "How Valuable are Woodland Clearings to Birdlife?"
Wilson Bul. Vol 50, No. 4, pp. 523-532.
47. Leopold, Aldo - "Environmental Controls for Game Through Modified
Silviculture," Journal Forestry, Vol. 28, No. 3, March, 1930,
pp. 321-326.
48. Leopold, Aldo - "Game Range," Journal Forestry, Vol. 29, 1931,
pp. 932-938.
49. Leopold, Aldo - "Game Management," Charles Scribners' Sons, 1936,
pp. 128-132.
50. Leopold, Aldo, etc. - "Wildlife Food Patches in Southern Wisconsin,"
Journal Wildlife Management, Jan., 1939, p. 60
51. Lloyd, Hoyes - "Forest Fire and Wildlife," Journal Forestry,
October, 1938, pp. 1051-1054.
52. Long, W. H. - "The Influence of Cover Improvements in Wildlife
Management on the Distribution, Abundance and Daily Activity
of Wild Birds," (Research 1932) Unpublished report.
53. Long, W. H. - "The Effect of Cover Improvements on Insect and Seed-
eating Birds 1931-1934," School of Forestry and Conservation;
Several papers in process of preparation.
54. Long, W. H. - "The Influence of Wildlife Management and Environment
on the Distribution, Abundance, and Seasonal Activity of
Wild Birds," Unpublished, 1934.
55. Martin, A. C. and May, F. H. and Clarke, T. E. - "Early Winter Food
Preferences of the Wild Turkey on the George Washington National
Forest," Transactions Fourth North American Wildlife Conference,
1939, pp. 570-578.

56. Montgomery, W. E. - "Forest Management on State Forests in Its Relation to Wildlife," Penna. Game News, November 1939, pp. 8-9.
57. Moore, E. C. - "Forest and Wildlife Management in the South Jersey Pine Barrens," Journal Forestry, Vol. 38, January, 1940, p. 27.
58. Morton, James N. and Sedam, John B. - "Cutting Operations to Improve Wildlife Environment for Forest Areas," Journal Wildlife Management, October, 1938, pp. 206-214.
59. Nelson, A. L., Clarke, T. E. and Bailey, W. W. - "Early Winter Food of Ruffed Grouse on the George Washington National Forest," U.S.D.A. Circular No. 504, 1938.
60. Robinson, C. S. - "Truck Trails and Firebreaks: Their Use by Deer On the Santa Barbara National Forest," Journal of Forestry, Vol 33, 1935, pp. 940-942.
61. Sedam, J. B. - "Environmental Controls," Penna. Game News, June, 1937, pp. 21-27.
62. Shantz, H. L. - "Recent Developments in Wildlife Management," Journal Forestry, Vol. 36, No. 2, February, 1938, pp. 149-153.
63. Shelford, V. E. - "Ecological Succession, Vegetation and the Control of Land Animal Communities," Biological Bulletin, Vol. 23, pp. 59-99.
64. Smith, V. G. - "Animal Communities of a Deciduous Forest Succession," Ecology, Vol. 9, 1928, pp. 479-500.

65. Stoddard, H. L. - "The Bobwhite Quail, its Habits, Preservation and Increase," Chapter XIV, Quail Preserve Development and Management, pp. 362-374, Charles Scribners' Sons, 1936.
66. Stoddard, H. L. - "The Use of Controlled Fire in Southeastern Game Management," Cooperative Quail Study Association, Thomasville Georgia, p. 31.
67. Stoddard H. L. - "The Use of Mechanical Brush Cutters in Wildlife Management," Journal of Wildlife Management, July, 1937, pp. 42-44.
68. Thornton, J. E. - "An Ecological Study of Forest Clearings on the Big Levels Game Refuge," A thesis for M. S. Degree, Virginia Polytechnic Institute, February, 1940, (unpublished.)
69. Trippensee, R. D. - "Development and Use of State Forests in New England in Relation to Wildlife," Journal of Forestry, Vol. 35, April, 1937, pp. 403-408.
70. Wight, E. M. - "The Effect of Forest Improvement Work on the Wildlife Environment," School of Forestry and Conservation, University of Michigan, Unpublished report.
71. Wilson Kenneth A. - "Quail Management in Maryland," Proceedings Third North American Wildlife Conference, 1938, pp. 709-716.

APPENDIX VII

AERIAL PHOTOGRAPH

OF

BIG LEVELS GAME REFUGE

(See Frontis piece)

Attention Patron:

Page 161 omitted from document

Attention Patron:

Page 162 omitted from document