SHENANDOAH NATIONAL PARK

MEADOW MANAGEMENT PLAN

APPROVED: _____ 1/22/85
Superintendent Date

Meadow Management Plan

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I. Introduction

A. Purpose

The purpose of this plan is to define the objectives for the future management of the Big Meadow and to establish a program by which these objectives can be met in an environmentally sound, esthetically pleasing and cost effective manner.

The open space at Big Meadows is identified in the General Management Plan as an historic zone. The objectives for the management of this area reflect both the historical value of the area and its significance as an outstanding interpretive resource.

B. Objectives

1. To maintain the meadow area as an open meadow or grassland representative of the way it appeared during early historic times.

2. To encourage natural vegetation diversity which is consistent with the open meadow theme.

3. To provide for and manage appropriate visitor use which is consistent with the preservation of the historical scene and the meadow's ecological values.

C. Origin of the Meadow

The Big Meadow is located on the crest of the Blue Ridge mountains at an elevation of 3,500 feet. This area of open meadowland is unique to the Park. It is the largest, most ecologically interesting and most scenic of the few remaining areas in the Park which were not forested at the time the Park was established. It adds a refreshing change of scene to the heavily-wooded, rugged slopes of this mountainous Park.

It is difficult to state how long the meadow has been in existence or under what conditions it developed. The edaphic--topographic features of the area undoubtedly have contributed to both the creation and continuance of the meadow. The approximately 100 acres which comprise the central portion of the meadow is a bowl-shaped depression which drains the surrounding land. Even during dry years, a small marshy area persists in the center of the depression. The headwaters of Hogcamp Branch originate from this point. Even though the meadow topsoil is rich and productive, it drains poorly, suggesting that a relatively impervious substrate underlays the area. In addition, the general area is very exposed to the ravages of wind and winter cold. These conditions are favorable for the growing

of shallow-rooted grasses and sedges. However, many of the species of climax forest trees common to the Park cannot thrive under these conditions.

This high elevation area has also been exposed to lightning. Summer storms during dry periods may have caused lightning--induced fires which would have retarded the encroachment of woody plants into the meadow. It is doubtful, however, that summer fires would have occurred with enough frequency to maintain the meadow.

Historical accounts relate that Indians frequently used fire in combination with the girdling of trees to create openings for agriculture and to attract grazing animals. The presence of the low marshy area would have been attractive to wood bison and elk as a consistent water supply and also as a summer wallow. A combination of frequent clearing by Indians, the effects of heavy grazing, and the natural tendency for the area to support a meadow type plant community may well have caused the area to persist as an open area.

Dr. John Lederer, an early explorer of this region, traveled through the Blue Ridge area in 1669. In his journal, he described a mountain top meadow which may have been what we now call Big Meadows. This is the only early historical reference to this mountain meadow.

Although the exact origin or early history of this meadow is uncertain, we do know how it was able to persist from the beginning of the 19th century. Ample water and feed for livestock attracted early settlers to the meadow by the early 1800's. By the time of the Civil War, the area was a leading producer of beef cattle. The meadow was enlarged by the effects of the constant grazing. By the end of the 1800's, the fields or barrens, as they were often called, exceeded 1,000 acres. This pasture was maintained by grazing until the Park was established.

D. Ecological Evaluation

The pre-settlement ecology of the meadow is of some academic interest and is the basis for its designation as an historic zone. The effects of man on the natural processes of the meadow over the last 150 years have so altered the area that pre-historic conditions can never be restored. What is relevant today is the current condition of the meadow and its ability to persist as an open area representative of that which was present during early historic times.

The recollection of area residents and Park personnel together with historical photographs, tell of dramatic ecological changes to the meadow since 1935. The sequence of plant succession during the last 40 years can be divided into four stages.

Stage 1 (1935-1940): pasture grasses, sedges, and a few forbes.

Stage 2 (1940-1945): reduced amounts of grasses, increased abundance of forbes, annual flowering plants such as daisy, yarrow, milkweed, and fleabane. Blackberry and tree seedlings present on the perimeter of the meadow.

Stage 3 (1945-1960): a mixture of grasses, large annual flowering plants and ferns. Stands of hazelnut, hawthorn, and black locust are common. Blackberry has become entrenched throughout the area.

Stage 4 (1960-1984): a vegetation mosaic of several vegetation types. Stands of hawthorn and hazelnut are firmly established. Fields of black locust and blackberry comprise over 30 percent of the total meadow area. Other hardwood tree species such as sassafras and wild cherry have become established on the perimeter. The area has lost its previous open meadow characteristics and botanically is very different from that which was present in the 1930's.

It is clearly evident that the meadow has rapidly progressed along its successional path towards some kind of forest cover type. In the absence of heavy grazing by herds of wild or domestic animals, the meadow vegetation has progressed towards what the present ecological conditions and past management actions in the meadow have favored.

A closer examination of the vegetation complexes in the meadow today shows that in the absence of grazing, native vegetation characteristic of high elevations bogs has begun to flourish in the central wet area. Some of these species are found in few other areas of the Park. Although uncommon, none of these species are considered rare or endangered, and most of them are also found in the area referred to as the Big Meadow swamp located adjacent to the campground. Fields of blueberries have become established in the well-drained upland meadow areas. Small stands of hazelnut and hawthorn grow in favorable locations near the edge of the bog. This diversity of vegetation provides cover and food for a wide variety of wildlife, which is frequently viewed by Park visitors.

The Park publication, "Vascular Plants of the Meadow at Big Meadows--SNP" by Emily Baxter (Appendix I) lists 272 species of vascular plants that have been identified in the meadow. This plant diversity makes the area of considerable botanical interest and importance.

E. Visitor Use

Big Meadows has long been popular with Park visitors because of its natural beauty, its open, airy and sunny appearance, the presence of easily-viewed wildlife, and the large patches of blueberries which ripen during the peak of the

visitor season. The Byrd Visitor Center was located adjacent to the meadow because of its historic scenic value. The building was designed with wide exposure of glass facing the meadow and provides visitors with a commanding view of the meadow and surrounding forests. This view often inspires visitors to take the time to walk out into the meadow to stretch their legs or linger in the sun.

F. Interpretation

Byrd Visitor Center was opened in April 1966. It contains a museum on the human history of the Park and plant succession in this locality. "The Gift," a 20-minute movie on Park and area history, is shown repeatedly during the day. The Park Library, Park Slide File, and Museum Study Collection are also located at the visitor center. Big Meadows has long been one of the primary localities for Park interpretation and a destination for many returning visitors. Ranger-naturalists lead conducted walks into the meadow throughout the year. They also give demonstrations and evening programs that relate to it. Topics covered include flora and fauna, ecological succession, history, and meadow management. Big Meadows is described and interpreted in many articles and publications on the Park.

II. The Problem

Constant grazing during the later years prior to the establishment of the Park maintained the grassy pasture relatively free of woody plants. It allowed a tough, dense turf to develop which was resistant to the encroachment of pioneer tree species. In the absence of grazing, natural plant succession has been allowed to continue. Without the constant cropping by cattle, the grasses have become less dense, allowing the germination of herbaceous plants, woody shrubs such as witch hazel and blueberry and pioneer tree species such as black locust and wild cherry. Once established, this successional process has accelerated to the degree that the historical scene is being lost and the once open meadow is threatened.

It is obvious that the natural processes at work, if left unchecked, would soon result in a brushy field as the first step towards complete forestation. The problem then is one of altering or stopping these natural processes in order to maintain the desired open meadow landscape. This process will require a large initial effort to reclaim portions of the meadow already lost to succession and an annual maintenance program to keep the area at the desired successional stage.

A secondary problem is controlling or channeling visitor use in the popular area. In the absence of designated trails, visitors wander throughout the meadow, traveling wherever they wish to go. Although this freedom of travel is most likely preferred by many visitors, it has led to a proliferation of trails that have little purpose or direction. In some locations, these trails

have become unsightly and detract somewhat from the natural appearance of the meadow. Resource impacts such as soil erosion have not yet become a significant problem.

III. Past Management Practices

Mowing

Prior to 1975, the meadow was mowed annually during the month of November in an attempt to keep the area free of woody vegetation. This practice was probably somewhat effective during the early years but became less and less effective as black locust and blackberry became better established. By the 1970's, it became apparent that in spite of the mowing, woody vegetation was rapidly encroaching on the meadow. It was decided that alternative methods were needed to maintain the area. Mowing was discontinued in 1974 so that experiments in other types of control could be conducted.

Prescribed Fire

The first prescribed fire ever undertaken in this Park was done in the meadow on March 24, 1975. This was still a controversial practice in the east at that time and drew a lot of attention from the managers and scientists in the regional and Washington offices. The burn was successfully accomplished and monitoring of the results was initiated. Another section of the meadow was burned on October 31 to test the effects of a fall burn on vegetation communities.

Over the next six years, several other prescribed fires were conducted on the meadow.

1976: Spring burn in March - northwest half of the meadow.

1977: Spring burn in March - southeast half of the meadow.

1978: Spring burn in March - northeast half of the meadow.

1979: Spring burn in March - southeast half of the meadow.

1980: Spring burn - cancelled.

1981: Spring burn in April - northwest half of the meadow.

1982: Spring burn in March - south of Rapidan Road.
Spring burn in April - northwest half of the meadow.

After the first three burns, it became evident that dormant season fires were having little effect on the abundance of black locust and blackberry. Later fires incorporated the mowing of vegetation the previous fall. However, the results were the same.

IV. Meadow Fire Ecology Research

Since 1975 several research projects have been conducted on the effects of mowing, burning and other practices on the soils and animal and plant communities in the meadow. Some of these were contract research projects performed by local universities and others were small informal studies done by Park personnel.

The effects of fire on the composition of plants in the meadow were studied by Cocking and Baxter. (see Appendix A, #1.) The project titled, "Plant Community Responses to Single and Repeated Prescribed Burns at Big Meadows, Shenandoah National Park," provided a great deal of valuable information and increased our understanding of how the various plant communities in the meadow actually respond to early spring or fall fires.

Robinia (black locust) cover was increased in proportion to other cover types following single and repeated spring burns. In Baxter's report, she states, "the 32 percent increase in total cover during the second summer after burning (recovered single burn) can be attributed mostly to increased shrub cover, specifically Robinia, which increased 110 percent in absolute cover. Increased cover from root sprouting compensated for the death of the year-old shoots, resulting in no change in Robinia absolute cover by August after a single burn. In the absence of a second fire, prolific root sprouting continued to increase cover significantly in the second growing season after burning. The vigor of the recovered Robinia suppressed growth of all herbaceous species." In summary, her findings have shown that following a spring fire, black locust are able to completely recover before the end of the growing season and in the absence of a fire, the second year will show an increase in total cover. In the presence of a second year burn, the percent increase was reduced to 64 percent, but total cover was still higher than in the unburned control plots.

Fire affects Rubus (blackberry) differently. Baxter found that fire retards Rubus growth. In her report she states, "the absence of change in August Rubus cover after a single burn compared to the 21 percent increase in control cover indicates that there is some suppression of Rubus growth in the summer following burning."

Baxter (see Appendix A, #1) also found that graminoids were affected differently depending under what conditions they were growing. She states, "graminoids were suppressed by fire in the grassland, but exhibited substantial gains in cover in the shrub sub-community."

In general, herbaceous plants other than graminoids were increased by fire in the shrub sub-community and decreased in the grass sub-community. However, gains in non-woody plant

cover were likely to be lost in two to three years following a burn because of shading and competition from rapidly growing locust sprouts.

Baxter concludes in her report, "overall, prescribed burning in the early spring at Big Meadows results in a transient reduction in plant community biomass, which is compensated for within one or two growing seasons with little impacts on the species composition of the community as measured by plant cover."

A second study by Stephen L. Lilly (see Appendix A, #6), titled, "Plant Community Standing Crop Responses to Single and Repeated Prescribed Burns at Big Meadows, Shenandoah National Park," was completed in 1980. This work studied the responses of total community standing crop responses to the same prescribed fires (1975, 1976) as was studied by Baxter. This work, however, also looked at the plant responses to mowing prior to being burned.

When studying the shrub sub-community, the author states, "all August graminoid standing crop estimates in vegetation which had been mowed in the fall of 1974 and burned on one or more occasions are higher than all mowed plots which had not been burned. This strongly suggests that burning promotes graminoid growth within shrub sub-community vegetation which has been recently mowed prior to burning."

In contrast to Baxter's study, Lilly (see Appendix A, #7) found that Rubus is a more successful competitor in the year immediately following single or repeated spring burns, and repeated burns would lead to a Rubus dominated community.

In general, Lilly (see Appendix A, #7) found that there were significant changes in total biomass in all communities as examined in August following a burn. In the grass sub--community, total biomass for all species was reduced, however, it must be kept in mind that biomass included dead plant matter also. The fire would have removed all litter and dried grass which, in itself would account for a reduction in the biomass totals. Total biomass of Robinia was reduced, but he found that the number of stems was increased following a single burn.

Near the end of the period in which these two studies were conducted, Park Biologist Phillips experimented with manually burning study plots during the summer months. Separate plots were burned in June, July, and August. Experiments were also conducted on the effects of mowing in the summer and manually burning the debris two weeks later. In one test, he hand cut Robinia sprouts after they had regrown following the first burning treatment. He found that repeated cutting and burning during the summer reduced locust stems by as much as 80 percent.

An investigation into the effects of prescribed fire on meadow fauna was conducted by Dr. Peter Dalby (see Appendix A, #6). He found that reptiles and amphibians were most affected by fire.

He recommended that burns be conducted early in the spring during cold weather when these animals are less apt to be active. Rodents and rabbits did not seem to be affected. Evidently, they were able to escape the flames by entering burrows. Although he thought that mowing must impact some animals, he was unable to document cases of this occurring.

Dr. Norman L. Christensen (see Appendix A, #5) conducted a study on the effects of mowing and burning on soil nutrients in the meadow. He concluded that although burning may provide some short-term soil enrichment that this was affected by rapid nutrient leaching with a net long-term loss of nutrients. In general, he stated that burning has little effect on soil nutrients in the meadow and should not be a major factor in determining what management practices to use.

Conclusions of Fire Ecology Research

Research on the effects of mowing and burning has concluded that neither practice is effective in reducing the percentage of shrub cover represented by Robinia and Rubus. Both dormant season (spring or fall) treatments have basically the same effect on woody plant species and briars. Robinia may, in fact, be encouraged to spread by dormant season cutting or burning. Dr. Cocking (see Appendix A, #3 and #4), the principal investigator of the two main plant fire ecology studies, summed up his findings in a paper presented at the First Conference on Scientific Research in the National Parks in 1976. He stated, "a fire stabilized community will also be dominated by shrubs. Spot treatments within patches of the shrub-briar community such as repeated burns during the growing season, or more severe eradication techniques may be necessary if a shrub grassland mosaic is to be maintained."

Soil fertility is slightly enhanced the first year following a burn, but in the long run, repeated burns may deplete nutrients due to losses of some nutrients into the atmosphere during combustion.

The effects of mowing or burning during the early spring have little affect on the meadow fauna. However, mowing during the summer may impact some ground-nesting birds, such as the eastern meadowlark and the rufous-sided towhee. However, the remaining unmowed area should provide adequate nesting areas to maintain the species.

It is clear that any attempts to stress or remove the woody plant species in the meadow must be conducted during the active summer growing season. Under the current meadow conditions, the only benefit derived from dormant season burning is the reduction of dead plant material which exposes more soil surface and promotes the germination of grass and forb seeds. These fires also stimulate established grasses by removing bedded thatch and temporarily reducing the shading from locust saplings. However,

because fire also stimulates the sprouting and spreading of locust and briars, fire is only beneficial in a grass dominated plant community where only occasional locust is found. In these situations, a strong healthy growth of grasses may successfully compete with young locust sprouts and retard their growth to the point where periodic fires can maintain the grassland relatively free of new locust growth.

V. Management Program

A. Goals

The primary goal of the management program is to restore an open grassland plant community to Big Meadows, which is representative of that which was present during early historic times. In order to accomplish this task, the woody plant species which are currently threatening the meadow must be removed and a plan of action followed that will prevent the future encroachment of these plant species.

A second goal is to manage visitor activity in the meadow so that use impacts do not significantly detract from the meadow scene or cause significant damage to the natural resources of the area. This must be accomplished in a way that does not detract from the interpretive value of the area.

B. Vegetation Management

Discussion

The primary woody plant species to be removed are Robinia pseudo-acacia and Rubus sp. Both of these are highly prolific and successful pioneer plant species. Robinia has formed large dense stands of sapling-sized trees over approximately 25 percent of the meadow and is present to some degree over 50 percent of the meadow. Rubus is less well established and usually is present in the Robinia stands especially following past prescribed fires or mowing operations.

In order to accomplish the desired results, drastic measures will be needed during the initial stages of management activity. It has been well documented that dormant season mowing or burning only serves to stimulate locust (Robinia) to form basal and lateral sprouts and brambles (Rubus) to spread. In order to control these species, they must be repeatedly stressed during the growing season. Several methods will be employed to create the needed stress to kill the plants. If these methods prove successful, the process should take from one to three years to accomplish. After the bulk of the unwanted plants are removed, a program including these stress methods plus periodic spring burns to stimulate the growth of grasses, forbes, and flowering herbaceous plants will be conducted. The central wet portion of the meadow including the small stands of hazelnut and witch

hazel will not be affected by these treatments. The meadow will be divided into three management zones according to relative amounts of target species present (see Appendix F).

Management Zone A consists of those areas having the highest density locust and blackberry growth (vegetation type A). Management Zone B includes large areas of mixed upland vegetation which contains low densities of locust and blackberry (vegetation type B). Zone C consists of the central boggy area of the meadow (vegetation type E though N) (see vegetation map, Appendix F).

Management Actions

Mowing

The primary objective during the early stages of the management program is to repeatedly stress the locust and blackberry during the active growing season until all of the root reserves are used up and the plants die. This will be accomplished by repeated mowing with a flail-type tractor mower. The first mowing will be undertaken as soon as the locust leaf comes out in the spring. The thick locust areas designated for mowing (Management Zone A) will then be mowed every three weeks or as soon as locust sprouts again reach 6-8 inches in height. The mowers' height will be adjusted to cut the locust stems as low as possible. This process will be repeated as long as locust saplings continue to resprout but likely will not exceed four consecutive mowings.

The long-term result of repeated summer mowing will be the reduction of woody and herbaceous plant biomass and an increase in graminoid biomass. However, a significant amount of short growing herbaceous plant species are expected to persist in the mowed area along with the grasses.

Flaming

Burning the locust saplings and blackberry brambles with a diesel-fueled flame thrower will be used as an alternative to mowing in the heavily-infested areas (Management Zone A) when the soil is too wet to use heavy mowers. This method is effective but very labor intensive. It will be used only when absolutely necessary to prevent regrowth and subsequent loss of the effects of stress on the target plants.

Manual Cutting and Stump Treating with Herbicide

In the areas where locust are relatively sparse (Management Zone B), locust samplings will be cut with a hand--held string trimmer equipped with a cutting blade. The cut stumps will then be treated with a herbicide using a wick applicator attachment on a hand sprayer. This will kill the locust root system upon one application of the chemical.

This method will allow the other vegetation in the community to remain intact, resulting in some needed and desirable plant diversity in this area.

Prescribed Burning

Although research has shown that dormant season prescribed fires are not effective in reducing Robinia or Rubus under present meadow conditions, this method may still prove to have some use in the future management of the meadow. It is well established that prairie fires were effective in preventing the spread of forests into the fertile Great Plains. In this case, fire was effective because the grass community was very dense and was resistant to the establishment of woody vegetation. The fires burned very hot and spring regrowth of native grasses was rapid enough to choke out the seedlings of invading vegetation.

In the absence of woody growth and with periodic summer mowing, the grass in Big Meadows may become much more dense thus providing greater resistance to the growth of Robinia and Rubus seedlings. If this should become the case, then spring burning of the meadow on a two or three year cycle may prove effective in at least partially controlling the invasion of woody plants.

Summer burning of the meadow would have even greater effect on woody vegetation if conditions were conducive for a steady, hot fire. Fine fuel moisture would have to be below 5 percent and relative humidity below 50 percent to carry a good fire. These conditions could only be met during an extended drought period. The low frequency of good summer burning periods coupled with the inherent risks of burning during these extreme conditions will result in this control method very infrequently being considered for use.

C. Visitor Use Management

Discussion

The meadow is a very popular visitor use area and, because of this popularity, some use impacts have become noticeable.

At the present time, there is a proliferation of trails which ramble throughout the meadow. In that the meadow is frequented by deer, it appears that visitors have used and worn the faint deer trails to the point that they have become thoroughly established as human trails. Their number is far greater than is necessary for people to visit and explore the meadow.

Three possible solutions to this concern have been identified. The first is to select those trails that form the best travel pattern over the meadow and adopt these as official meadow trails. The remainder of the trails would be obliterated.

Visitors would be encouraged to confine their travel to these trails. The second solution would be to select a loop trail route using as many of the existing trails as possible. The remainder of the heavily-used trails would be obliterated. Visitors would not be required to stay on the trail. However, the trail would, in fact, absorb much of the foot travel in the meadow. There is a third alternative and that is to allow current use patterns to continue. Present impacts to the natural resources are thought to be minimal. The major concern at this time is that any increase of foot travel on these trails could result in soil erosion problems. It is expected, however, that future vegetation management techniques will alter the plant communities, and is possible that the expected increase in grass cover will make the ground surface more resistant to wear and thus reduce foot traffic impacts.

Management Actions

For the first three years, no controls will be placed on visitor use in the meadow. The foot trail system will be allowed to respond to the overall meadow vegetation management treatment. The effects of this treatment on the trails will be monitored to determine any changes over time. After this period, the situation will be evaluated and a future plan of action determined.

A study committee will be formed to evaluate the type of visitor use currently permitted in the meadow and the resulting impacts. This committee will consist of a representative of the central district maintenance, RM&VP, and interpretive divisions. The goal of this group will be to explore methods to control impacts and recommend any needs for future management action or research. If studies are needed, the central district ranger, in consultation with the district foreman and interpreter will be responsible for carrying out the needed research.

Interpretive activities, programs, and publications will be used to keep visitors appraised of management actions and future plans. Visitor comments on our management actions will be actively solicited.

D. Monitoring

The effectiveness of the management actions will be monitored annually. Long-term vegetation monitoring plots will be established in the meadow. Plot sampling will be done in the late spring just after complete green-up and prior to the first management treatment of the summer. Monitoring at this time should accurately reflect the effects of the past seasons management actions on the plant community. Changes in plant composition will be described in terms of species density (stem count) per unit of area (m^2). The results of each year's sampling will be added to this plan as Appendix H.

In addition to the sample plots, aerial photographs will be taken at the same time the plots are sampled. Color infrared and standard color photographs will be taken from a fixed wing aircraft at an elevation of 1,000 feet above the meadow. These photographs will be printed at the same scale each year and utilized to determine any changes in vegetation composition or trail impact as reflected by the imagery.

A breeding bird census will be conducted by the interpretive division on an as needed basis to monitor any changes in the bird community in the meadow.

VI. Meadow Management Plan Five-Year Management Program Summary

Schedule of Accomplishments

FY 84

Management Actions	Staffing	Costs	Supervisor
(a) Mowing (from June-Sept) two to four week intervals as needed. Total of four mowings Management Zone A	36 WD	$3,000	C.D. R&T Foreman
(b) Manual cutting and application of herbicide. July-one treatment Management Zone B	10 WD	$1,000	C.D. R&T Foreman
Monitoring			
(a) Establish vegetation survey plots-June	5 WD	$ 300	C.D. RM&VP
(b) Take aerial CIR color photographs of the meadow	1 WD	$ 200	HQ RM

FY 85

Management Actions			
(a) Mowing (from June-Sept) two to four week intervals as needed. Total of four mowings Management Zone A	36 WD	$3,000	C.D. R&T Foreman
(b) Manual cutting and application of herbicide. July-one treatment Management Zone B	5 WD	$ 500	C.D. R&T Foreman
(c) Analyze visitor use impacts. Suggest alternatives for action.	---	---	Study Committee

Monitoring

(a) Sample vegetation survey plots-June	4 WD	$ 200	C.D. RM&VP
(b) Take aerial CIR and color photographs of the meadow	1 WD	$ 200	HQ RM
(c) Breeding bird census	2 WD	$ 100	C.D. Interp.

FY 86

Management Actions	Staffing	Costs	Supervisor
(a) Manually cut and apply herbicide to remaining locust in Zone A	4 WD	$ 400	C.D. R&T Foreman
(b) Conduct needed research or perform any impact rehab work	--	--	Committee

Monitoring

(a) Sample vegetation survey plots-June	6 WD	$ 300	C.D. RM&VP
(b) Take aerial CIR and color photographs of the meadow	1 WD	$ 200	HQ RM
(c) Breeding bird census	2 WD	$ 100	C.D. Interp.

FY 87

Management Actions

(a) Study results of mowing and adjust program, if needed	--	--	
(b) Analyze need for future visitor use impact controls or rehab programs	--	--	Committee

Monitoring

(a) Sample vegetation survey plots-June	6 WD	$ 308	C.D. RM&VP
(b) Take aerial CIR and color photographs of the meadow	1 WD	$ 200	HQ RM
(c) Breeding bird census	2 WD	$ 100	C.D. Interp.

FY 88

Management Actions

(a) Possible spring prescribed burn	15 WD	$1,000	C.D. RM&VP
(b) Revise Meadow Mgmt Plan	5 WD	$ 400	HQ RM

Monitoring

(a) Sample vegetation survey plots June	6 WD	$ 300	C.D. RM&VP
(b) Take aerial CIR and color photographs of the meadow	1 WD	$ 200	HQ RM

ENVIRONMENTAL ASSESSMENT MATRIX SUMMARY
RESOURCES MANAGEMENT PLAN

PROJECT STATEMENT CODE AND TITLE: SHEN-N-013 Meadow Management

NEED FOR THE PROPOSAL: Big Meadows is managed to protect and perpetuate the historic scene. Plant succession and visitor use are resulting in changes and impacts which are threatening the meadow scene.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION Implement meadow mgmt plan.	NO ACTION Stop current actions	ALTERNATIVE Continue past practices of managing the meadow.	ALTERNATIVE
Cultural Resources	Historic scene will be protected.	Historic scene will be lost.	Historic scene will be altered.	
Wildlife	Unique wildlife habitat will be protected. Some species may be displaced in the meadow uplands.	Unique habitat will be lost in about 20 years.	Unique habitat will be eventually lost.	
Vegetation	Most of the locust and blackberry will be removed. Grasses will be enhanced.	Plant succession will result in a rapid encroachment of woody plant species.	Control of locust will continue to present progressively more difficult control problems.	
Aesthetic Values	The meadow will be maintained with methods that will produce as natural an appearance as possible. A method of reducing trails will be sought.	The area will become a brushy field prior to being reclaimed by the forest.	Annual cutting and mowing will continue to result in unsightly conditions.	
Visitor Use	Traditional visitor use will continue.	Visitor use will decline because of thick growth and loss of accessibility.	Past levels of visitor use will continue until the brushy growth gets too thick for easy travel.	

VIII. Appendices

A. References Cited or Reviewed

B. Historical Photographs of Big Meadows

1. Aerial Photographs Taken in 1955
2. Panoramic View Taken in 1936

C. Aerial Monitoring Photographs

D. Vegetation Monitoring Project (N-94)

E. Map of Permanent Vegetation Plot Locations

F. List of Vegetation Types and Vegetation Classification Map - 1984

G. Site Record of Vegetation Quadrats at Big Meadows

H. Annual Vegetation Sampling Data

I. List of Vascular Plants of Big Meadows

APPENDIX A

References Cited or Reviewed

1. Baxter, Emily E. 1978. Plant Composition Responses to Single and Repeated Burns at Big Meadows, Shenandoah National Park.

2. _____. 1979. Vascular Plants of the Meadow at Big Meadows, Shenandoah National Park.

3. Cocking, W. D., Emily E. Baxter, and S. L. Lilly. 1976. Plant Community Responses to the Use of Prescribed Burning as an Alternative to Mowing in the Management of Big Meadows, Shenandoah National Park. Pres., 1st Conference on Scientific Research in the National Parks.

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APPENDIX B

Historical Photographs of Big Meadows



Photo# 1. Big Meadows looking East. Dedication day, 1936.

Appendix B.

Historical photographs of Big Meadows

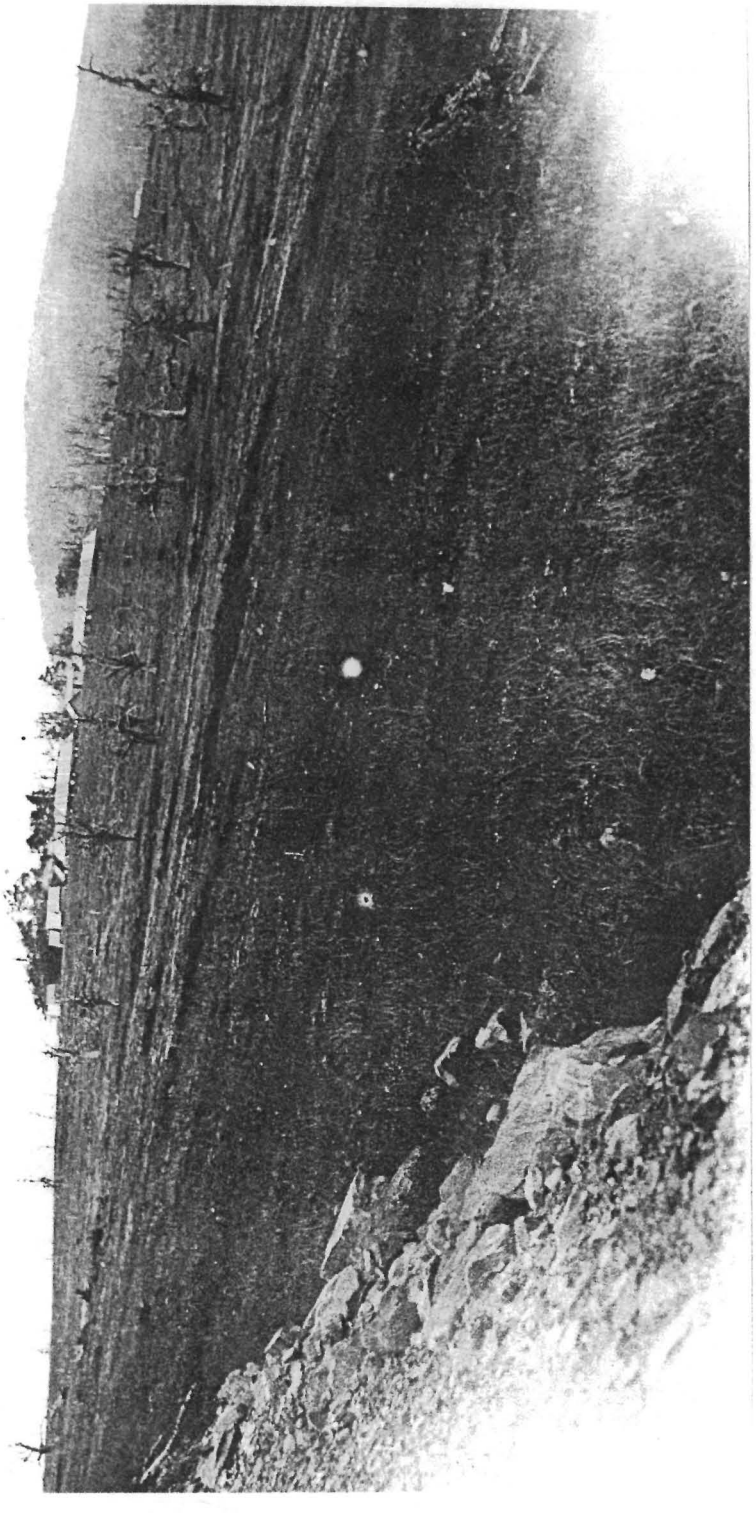


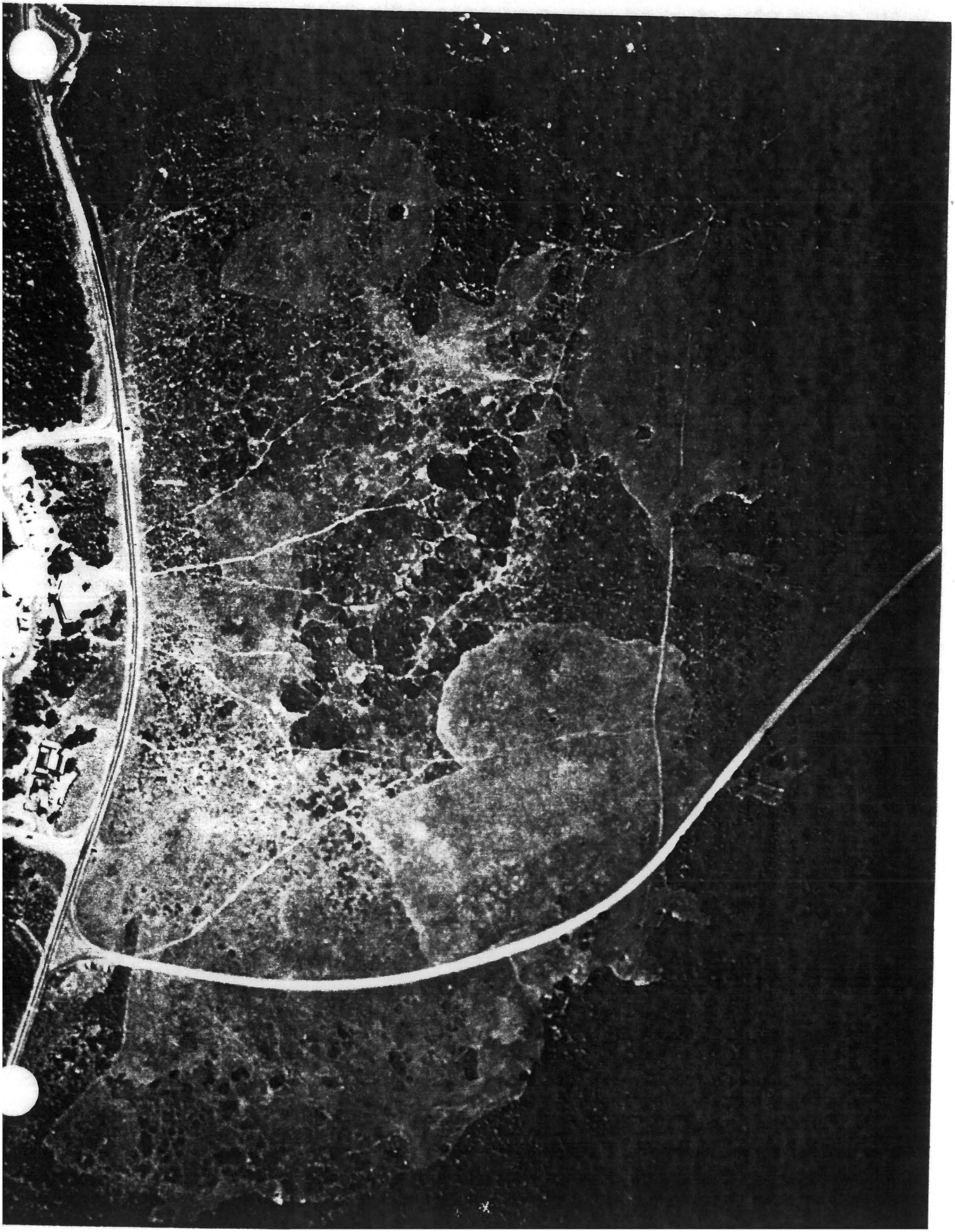
Photo #2. Meadow and the old CCC camp.

APPENDIX C

COLOR INFRARED PHOTOGRAPHS

Taken annually to monitor the response
of vegetation in the meadow to management practices.

FIRST photograph - September 7, 1984.



APPENDIX D

Natural Resource Management
Research Project
Shenandoah National Park

Title: The Effects of Mowing on Vegetation in The Big Meadow

RSP Number: 4840-RMVP-N-94

Investigators: Resource Management Specialist

Research Objective: The objective of this research is to monitor the changes in black locust (*Robina pseudo-acacia*) and blackberry (*Rubus*) densities in The Big Meadow as influenced by mowing and hand cutting operations.

Statement of the Problem: The Big Meadow is a unique area of the Park which, if left unrestrained, would follow natural succession and eventually become a forest. The problem, then, is developing a method of controlling natural succession in order to maintain the meadow in an open grass/shrub stage. The major methods used in the past have utilized dormant season mowing or burning, which has been essentially ineffective in controlling black locust (*Robina pseudo-acadia*) and blackberry (*Rubus spp.*).

Numerous mowings during the active growing season will be initiated in areas of high locust concentration during 1984. In areas of low locust concentration, hand cutting and herbicide application to stumps will also be initiated. In order to determine the effectiveness of these operations, vegetation sampling of locust and blackberry density will be necessary preceeding each year's control operations.

Methods: Vegetation sampling generally falls under one or two schemes -- random plots or permanent plots. Permanent plots have the advantage that individual plots can be compared. Their disadvantage is that they must be well marked so that they can be accurately relocated each year. Random plots have the convenience of no relocation problem; however, the plots must be considered as a composite for the year, not on an individual basis.

A study done by W. Dean Cocking in 1978 and 1980 established permanent plots in one portion of the meadow. Six of these plots will be sampled. Within each 3 x 3 meter plot, the number of black locust and blackberry stems will be counted. The coordinates of the six plots to be used are listed below. The coordinates indicate the two outer sides of the plot, not the center of the plot. (For example, plot (15, 3) falls within the intersection of (15, 3) and (14, 2).) All plots are in Sector C. Consult the Cocking study for further details on the location of the plots.

Plot Number	X Coordinate (m East)	Y Coordinate (m South)
1	15	3
2	24	3
3	21	27
4	12	33
5	24	36
6	12	39

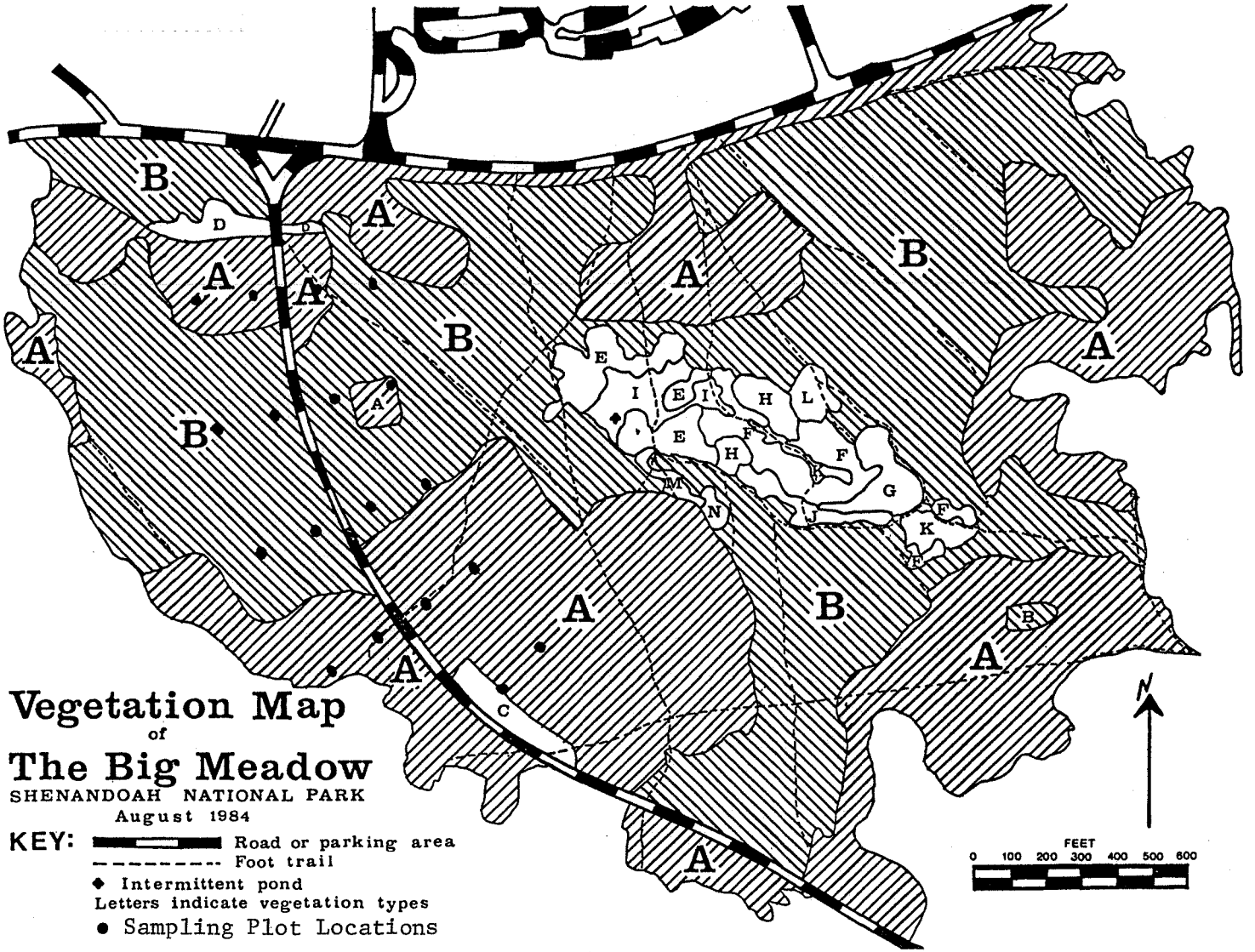
In addition, 18 plots will be systematically located along the Rapidan Road. These will not be permanent plots, so all distances and bearings will be approximate. They will; however, be paced and a compass used so that bias in selecting plot locations will be eliminated and plots will be well distributed. The plots will be located on transects located approximately 50, 150, 250, 350, and 450 meters southeast of the gate along the road.

Transects 1-4 will have four plots each, with two plots on each side of the road. Transect 5 will have two plots on the left side of the road. Plots will be located along a bearing approximately perpendicular to the road and at distances approximately 25 and 75 meters from the road edge. These plots will also be 3 x 3 meters and the black locust stems will be counted; however, the blackberry stems will only be counted in one-quarter of the plot.

Data Analysis: Data gathered in the permanent plots will be compared on a plot by plot basis with the data collected by Cocking and with the data collected yearly. Data for the other plots will be grouped by mowed plots and unmowed plots and then compared on a yearly basis within these two categories.

Funding: This research project will be carried out with annual Park operating funds by the Resource Management Specialist.

Manpower Requirements: An estimated four mandays will be needed to do the annual sampling.


Vegetation Map
of
The Big Meadow
SHENANDOAH NATIONAL PARK
August 1984
KEY:
Road or parking area
Foot trail
Intermittent pond
Letters indicate vegetation types
Sampling Plot Locations
N
FEET
0 100 200 300 400 500 600

Vegetation Types
of
The Big Meadow
Shenandoah National Park

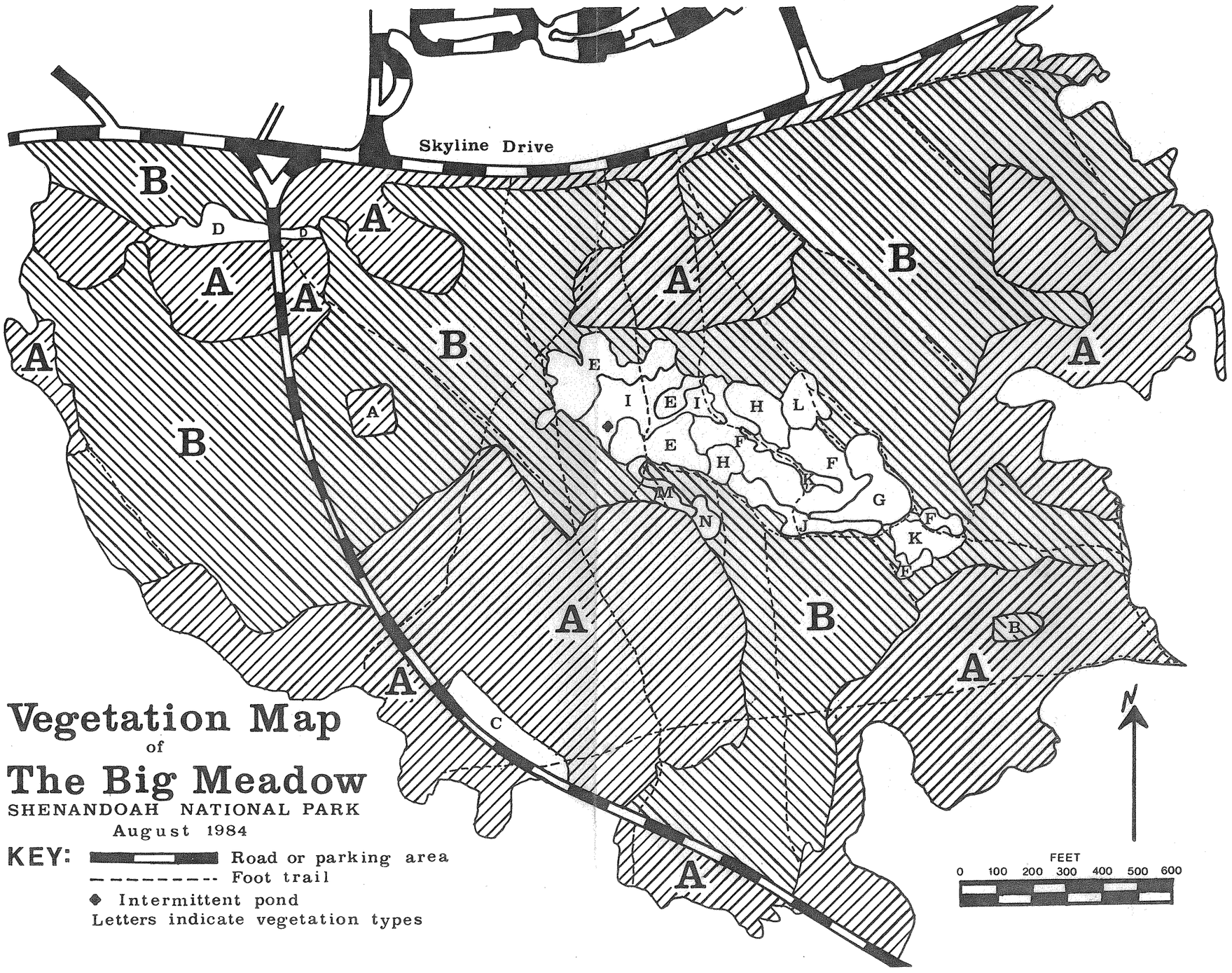
Type	Description
A	Mowed area - due to mowing grasses dominate, other species present include blueberries and black locust.
B	Heterogeneous mixture including grasses, blueberries, blackberries, hazelnuts, and maleberry. In the western portion large patches of hazelnuts and black chokeberry are present. In the southern portion maleberry is common.
C	Area burned in 1983 - dominated by grasses, other species present include blackberries and black locust.
D	Black locust stand averaging about 10 feet in height.
E	Homogeneous mixture dominated by panicled dogwood with broadleaf meadowsweet, american hazelnut, and maleberry as codominants.
F	Homogeneous mixture dominated by broadleaf meadowsweet with panicled dogwood and black chokeberry present.
G	Mostly pure hawthorn about 10 feet in height with scattered small trees and patches of panicled dogwood.
H	Almost pure grasses with interspersed panicled dogwood and broadleaf meadowsweet.
I	Heterogeneous wetland mixture of grasses, burnet, goldenrods, and blueberries.
J	Heterogeneous mixture of shrubs dominated by panicled dogwood, broadleaf meadowsweet, winterberry, blackberries, maleberry, and grasses.
K	Wetland complex of grasses, sedges, and common rush.
L	Heterogeneous mixture dominated by black chokeberry with grasses and blueberries present.
M	Homogeneous mixture dominated by sweet fern with grasses and blackberries present.
N	Almost pure american hazelnut with grasses present.

The preceeding descriptions primarily include the plants which persist throughout the growing season. Other plants (wildflowers, etc.) which are present at various times are beyond the scope of this project.

Taxonomical List of Plants used in Vegetation Type Descriptions

Blackberries	*Rubus spp.*
Blueberries	*Vaccinium spp.*
Burnet	*Sanguisorba canadensis*
Chokeberry, black	*Pyrus melanocarpa*
Dogwood, panicled	*Cornus racemosa*
Goldenrods	*Solidago spp.*
Grasses	*Gramineae spp.*
Hawthorn	*Crataegus macrosperma*
Hazelnuts	*Corylus spp.*
Hazelnut, American	*Corylus americana*
Locust, black	*Robinia pseudo-acacia*
Maleberry	*Lyonia ligustrina*
Meadowsweet, broadleaf	*Spirea latifolia*
Rush, common	*Juncus effusus*
Sedges	*Cyperaceae spp.*
Sweet fern	*Comptonia peregrina*
Winterberry	*Ilex montana*

APPENDIX F


Skyline Drive
Vegetation Map
of
The Big Meadow
SHENANDOAH NATIONAL PARK
August 1984
KEY:
Road or parking area
Foot trail
Intermittent pond
Letters indicate vegetation types
N
FEET
0 100 200 300 400 500 600

APPENDIX G

SITE RECORD OF THE PERMANENTLY MAPPED VEGETATION QUADRATS AT BIG MEADOWS SHENANDOAH NATIONAL PARK, VIRGINIA

July 20, 1980

Submitted by:

W. Dean Cocking

Emily Baxter

Department of Biology
James Madison University
Harrisonburg, VA 22807

Permanently marked quadrats have been established within the mesic vegetation of Big Meadows, Shenandoah National Park, for the purpose of following the encroachment process characteristic of Robinia pseudo-acacia L., black locust, and Rubus spp., the blackberries and dewberries. The grid was established using a concrete pylon, USDI 796-88 NPS, as the permanent reference point, and is oriented along a magnetic north-south and east-west set of coordinates. For location purposes, the pylon is approximately due south of the Byrd Visitor Center (Fig. 1). The details of the location of survey markers and the arrangement of the 3 x 3 m contiguous quadrats are illustrated in Fig. 2.

Each of the sectors has been mapped by counting the number of Robinia and Rubus stems occurring within each quadrat. The Rubus stems were further subdivided into large, relatively heavy canes characteristic of Rubus allegheniensis Porter, the Allegheny blackberry, and the smaller, more flexible stems typical of Rubus flagellaris Willd., the dewberry. The line of demarcation between these species is indistinct when only vegetation tissues are present and therefore the separation is one of growth form and not necessarily floristically accurate in all instances. In addition, the area within each quadrat which was covered by members of the Ericacea is also mapped. The original mapping (Fig. 2) of SECTORS A and C was carried out in late-July, 1978, and SECTOR B was mapped during mid-July of 1980. The original mapping of each is presented for each in the Appendix Figures.

The history of the mapped areas can be traced back to the fall of 1974 when each was mowed with a bush-hog. The vegetation then was left unmanaged during 1975 and then treated with a headfire prescribed burn in the spring of 1976. It was then left unburned and unmowed in 1977 and the spring of 1978. A relatively good standing crop of vegetation was therefore present in all

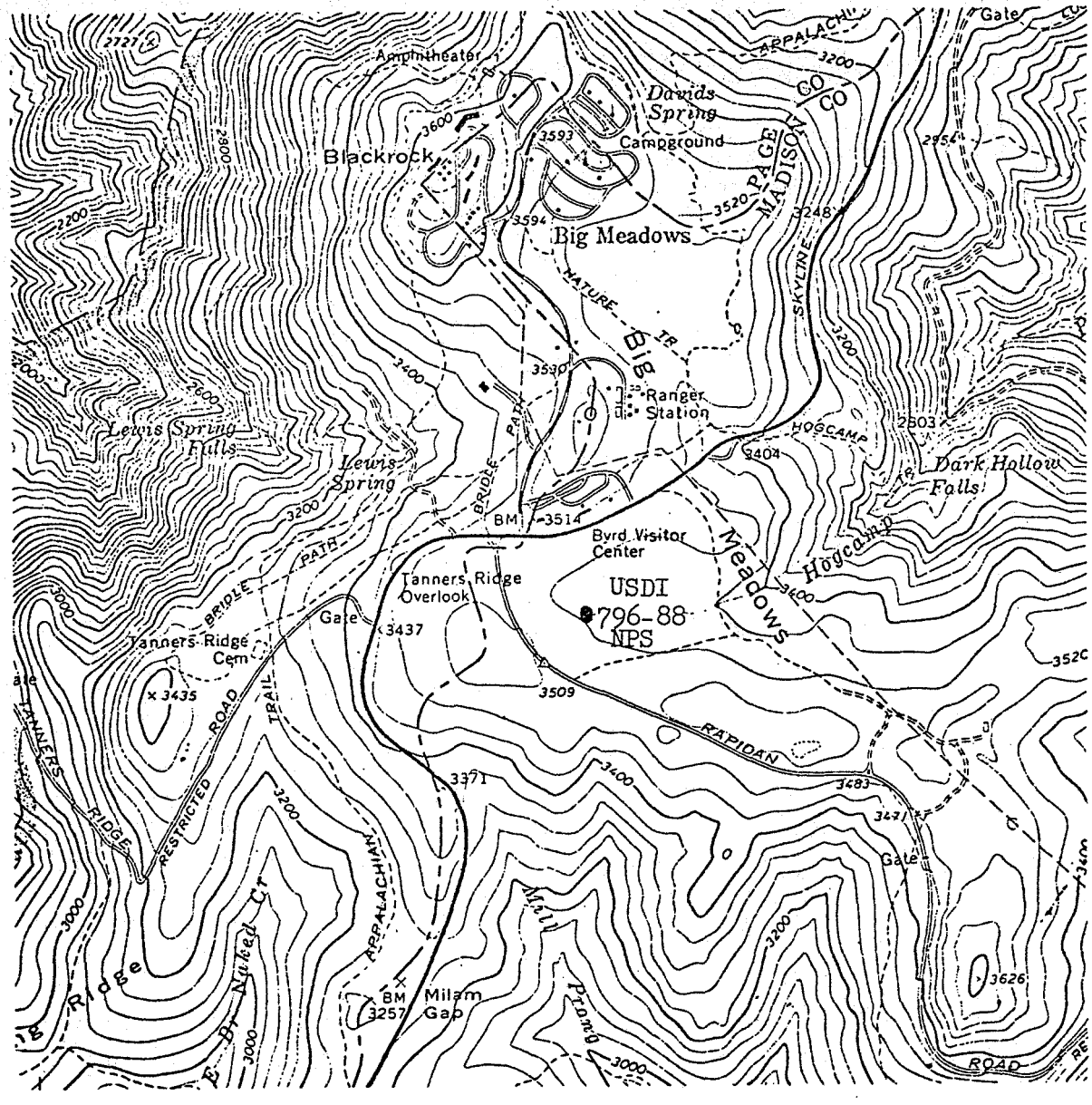


Fig. 1. Location of the mapped area within Big Meadows, Shenandoah National Park. The reference point for the research site is the permanent survey marker (●) USDI 796-88 NPS, which is located directly south of the Byrd Visitor Center.

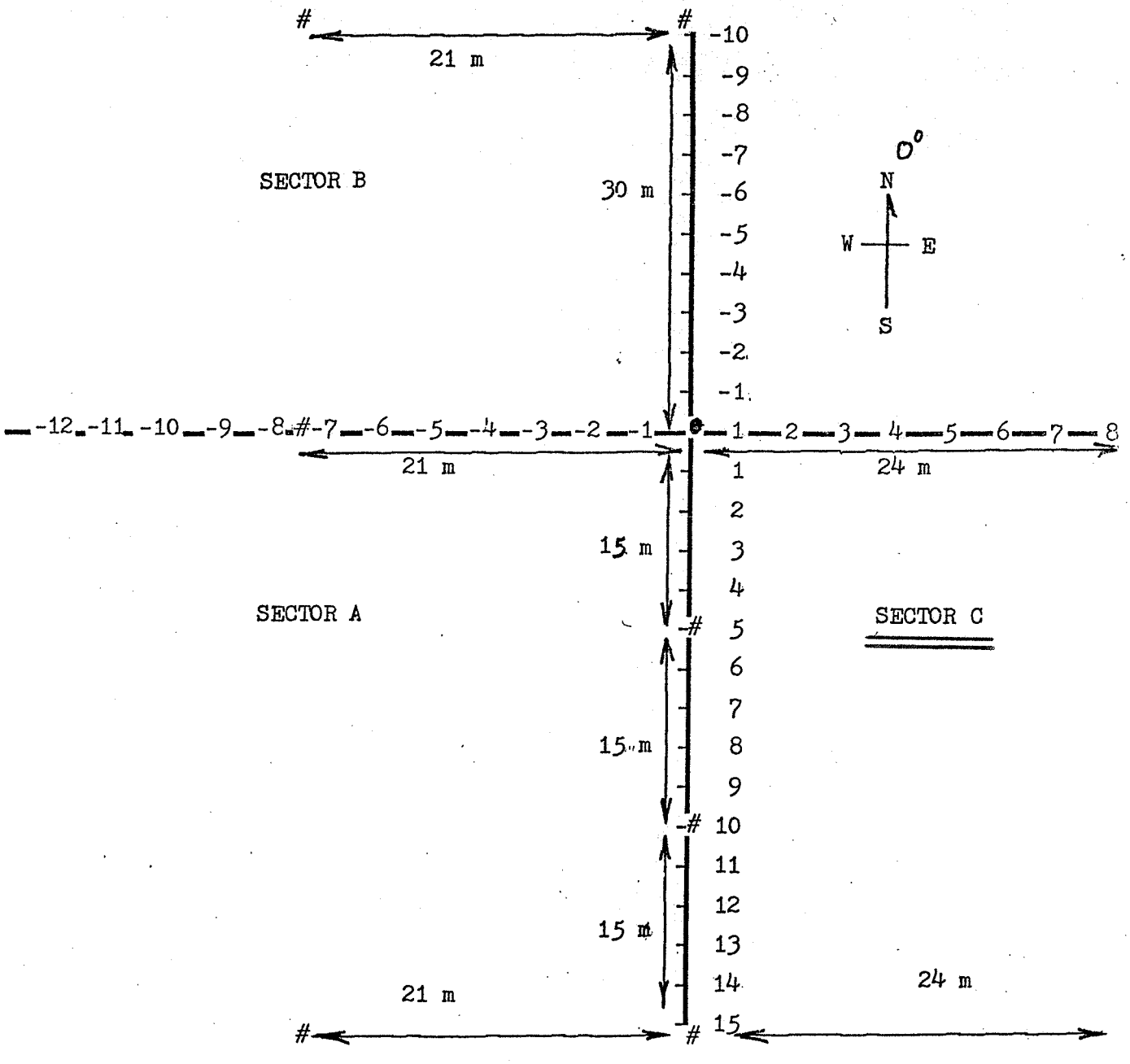


Fig. 2, Physical layout of mapped area at Big Meadows, Shenandoah National Park. The axes indicate the coordinates of the location of 3 x 3 m permanently marked quadrats. Orange survey markers are located (#) along the margins of the sectors as indicated. ● = concrete pylon USDI 796-88 NPS.

SECTORS by mid-summer 1978 (Fig. 2). At this point, the treatment of the SECTORS differed. SECTOR A was defined as a control and the only management which has occurred therein since the original mapping in 1978 was a prescribed spring burn headfire in 1979. SECTOR B was also subjected to this burn, but was not mapped prior to the summer of 1980. SECTOR C was originally designated as the experimental plot for an experiment designed to investigate the impact of an August mowing and spot burn on the encroachment process. Subsequent to the 1978 mapping the vegetation was mowed, allowed to dry for several weeks, and then burned with a back-fire torch. This pre-treated vegetation was then burned along with SECTORS A and B in the spring of 1979. The original experimental design involved an end of the summer evaluation comparing the spot-burned SECTOR C with the control SECTOR A. Unfortunately, another experimentor working at the meadow added an unprogramed treatment to SECTOR C prior to the 1979 sample date. This involved the removal by individual clipping of all Robinia stems present within SECTOR C during August. Individual selective removal of the stems of a single species does not approximate the management technique which was originally being investigated since this would result in a disruption of patterns of competition within the plant community. Therefore, the experiment was disrupted significantly. The reason for mapping SECTOR B in 1980 was to repeat the original 1978 experiment which was aborted. This area will be mowed and burned during August 1980 and then both SECTORS A and B will receive a prescribed spring burn in 1981. A repetition of the mapping process in late July or August of 1981 will provide the information originally sought through the experiment which was started in 1978.

APPENDIX H

Annual Vegetation Sampling
in the Big Meadow
4840-RMVP-N-94
1984

Introduction and Methods

This was the first year of the sampling. Six permanent plots from the Cocking study and 18 temporary plots were sampled on June 15 and 18. The permanent plots were all in an area that was later mowed. Of the temporary plots, 10 were later mowed and 8 were left unmowed. The attached map shows the mowed areas (Type A) and the general location of the 18 temporary plots.

Results

The attached sheet shows the count from each plot. The data for the permenent plots can be compared with 1985 data on a plot by plot basis; however, the data for the temporary plots must be grouped. The summary of this years data is as follows:

	Locust		Blackberry	
Plot	Mean Stems per Plot ($9m^2$)	Mean Stems per $Meter^2$	Mean Stems per Plot[a,b]	Mean Stems per $Meter^2$
Permanent	0.6	0.074	119.5[a]	13.27
Temporary				
Mowed	21.3	2.36	22.7[b]	10.08
Unmowed	0.0	0.0	10[b]	4.4

[a] $9m^2$ [b] $2.25m^2$

Data Sheet
Big Meadow Vegetation Sampling

June 15 & 16, 1984

Transect Number	Side of Road	Plot Number	Number Locust Stems[1]	Number Blackberry Stems[2]	Mowed or Unmowed Area
1	Left	1	6	14	Mowed
		2	0	0	Unmowed
	Right	1	32	16	Mowed
		2	17	28	Mowed
2	Left	1	0	36	Unmowed
		2	20	3	Mowed
	Right	1	0	0	Unmowed
		2	0	23	Unmowed
3	Left	1	0	4	Unmowed
		2	0	0	Unmowed
	Right	1	0	0	Unmowed
		2	0	17	Unmowed
4	Left	1	35	8	Mowed
		2	49	54	Mowed
	Right	1	9	9	Mowed
		2	21	45	Mowed
5	Left	1	10	31	Mowed
		2	14	19	Mowed

[1] $9m^2$ plot (3m x 3m)

[2] $2.25m^2$ plot (1/4 of 3m x 3m plot)

Data Sheet
Big Meadow Vegetation Sampling

June 15 & 16, 1984

Sector	X Coordinate[1]	Y Coordinate[2]	Number Locust Stems[3]	Number Blackberry Stems[3]	Mowed or Unmowed Area
C	15	3	0	48	Mowed
	24	3	1	2	Mowed
	21	27	0	259	Mowed
	12	33	1	130	Mowed
	24	36	0	183	Mowed
	12	39	2	95	Mowed

[1] 3 Distance (m) east from pylon

[2] 4 Distance (m) south from pylon

[3] $9m^2$ plot (3m x 3m)

APPENDIX H

Annual Vegetation Sampling in the Big Meadow 4840-RMVP-N-94 1985

Introduction and Methods

During this second year of the Big Meadow Vegetation survey, the six permanent plots from the Cocking study and 18 temporary plots were sampled on June 4, 1985. All permanent plots occurred in the mowed area. Of the temporary plots, 10 were in the mowed area and 8 were in the unmowed area. Sampling was conducted with the aid of Bob Boeren, Central District. Methods are reviewed in Appendix D of the Meadow Management Plan.

Results

Results of this years survey indicates conclusively that successive mowings during the summer reduces the density and numbers of black locust and blackberry. Table 1 contains a summary of this years data and a comparison with the 1984 results.

Table 1. Summarized data for 1984 and 1985.

Plot	LOCUST				BLACKBERRY			
	Mean Stems per Plot ($9m^2$)		Mean Stems per $Meter^2$		Mean Stems per Plot[a,b]		Mean Stems per $Meter^2$	
	'84	'85	'84	'85	'84	'85	'84	'85
Permanent	0.6	0.8	0.07	0.09	119.5[a]	16.0[a]	13.27	1.78
Temporary								
Mowed	21.3	0.7	2.36	0.08	22.7[b]	2.9[b]	10.08	0.32
Unmowed	0.0	0.0	0.00	0.00	10.0[b]	6.1[b]	4.40	0.68

[a] $9m^2$ [b] $2.25m^2$

Locust stem densities increased in the permanent plot locations by 25 percent. Densities of locust stems decreased though in the temporary mowed plots by 97 percent, and exhibited no change numerically in the unmowed temporary locations.

Blackberry stem densities decreased in all three plot locations, dropping 87 percent in the permanent plot locations, 87 percent in the temporary mowed sections, and 39 percent in the temporary unmowed sections.

DISCUSSION

In the permanent plots, the amount of blackberry present in each of the six plots dropped drastically. The percent of decrease among the six plots ranged from 48 percent to 100 percent. This reduction is quite significant. Of the locust in the permanent plots, the numbers both decreased and increased, leading to an overall slight increase in the numbers of stems present. However, the number of locust stems that have been present in these plots over the past two years has been very low, thus the significance of these comparisons is of little statistical value.

In the temporary plots, a major reduction of both locust stems and blackberry stems was evident in the mowed sections of the meadow. The unmowed sections showed no change in locust stems present. A reduction in the number of blackberry stems was found in the unmowed sections and was very significant. The reason for this change is unknown. Based on these results, major mowing operations appear to be benefiting our objective of retarding locust and blackberry intrusion into the meadow management area.

Data Sheet

Big Meadow Vegetation Sampling

June 4, 1985

Transect Number	Side of Road	Plot Number	Number Locust Stems[1]	Number Blackberry Stems[2]	Mowed or Unmowed Area
1	LEFT	1	0	7	Mowed
		2	0	0	Unmowed
	RIGHT	1	1	1	Mowed
		2	2	4	Mowed
2	LEFT	1	0	31	Unmowed
		2	0	2	Mowed
	RIGHT	1	0	0	Unmowed
		2	0	1	Unmowed
3	LEFT	1	0	8	Unmowed
		2	0	4	Unmowed
	RIGHT	1	0	0	Unmowed
		2	0	5	Unmowed
4	LEFT	1	0	1	Mowed
		2	0	6	Mowed
	RIGHT	1	0	0	Mowed
		2	4	0	Mowed
5	LEFT	1	0	1	Mowed
		2	0	7	Mowed

[1] $9m^2$ plot (3m x 3m)

[2] $2.25m^2$ plot (1/4 of 3m x 3m plot)

Data Sheet

Big Meadow Vegetation Sampling

June 4, 1985

Sector/plot	X Coordinate[1]	Y Coordinate[2]	Number Locust Stems[3]	Number Blackberry Stems[3]	Mowed or Unmowed Area
C 1	15	3	0	25	mowed
2	24	3	0	0	mowed
3	21	27	0	37	mowed
4	12	33	2	3	mowed
5	24	36	0	24	mowed
6	12	39	3	7	mowed

[1] 3 Distance (m) east from pylon

[2] 4 Distance (m) south from pylon

[3] $9m^2$ plot (3m x 3m)

Appendix H

Annual Vegetation Sampling in the Big Meadow NRSP-N-94 1986

Introduction and Methods

This was the third year for this vegetation survey. The permanent plots from the Cocking study were eliminated this year because they were no longer representative of the majority of the meadow. The temporary plots were run later in the year (July) than last year because the very few stressed locust seedlings remaining were so slow growing that they were not tall enough to be seen until later on in the year.

Results

The numbers of locust and blackberry plants continued to decrease this year. In fact there were not any locust saplings found in the study transects. There were, however, two areas not covered by the plots where some locust plants were visible. A small area 100 feet from the Drive and opposite the visitor center contained approximately 200 plants and was treated by hand (clip and stump treatment) with Garlon 3A in August. A larger area in Zone A, on the southeast side of the meadow, contained numerous small locust seedlings. It was decided to let this area go and mow it the following June.

Except for these two areas the rest of the meadow was largely free of locust and blackberry. The appearance of the meadow this year was excellent.

Color infrared photos of the area were taken by the U.S. Forest Service, Forest Pest Management Office in Atlanta. These will be used to document the changes in meadow flora between 1984 and 1986.

Table 1. Data summaries for 1984, 1985, and 1986

	Locust			Blackberry		
Plot	Average stems per plot			Average stems per plot		
	84	85	86	84	85	86
Mowed	21.3	.7	0	22.7	2.9	4.8
Unmowed	0	0	.13	10.0	6.1	1.2

DATA SHEET

BIG MEADOW VEGETATION SAMPLING

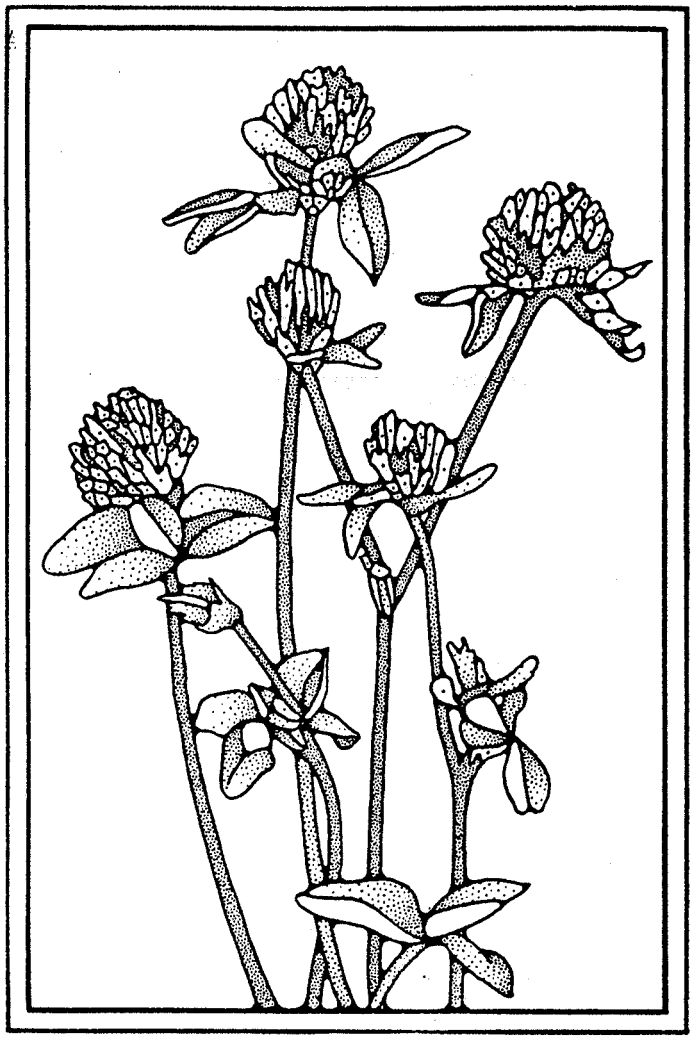
DATE: 07 /06 /86

TRANSECT NUMBER	SIDE OF ROAD	PLOT NUMBER	NUMBER LOCUST STEMS [1]	NUMBER BLACKBERRY STEMS[2]	MOWED OR UNMOWED AREA
1	LEFT	1	0	5	MOWED
		2	0	1	UNMOWED
	RIGHT	1	0	0*	MOWED
		2	00	0*	MOWED
2	LEFT	1	0	32	UNMOWED
		2	0	0	MOWED
	RIGHT	1	0	0	UNMOWED
		2	0	8	UNMOWED
3	LEFT	1	0	14	UNMOWED
		2	1	0	UNMOWED
	RIGHT	1	0	2	UNMOWED
		2	0	43	UNMOWED
4	LEFT	1	0	4	MOWED
		2	0	4	MOWED
	RIGHT	1	0	4	MOWED
		2	0	0	MOWED
5	LEFT	1	0	19	MOWED
		2	0	12	MOWED
			00		

*These two plots were mowed immediately prior to survey, for 50th anniversary.

[1] $9m^2$ plot (3m X 3m)

[2] $2.25m^2$ plot (1/4 of 3m X 3m plot)



Vascular Plants

of the Meadow at Big Meadows Shenandoah National Park

Emily E. Baxter
Biology Department
James Madison University
Harrisonburg, VA 22807

This brochure is provided free of charge by the Biology Department, James Madison University, which along with the National Park Service, supported this study.

Lycopodiaceae - Clubmoss Family
Lycopodium flabelliforme (Fern.) Blanchard - ground pine; T,Au
L. obscurum L. - ground pine; T,Au

Ophioglossaceae - Adder's Tongue Family
Botrychium dissectum Spreng. - grape-fern; *,T,Au,Se
B. dissectum Spreng. var **obliquum** (Muhl.) Clute - grape-fern; T,Au,Se
B. multifidum (Gmel.) Rupr. var. **intermedium** (D.C.Eat.) Farw. - leather grape-fern; T,Au
B. virginianum L. - rattlesnake fern; S,E,Je

Osmundaceae - Royal Fern Family
Osmunda cinnamomea L. - cinnamon fern; *,S,Ma,Je
O. claytoniana L. - interrupted fern; *,T,Ma,Je

Polypodiaceae - Fern Family
Asplenium platyneuron (L.) Oakes - ebony spleenwort; T,Jy
Dennstaedtia punctilobula (Michx.) Moore - hay-scented fern; *,T,Jy
Onoclea sensibilis L. - sensitive fern; *,Au,Se
Polystichum acrostichoides (Michx.) Schott. - Christmas fern; SE,W,Je,Jy,Au
Pteridium aquilinum (L.) Kuhn - bracken fern; *,T,Au
Thelypteris noveboracensis Nieuwl. - New York fern; *,S,Je

Pinaceae - Pine Family
Abies balsamea (L.) Mill. - balsam fir; E
Pinus pungens Lamb. - table mountain pine; E
P. rigida Mill. - pitch pine; T
P. strobus L. - white pine; E
P. virginiana Mill. - scrub pine; T

Cupressaceae - Cypress Family
Juniperus virginiana L. - red cedar; S,E

Gramineae - Grass Family
Agrostis alba L. - redtop; W,Jy,Au
A. tenuis Sibth. - colonial bent grass; *,T,Jy
Andropogon scoparius Michx. - little bluestem; N,S,Au,Se
Anthoxanthum odoratum L. - sweet vernal grass; *,E,Ma
Arrhenatherum elatius (L.) Mert. & Koch. - tall oatgrass; E,Je
Calamagrostis canadensis (Michx.) Nutt. - bluejoint; *,T,Jy
Dactylis glomerata L. - orchard grass; N,S,Je
Danthonia compressa Aust. - mountain oatgrass; *,T,Je,Jy
D. spicata (L.) Beauv. - poverty oatgrass; E,Je
Deschampsia flexuosa (L.) Trin. - crinkled hairgrass; E,Je
Dichanthelium lanuginosum (Ell.) Gould - hairy panic grass; *,S,Jy
D. latifolium (L.) Harvill - T,Je
D. linearifolium (Scribn.) Gould - low panic grass; T,Je,Jy
Festuca elatior L. - meadow fescue; T,Je
F. ovina L. - sheep fescue; E,Je
F. rubra L. - red fescue; S,E,Ma
Glyceria striata (Lam.) Hitchc. - fowl mannagrass; *,Jy
Leersia oryzoides (L.) Sw. - rice cutgrass; *,Au
Muhlenbergia frondosa (Poir.) Fernald - wirestem muhly; S,Au
Panicum capillare L. - old witch grass; N,E,Au
Phleum pratense L. - timothy; T,Jy,Au
Poa chapmaniana Scribn. - NW,Jy
P. compressa L. - Canada bluegrass; *,W,Jy
P. cuspidata Nutt. - short-leaved bluegrass; W,Je
P. palustris L. - fowl bluegrass; S,Je
P. pratensis L. - Kentucky bluegrass; T,Je

Cyperaceae - Sedge Family
Carex argyrantha Tuckerm. - *,T,Ma,Je
C. buxbaumii Wahlenb. - *,Ma,Je
C. granularis Muhl. - *,Ma,Je
C. laxiflora Lam. - S,Je
C. molesta Mack. - *,S,Jy
C. normalis Mack. - S,Je
C. pensylvanica Lam. - *,T,Ap,Ma

C. radiata (Wahl.) Dewey - *,Ma
C. trisperma Dewey - W,Je
Eleocharis obtusa (Willd.) Schultes. - *,Jy,Au

Araceae - Arum Family
Arisaema triphyllum (L.) Schott - Jack-in-the-pulpit; *,S,Ma

Juncaceae - Rush Family
Juncus acuminatus Michx. - *,Je
J. effusus L. - common rush; *,Ma,Je
J. tenuis Willd. - path rush; *,Je,Jy
Luzula bulbosa (Wood) Rydb. - *,T,Ma

Liliaceae - Lily Family
Allium cernuum Roth - wild onion; *,T,Jy,Au
Amianthium muscaetoxicum (Walt.) Gray - fly-poison; *,T,Je,Jy
Chamaelirium luteum (L.) Gray - devil's bit; *,N,Je
Hemerocallis fulva L. - common day lily; E,Jy
Lilium superbum L. - Turk's-cap lily; *,T,Jy,Au
Melanthium latifolium Desr. - crisped bunchflower; N,S,Au
Polygonatum biflorum (Walt.) Ell. - common Solomon's seal; S,Je
Smilacina racemosa (L.) Desf. - false Solomon's seal; S,W,Je
Smilax herbacea L. - carrion flower; T,Je
S. rotundifolia L. - green greenbriar; *,Je
Trillium grandiflorum (Michx.) Salisb. - large flowered trillium, T,Ma
Uvularia perfoliata L. - mealy bellwort; N,S,Ma
U. sessilifolia L. - merrybells; *,T,Ma
Veratrum viride Ait. - white hellebore; *,Je

Dioscoreaceae - Yam Family
Dioscorea quaternata (Walt.) J.F.Gmel. - four-leaved wild yam; N

Amaryllidaceae - Amaryllis Family
Hypoxis hirsuta (L.) Coville - yellow star grass; *,N,E,Je,Jy
Narcissus poeticus L. - poet's narcissus; E,Ma
N. pseudo-narcissus L. - daffodil; E,Ma

Iridaceae - Iris Family
Sisyrinchium angustifolium Mill. - blue-eyed grass; *,T,Je,Jy

Orchidaceae - Orchid Family
Habenaria lacera (Michx.) Lodd. - ragged fringed orchid; S,Au
Spiranthes cernua (L.) Richard. - nodding ladies' tresses; S,Se

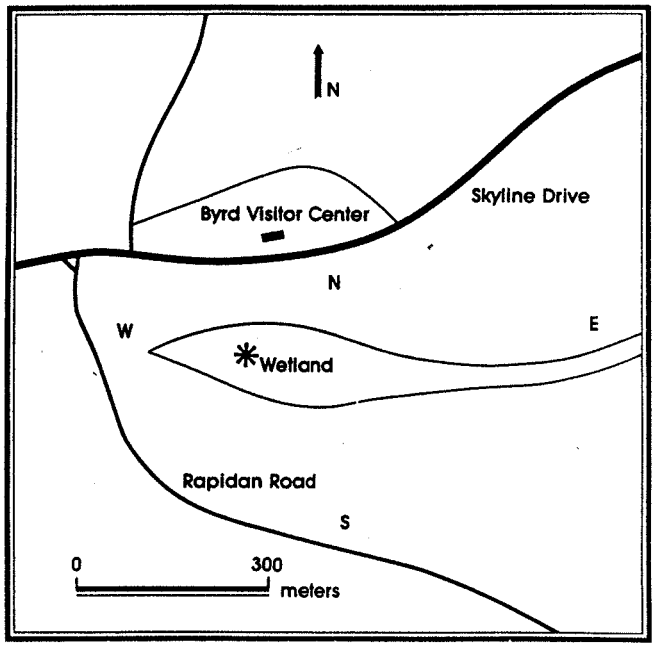
Salicaceae - Willow Family
Salix discolor Muhl. - glaucous willow; *,N,Ma
S. tristis Ait. - dwarf upland willow; *,Ma

Myricaceae - Bayberry Family
Comptonia peregrina (L.) Coult. - sweet fern; *,Ma,Je

Juglandaceae - Walnut Family
Carya ovalis (Wang.) Sarg. - red hickory; E

Corylaceae - Hazel Family
Betula lenta L. - sweet birch; N,NE
B. populifolia Marsh. - gray birch; *,SE,Ma
Corylus americana Walt. - hazelnut; *,N,S,Je
C. cornuta Marsh. - beaked hazelnut; N,S,SE,Je

Fagaceae - Beech Family
Castanea dentata (Marsh.) Borkh. - American chestnut; N
Quercus alba L. - white oak; N,S
Q. rubra L. - red oak; *,N,S



This study was limited to herb and shrub communities bounded by Skyline Drive on the north, Rapidan Rd. on the west and south, and the forest on the east and southeast.

The following abbreviations denote months for flowering and maturing of club moss and fern sporangia, type of habitat and main locations:

Ap = April
Ma = May
Je = June
Jy = July
Au = August
Se = September

N = north part
S = south part
E = east part
W = west part
* = wetland; poorly drained habitat
T = throughout drained meadow (in 3 or more parts of meadow)

Polygonaceae - Buckwheat Family
Polygonum cespitosum Blume - Asiatic water pepper; *,Au
P. convolvulus L. - black bindweed; S,SW,Jy,Au
P. persicaria L. - lady's thumb; *
P. sagittatum L. - arrowleaf tearthumb; *,Au
Rumex acetosella L. - sheep sorrel; *,T,Ma,Je,Jy

Chenopodiaceae - Goosefoot Family
Chenopodium album L. - lamb's quarters; N

Caryophyllaceae - Pink Family
Cerastium vulgatum L. - common mouse-ear chickweed; *,T,Je,Jy
Dianthus armeria L. - Deptford pink; *,T,Jy,Au
Saponaria officinalis L. - soapwort; E,Au
Silene pensylvanica Michx. - wild pink; T,Ma
S. stellata (L.) Ait.f. - starry campion; T,Jy,Au
Stellaria pubera Michx. - great chickweed; T,Ma

Ranunculaceae - Crowfoot Family
Anemone quinquefolia L. - wood anemone; *,T,Ma
A. virginiana L. - thimbleweed; T,Je
Aquilegia canadensis L. - wild columbine; *,T,Je,Jy,Au
Cimicifuga racemosa L. - black snakeroot; T,Jy
Clematis virginiana L. - virgin's bower; *,T,Au
Ranunculus abortivus L. - kidney-leaf crowfoot; S,Ma
R. hispidus Michx. - hispid buttercup; *,T,Ma
Thalictrum dioicum L. - early meadowrue; S,E,Ma
T. polygamum Muhl. - tall meadowrue; *,Jy
Trautvetteria caroliniensis (Walt.) Vail - tasselrue; *,Jy,Au

Berberidaceae - Barberry Family
Berberis thunbergii DC. - Japanese barberry; E,Ma

Lauraceae - Laurel Family
Sassafras albidum (Nutt.) Nees - white sassafras; T

Papaveraceae - Poppy Family
Sanguinaria canadensis L. - bloodroot; S,W, Ap,Ma

Cruciferae - Mustard Family
Arabis canadensis L. - sicklepod; S,Je,Jy
Barbarea vulgaris R.Br. - winter cress; *,T,Ma

Saxifragaceae - Saxifrage Family
Ribes rotundifolium Michx. - smooth gooseberry; *,T,Ma

Hamamelidaceae - Witch-hazel Family
Hamamelis virginiana L. - witch-hazel; E,Fall

Rosaceae - Rose Family
Agrimony striata Michx. - striate agrimony; S,Au
Crataegus macrosperma Ashe - variable hawthorn; *,T,Ma
Fragaria virginiana Duchesne - Virginia strawberry; *,T,Ma,Je
Gillenia trifoliata (L.) Moench. - bowman's root; *,S,Je,Jy
Potentilla canadensis L. - Canada cinquefoil; *,T,Ma,Je,Jy
Prunus serotina Ehrh. - wild black cherry; *,T,Ma,Je
P. virginiana L. - choke cherry; *,T,Ma
Pyrus americana (Marsh.) DC. - mountain ash; S,E,Je
P. arbutifolia (L.) L.f. - red chokeberry; *,T,Ma
P. coronaria L. - wild crabapple; *,Ma
P. melanocarpa (Michx.) Willd. - black chokeberry; *,N,E,Ma,Je
Rosa carolina L. - pasture rose; *,T,Jy
R. eglanteria L. - sweetbrier; E,Je
Rubus allegheniensis Porter - Allegheny blackberry; *,T,Je
R. flagellaris Willd. - dewberry; *,T,Je,Jy
R. hispidus L. - groundberry; *,Jy
Sanguisorba canadensis L. - burnet; *,Je Jy Au
Spirea latifolia (Ait.) Borkh. - broadleaf meadowsweet; *,Jy,Au

Leguminosae - Pulse Family
Baptisia tinctoria (L.) R.Br. - wild indigo; *,T,Jy,Au
Desmodium rotundifolium DC. - S,E,Au
Melilotus alba Desr. - white sweet clover; S,E,Jy,Au
M. officinalis (L.) Lam. - yellow sweet clover; E,Jy
Robinia pseudo-acacia L. - black locust; T,Je
Trifolium agrarium L. - yellow hop clover; T,Je,Jy,Au
T. campestre Schreber - low hop clover; N,E,Au
T. pratense L. - red clover; T,Je,Jy,Au
T. repens L. - white clover; T,Je,Jy,Au

Oxalidaceae - Wood Sorrel Family
Oxalis europaea Jord. - yellow wood sorrel; *,T,Je,Jy,Au

Geraniaceae - Geranium Family
Geranium columbinum L. - long-stalked crane's-bill; N,E,Jy
G. maculatum L. - wild geranium; *,T,Ma,Je,Jy

Rutaceae - Rue Family
Ptelea trifoliata L. - hoptree; *,Jy

Callitrichaceae - Water Starwort Family
Callitriche heterophylla Pursh - larger water starwort; *,Ma

Anacardiaceae - Cashew Family
Rhus copallina L. - shining sumac; SE,Jy,Au
R. glabra L. - smooth sumac; T,Jy
R. radicans L. - poison ivy; S
R. typhina L. - staghorn sumac; E,Jy

Aquifoliaceae - Holly Family
Ilex montana T.&C. - mountain holly; N,E,Je

Celastraceae - Stafftree Family
Celastrus orbiculata Thunb. - bittersweet; S,E,Je

Aceraceae - Maple Family
Acer pennsylvanicum L. - striped maple; NE,NW
A. rubrum L. - red maple; *,T,Ap

Vitaceae - Grape Family
Parthenocissus quinquefolia (L.) Planch. - Virginia creeper; S

Guttiferae - St. John's-wort Family
Hypericum multilum L. - small-flowered St. John's-wort; *,Jy,Au
H. perforatum L. - common St. John's-wort; *,T,Jy,Au
H. punctatum Lam. - dotted St. John's-wort; *,Jy,Au

Violaceae Violet Family
Viola cucullata Ait. - marsh blue violet; *,Ma
V. palmata L. x **V. papilionaceae** Pursh. - early wood violet x common violet; S,E,Ma
V. papilionaceae Pursh. - common violet; T,Ma
V. pensylvanica Michx. - smooth yellow violet; SW,Ma
V. sagittata Ait. - arrow-leaf violet; T,Ma

Onagraceae - Evening-primrose Family
Epilobium angustifolium L. - fireweed; S,W,Jy
E. leptophyllum Raf. - linear-leaved willow-herb; *,Au
Oenothera fruticosa L. - narrow-leaved sundrops; NW,Jy
O. parviflora L. - northern evening primrose; *,S,E,Au,Se

Araliaceae - Ginseng Family
Aralia nudicaulis L. - wild sarsaparilla; N,Ma

Umbelliferae - Carrot Family
Angelica venenosa (Greenway) Fernald - hairy angelica; *,Au
Cicuta maculata L. - water hemlock; *,Au
Daucus carota L. - wild carrot; *,T,Jy,Au
Pastinaca sativa L. - parsnip; E,Jy
Thaspium trifoliatum (L.) Gray - woodland meadow-parsnip; *,T,Ma

Cornaceae - Dogwood Family
Cornus alternifolia L.f. - alternate-leaved dogwood; E,Je
C. florida L. - flowering dogwood; E,Ma
C. racemosa Lam. - panicled dogwood; *,Jy

Ericaceae - Heath Family
Gaylussacia baccata (Wang.) K. Koch. - black huckleberry; N,E,Je
Kalmia latifolia L. - mountain laurel; E,Je
Lyonia ligustrina (L.) DC. - maleberry; *,T,Jy,Au
Menziesia pilosa (Michx.) Juss. - Allegheny menziesia; E,Ma
Rhododendron roseum (Loesel.) Rehd. - rose azalea; N,W,Ma,Je
Vaccinium angustifolium Ait. - early low blueberry; T,Ma,Je
V. stamineum L. — deerberry; N,S,Ma,Je
V. stamineum L. var. **neglectum** (Small) Deam - smooth deerberry; N,Ma,Je
V. vacillans Torr. - late low blueberry; T,Je

Primulaceae - Primrose Family
Lysimachia ciliata L. - fringed loosestrife; *,E,W,Jy
L. quadrifolia L. - whorled loosestrife; *,T,Jy

Oleaceae - Olive Family
Syringa vulgaris L. - lilac; E,Ma

Gentianaceae - Gentian Family
Gentiana quinquefolia L. - five-flowered gentian; T,Se

Apocynaceae - Dogbane Family
Apocynum androsaemifolium L. - spreading dogbane; N,E,Je,Jy,Au
A. cannabinum L. - Indian hemp; *,T,Jy

Asclepiadaceae - Milkweed Family
Asclepias exaltata L. - poke milkweed; *,T,Jy
A. syriaca L. - common milkweed; *,T,Jy,Au
A. tuberosa L. - butterfly weed; T,Jy,Au

Convolvulaceae - Morning-glory Family
Convolvulus sepium L. - hedge bindweed; *,T,Je,Jy
C. spithamaeus L. - upright bindweed; T,Je,Jy

Labiatae - Mint Family
Lycopus virginicus L. - bugleweed; *,S,Au
Monarda clinopodia L. - basil balm; N,S,Jy,Au
Nepeta cataria L. - catnip; S,Au
Prunella vulgaris L. - bumblebee weed; *,T,Jy,Au
Pycnanthemum pycnanthemoides (Leavenw.) Fernland southern mountain mint; S,Au
Satureja vulgaris (L.) Fritsch - field basil; *,T,Jy,Au

Solonaceae - Nightshade Family
Solanum carolinense L. - horse-nettle; N,S,Jy

Scrophulariaceae - Figwort Family
Gratiola neglecta Torr. - clammy hedge-hyssop; *,Au
Linaria vulgaris Hill. - toadflax; N,Jy,Au
Pedicularis canadensis L. - common lousewort; T,Ma
Penstemon hirsutus (L.) Willd. - hairy beardtongue; *,T,Je,Jy
P. laevigatus Soland. ex Ait. - smooth beardtongue; SE,Je
Scrophularia lanceolata Pursh - hare figwort; T,Je,Jy
Verbascum thapsus L. - great mullein; S,E,Jy,Au
Veronica officinalis L. - common speedwell; N,Je
Veronicastrum virginicum (L.) Farwell - culver's-root; *,Au

Plantaginaceae - Plantain Family
Plantago lanceolata L. - buckhorn plantain; N,Je,Jy
P. rugelii Dcne. - common plantain; E,Jy

Rubiaceae - Madder Family
Diodia teres Walt. - rough buttonweed; N,E,Au
Houstonia caerulea L. - bluets; *,T,Ma,Je,Jy
H. longifolia Gaertn. - long-leaved summer bluets; T,Jy,Au

Caprifoliaceae - Honeysuckle Family
Symphoricarpos orbiculatus Moench. - Indian current; N,E,Au
Triosteum perfoliatum L. - tinker's weed; *,T,Je,Jy
Viburnum recognitum Fernald - smooth arrowwood; *,E,Je

Lobeliaceae - Lobelia Family
Lobelia inflata L. - Indian tobacco; S,Au

Compositae - Composite Family
Achillea millefolium L. - yarrow; *,T,Jy,Au
Ambrosia artemisiifolia L. - common ragweed; *,T,Au
Antennaria neglecta Greene - field pussytoes; T,Ma
A. plantaginifolia (L.) Richards. - plantainleaf everlasting; T,Ma
Arctium minus (Hill) Bernh. - common burdock; N
Aster dumosus L. - bushy aster; *,T,Au,Se
A. paternus Cronq. - white-topped aster; E,Jy
A. radula Ait. - low rough aster; *,Se
A. umbellatus Mill. - flat-top white aster; *,S,Au
A. undulatus L. - wavy-leaf aster; *,T,Au,Se
Cacalia atriplicifolia L. - pale Indian plantain; *,T,Jy,Au
Centaurea maculosa Lam. - spotted knapweed; T,Jy,Au,Se
Chrysanthemum leucanthemum L. - ox-eye daisy; *,T,Jy,Au
Cichorum intybus L. - chickory; N,Au
Cirsium pumilum (Nutt.) Spreng. - pasture thistle; T,Jy,Au
C. vulgare (Savi) Tenore - common thistle; *,T,Au,Se
Erechtites hieracifolia (L.) Raf. - fireweed; S,Se
Erigeron anuus (L.) Pers. - white-top; *,T,Jy,Au
E. strigosus Muhl. - daisy fleabane; N,Je
Eupatorium rugosum Houtt. - white smakeroot; S,Au
E. perfoliatum L. - boneset; *,Au
Gnaphalium obtusifolium L. - cudweed; S,Se
G. uliginosum L. - low cudweed; *,Au
Hieracium pilosella L. - mouse-ear hawkweed; N,Je
H. pratense Tausch. - king devil; *,T,Je,Jy
H. scabrum Michx. - rough hawkweed; N,S,Au,Se
H. venosum L. - rattlesnake-weed; *,N,Jy
Lactuca canadensis L. - wild lettuce; *,T,Jy
Parthenium integrifolium L. - American feverfew; N,Se
Rudbeckia hirta L. - black-eyed Susan; T,Jy,Au
R. laciniata L. - tall coneflower; *,Au
Senecio aureus L. - golden ragwort; *,T,Ma,Je
S. smallii Britt. - Small's ragwort; SE,SW,Jy
Solidago bicolor L. - silverrod; *,T,Au,Se
S. canadensis L. - Canada goldenrod; S,Se
S. gigantea Ait. - late goldenrod; S,E,Se
S. graminifolia (L.) Salisb. - grass-leaved goldenrod; S,SW,Au,Se
S. juncea Ait. - early goldenrod; *,T,Jy,Au,Se
S. nemoralis Ait. - oldfield goldenrod; *,N,S,Au,Se
S. rugosa Ait. - wrinkled-leaf goldenrod; *,Au,Se
S. squarrosa Muhl. - squarrose goldenrod; N,Au,Se
Taraxacum officinale Weber. - common dandelion; *,T,Ma
Tragopogon major Jacq. - goat's beard; T,Je
Vernonia noveboracensis (L.) Michx. - New York ironweed; *,Au,Se

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