May 18, 1954

To the Graduate Council:

I am submitting herewith a thesis written by Vernon Collis Gilbert, Jr. entitled "Vegetation of the Grassy Balds of the Great Smoky Mountains National Park." I recommend that it be accepted for fifteen quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Botany.

Royal E. Shanks
Major Professor

We have read this thesis
and recommend its acceptance:

E. Winter

H. C. Annick

A. J. Sharp

Accepted for the Council:

Dean of the Graduate School

VEGETATION OF THE GRASSY BALDS OF THE GREAT SMOKY MOUNTAINS NATIONAL PARK

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

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by

Vernon Collis Gilbert, Jr.

June 1954

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

On the tops of many mountains in the Southern Appalachians are areas which are essentially treeless and which are called "balds." These balds are of two general types, "heath balds" and "grassy balds." The heath balds are largely made up of woody ericaceous species, while the grassy balds are dominated by herbaceous species. This study is concerned with the grassy balds.

The problem of the origin of these grassy balds has long been of interest, and a great deal has been written about the general topic. In this thesis a review is made of the views and theories that have been advanced concerning bald origin. The primary purpose of the study, however, is to describe the vegetation of the grassy balds of the Great Smoky Mountains National Park. To this end the summer of 1953 was spent working in these areas. The first part of the summer was spent in becoming generally familiar with the vegetation of all the grassy balds in the Park. The actual sampling of the vegetation was done during July, August, and September on five of the eight larger balds.

II. GENERAL DESCRIPTION OF THE AREA - CLIMATE, GEOLOGY, SOILS, AND VEGETATION

The grassy balds of the Great Smoky Mountains National Park are located at positions along the ridge crests from Forney Ridge west to within four miles of the Little Tennessee River. The climate of the area is characterized in general by a lower temperature, greater precipitation, and higher wind velocity than that of the surrounding lowland. Although there are no weather data for the grassy balds, local climate can be inferred from that available for the general region as compiled by Shanks (1954). The normal annual precipitation is approximately eighty inches on the most eastern balds, becoming somewhat less toward the west. September and October are usually the driest months. Occasional periods of severe drought have occurred. Wells (1937) reported that the Smoky Mountains National Park balds suffered severely during the dry summer of 1936, when the dominant mountain oat grass was killed in certain areas and subseres of weed-like plants (Potentilla, Fragaria, Solidago) were initiated. Brown (1941) also reported that this same dry period was serious enough to kill as high as 20 per cent of the grass clumps in some areas of the Roan Mountain bald. More recently another very dry period during the late summer and fall of 1952, was serious enough to reduce the grass cover and favor the development of the weed communities.

The temperature in the Smokies is variable and subject to rapid changes, yet seldom does the temperature on the balds rise above 85° F. in the summer or fall below 0° F. in the winter. Occasional sub-zero

temperatures have been recorded at Newfound Gap, which lies at 5000', the approximate average elevation of the grassy balds. The average rate of decrease in temperature with an increase in altitude is 2.23° F. per thousand feet, so the grassy balds average approximately 10° F. cooler than the base of the mountains during the growing season.

Although snowfall is irregular, heavy snowfall is not uncommon for the tops of the Smokies. For a period of twelve consecutive months, February 1, 1946, through January 31, 1947, the total snowfall at Newfound Gap was only three inches, yet the very next month, February, a total of sixty-one inches fell. Bill Cooper of Knoxville stated that he remembered "one winter on Russell Field around 1916, when the ground was covered with snow for three months and that often a three foot picket fence not far from the cabin was covered." The average annual snowfall for an eight year period, 1939 through 1946, was reported to be seventy-three inches in the vicinity of Newfound Gap.

On areas such as the grassy balds where there are no protective trees some wind is usually evident and sometimes is strong. Camp (1931) attributed the balds to the drying effect of the sometimes hot southwesterly winds of mid-summer. He stated:

> The effect of these winds is easily noted by climbing from the river to Parson Bald or Gregory Bald, for as one ascends, the forest becomes more open and park-like with numerous small grassy areas often containing a considerably dry heath population. It is not meant to convey the impression that all the southwesterly winds are dry and hot, for the grassy balds are often bathed in fog, but in mid-summer there are occasional periods of excessive drought, and it is this extreme that limits the character of the bald rather than the general climatic mean.

As to the occasional force of the wind, "blow-down" damage to forest is almost an annual occurrence on or near the high peaks in the Smokies. In April, 1936, a terrific windstorm struck Andrews Bald and vicinity and resulted in a great amount of damage to the trees fringing the bald.

The rocks underlying the grassy balds are all somewhat metamorphosed sandstones with the beds generally dipping at a low angle to the south-southeast. The rocks vary from metagraywacke to nearly pure metaquartzite, but locally contain a few interbeds of dark, slaty, slightly pyritic shale. Also found locally are joints and odd boulders of milky quartz. Although the rocks are of somewhat different composition at different places, the general type is the same, and certainly there is no obvious relation of the balds to the type of bedrock. The same general observation can be made of the soils - that there is no obvious relation of the balds to any certain soil type. Most of the data concerning the geology and the soils were obtained from the field observations made by certain members of the following group who visited Spence Field on March 16, 1953, to investigate the geology, the soils, and the vegetation: W. S. Ligon and G. H. Robinson of the Division of Soil Survey; R. B. Newman and H. E. Malde of the United States Geological Survey; Arthur Stupka and Henry Lix of the National Park Service, G. S. M. N. P.; R. E. Shanks, A. J. Sharp, and V. C. Gilbert, Jr. of the University of Tennessee; Jack Fisher of Maryville, Tennessee, former Cades Cove resident and onetime superintendent of C. C. C. camp in Cades Cove; and David Dickey, reporter for

the Knoxville News-Sentinel.

Three pits were dug for examination of the soil at the following sites:

Site #1. Occupied a high knoll on Spence Field under grass. Well drained situation. Depth to first large size metagraywacke rocks, nineteen inches.

Site #2. Occupied a ridge saddle position between knolls. Vegetation cover was grass. Depth to rock, twenty-seven inches.

Site #3. Occupied a well drained and gently sloping position on a southern spur, about 500 feet within the hardwood forest boundary. Depth to rock, thirty-two inches.

The soils at all three sites were interpreted to be an acid Brown Forest soil, and tentatively called a Burton Loam. The morphology of the soils at all three sites indicated that they probably were developed under forest; however, the surface soils indicated that the soils had been under grass for some time, particularly at site #1, which was darkened to a greater depth than were the others. The pH values of these soils were very low, ranging between 4.3 and 5.3.

To present a very general picture of the vegetation, the grassy balds are highly herbaceous communities consistently dominated by Danthonia compressa Aust., the mountain oat grass. A variety of herbs occurs on the balds, including some that are common to the adjacent forests and others that were introduced when the balds were grazed. There are also several shrubs and a few scattered trees on the balds, though their coverage is usually quite low.

Treatises on the grassy balds have consisted largely of attempts to explain their origin rather than to describe the composition of the vegetation of these communities. Several authors who have written about the origin of the balds, however, have included in their writings some description of the vegetation. Camp (1931) noted several of the species that occurred on Gregory Bald. He did not present a floristic list because of the closely browsed and grazed condition of the plants which made the determination of species difficult. Wells (1936) in discussing the origin of Andrews Bald gave a brief description of the vegetation. In a later publication (1937) he described and presented a plant list of 125 species for twenty-three grassy balds in the Southern Appalachians. Nine of these balds he described were in the Smokies. Whittaker (1948) in his doctoral thesis presented additional data on the vegetation of the balds, and then, in a later publication (1952), gave a short summary description of the grassy bald type of vegetation.

III. CAUSES OF THE TREELESS CONDITION

As has been indicated before, the grassy balds in the Great Smoky Mountains have for a long time been a subject of wide speculation, and many theories have been advanced as to their origin. Although it is beyond the scope of this thesis to investigate the cause or causes of the bald condition, it is pertinent to review the theories that have been offered on bald origin. The literature concerned involves not only the grassy balds of the Great Smoky Mountains National Park but also those of other mountains of East Tennessee and Western North Carolina. The review of this literature will follow the subsequent outline, in which the various proposed explanations of the treeless condition are classified.

I. Explanations proposed to account for the treelessness

- A. Natural
  - 1. Climatic
    - a. Ice, snow, and wind breakage
    - b. Present day moisture deficiency
    - c. Xeric period (lingering effect)
    - d. Cold period (lingering effect)
  - 2. Edaphic
    - a. Soil moisture
    - b. Soil depth
    - c. Soil fertility
    - d. Chemical or physical properties from parent material

3. Topographic
   a. Exposure to prevailing winds and evaporation
   b. Run-off and erosion
4. Biotic
   a. Man
      (1.) Clearing
      (2.) Burning
      (3.) Grazing pressure
   b. Natural grazing, trampling, and browsing
   c. Plant competition
   d. Insect damage
   e. Rodent damage
5. Fire

B. Super-natural - Cherokee Indian legends

Discussion of the Theories on Bald Origin

Theories based on climatic factors or climatic factors in conjunction with edaphic and topographic factors have been the most numerous. Mrs. Helen Edson (1894) was probably the first to advance a theory attributing the treeless condition of Roan Mountain summit to the effect of snow and ice of winter. While spending a winter in the lodge on Roan Mountain summit, Mrs. Edson had the opportunity to observe the action of winter storms upon the vegetation. Her primary interest, however, was in studying and describing the different frost forms produced by these storms. In a brief statement Mrs. Edson told of the production of frost forms from frozen vapor and of the resultant breakage of limbs due

to the weight of the ice. To strengthen her conclusion that the absence of trees was due to the effect of winter ice and snow, she mentioned an ice storm at Philadelphia which damaged large trees that had stood for centuries.

Harshberger (1903) also advanced a theory of ice storm injury to which he added the factor of exposure. In this study of the flora of mountainous North Carolina, he distinguished four ecological formations determined primarily by climate. These were as follows:

1. Mixed Deciduous Forest Formation (2000 - 5000')
2. Coniferous Forest Formation (5000 - 6700')
3. Sub-alpine Dwarf Tree-shrub Formation (6000')
4. Sub-alpine Treeless Formation (above 6000')

These last two formations, the dwarf tree-shrub and the sub-alpine treeless, resulted from the action of winter storms. In the treeless areas the topography was such as to receive the full force of the ice storm, and grassy stretches or thickets of alder and rhododendron replaced the trees.

Davis (1930) mentioned several possible causes of the balds: (1) failure of the orchard association to replace its trees, (2) grazing, and (3) fire and clearing. His explanation, however, was that the balds were caused by the great extremes in atmospheric conditions and soil temperatures. He described the grassy bald association as a physiographic-edaphic climax.

Camp (1931) also gave considerable importance to the factor of exposure. His theory was that occasional desiccating southwesterly

winds caused the grass balds. He pointed out that the balds occur in the southwestern portion of the park and are more exposed to the occasional dry and sometimes hot southwesterly winds that sweep in across the valley of the Little Tennessee River in mid-summer. Even though the grassy balds were often bathed in fog, in mid-summer there were periods of drought that determined the character of the balds. Camp, in addition, stated that probably the grassy balds were originally meadows containing numerous clumps of shrubs, mostly ericaceous, with higher shrubs at the margin, and that any clearing that the early settlers had done was only to enlarge those grassy areas already present.

Cain (1931) believed that the grassy balds were natural though he never published a theory concerning their origin. He did state, however, that the soil was too "rich and deep" for the balds to have been formed in recent history and that the eccentric growth rings of trees at the bald margins indicated that they had been in their present condition for nearly a century. Depth of soil bears no obvious relationship to the presence or absence of forest cover, nor has evidence been presented that the fertility of the soil under grass differs appreciably from that under forest. The Spence Field samples had very low base status in both cases.

Peattie (1936) attributed the balds of the Smokies to excessive evaporation due to the isolation of the peaks. It should be pointed out in reference to this hypothesis that the bald spots are often no more isolated than many of the forested areas.

Brown (1941) in his study of vegetation of Roan Mountain gave a very complete picture of the structure and composition of a grassy bald community in addition to an attempt to explain its origin. He gave evidence that the grassy balds were once more extensive along the summit of Roan Mountain than they now are, having given way to shrub and forest communities. This he explained was due to climatic change. Formerly, insufficient soil moisture, at times critical to woody seedlings, was responsible for maintaining the bald. More recently a climatic change, which shortened these dry periods at critical times, resulted in an advance of the shrubs and conifers into the grassy area. In a more recent study Brown (1953) gave further evidence that the forest was advancing into the bald of Roan Mountain. In addition he reported that conifer seedlings transplanted on the summit of Roan Mountain bald in 1937 had survived and grown. Since the data indicated that the conditions were favorable for survival and growth of transplanted seedlings, the explanation for the absence of natural seedlings must be sought in the seed supply or in factors which may inhibit germination and early survival.

Whittaker (1948) suggested that these balds could be compared to the depressed timberlines and local balds on isolated or exposed summits in the West where the tree line is depressed below its normal elevation for the latitude. He added to the factor of critical moisture balance the fact that the deciduous forests involved were boreal members of their type, of reduced stature, and possibly beyond their temperature optima. His conclusion was that the balds were sites in which high

elevation and high exposure, with low temperature and low moisture balance, act together to exclude deciduous trees.

Thus far, most of the climatic, edaphic, and topographic factors have been mentioned in the theories discussed. Soil depth, fertility, and chemical or physical properties inherent from the parent material, however, have not been seriously proposed as possible causes of treelessness. Soil depth is obviously not a factor involved since the soil supporting forest vegetation is often extremely shallow. Likewise, soil fertility can be ruled out since the soils on the balds differ only slightly from those under forest cover. Physical and chemical properties inherent from the parent material cannot be factors involved since the parent material is the same kind in both situations. There is a small amount of erosion that has taken place on the balds in patches or in draws. This can hardly be considered to be a factor in bald maintenance, however, for it is in these patches of broken sod that certain shrubs and trees become established.

Wells stands alone as a proponent of man as a possible cause of the treeless condition. In several publications (1936, 1937, 1938, and 1946) he expounded the theory that the balds had come into existence through activity of the Cherokee Indians such as clearing for campsites and lookouts. In his 1937 study, "Southern Appalachian Grass Balds," Wells described twenty-three balds in the Southern Appalachians. His chief support for his theory lies in the following evidence. He pointed out that the normal succession following fire or clearing is a return to forest. Through human interference at the soil level, this normal

succession was prevented, making possible the establishment of the mountain oat grass (Danthonia compressa), which was able to compete successfully with the woody vegetation. This theory of Indian origin of the balds has not proved posular, and has attracted some critical comment. It was pointed out by Fink (1931) that the Indians lacked the energy to labor at clearing the balds, particularly with their stone axes. Brown (1941) pointed out that the Cherokee Indians were of a lowland habit and supposedly did not frequent the high mountains. The strongest point against this theory is the lack of positive evidence that the Indians had ever used these areas as camping grounds. No arrowheads or other artifacts, which were fairly common around former lowland campsites of the Indian, have been found. It is also pertinent that the Indians themselves were seemingly puzzled over the balds, in that they had several supernatural legends as to their origin (related by Mooney, 1898).

Natural grazing, browsing, and trampling have certainly been minor factors. Bears frequently wander about on the balds, sometimes leaving a network of paths and occasional "wallows," especially in patches of Rubus. On the other hand it is generally agreed that some one hundred years of grazing by man's domestic animals on most of the balds has had an important effect. Clearing and occasional burning have also had a part in the history of the balds.

Gates (1941) advanced the hypothesis that balds were caused by the destruction of trees by wasps (twig gall wasps). He reached this conclusion after observing huge numbers of these wasps destroying trees

on two of the North Carolina balds, Wayah and Wine Sap Bald. In occasional years when the wasps or any other destructive insects reached a peak in their population cycle, they might contribute to enlarging a bald or to maintaining one that was sparsely forested. In general, however, their activities would be too scattered to establish or maintain the balds. During the present study, one case of insect damage to trees was observed in June, 1953. Two small trees of Pinus rigida on Spence Field were completely defoliated by the "Red Headed Pine Saw-fly." In certain cases as on most of the balds where trees are only sparse, this factor certainly should not be overlooked.

On certain of the balds a close network of rodent burrows are present, always in areas covered by dead mountain oat grass (Danthonia compressa), living sheep-sorrel (Rumex acetosella), and cinquefoil (Potentilla canadensis). There is no evidence that the rodents had anything to do with maintaining the bald condition through destruction of woody seedlings. Perhaps they had been an agent in the killing of the mountain oat grass, but probably they came into the area after the death of the grass.

Cain (1930) reported that many mountaineers and woodsmen familiar with the Smokies considered fire to be a very important factor in the initiation and maintenance of heath balds, but only one person, F. E. Clements, is alleged to have attributed the origin of grassy balds to fire, (reported in correspondence of H. M. Jennison). It was argued by Wells (1937) that fire alone could not have been responsible for the balds, for the normal plant succession after fire is back to forest.

The supernatural explanations of the origin of balds, in the Cherokee Indian legends related by James Mooney (1898), are not only interesting tales, but are pertinent as evidence of the antiquity of some of the balds.

Gregory Bald was called Tsistuyi, the "Rabbit Place," by the Cherokees. "Here the rabbits had their townhouse, and here lived their chief, the Great Rabbit; and in old times the people could see him. He was as large as a deer, and all the little rabbits were subject to him." This particular legend is even mentioned in a Cherokee song.

Another legend is that in the ancient days the Indian villages were subject to invasions by a very large bird which would carry off children. After many raids by this monster and many unsuccessful attempts by the Indians to defend their villages, sentinels were posted along the mountain tops and by this means the monster was finally traced to its lair, an inaccessible cavern, high on a sheer, precipitous mountain side. "While they had found its retreat, the Indians were little better off than before, so they gathered together in a great council and implored divine assistance. The Great Spirit heard their pleas, and sent to their aid the lightning, which at one tremendous stroke split off the entire side of the mountain. When the smoke and dust cleared, the monster was dazed but still alive, so the Indians fell upon it with spear and ax, ridding themselves forever of the dread scourge. So pleased was the Great Spirit with their initiative in uncovering its hiding place, their piety in appealing for divine aid, and their bravery in final combat, that He decreed that in the future the

the tops of the highest mountains should be destitute of trees."

Another legend involved a bald mountain near the head of Valley River, on the line between Graham and Cherokee counties. It was called Diyahaliyi, the "lizard place," from a traditional great lizard, with glistening throat, which used to haunt the place and was frequently seen sunning itself on the rocky slopes.

Cheowa Maximum, a bald mountain at the head of Cheowa River on the line between Graham and Macon counties and an adjoining peak, Swim Bald, are together called Sehwateyi, "Hornet Place," from a monster hornet, which according to tradition, formerly had its nest there, and could be seen flying about the tree tops or sunning itself on the bald spots, and which was so fierce that it drove everyone away.

Another Indian tradition reported by Lanman (1854) tells of three great battles fought on Roan Mountain, the Catawbas winning against the Cherokees. After these battles the Great Spirit "caused the forest to wither from the three peaks." This legend is an indication of the great antiquity of the bald.

One other legend of interest stated that the Nunnehi (people who live anywhere), a race of spirit folk who inhabited the high mountains, "had a great many town houses on the balds, 'udawagunta,' the Cherokee name for bald mountains."

Excluding the supernatural explanations, there has in a sense been somewhat of an evolution of ideas concerning bald origin. The most recent ones are explanations indicating natural causes due to climatic changes, while the earlier ones generally inclined toward a

catastrophic change of some sort. Likewise there is recent opinion indicating that the forests are slowly encroaching on the balds, whereas, for a long time, they were assumed to be permanently stable communities maintaining themselves. It should be pointed out that origin and maintenance of the balds may well be relatively distinct problems. Such an explanation as the recent one of Brown (1941) in which grass balds are considered to be relics of more xeric climate with climatic change causing dynamic trends in the vegetation, such as the grassy bald gradually giving way to the forest, still leaves an unanswered question if we are thinking primarily of the origin of balds and not of their maintenance. Why are some of the peaks of equal or higher elevations still in forest? Encroachment of the forest may well have been prevented by dry periods at critical times for tree seedlings, in combination with other factors, but a disturbance of some nature had to occur in order to eliminate the forest on the peaks or ridges that are bald. The location of the balds cannot be attributed entirely to differential exposure, for some of the forested peaks and ridges are the most exposed ones. Why should we be inclined to place the responsibility of their origin in any one or two factors? One or a combination of factors could have been involved in the original elimination of trees on certain of the peaks and ridges. Nor do the factors responsible for one bald have to be the same ones accounting for the others.

Once the trees were eliminated, environmental conditions had to be such that the balds could be maintained. Many factors have to be taken into account when considering the genesis and maintenance of any

vegetation type. Although the problem of the balds has been approached through individual factors and their effects, the environment consists of many factors interacting upon each other and upon the vegetation; therefore, explanations should not be limited to individual factors.

Maybe the Indians and the wasps have had a part to play in some of the balds, and it is generally agreed that the effects of a hundred years of grazing, cultivation, clearing, and occasional burning cannot be left out. Natural forces such as the effect of wind, frozen fog, and even lightning must be taken into consideration. Competition from the mountain oat grass is important in retarding the establishment of woody seedlings in areas which appear to be climatically capable of supporting forest. In fact about the only hypotheses that can be safely rejected in their entirety are those of the Cherokee Indians legends.

Historical Account

To determine whether or not the forest have encroached onto the grassy balds, we must have some record of how extensive they were in the past. This record has been meager especially in regard to the balds in the Great Smoky Mountains National Park. Probably the first recorded mention of a grassy bald exclusive of the Indian legends that is now available was that of Mitchell (1835), who wrote about the Roan Mountain bald. He stated:

> With the exception of a body of rocks looking like the ruins of an old castle, near the southwestern extremity, the top of Roan may be described as a vast meadow, without a tree to obstruct the prospect; where a person may gallop his horse for a

> mile or two, with Carolina at his feet on one side and Tennessee on the other.

Brown (1941) stated that the area Mitchell had described now supports too many shrubs and trees to allow one to gallop a horse more than a quarter of a mile in any direction.

Brown (1941) also reported that the rounded portion of the southwestern summit of Roan, described by Gray (1842) as having a few dwarf specimens of Abies fraseri extending into the open summit, has now a forest cover.

Colton (1859) quoted the junior editor of the North Carolina Standard, who visited Roan Mountain in 1857, as finding a comparatively level prairie, several miles in extent, covered with grass, with huge rocks and patches of fir trees at intervals. He also stated that many cattle graze over this area in the summer.

Up until this time all of the early descriptions were of Roan Mountain bald. In 1863, Guyot in "Notes on the Geography of the Mountain District of Western North Carolina," designated Gregory Bald as "Great Bald" and Parsons Bald as "Little Bald" in a preliminary sketch of a map of Western North Carolina (including part of Tennessee). He also stated that all of the portion of the Smoky Mountains from Forney Ridge to "Great Bald" was used by the Tennesseans for grazing cattle. He gave a very brief description of the vegetation of the balds and said that elevation alone was not a sufficient explanation for the baldness. (His comments were founded on observations made in the summers during the period of 1856-1860.)

Redfield (1879) on a trip to Roan Mountain in company with Dr. Gray, described Roan as being "a grassy park of hundreds of acres, studded with copses of the brilliant Rhododendron catawbiense." He stated that much of the summit prairie flora had been destroyed by the large herds of cattle, horses, and sheep, which were pastured on the mountain top every summer. In addition, he suggested that there was reason to believe that the forest had been encroaching upon the bald, but that the encroachment was likely to be checked by the cutting of wood for fire and fences.

Most of the historical record concerning the grassy balds of the Smokies is unwritten and can only be obtained through conversations with the older natives of the area. By talking with these people, such information on the balds as the amount of burning and clearing, how extensive they were, and how much grazing there was can be obtained. Cain (1931) stated that:

> Many mountaineers and woodsmen familiar with the region, as Mr. Andy Gregory, of the Little River Lumber Company, and Mr. Horace Kephart, of Bryson, North Carolina, who are usually close observers think that fire is a very important if not universal factor in the initiation and maintenance of heath balds.

Fire was evidently much less common on the grassy bald. John Oliver, a resident of Cades Cove for over fifty years, related that only once in his memory had a bald been burned, Gregory Bald having been burned during the fall of a very dry year. This happened prior to the time when Mr. Oliver left Cades Cove, possibly during the dry fall of 1936. A similar opinion was given by Bill Cooper of Knoxville, Tennessee, who lived for three years, around 1916, on Russel Field. Mr. Cooper said

that never in his memory had there been any fires on the balds, nor had anyone done any burning for the purpose of clearing. Camp (1931) stated that grazing and fire had been important factors in the changing physiognomy of the balds, but that examination of the region over a period of three years and at various seasons gave no hint that these factors had been the ones which gave rise to the typical grassy bald.

As for clearing on the grassy balds, Carlos Campbell of Knoxville, Tennessee, told of Andrew Maxey who remembered the beech trees covering Spence and Russell Field before clearings were made on both places about 1880. (There was no mention of Spence or Russell Field in Guyot's 1863 account.) Maxey was eighty-three years old when he told this to Mr. Campbell in 1940, and would have been twenty-three years old when the clearing was done. Mr. Campbell also told of "Uncle Dan Myers" (now deceased), of Cades Cove, who said that Spence Field was a beech forest when he was a boy. John Oliver, who is now seventy-six years old, also said that he remembered stumps all over Spence Field. In addition he stated that the bald portion of Thunderhead Mountain was considerably shrubby. It was Mr. Oliver's opinion that all of the balds were cleared of shrubs or trees at one time for the purpose of grazing cattle. /Wells (1937) indicated that he believed Spence Field was only enlarged from a bald already present./ Mr. Oliver also indicated that he thought that some of the balds had been tree covered and others covered with shrubs. Gregory Bald when he first saw it had a great many shrubs up to the summit, though he could not remember any clearing having been done. Camp (1931) quoted Mrs. John Oliver, who said that she "had it from the

older folks long dead" that Gregory Bald was "originally a blueberry meadow" and had "always been a bald." There are still scattered clumps of blueberry on Gregory, but most of these are included in the shrub border around the bald.

In later years, around 1916, Bill Cooper and his father, Tom Cooper, did a lot of clearing on Russell Field. Most of this clearing was of a "laurel slick," and most of the wood was burned as firewood. As for any clearing on the other balds - Andrews, Silers, Little Bald, Gregory, and Parsons - none of these people could remember that there had ever been any done.

How many years the grassy balds had been grazed prior to Guyot's visit to the Smokies around 1856 is not known; but it is known that after that date up to the time of the establishment of the Great Smoky Mountains National Park in 1936 grazing was very common. Probably grazing on some of the balds in the western end of the Park began shortly after the Cades Cove area was settled by the first white men around 1818. The extent of the grazing and the grazing pressure was at times heavy. Acy Sparks, a resident of Cades Cove, said that his father, Nace Sparks, at times grazed as many as 700 head of cattle on "Spence place." It was the custom for the owners of these "fields" to allow cattle owners from all around to graze their cattle at so much per head. According to Mr. Oliver, cattle, horses, sheep, and hogs were all grazed on the grassy balds. The sheep, hogs, and horses usually grazed near the top, and the cows around the edges. He said that where there were many sheep, the cows would not graze. "They did

not like the scent."

The only cultivation that is reported to have been done on the grassy balds was on Spence and Russell Fields. This was only to support the families that lived there at the time. The soil was reported to have been productive for most crops, especially for potatoes and turnips. Wheat and corn were also grown, but the corn did not mature because of the early frost.

Although the historical picture of the grassy balds is far from complete, it is adequate to show that man has had considerable effect - through clearing on some of the balds and through grazing of domestic animals on all of the balds.

IV. VEGETATIONAL ANALYSIS

The present study was designed to sample the vegetation of several representative grassy balds so as to present an accurate picture of the vegetation of these communities.

Sampling Methods

The sampling method is described as follows:

A spring steel hoop which measured one yard in diameter was tossed in three different directions from a central point which was marked by a wooden staff. These central points were usually at fifty pace intervals along lines parallel to the main axis of the bald. (The number of lines depended upon the width of the bald.) This ring method worked well for the usual low type vegetation. When, however, it happened to hang suspended in an occasional shrub or tree, it was placed on the ground as near to the obstructing limb as possible, and the species in the ring at that point plus the shrub or tree were listed. The spring steel hoop, of one yard diameter, was chosen primarily for convenience in handling. The dominant species in the grassy balds are usually dense enough and uniform enough in distribution that high frequencies would result even though the sample plots were relatively small.

The distance of the throw was varied both intentionally and because of the wind. The distance of the throw from center point ranged from 15'-45'. Other than to avoid having the hoop fall in the same area twice, there was no attempt to control where it landed. In this manner the sample plots were essentially randomly distributed even

though the sampling was done along parallel lines.

Under most circumstances it was not practical to make actual species counts, so a scale of abundance was set up to make a rapid estimate of the number of plants of each species. The pattern for the scale was as follows:

1. Very dense
2. Dense
3. Medium-dense
4. Medium
5. Light-medium
6. Light
7. Very light
8. Rare

At the beginning of each series of samples the actual numbers of different species in the sample plot were counted, and the space occupied by them noted. In this manner each level in the scale of abundance could be assigned an approximate range of numbers for each species. Thereafter, estimates were made according to the scale of abundance, except for those species occurring in small numbers which were actually counted.

For rapid estimation of cover, the following coverage classes were set up:

Class 1. Covering less than 5 per cent of the ground surface

Class 2. Covering 5 to 25 per cent

Class 3. Covering 25 to 50 per cent

Class 4. Covering 50 to 75 per cent

Class 5. Covering 75 to 100 per cent

Results and Discussion

Each individual bald is treated here as a separate community, and frequency percentage for each species as recorded from the sample plots is shown in Table I. /Plant names generally follow the usage of Gray's Manual of Botany, eighth edition, Fernald (1950). For Vaccinium Camp (1945) is used as authority./ The three species which have a frequency greater than 75 per cent on all of the balds are Danthonia compressa, Potentilla canadensis, and Rumex acetosella. On two of the balds, Gregory and Parsons, Aster surculosus occurred in more than 80 per cent of the sample plots. It can be generally concluded that several of the species on each bald having very low frequencies contribute no more to the make-up of the community than many of the species collected on the bald which did not fall within the sample plot. (A complete species list appears in Table III, Appendix A.) The listing of these low frequency species could in many cases be attributed to chance only. At the other extreme there are also those species which have relatively low frequencies and a high coverage when present. In other words, they are species which attain "spot dominance." Examples include certain species which make up the different weed communities that are variously distributed throughout all of the balds. The species which make up the "shrub islands" also have a low frequency but a high coverage class in their respective sites. These species have not been indicated in the distribution of coverage classes in Table II because their total coverage

TABLE I

FREQUENCY DATA FOR SPECIES OF THE GRASSY BALD COMMUNITIES
(PER CENT OF SAMPLES CONTAINING THE SPECIES DESIGNATED)

	Parsons Bald	Gregory Bald	Spence Field	Silers Bald	Andrews Bald
Number Samples	60	50	70	40	30
Floristic List					
PTERIDOPHYTES					
Botrychium dissectum	1.7	2		2.5	
Dennstaedtia punctilobula	1.7		1.4	2.5	
HERBS					
Achillea millefolium	1.7				
Agropyron repens			1.4		
Agrostis alba			1.4		
Agrostis tenuis					16
Andropogon scoparius	15				
Angelica triquinata			2.85		33
Asclepias tuberosa		2	1.4		
Aster surculosus	81	86			
Aster spp.	30	20	12.85	40	10
Carex spp.	1.7	2	2.85	2.5	17
Cerastium arvense			1.4		
Cirsium lanceolatum	3.3				
Danthonia compressa	100	100	97	100	93
Daucus carota	5				

TABLE I

FREQUENCY DATA FOR SPECIES OF THE GRASSY BALD COMMUNITIES
(PER CENT OF SAMPLES CONTAINING THE SPECIES DESIGNATED)
(CONTINUED)

	Parsons Bald	Gregory Bald	Spence Field	Silers Bald	Andrews Bald
Number Samples	60	50	70	40	30
Floristic List					
Fragaria virginiana	20	6	2.85	30	10
Helianthus divaricatus				2.5	
Hieracium paniculatum				2.5	
Houstonia purpurea					3.3
Houstonia serpyllifolia	10	4	2.85	5	3.3
Hypericum graveolens		6			17
Juncus tenuis		2	2.85		
Lechea sp.	1.7	2			
Lysimachia quadrifolia	1.7				
Pedicularis canadense	1.7			2.5	
Phleum pratense			5.7	2.5	
Poa pratensis			1.4		
Potentilla canadensis	90	92	97	97	87
Prunella vulgaris	1.7		2.85		
Rubus canadensis	8.3	14	16	30	27
Rudbeckia laciniata				25	
Rumex acetosella	78	78	91	91	87

TABLE I

FREQUENCY DATA FOR SPECIES OF THE GRASSY BALD COMMUNITIES
(PER CENT OF SAMPLES CONTAINING THE SPECIES DESIGNATED)
(CONTINUED)

	Parsons Bald	Gregory Bald	Spence Field	Silers Bald	Andrews Bald
Number Samples	60	50	70	40	30
Floristic List					
Senecio smallii		2	2.85		3.3
Smilax rotundifolia				2.5	
Solanum carolinense	11.6				
Solidago spp.	6.7	8	24	17.5	17
Stachys clingmanii				2.5	
Stenanthium gramineum	1.7			7.5	10
Thalictrum revolutum				2.5	
Trautvetteria carolinensis				15	
Trifolium repens	1.7				
Viola spp.	11.6	10	18.6	60	62
Viola sagittata	11.6				
TREES					
Acer rubrum			2.85		
Aesculus octandra			1.4		
Amelanchier laevis		4	2.85	2.5	
Pinus strobus	1.7				
Quercus rubra	1.7				

TABLE I

FREQUENCY DATA FOR SPECIES OF THE GRASSY BALD COMMUNITIES
(PER CENT OF SAMPLES CONTAINING THE SPECIES DESIGNATED)
(CONTINUED)

	Parsons Bald	Gregory Bald	Spence Field	Silers Bald	Andrews Bald
Number Samples	60	50	70	40	30
Floristic List					
SHRUBS					
Crataegus macrosperma		4			3.3
Kalmia latifolia			4.3		
Lyonia ligustrina		8			
Rhododendron calendulaceum		6			
Rhododendron catawbiense			1.4		

TABLE II

DISTRIBUTION OF COVERAGE CLASSES OF SPECIES WITH A MEAN COVERAGE GREATER THAN 5 PER CENT

		Floristic List	Frequency Per Cent	Distribution of Coverage Classes 1	2	3	4	5
I.	Parsons Bald	Danthonia compressa	100	2	31	16	8	3
		Aster surculosus	81	2	7	16	22	2
		Potentilla canadensis	90	8	20	16	7	3
		Rumex acetosella	78	14	29	3	1	0
II.	Gregory Bald	Danthonia compressa	100	1	22	12	11	4
		Aster surculosus	86	5	10	13	12	0
		Potentilla canadensis	92	14	22	9	1	0
		Rumex acetosella	78	21	10	7	1	0
III.	Spence Field	Danthonia compressa	97	5	9	20	25	9
		Potentilla canadensis	97	15	22	27	4	0
		Rumex acetosella	91	41	15	6	2	0
IV.	Silers Bald	Danthonia compressa	100	2	2	11	24	1
		Potentilla canadensis	97	22	10	6	1	0
		Rumex acetosella	91	30	3	3	0	0
V.	Andrews Bald	Danthonia compressa	94	0	4	14	8	2
		Potentilla canadensis	89	6	13	7	0	0
		Rumex acetosella	89	17	8	1	0	0

for the bald is low. To indicate the relative importance of these species attaining "spot dominance" a description of several of these small communities is given in the section concerning the individual balds.

In addition to these areas there are eroded patches in which the vegetation picture differs somewhat from that of the bald in general. In these sites certain shrubs and trees may become established. Typically found here are Kalmia latifolia, Oxydendrum arboreum, and occasional specimens of Rhododendron catawbiense. Houstonia serpyllifolia and Viola sagittata are always present and Danthonia compressa and Potentilla canadensis, the species so characteristic of the rest of the bald, are only sparsely present.

Table II indicates that although Danthonia compressa has the higher frequency on Gregory and Parsons Bald, Aster surculosus, when present, has equal or greater coverage for the community. The high coverage of this "creeping aster," the basal leaves of which form a dense mat in many sites, may be favored by the suppression of the Danthonia following successive dry seasons. The Danthonia, however, was present in all of the sample plots on both Gregory and Parsons, and in the more mesic sites had such a high coverage as to reduce or exclude the Aster surculosus. Potentilla canadensis and to a lesser extent Rumex acetosella were consistently present in both the open bald and within the weed communities as a ground cover. These species showed particularly good development associated with Rubus species.

Many of the species in the floristic list represent plants which

must have been introduced into the areas by grazing animals. Of these Rumex acetosella is the only species that attains a high frequency throughout the community. Solanum carolinense, however, occurs in rather large numbers in one site on Parsons Bald. Juncus tenuis, the path rush, is commonly found along the edges, though it rarely occurs in large numbers.

There are no tundra species present in the vegetation, thus there is no evidence in the vegetation that the balds were remnants of a colder climate. The bulk of the vegetation has been derived from the ground cover of the contiguous forest. A lesser number of species was introduced by grazing animals.

Shrubs and trees are typically present in all of the grassy balds. They may be present in a border or transition zone near the edge of the bald, in "shrub islands" within the bald, or scattered throughout the bald. The most common deciduous tree on the balds is Amelanchier laevis. Other trees which are also common are as follows: Acer rubrum, Betula lutea, Crataegus macrosperma var. roanensis, Oxydendrum arboreum, Pinus pungens, Pinus rigida, Pinus strobus (on lower balds), Prunus pensylvanica, and occasionally Quercus rubra. The most common shrubs on the balds are Vaccinium spp. with Vaccinium constablaei, the high bush blueberry, being the most typical. Other shrubs which are generally present are: Kalmia latifolia, Rhododendron calendulaceum, and Rhododendron catawbiense. Shrubs which are limited in occurrence will be mentioned in the descriptions of individual balds.

Wells (1936) indicated that certain of the grassy balds which were known to have been cleared by white settlers, differed in character from the others and were easily recognizable. There has been enough lapse of time since that date that the "cleared balds" cannot now be distinguished by character of the vegetation or species present. The amount of forest encroachment on a "cleared bald" in contrast to that on a "natural bald" can seldom be used as conclusive evidence to distinguish between the two. There has been definite encroachment of the forest on all of the balds in recent years. Figure 6, Appendix B, is a general view of Spence Field in May, 1936. Figure 7 is approximately the same view in July, 1953. Figure 8 is a view of the eastern end of Spence Field in April, 1938, and Figure 9 is a view of the eastern end of Spence Field in July, 1953. Each of these pairs of photographs shows that the trees have definitely encroached onto the bald. Invasion has been most active up the northern slope of the bald, yet scattered trees and shrubs have become established throughout. Figure 10, a view of Russell Field in October, 1936, and Figure 11, approximately the same view in August, 1953, show that Russell Field has also been invaded by forest. In this case the invasion has been more pronounced than on any of the other balds. (Figure 10 shows a group of men engaged in erosion control work on Russell Field).

The encroachment of forest onto a "natural bald" is shown in Figures 12 and 13, photographs of the northern section of Silers Bald in September, 1938, and in April, 1954. The 1954 photograph was taken from a point just above the rock in the foreground of the 1938 photograph.

These pairs of photographs show that invasion of forest has not been restricted to the "cleared balds." There has also been invasion of the forest in recent years onto Parsons, Gregory, and Andrews Balds althcugh comparable photographs are not available.

V. INDIVIDUAL BALD DESCRIPTIONS

Although the following descriptions of the individual balds are chiefly concerned with those areas considered to be the largest and most typical, there are other balds within the Park that are worthy of a brief description.

At the extreme eastern end of the Great Smoky Mountains National Park in Haywood County, North Carolina, is Mount Sterling Bald, at an elevation of 5800 feet. This bald is a very small, roughly rectangular area with the main axis running east-west on a gentle northwest slope near the top of the mountain. The bald is bordered on all sides by spruce-fir forest with fir (Abies fraseri) in greater size and number than the spruce (Picea rubens). There is a suggestion that the bald had been cleared in the past, for there is an abrupt transition from the grassy bald to large trees, and the edges tend to be rather straight. The predominant shrub on the bald is Diervilla sessifolia, with a generous number of Vaccinium constabaei and Vaccinium altomontanum scattered around the edges. There is a fairly dense stand of Danthonia here, and in the more moist places a fair amount of certain Carex species, especially Carex debilis and Carex normalis.

Another small bald is located along the Appalachian Trail less than a mile to the east of Silers Bald. This bald lies at an elevation of 5500 feet, with the main axis in an east-west direction. The part to the north of the trail is on a gentle slope, but that south of the trail is on a steep slope. The bald is covered with Danthonia, with

several scattered specimens of Kalmia latifolia and a few of Rhododendron catawbiense. The southern border has a narrow zone of Crataegus and Vaccinium. The bordering forest is beech (Fagus grandifolia) with a few spruce intermixed.

One of the larger and more interesting of the balds not included in the vegetational analysis is Thunderhead Mountain Bald. This bald lies at an elevation of 5500 feet, and is located approximately fifty yards below the summit of the mountain. The largest portion of the bald lies north of the Appalachian Trail and the main axis on a rather steep slope with a northwestern exposure. As mentioned earlier John Oliver, formerly of Cades Cove, reported that Thunderhead was once much more shrubby than it is now. The mountain top, except for a small patch of Danthonia on the very summit, is covered with dense Rhododendron maximum. Unexpectedly found in this mat of Rhododendron near the summit was a lone, wind deformed, six foot Tsuga canadensis which had grown in the partially protected position afforded by the Rhododendron. This hemlock was well above its normal range in altitude, yet in one other case on an exposed northern slope of Mount Sterling at about 5700 feet elevation, a fifteen foot hemlock was found.

Between Thunderhead Mountain and Spence Field along the Appalachian Trail ridge there are long stretches of narrow balds with southwestern exposure. The forest bordering the bald is predominantly beech and northern red oak with varying amounts of Betula lutea, Crataegus, Pyrus americana, and Amelanchier. The bald has a high coverage of Danthonia except for one portion below Rocky Point approaching Spence Field.

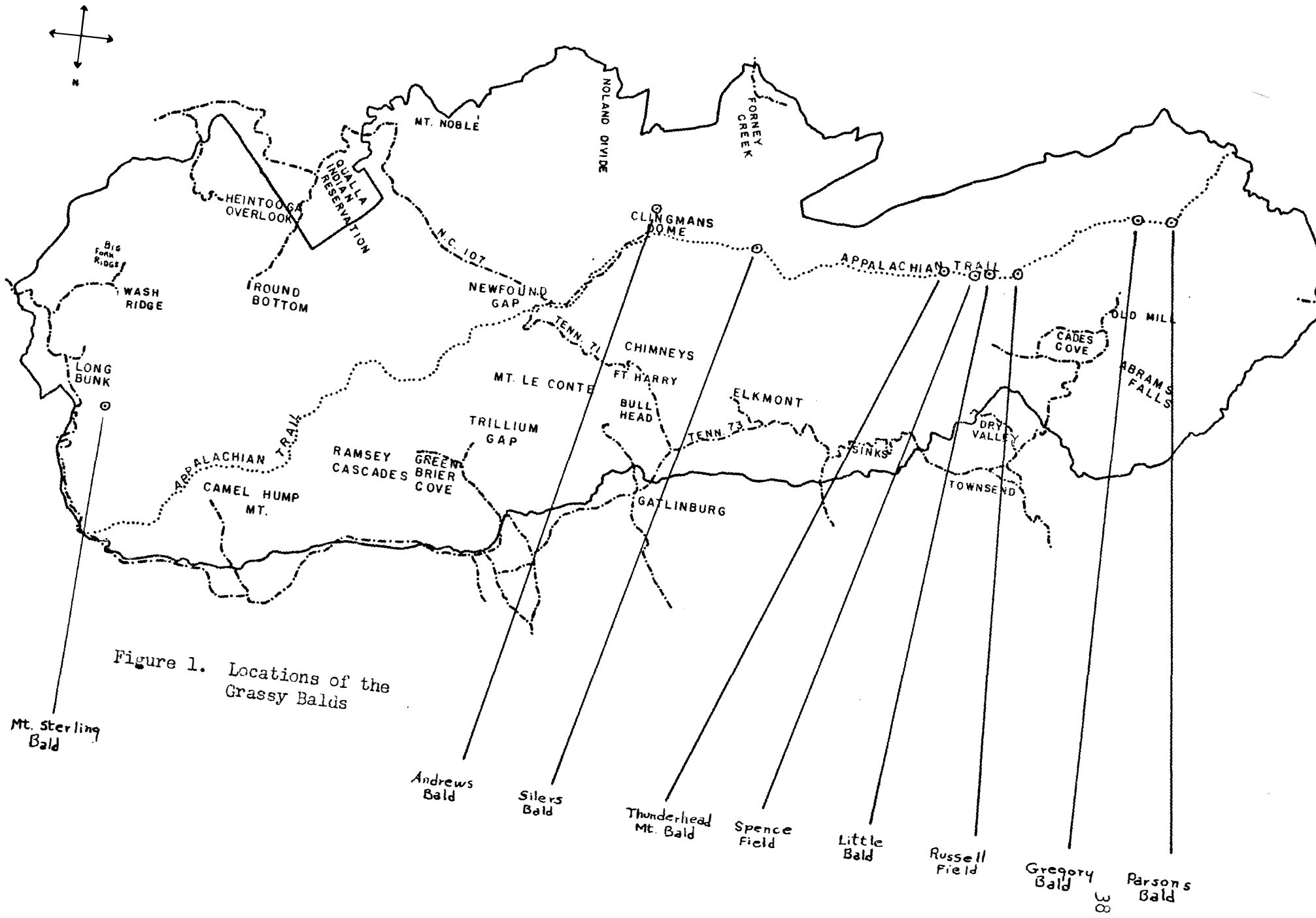

Figure 1. Locations of the Grassy Balds

Legend to accompany figures 3 through 6:

 = Trail

 = Rock outcrop

 = Eroded area

 = Sunken area

 = Dead grass area

 = Weed communities dominated by Rubus

 = Vaccinium

 = Bench mark

 = Pine

PR = Pinus rigida

PP = Pinus pungens

PS = Pinus strobus

 = Deciduous tree

AP = Acer pensylvanicum

AR = Acer rubrum

AO = Aesculus octandra

AL = Amelanchier laevis

BL = Betula lutea

CD = Castanea dentata

CM = Crataegus macrosperma var. roanensis

FG = Fagus grandifolia

LT = Liriodendron tulipifera

OA = Oxydendrum arboreum

PP = Prunus pensylvanica

PA = Pyrus americana

QR = Quercus rubra

Parsons Bald

Parsons Bald is located on the Tennessee-North Carolina line approximately four miles up from the Little Tennessee River and is the westernmost grassy bald in the park. The elevation of the rounded summit is 4730 feet. The main axis runs north-south, sloping gently to the South with the sides extending approximately equally down the east and west slopes.

The forest bordering the bald is largely made up of Quercus rubra and was formerly a red oak-chestnut forest. Quercus alba becomes important in the upper eastern portion of the bald. Within the grassy area, yet still fringing the bald, there are more than 150 pines, with Pinus rigida and Pinus pungens in approximately equal numbers and somewhat less numbers of Pinus strobus. Also occupying an intermittent fringe around the bald, particularly prominent around the northern end, is Rhododendron calendulaceum.

Danthonia compressa is found all over the bald but only locally in dense stands. Aster surculosus very often has a greater coverage, its basal leaves forming dense mats. Common on Parsons Bald only is Andropogon scoparius, which is widely scattered over the bald. Solanum carolinense is another species common in large numbers to Parsons Bald only. This species is present in a large weed community near the center of the bald.

The largest "shrub island" on any of the grassy balds is on the rounded summit of the northern end of Parsons. This "shrub island" is made up of a dense stand of Vaccinium altomontanum. Present within this

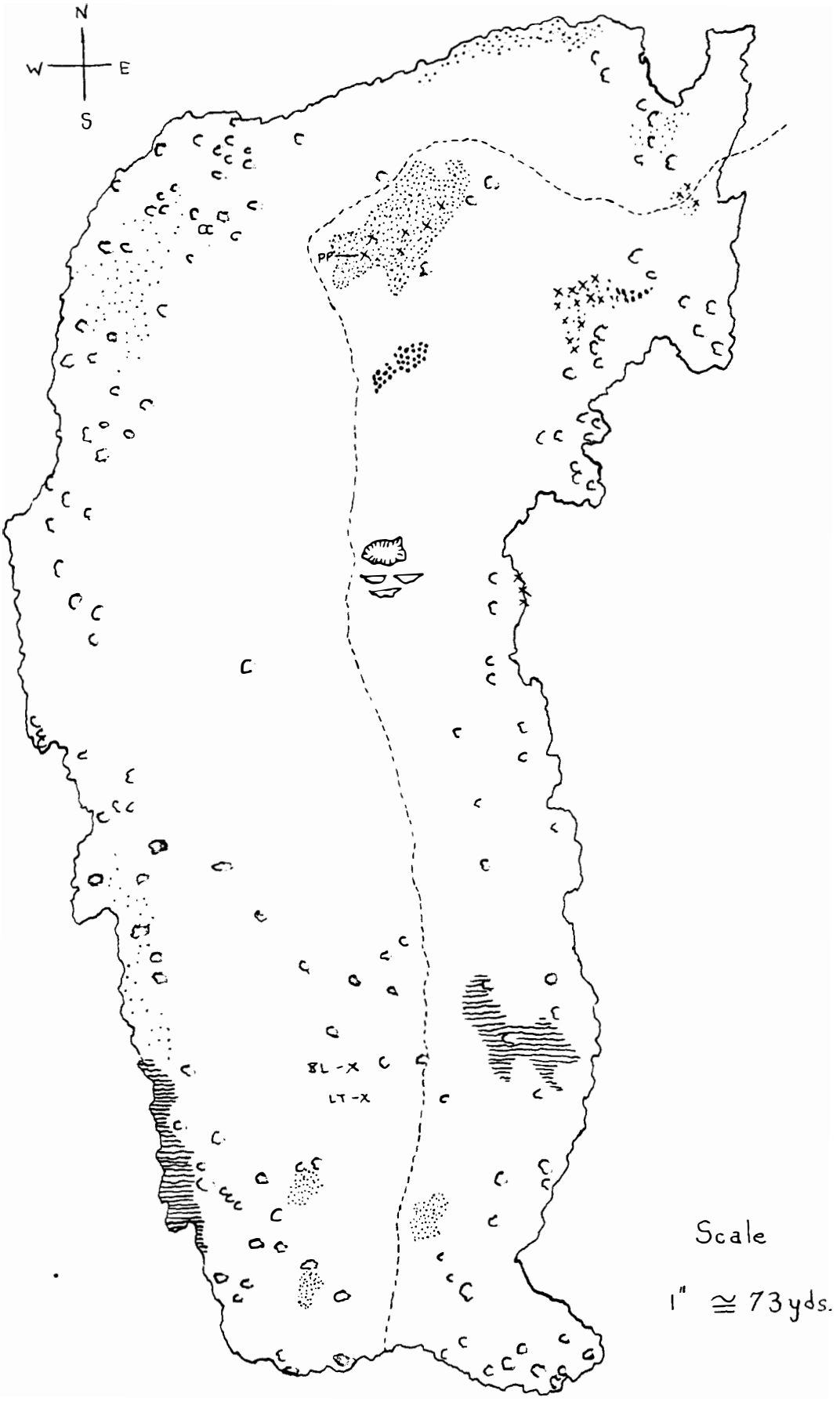

Figure 2. Parsons Bald

stand are the following species:

Pteridium aquilinum

Smilax rotundifolia

Rubus canadensis

Lespedeza capitata

Salix humilis var. microphylla

Rhododendron calendulaceum

Crataegus macrosperma var. roanensis

Quercus rubra

Acer rubrum

Acer pensylvanicum

Prunus pensylvanica

Scattered over the bald are several trees in addition to the pines mentioned. Prunus pensylvanica, Amelanchier laevis, Liriodendron tulipifera, and Quercus rubra are fairly common. Located just east of the large shrub island in the northern end of the bald is one lone three foot Juniperus virginiana.

A large eroded area similar to those of the other balds is located on the lower eastern side of the bald.

Gregory Bald

Gregory is located on the Tennessee-North Carolina line about one mile east of Parsons Bald. It occupies the rounded summit of a ridge and extends down all sides but with the main axis east-west. The elevation of the highest point is 4948 feet.

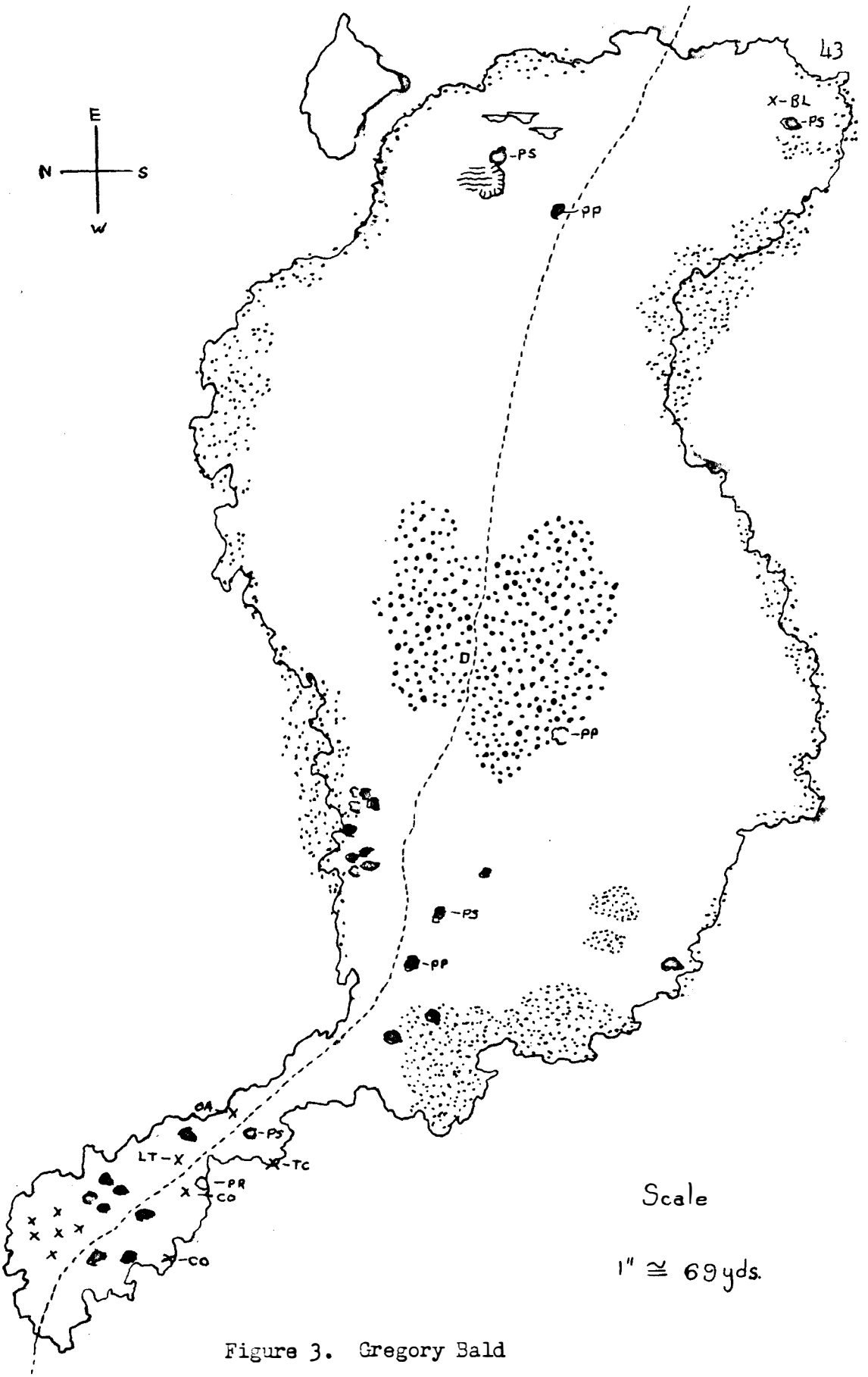

Figure 3. Gregory Bald

The forest bordering the bald as on Parsons is made up largely of Quercus rubra with scattered Castanea dentata. Toward the lower western end there are increasing numbers of Fagus grandifolia and Betula lutea.

The general aspect of Gregory has changed somewhat since the cessation of grazing, though many of the woody plants that are now present and conspicuous must have been present then. Camp (1936) stated that:

> At first glance the bald seems to be open grassland completely devoid of woody species, the low meadow vegetation stopping abruptly at the edge of the dwarf forest. A closer examination reveals that in a few places shrubs six to eight feet high occur between the open grassy area and the forest. A still closer examination shows that the meadow is by no means a pure herbaceous association, but has a zone around the edge sometimes over fifty yards wide, which contains a high percentage of woody species so closely browsed that whole areas may stand less than six inches high. These areas of browsed shrubs are by no means confined to the margin of the bald, but occur in scattered patches over the lower slopes, thinning out toward the top.

The species that make up the woody flora of this bald are numerous. Azaleas are the largest, most numerous, and conspicuous shrubs.

The azalea population presents an interesting taxonomic problem which has not yet been solved. This population, which may be called a hybrid swarm, has intergrades between at least three species. (Information received from personal correspondence with F. C. Galle). The species involved are Rhododendron arborescens richardsoni, one of the high elevation varieties of Rhododendron viscosum, possibly var. montana, and an unknown species which is probably of Rhododendron calendulaceum alliance.

Another common large shrub is Crataegus macrosperma var. roanense. Vaccinium hirsutum is often found in small dense colonies, especially on the lower western end of Gregory. Lyonia ligustrina is common around the edges. Salix humilis var. microphylla is found in dense colonies widely scattered over the southern slope of the bald. There are occasional specimens of Kalmia latifolia and Rhododendron catawbiense.

The trees on Gregory Bald include the same three pine species found on Parsons Bald, Pinus rigida, Pinus pungens, and Pinus strobus, yet in lesser number than on Parsons. Also common are Amelanchier laevis, Quercus rubra, and Betula lutea.

Danthonia compressa has the highest coverage of any single species on Gregory Bald, but as on Parsons Bald, the Aster surculosus often has a greater coverage when present.

The central portion of the bald near the top is rocky and supports a large weed community. The following plants are the most prominent in the make-up of this community:

Rubus canadensis

Rumex acetosella

Potentilla canadensis

Fragaria virginiana

Aster spp.

Solidago spp.

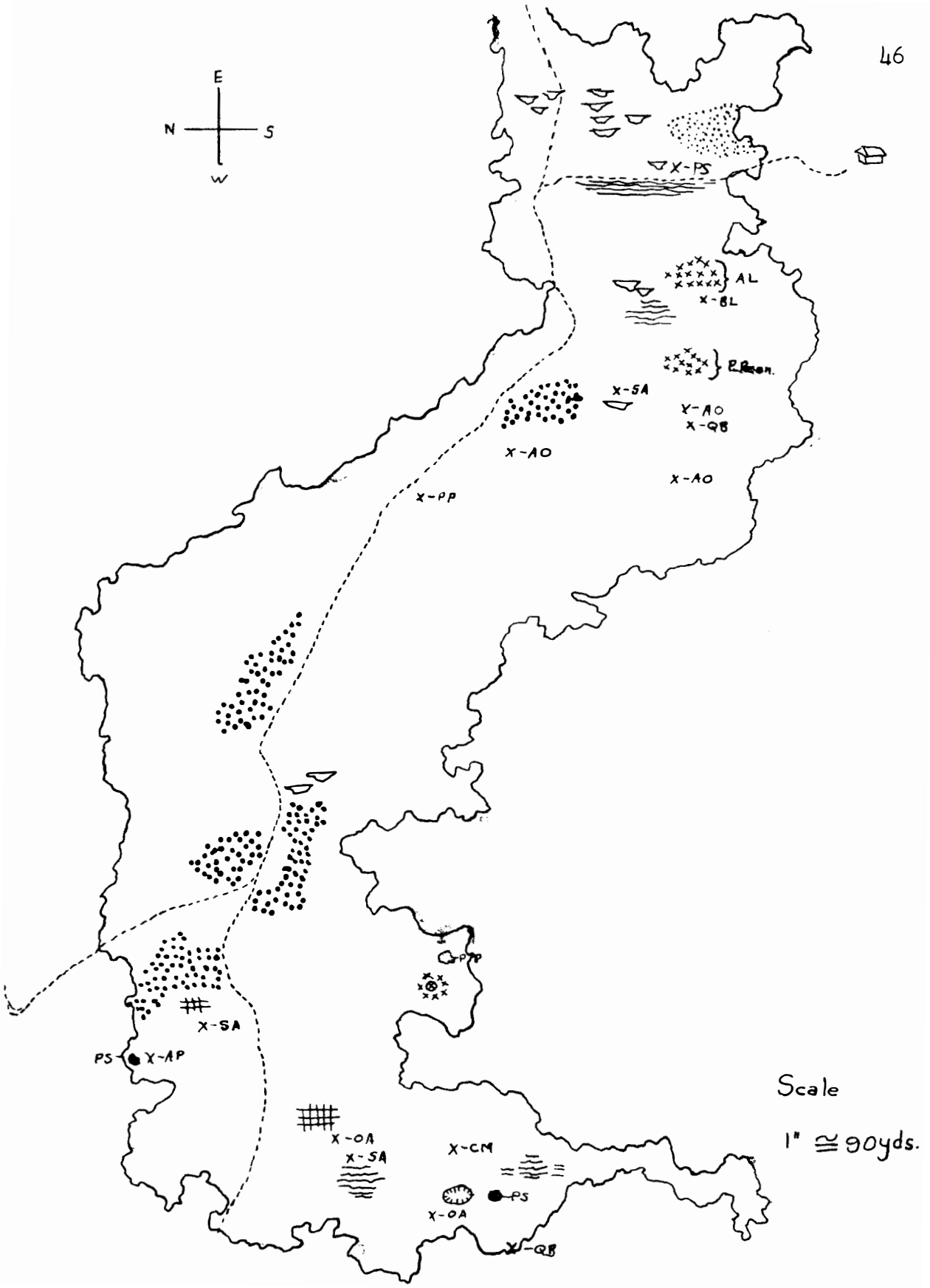

Figure 4. Spence Field

Spence Field

Spence Field is located on the Tennessee-North Carolina line three miles west of Thunderhead Mountain. The bald covers an extensive area at an approximate average elevation of 5000 feet along the main east-west ridge on rolling terrain. The forest bordering the bald is predominantly Quercus rubra and Fagus grandifolia. The south side of the eastern end of the bald has a wide zone of Kalmia latifolia and Rhododendron spp. bordering the grassy area. On this end in the draw near the trail leading to the shelter cabin erosion has cut deep gullies. The border of Quercus rubra on both the east and west ends of the bald is abrupt, the grassy area extending up to trees thirty to forty feet in height. The border edge on the north side of the bald is straight and not far from the ridge axis; the southern edge is very irregular and extends down the slope some distance from the ridge axis, thus a large portion of the bald has southern exposure. The trees seem to be actively invading the bald along the northern edge of the eastern end. Here the forest seems to thin out into a zone of scattered small trees and shrubs.

The best overall development of Danthonia compressa is shown on Spence Field. Even though the weed communities of Rubus, Potentilla, and Rumex are numerous, the Danthonia has the greatest coverage over most of the bald.

The eastern end of the bald differs from the general character in that there are numerous rock outcrops on the west facing slope of the draw. On the opposite slope west of the draw is a large shrub island in which the following plants are found:

Betula lutea - (one twenty foot specimen)

Fraxinus americana

Castanea dentata

Amelanchier laevis

Quercus rubra

Prunus pensylvanica

Acer saccharum

Vaccinium constablaei

Crataegus macrospermum var. roanensis

Rhododendron catawbiense

Rhododendron maximum

Kalmia latifolia

Rubus canadensis

Smilax rotundifolia

Solidago spp.

Dennstaedia punctilobula

Habenaria ciliaris - (around the edge)

Although Spence Field is considerably east of the usual range for Vaccinium hirsutum, one specimen was found in a small eroded area near the center of the bald.

One of the most characteristic features on Spence Field during the summer of 1953 was the presence of several dead grass areas which in later stages are dominated by Rumex and Potentilla. From a distance these areas appeared as brown-red patches scattered within the greener grassy areas. In each of these the turf was made very spongy by the great

number of rodent burrows in the soil beneath the dead grass. It is doubtful that the rodents had made their burrows before the death of the Danthonia, because there are no burrows found in areas with living grass. The only other locality in which a dead grass area with rodent damage was found was a small spot on Parsons Bald.

One other interesting phenomenon familiar on Spence Field was the presence of "fairy rings" on the hay-scented fern (Dennstaedia punctulobula). They were common on the western end of Spence Field.

Silers Bald

Silers Bald is located on the Tennessee-North Carolina line five miles west of Clingman's Dome at an elevation of 5600 feet. The main axis of the bald is north-south with a long western lobe off the middle section. In general the bald slopes moderately steeply to the south.

The forest surrounding Silers is an almost pure stand of Fagus with only occasional specimens of Betula lutea and Aesculus octandra.

The main bald is best divided into three sections. Another small bald lies about 200 yards south of the main bald separated by a forest of large Fagus and occasional Betula lutea. In the main bald the small northern section on the ridge top is, except for the trail, almost cut off from the rest of the bald by about twenty yards of Fagus. The most northern part of this section, in which there are several southward dipping rock outcrops, is very weedy. Rubus canadensis, Rudbeckia laciniata, Solidago spp., Aster spp., and Potentilla canadensis are the most prominent plants found here. A few trees, Pyrus americana, Betula lutea, and Prunus pensylvanica are also present. The rest of the

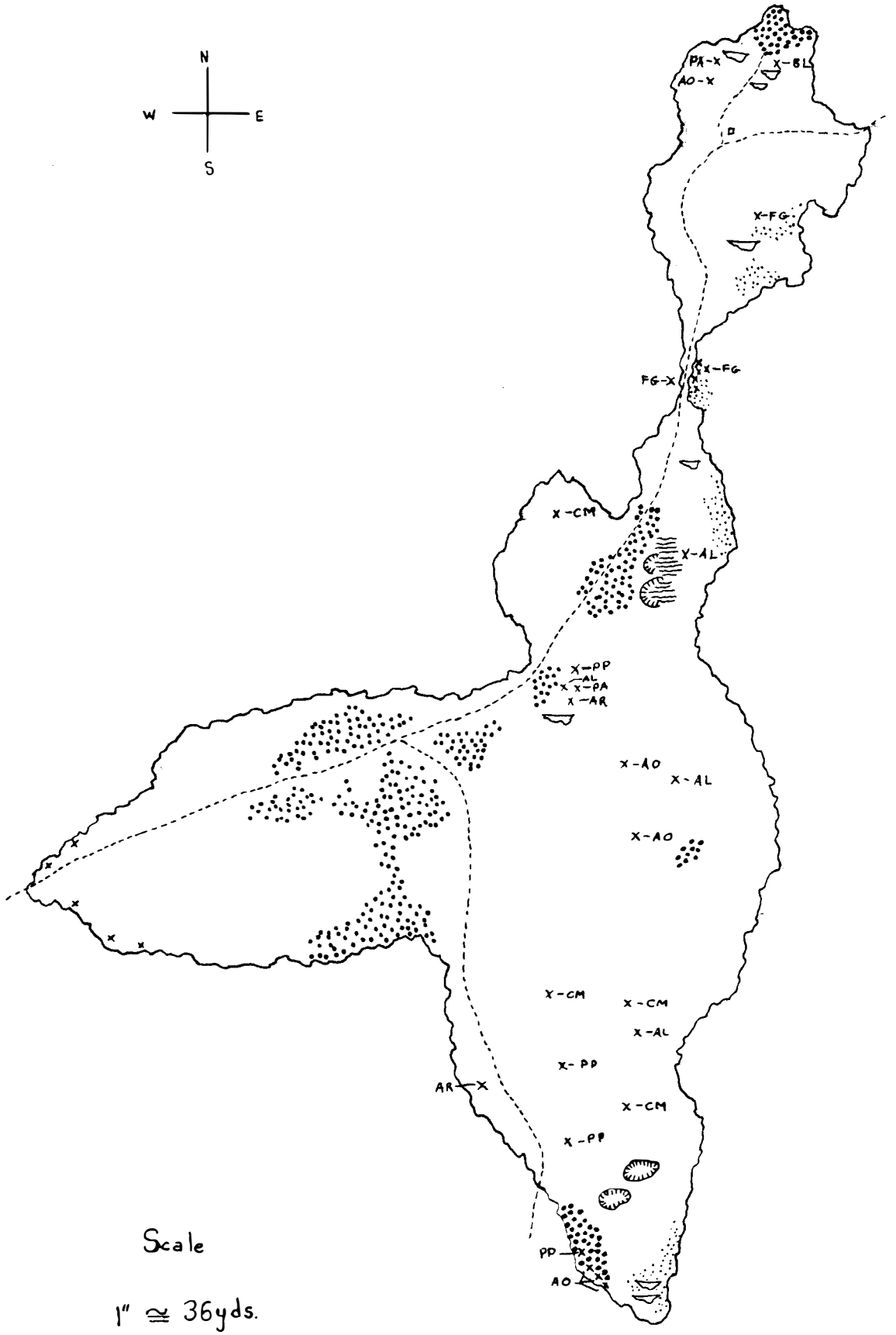

Figure 5. Silers Bald

top section of the bald is dominated by Danthonia with a few Vaccinium constablaei and small Fagus near the edge.

The middle section which includes the large western lobe is characterized by rather large patches of Rubus canadensis and smaller areas dominated by Rudbeckia laciniata. In the lobe, in addition to large patches of Rubus, there is a large area dominated by Thalictrum revolutum. There are few trees present in the lobe, but in the center of the middle section there is one conspicuous eighteen foot Aesculus octandra which is nine and three-fourths inches d. b. h. Another conspicuous feature of the middle section is a large sunken area now covered with Danthonia with a few small specimens of Kalmia latifolia and one Amelanchier laevis.

The southern section is for the most part densely covered over by Danthonia. In the extreme southwestern portion there are several large trees within the grassy bald. The largest of these is a Prunus pensylvanica which measured fifteen inches d. b. h. Around this Prunus are three specimens of Aesculus octandra which measure more than one foot in diameter.

The small bald 200 yards south of Silers Bald is for the most part very weedy in character. Large areas are covered with Rubus and Potentilla, and Danthonia is heavy elsewhere. Several specimens of Lilium superbum are found scattered about the area, and the usual trees and shrubs are scattered throughout.

Andrews Bald

Andrews Bald is one of the best examples of a grassy bald in the Great Smoky Mountains National Park. It is easily accessible, being located on a gentle southwest slope at the end of a high ridge one and a half miles south of the Forney Ridge parking area. This "mountain meadow," as it is often called, is the highest of the grassy balds in the Park. It lies at an elevation of 5860 feet and is for the larger portion bordered by spruce-fir forest.

The tree border on the north end of the bald is abrupt, the grassy area extending up to trees from twenty-five to thirty-five feet in height. This northern edge of the bald runs generally east-west in a fairly straight line. The border to the northwest and west is less definite and abrupt in that there is a transition through a belt of Amelanchier laevis, with smaller numbers of Prunus pensylvanica, Rhododendron catawbiense and Picea rubens. The southwestern end of the bald is predominantly fringed with deciduous trees, most of which are Fagus grandifolia, with some Betula lutea. To the south the border has increasing numbers of Quercus rubra and Picea rubens. To the southeast there is a fringe of shrubs, mostly Vaccinium constablaei which leads into spruce forest.

The large grassy area is generously dotted with shrubs which are generally larger and more scattered than on any of the other balds. Here there are no large clumps of shrubs that are characteristic of the more western balds. The most prominent shrub in number is the Vaccinium constablaei. Other common shrubs are Viburnum cassinoides, Ribes

rotundifolia, Vaccinium erythrocarpum, Rhododendron calendulaceum, Rhododendron catawbiense, Kalmia latifolia, and a few specimens of Crataegus macrosperma var. roanense. Among these species Viburnum cassinoides, Ribes rotundifolium, Vaccinium erythrocarpum are not typical of any bald other than Andrews.

Occurring in fairly large numbers over the bald are also several tree species, Amelanchier laevis being the most numerous. Prunus pensylvanica, Betula lutea, Fagus grandifolia, Picea rubens, and an occasional specimen of Abies fraseri are found. Along the northeastern edge of the bald are several specimens of Ilex montana.

Most of this area is covered with a dense stand of Danthonia compressa; however, Carex spp. occur in greater numbers here than on the other balds. Carex debilis is the most common with Carex normalis in lesser quantity. Potentilla canadensis and Rumex acetosella both occur in high frequency over most of the area. Other species of importance are Hypericum mitchellianum, Angelica triquinata, Stenanthium gramineum, Lilium superbum, Houstonia purpurea, Viola spp., Solidago spp. (especially Solidago bicolor and Solidago glomerata), and Rubus canadensis.

An area not typical of the usual grassy bald type is located in the lower southwest corner of Andrews. This area, fed by a permanently flowing spring, is a small high mountain bog, covered by a soft, wet cushion of Sphagnum moss. Found growing in this wet area are Houstonia serpyllifolia, Juncus effusus, Viola pallens, Spiranthes sp., Carex crinita, Hypericum graveolens, Drosera rotundifolia, and Bartonia.

Just north of the bog area is the remains of an old herder's cabin.

This cabin was shown in a photograph taken by H. M. Jennison to have been crushed by a giant spruce during the "wind fall" of 1936. Wells (1936) reported that the hummocks and depressions on the upper northern and lower southern sides of the bald were produced by windfall.

Andrews Bald, because of the conspicuous floral display of several of the species making up the vegetation, shows quite different seasonal aspects. In midsummer the numerous tall plants of Lilium superbum make an attractive display, and in late summer the Solidago species, Stenanthium gramineum, and Angelica triquinata show aspect dominance.

VI. SUMMARY

A study of the vegetation of the grassy balds of the Great Smoky Mountains National Park was made during the summer of 1953.

The areas studied were situated along or near the main ridge of the Smoky Mountains from Forney Ridge to within a few miles of the Little Tennessee River at the western end of the Park. The climate of these areas, which lie at an average elevation of 5000 feet, is characterized by higher precipitation and lower temperature than that of the surrounding lowland.

The theories concerning the origin of the balds are reviewed. It is concluded that the factors responsible for the origin of the balds could have been one or several, and the factors responsible for maintaining the balds have been several factors in combination. The historical account, although far from complete, has shown that man has had considerable modifying effect - through clearing on at least two of the balds, and through the grazing of animals on all of them.

The vegetation of the balds is usually dominated by one species, Danthonia compressa. Other very frequent species are Potentilla canadensis and Rumex acetosella. Aster surculosus is high in both frequency and coverage on Gregory Bald and Parsons Bald. Certain trees and shrubs are typically present on the balds. Amelanchier laevis is the predominant deciduous tree, and species of Vaccinium are the most common shrubs.

Sketches and individual descriptions of the general character

and vegetation of each of the grassy balds are given. It is not evident from the character of the vegetation or the species present whether a particular bald has been previously cleared. The flora in each case is made up of species derived from the surrounding forest vegetation and introduced by domestic animals.

The forest has definitely encroached on all of the balds in recent years, the invasion having been most active along the northern edges. This encroachment is shown in comparable photographs taken in 1936 and 1953.

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APPENDIX A

TABLE III

FLORISTIC LIST

Species	Andrews Bald	Silers Bald	Spence Field	Gregory Bald	Parsons Bald
PTERIDOPHYTES					
Athyrium Filix-femina var. asplenioides			x	x	x
Botrychium dissectum		x			x
B. dissectum forma obliquum				x	x
Dennstaedtia punctilobula	x	x	x	x	x
Pteridium aquilinum					x
HERBS					
Achillea millefolium		x	x	x	x
Agrimonia gryposepala		x			
Agropyron repens			x		
Agrostis alba	x	x	x	x	x
Agrostis scabra				x	x
Agrostis tenuis	x				
Ambrosia artemisiifolia				x	x
Andropogon scoparius var. frequens				x	x
Angelica triquinata	x	x	x		
Antennaria plantaginifolia	x				
Arctium minus				x	x
Asclepias tuberosa				x	x
Aster acuminatus	x	x			
Aster divaricatus	x	x	x	x	x
Aster lateriflorus				x	x
Aster surculosus				x	x
Aster undulatus				x	x
Baptisia tinctoria					x
Carex brunnescens var. sphaerostachya			x		
Carex crinita	x				

TABLE III

FLORISTIC LIST (CONTINUED)

Species	Andrews Bald	Silers Bald	Spence Field	Gregory Bald	Parsons Bald
Carex debilis var. Rudgei	x	x	x	x	x
Carex intumescens var. Fernaldii	x		x		
Carex normalis	x	x	x	x	x
Carex Ruthii	x				
Carex Swanii					x
Carex vulpinoides			x		
Cerastium arvense	x	x	x		
Chrysanthemum Leucanthemum	x		x	x	x
Chrysopsis mariana var. maeradenia				x	
Cirsium vulgare				x	x
Claytonia caroliniana	x	x			
Clintonia borealis		x			
Cuscuta rostrata		x			
Dactylis glomerata			x		
Danthonia compressa	x	x	x	x	x
Danthonia spicata			x	x	
Daucus carota				x	x
Deschampsia flexuosa	x				
Drosera rotundifolia	x				
Epigaea repens	x			x	x
Erythronium americanum		x			
Eupatorium purpureum		x			
Eupatorium rugosum var. roanense			x		
Fragaria virginiana	x	x	x	x	x
Gentiana clausa	x	x			
Gentiana decora				x	
Gentiana quinquefolia		x			
Gentiana saponaria	x				
Gentiana villosa	x	x			
Habenaria ciliaris			x	x	
Glyceria melicaria		x			

TABLE III

FLORISTIC LIST (CONTINUED)

Species	Andrews Bald	Silers Bald	Spence Field	Gregory Bald	Parsons Bald
Glyceria nubigena	x				
Helianthemum canadense	x				
Helianthus divaricatus	x	x			
Heuchera americana			x		
Hieracium paniculatum	x		x		
Holcus lanatus			x		
Houstonia purpurea	x	x	x	x	x
Houstonia serpyllifolia	x	x	x	x	x
Hypericum mitchellianum	x	x	x		
Juncus acuminatus	x				
Juncus effusus	x				
Juncus marginatus	x				
Juncus tenuis	x	x	x	x	x
Krigia biflora				x	
Lechia sp.				x	x
Lespedeza capitata					x
Lilium superbum	x	x			
Lysimachia quadrifolia	x	x	x	x	x
Maianthemum canadense			x		
Monarda didyma		x			
Panicum philadelphicum					x
Phleum pratense		x	x	x	
Plantago major				x	x
Poa compressa				x	
Poa pratensis	x		x		
Polygonum scandens			x		
Potentilla canadensis	x	x	x	x	x
Prenanthes trifoliolata	x	x		x	x
Prunella vulgaris var. lanceolata	x	x	x	x	x

TABLE III

FLORISTIC LIST (CONTINUED)

Species	Andrews Bald	Silers Bald	Spence Field	Gregory Bald	Parsons Bald
Rubus canadensis	x	x	x	x	x
Rubus idaeus var. stigosus	x				
Rudbeckia hirta			x		
Rudbeckia laciniata	x	x	x		
Rumex acetosella	x	x	x	x	x
Rumex obtusifolium			x		
Senecio rugellii					
Senecio Smallii			x	x	x
Silene stellata	x				
Silene virginica			x		
Sisyrinchium angustifolium	x				
Smilacina racemosa		x			
Smilax rotundifolia		x	x		x
Solanum carolinense			x	x	x
Solidago bicolor	x	x			
Solidago Curtisii			x		
Solidago glomerata	x	x			
Solidago juncea	x				
Solidago patula	x				
Solidago puberula					
Sorghastrum nutans					x
Spiranthes sp.	x				
Stachys Clingmanii	x	x			
Stenanthium gramineum var. micranthum	x	x			
Thalictrum revolutum		x			
Trautvetteria caroliniensis		x	x		
Trifolium pratense				x	
Trifolium repens				x	
Verbascum Thapsus				x	
Viola pallida	x	x	x	x	x
Viola sagittata	x	x	x	x	x
Viola spp.	x	x	x	x	x

TABLE III

FLORISTIC LIST (CONTINUED)

Species	Andrews Bald	Silers Bald	Spence Field	Gregory Bald	Parsons Bald
WOODY PLANTS					
Abies fraseri	x				
Acer pensylvanicum				x	x
Acer rubrum	x	x	x	x	x
Acer saccharum			x	x	
Aesculus octandra		x	x		
Amelanchier laevis	x	x	x	x	x
Betula lenta				x	
Betula lutea	x	x	x	x	x
Castanea dentata			x	x	x
Crataegus macrosperma var. roanensis	x	x	x	x	x
Diervilla sessilifolia	x	x			
Fagus grandifolia	x	x	x	x	x
Fraxinus americana			x	x	
Ilex montana	x		x		
Juniperus virginiana					x
Kalmia latifolia	x	x	x	x	x
Liriodendron tulipifera				x	x
Lyonia lingustrina	x			x	x
Oxydendrum arboreum		x	x	x	x
Picea rubens	x				
Pinus pungens				x	x
Pinus rigida				x	x
Pinus strobus			x	x	x
Prunus pensylvanica	x	x	x	x	x
Pyrus americana	x	x	x		
Pyrus melanocarpa			x		
Quercus alba					x
Quercus rubra	x		x	x	x
Rhododendron arborescens richardsoni				x	
Rhododendron calendulaceum	x			x	x
Rhododendron catawbiense	x	x	x	x	x
Rhododendron maximum			x		
Rhododendron viscosum				x	

TABLE III

FLORISTIC LIST (CONTINUED)

Species	Andrews Bald	Silers Bald	Spence Bald	Gregory Bald	Parsons Bald
Rhus copallina					x
Ribes rotundifolium	x				
Salix humilis					x
Salix humilis var. microphylla				x	x
Sambucus canadensis		x	x		
Tsuga canadensis				x	
Vaccinium altomontanum				x	x
Vaccinium constablaei	x	x	x	x	x
Vaccinium erythrocarpum	x				
Vaccinium hirsutus			x	x	x
Vaccinium stamineum			x		
Vaccinium vacillans				x	
Viburnum cassinoides	x		x		
Vitis aestivalis var. argentifolia					x

APPENDIX B

Figure 6. Spence Field, 1936 (Photo by Willis King)

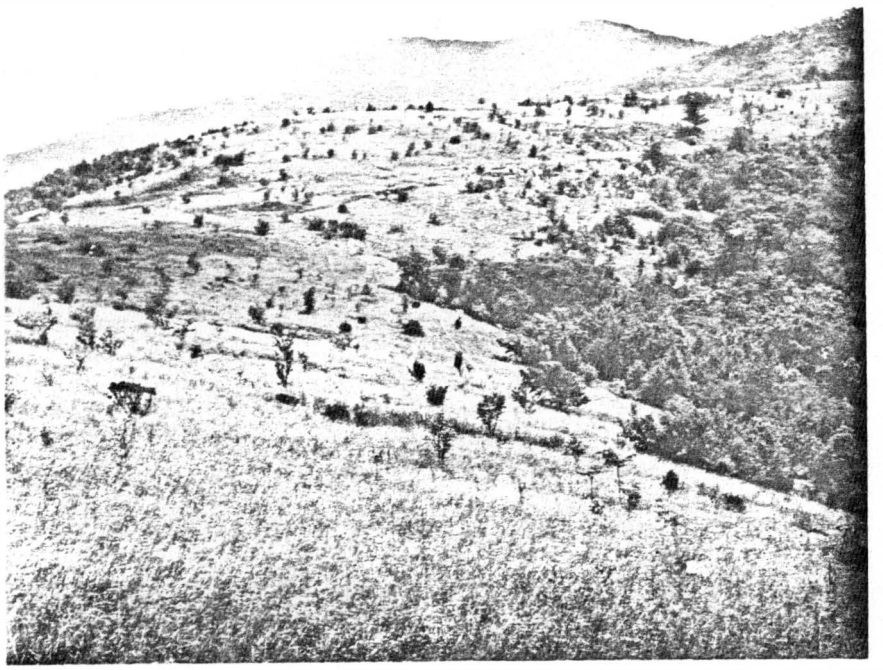

Figure 7. Spence Field, 1953

Figure 8. Spence Field, 1938 (Photo by A. J. Sharp)

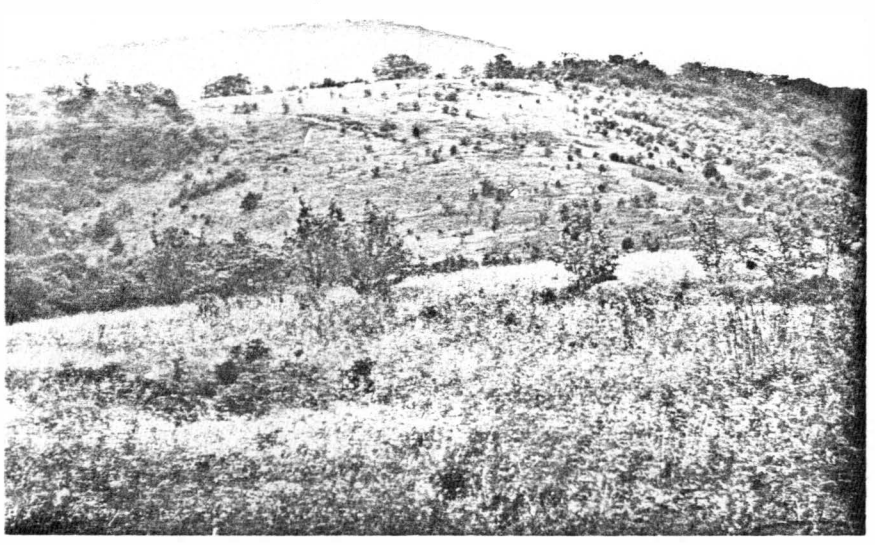

Figure 9. Spence Field, 1953

Figure 10. Russell Field, 1936 (Photo by Willis King)

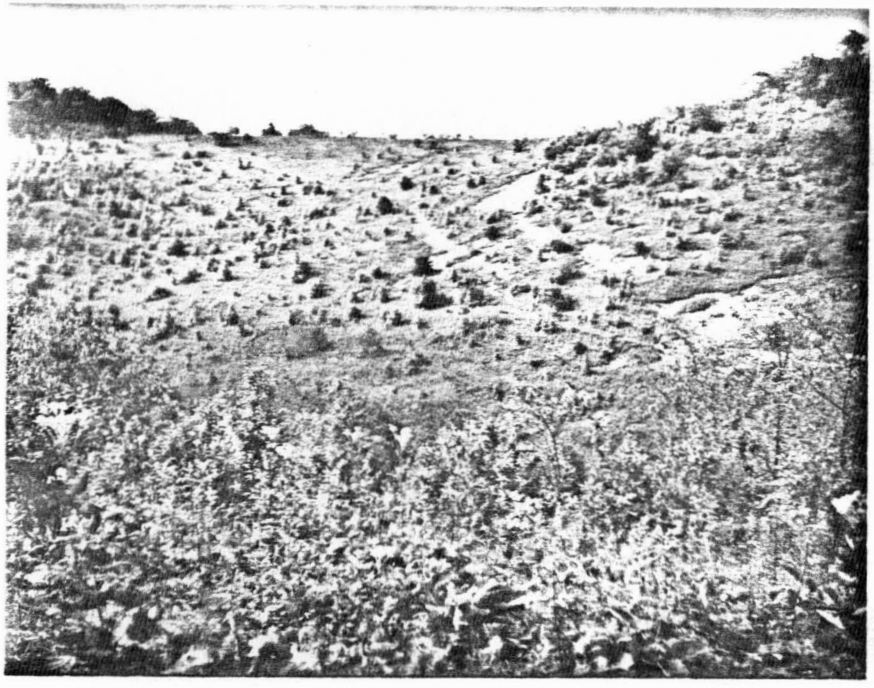

Figure 11. Russell Field, 1953

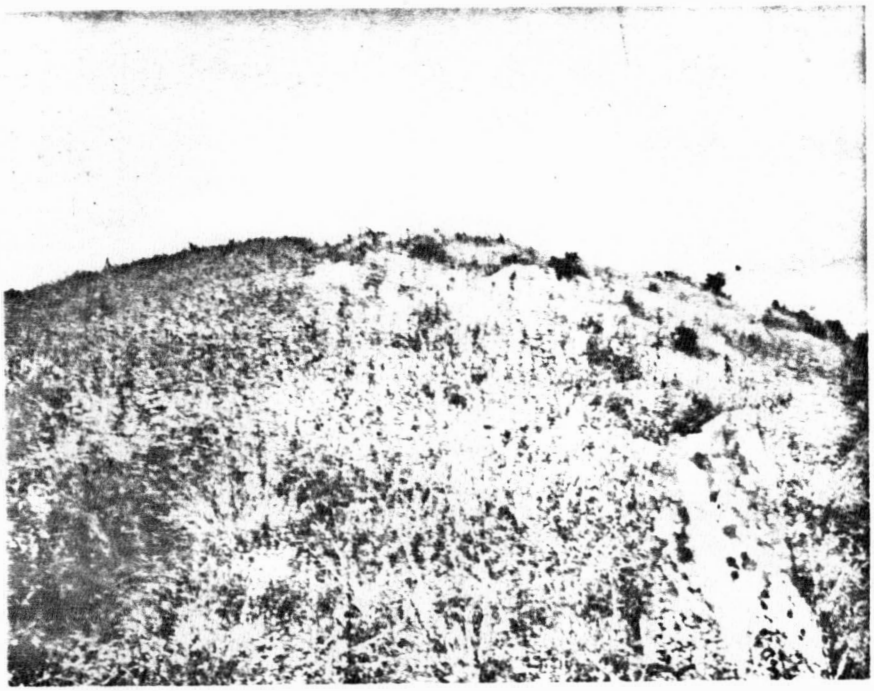

Figure 12. Silers Bald, 1938 (Photo by A. J. Sharp)

Figure 13. Silers Bald, 1954