Application of the vegetation inventory to recreation site planning
by Thomas Patrick Eggensperger

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Agronomy
Montana State University

Abstract:
Recognizing that recreation site planning schemes have failed to incorporate a vegetation inventory and realizing the need for recreation sites which maintain a natural appearance with time, research was conducted to ascertain what value the vegetation inventory could be to recreation site planners.

The endemic vegetation of a potential recreation site was inventoried and selected species were subjectively rated for their contribution to selected recreation activities. Partitioned units within the site were then evaluated for their compatibility with recreation activities. This was done using the vegetation inventory and an inventory of environmental resources. Plant species with indicator value for recreation use compatibility were identified and utilized to predict, employing a computer program, which areas within the site were compatible with declared recreation activities. It was concluded that certain vegetative species show preference for specific biophysical resources and that these species, as indicator species, can be used to select areas of recreation use compatibility.

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MONTANA STATE UNIVERSITY
Bozeman, Montana

August, 1976

ACKNOWLEDGMENTS

Many people contributed time, effort and encouragement throughout the completion of this project. To them go may grateful thanks.

To my parents I owe a debt of gratitude for their love and encouragement.

To my committee chairman, Dr. Erhardt Hehn, a special thank you for his time, encouragement and assistance. Without him this study would not have been.

I would like to thank Dr. Joseph Ashley and Dr. Gerald Nielsen for their contributions to the project as members of my Graduate Committee.

To Joe Gutkoski and the Forest Service, many thanks for allowing me to use the Hyalite Canyon area for my study.

A special thanks to Dee Griffith for her patience and expertise in the preparation of this thesis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES CONTINUED

LIST OF FIGURES

LIST OF FIGURES CONTINUED

ABSTRACT

Recognizing that recreation site planning schemes have failed to incorporate a vegetation inventory and realizing the need for recreation sites which maintain a natural appearance with time, research was conducted to ascertain what value the vegetation inventory could be to recreation site planners.

The endemic vegetation of a potential recreation site was inventoried and selected species were subjectively rated for their contribution to selected recreation activities. Partitioned units within the site were then evaluated for their compatibility with recreation activities. This was done using the vegetation inventory and an inventory of environmental resources. Plant species with indicator value for recreation use compatibility were identified and utilized to predict, employing a computer program, which areas within the site were compatible with declared recreation activities. It was concluded that certain vegetative species show preference for specific biophysical resources and that these species, as indicator species, can be used to select areas of recreation use compatibility.

INTRODUCTION

Of the many recreation areas available to recreationists, few have been able to foster a pristine appearance and escape the telltale signs of overuse manifested in vegetative reductions and degradation of physical resources. Realizing that it is nearly impossible to maintain an unspoiled environment, it is questioned what can be done to improve recreation areas through either rehabilitation or improved planning techniques. It is obvious that the better solution lies with improved planning techniques.

In researching planning techniques it became apparent that most schemes failed to incorporate the vegetation inventory in their methodology. Considering the initial sign of recreation site overuse is a vegetative reduction, it appears that a site planning scheme utilizing the vegetation inventory in a manner which selected site compatible recreation use areas, would yield a more natural appearing site with normal recreation use.

This research attempted to answer two questions. First can site durability predictions be made utilizing a vegetation inventory and rating species for their inherent compatibility with various recreation activities. Secondly, can indicator species be identified which rapidly indicate site compatible recreation use areas.

The research was conducted within an area of Hyalite Canyon, south of Bozeman, Montana, which had potential for development as a recreation site. By conducting a vegetation inventory and evaluating the vegetation and site resources, it was hoped to develop an additional tool for recreation site planners.

LITERATURE REVIEW

The importance of outdoor recreation has reached a level where its documentation is no longer necessary, while research of the recreation site and recreation site users has just begun to be reported. Two approaches were observed in outdoor recreation research, 1) examination of interactions between recreationists and 2) examination of the effects recreationists have on the biophysical environment of the recreation site.

Lucas and Stankey (30), in their survey of the social carrying capacity for backcountry recreation found that recreationists desired solitude and valued campground privacy highly. Clark (8), observing the modern camping culture revealed that campers valued the emotional satisfaction of solitude and tranquility and gaining an awareness of unspoiled beauty. As part of the Gallatin Canyon Study, aimed at evaluating the impacts of large recreational developments upon semi-primitive environments, researchers Dick, Williams, Ballas and Gilchrist (13) typed campers as to their preferences and attitudes as an aid in management decisions. They noted the occurrence of recreation succession where repetitive site users migrate to secluded more primitive sites as the population of new campers to an area increased.

Recreationist interaction research provides a profile of site users, inherently obvious observations that are only conjectural until proven valid. Understanding the users of a recreation site is important to providing a recreation site that will best serve their needs.

Recreation research on the interaction between recreationists and the recreation site considers the impact of recreationists on the site resources. Recreational use of forest and wildlands, according to James (23), was an estimated 450 million visitor days in 1972. When man returns to the same site repeatedly, he has a cumulative impact on the soils and vegetation of a recreation site. It is on these two elements that man's activities exert the most effect. Researchers have studied this effect, and how it can be diminished, by either restoration of the natural amenities of a site or their preservation gained through utilizing effective site planning and design schemes. The importance of research concerning the impact of the recreation site user is cited by many researchers in rationalizing the need for research. Burden and Randerson (6), working in England, emphasized the paucity of studies documenting the precise effects of recreation on the vegetation and soils of semi-natural areas. William Ruckelshaus (39), in an address to the Society of American Foresters, emphasized the shift in what is fashionable in recreation, the return to outdoor activities, and how this added pressure posed a burden on our forests. We should be prepared to deal with aerial contamination, littering, trampling of ground cover, erosion of soils and the alteration of entire bio-communities.

Considering the effects of use on the various elements of the recreation site, LaPage (25) gave one of the first accounts of increased soil compaction which accompanied prolonged use of a site. Dotzenko (14) verified this increase in soil compaction and also noted decreased water infiltration rates, increased runoff and increased soil erosion. Researching established campgrounds in Rocky Mountain National Park, and using soil bulk density as a compaction indicator, Dotzenko found that soils from a heavily used site had a 55.3% greater bulk density than soils from lightly used sites. The compaction effect of intensive use was most pronounced in the 0-2 inch soil layer.

Settergren and Cole (40) recorded decreases in both the moisture field capacity of the soil and in the percent water present at the wilting point of the soil. They found this to be characteristic of soils of heavily used sites. A consequence of water erosion removing the finer particles of the soil matrix was an accumulation of rock at the surface of the site.

Lutz (31), in one of the first reported examinations of soil alteration on picnic grounds in public forest parks, observed that the most intensive changes occur on picnic and campground sites and that wind was an important factor, exhibiting a tendency to sort finer particles from larger sand sized particles.

The value of knowing the impact of recreational use on the soils of a site is important in considering engineering capabilities of selected soils for varying types of recreational use. Soil compaction also has an effect on the vegetation of the site, being the rooting medium for plants. A compacted soil restricts root growth. Root impedence can be viewed as an indirect consequence, resulting from soil compaction occurring after a loss of vegetative ground cover. The quantitative loss in vegetation is the common direct consequence of recreation use pressure.

The impact of recreationists on the natural vegetation of the site can be measured in two ways. First it can be guaged as a direct loss in percentage of original vegetation or it can be examined as changes in the nature of the vegetation.

Bates (3) examined the vegetation of paths and sidewalks and observed a repeated continuum of *Poa pratensis*, *Lolium perenne* and *Trifolium repens* perpendicular to the path. *P. pratensis* exhibited the most resistance to trampling, which Bates attributed to the morphology and growth characteristics of the species. The conduplicate stem and folded leaf presented a flatter surface to the crushing action of the foot. Bates' research is one of few to relate physical characteristics of a plant to the plant's ability to withstand or succumb to recreation traffic.

Dale (11), examining the vegetation associated with trails in the Madison Range in Montana, found a vegetational gradient perpendicular to the trail. He rated several species on the basis of whether trail use caused no change, an increase, a decrease, or an increase and a decrease in species presence in three habitat types. Dale made observations as to why a particular species reacted as it did to trail use.

Burden and Randerson (6) looked at three different and separate types of trampling pressure. Considering the short term effect and looking at areas of light, medium and heavy trampling pressure, the researchers arrived at an equation by regression analysis for predicting the loss of vegetation at a chosen intensity of trampling pressure. The equation employed variables for the intensity of trampling pressure, the degree of soil compaction and a grazing factor along with two regression coefficients. The resulting value was expressed as dry weight of a particular species or plant fraction.

Bogucki (4) studied the impact of short term camping on ground level vegetation. Preceeding activity there was a prevalence of moss/lichen and blueberry associations. Two days later, following the use of the site for a group camp, there was a decline in moss/lichen and blueberry occurrences and an increase in the amount of bareground and bedrock exposed.

In 1963 LaPage (26) began a continuing study to record changes in the vegetation on 17 units of a newly established campground in the Allegheny National Forest. Following the first year of use the average loss of plant cover for all camp sites measured 45 percent. A correlation between camper-days of use and loss in vegetation cover was attempted and it was found that 200 camper days of use was a feasible maximum to minimize native cover loss. LaPage did not consider the number of camper-days of use a very good tool to estimate vegetative cover loss. In noting the relative occurrences of several species over three years of the study, LaPage gave a ranking of tolerance to trampling levels for several plant species. Two conclusions drawn by LaPage were:

(1) An initial and inevitable heavy loss of ground cover follows the onset of camping use and the extent of the loss is strongly related to the use intensity the first year.

(2) Plant species composition of original cover undergoes a gradual rearrangement in which more resistance and drought tolerant species become increasingly abundant.

In a simulated trampling study using a corrugated roller passed over selected plots representing various forest and environmental conditions, Cieslinski and Wagar (7) related surviving vegetation to soil and topographic features by multiple regression. Resulting equations explained 64 percent of the variability in amounts of surviving vegetation, and a positive relationship was observed between the amount of clay in the soil and the amount of surviving vegetation.

Similar research with recreationist effects on ground level and overstory vegetation was conducted by Echelberger (15), Frissell (16), and Wagar (43).

The relevancy of research on the ground cover vegetation of outdoor recreation sites rests with how the research results can be applied to ameliorate undesirable situations. This can be reflected in management techniques or planning guidelines.

Several rehabilitative procedures have been suggested as a means of site improvement. Appel (2) advocated spreading sawdust and rototilling as a method to improve soil physical properties. This treatment would increase the water holding capacity, lessen the bulk density and increase infiltration rates.

Herrington and Beardsley (21) reported the results of cultural treatments of watering, fertilizing and seeding as a means of improving the ground cover vegetation. With the addition of all three treatments the rehabilitation of the campground was significantly hastened.

Wagar and Beardsley (44) studied the effects of cultural treatments on the ground cover vegetation. Cultural treatments, while being costly, also present an inconvenience to campers and result in an addition to the site of plant species not part of the native floral array.

Hendee and Lucas (20) compared the merits and disadvantages of restricting use of wilderness sites by restricting use to permit only. This philosophy could be applied to forest recreation sites with the result being massive regulation of campers on existing campgrounds and accelerated efforts to establish new campgrounds which would accommodate all recreationists desiring to participate in the camping experience.

A practical method to alleviate the problem of recreation site deterioration lies with better planning and design of facilities to include elements which will lessen the effect of site users on the natural resources of the site. Orr (35) recognized the importance of planning to the development of a successful campground. He stated that the failure of the public to use a site can be indicative of the developer not knowing the market of users. The physical failure of a site is usually the result of a lack of knowledge about the site.

Lime (28) suggested the incorporation of resistant features into the site design in the form of tent pads and barriers to direct and channel the flow of pedestrian and vehicular traffic.

The implementation of natural resource inventories in site planning has been primarily concerned with utilizing soil inventories or soil surveys. Partain (36) outlined the benefits of a properly interpreted soil map in selecting and planning sites for camping activities.

Stevens (41) discussed the types of interpretations that are possible from an accurate soil survey of the proposed site. He also outlined five areas of soils interpretation research that are needed to maximize the value of soil survey information to the site planner.

James (23) stated that a knowledge of soils and soil characteristics was the most essential element in selection of potential areas for recreation site development. He also developed a puzzle analogy for effective site utilization. Knowledge of soils, the site design, vegetation management and maintenance techniques comprise the pieces to the puzzle, with the border including the control, regulation, education and interpretation of the site to users.

In researching the application of the vegetation inventory to recreation site planning, it was apparent that there exists a definite lack of research involving its application.

Lindsay (29) discussed using the information that could be gleaned from aerial photos as a site evaluation tool. Using overstory densities as site selectors, possible sites can be inventoried.

Pfister (37) suggested management implications of forest ecosystems according to the habitat type of the site, concluding that management implications of habitat types for recreation have little effective value except as an aid in site selection by the climatic and ecologic conditions suggested by the habitat type.

Wilde and Leaf (46) reported that ground cover vegetation serves as an indicator of site conditions and can often reveal concealed heterogeneity of selected areas. The composition of soil profiles is closely related with both qualitative and quantitative aspects of ground cover vegetation. Plants possessing indicator value have a pronounced tendency to attain maximum density and frequency of distribution on certain soil types.

Layser (27) stated that the ecological classification based on vegetation offers a strong management tool, but little use has been made of indicator plants or plant associations.

McHarg (33) asks us to assess which lands are intrinsically suitable for active and passive recreation, and to view the sustainance of native vegetation as a valuable public resource.

The best application of natural resource inventories encountered was the use of basic soil conditions to predict ground cover persistance. Orr (35) developed a formula for determining a ground cover index by manipulating variables of the potential pedestrian impact, the depth of soil sub surface, the percent of the surface covered by rock, the amount of silt in the substratum, the percent slope and the depth to the water table in inches. The resulting value is a prediction of the amount of site deterioration. Expecting significant soil movement with less than 75 percent of the original ground cover present, the critical value derived from the equation was set at 75.

MacKay (32), in a study of old and new campgrounds on a particular forest soil, stated predictions could be made for which area will stand up best under active recreation based on the ratio of sand/(silt + clay). A low ratio conveyed more desirable conditions than a high ratio.

Wagar (42) developed a simple slide rule method of predicting recreation tolerance which is usable if data is available for the amount of vegetation that will grow on the site in the absence of trampling, the percent cover by grasses and woody vines, and the percent sunlight to the site blocked by shade casting objects. Wagar assumed a constant level of trampling which is unlikely given the various types of recreation activities that could occur on a recreation site.

MATERIALS AND METHODS

The study area selected to evaluate the potential of applying the vegetation inventory to recreation site planning was located in Hyalite Canyon south of Bozeman, Montana. The legal description placed it partially in Sections 32 and 33 of Township 3S, Range 6E and partially in Sections four and five of Township 4S, Range 6E. Geographically the area was east of Langohr's Campground and Hyalite Creek. Access to the area is gained by a Forest Service road paralleling the east side of Hyalite Canyon and by an abandoned logging road which leaves the Hyalite Canyon road and leads into the study area, traversing its length from south to north (Figure 1). Part of a larger area being utilized for summer livestock grazing, the study area was bordered on the east by the foot slopes of the drainage divide between Hyalite Creek and Bozeman Creek, on the north by Buckskin Creek, on the west by a lateral moraine remnant of a Hyalite Canyon glacier and on the south by the point at which the access logging road turns from running perpendicular to Hyalite Creek and begins to parallel the Creek.

Essentially level on the southern end, the area was dissected on the northern end by previous erosional cycles. Elevations ranged from 6370 feet at the northern end to 6550 feet at the northeast corner. Slopes varied from level to nearly 30 percent and a full complement of aspects was found. The general area was logged during the preceding 50 years and showed evidence of wildfire. The vegetational composition included gramineous species, annual and perennial forbs, woody shrubs,

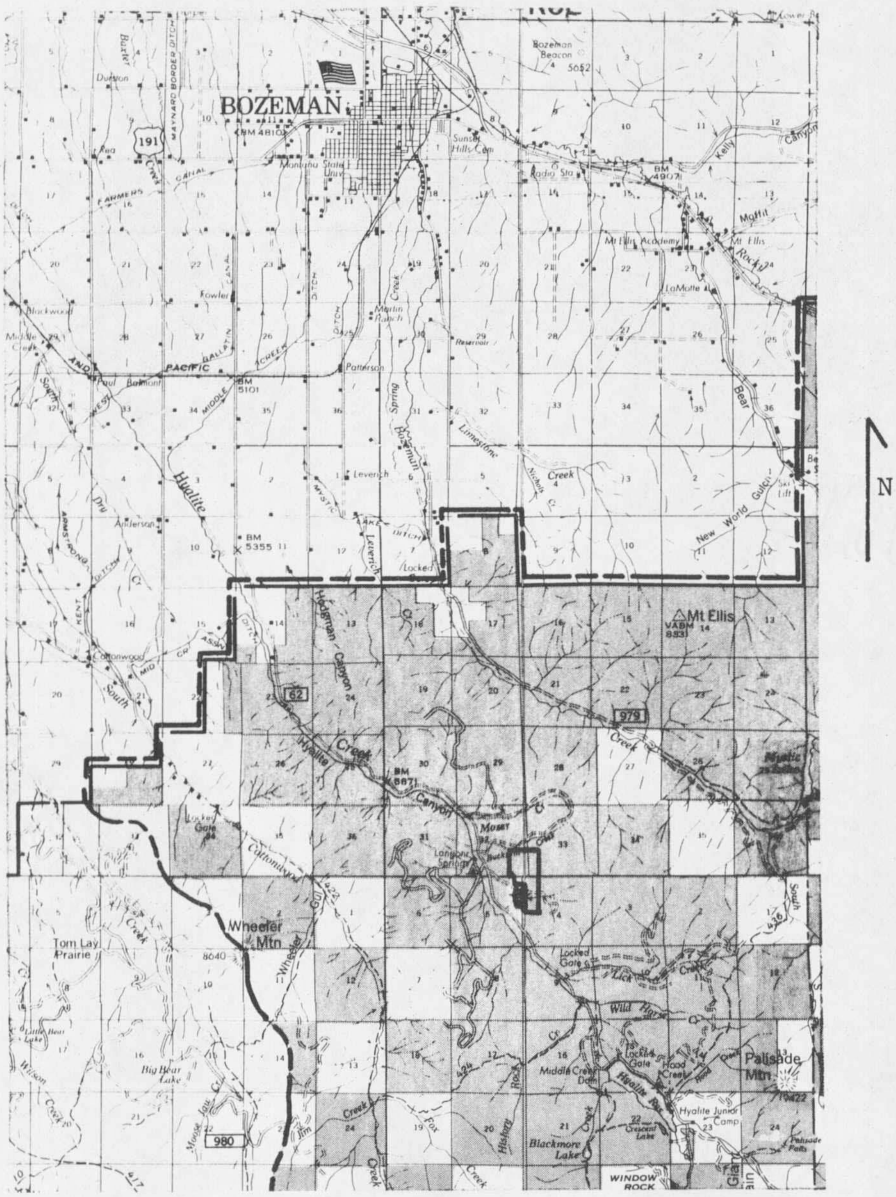

Figure 1. Location of study area in Hyalite Canyon near Bozeman, Montana, used in evaluating the application of the vegetation inventory to outdoor recreation site planning. (From USDA FS series, Gallatin Ranger District, Montana. 1971.)

deciduous trees and evergreens. Soils consisted of deep silty clays with thick silt loam surfaces and inclusions of deep gravelly clay loams with gravelly loamy surfaces and imperfectly drained clayey soils, Alvis (1). A comprehensive soil classification has not been completed for the area. Geologically the study area is underlain by layers of tilted bedrock shale and limestone, Weber (45).

First excursions into the study area were made in early July of 1975 to examine potential areas for recreation activities and to collect frequently and uniquely accurring flora for identification. Identification of species was done by the investigator using appropriate floral identification tests for the area, Booth (5), Craighead (9), and Harrington (18). The identified floral array included 70 shrub, forb, and gramineous species and six tree species (Appendix 1). For brevity, throughout the project the species were coded by combining the first letters of the generic and specific names to form an acronym for each plant species. A list of acronyms and corresponding plant species is found in Appendix 1. The area exhibited a varied array of flora including the saprophytic orchid, Corallorhiza maculata, common mountain plants Geranium viscossissimum and Spirea betulifolia, water associated plants Juncus sp. and indicators of man's intrusion - Trifolium sp. and Cirsium arvense. The area exhibited a varied ecology of plant communities from which to predicate site planning schemes.

The area was unaccessible only in the spring when the Hyalite road was closed to public travel due to mud. During the fall and winter the area was open for recreational use and was a popular area for cross country skiers and winter camping. Potentially the area offered year around recreation opportunities.

The area was scheduled for timber removal due to the presence of disease among the trees and consequently the area was not designated for use as a recreation site.

To facilitate the vegetation inventory, the study area was partitioned into square cells of 2500 square meters. This was done by establishing a baseline with steel fence posts 50 meters apart, traversing from south to north. Cells were laid out using a compass and two 50 meter cloth surveyor tapes, working east and west of the baseline and back sighting when possible. Cell corners were established with fluorescent flagging attached to lath stakes driven into the ground. Each cell was identified at its southwest corner with a designation on the lath stake for the row and column in which the cell existed. Rows and columns were identified with a number and letter for the relative position of the row or column north and south or east and west of a point of origin. 115 cells were located covering a total area of 28.75 hectares (Figure 2).

The vegetation inventory was conducted during July and August and involved recording occurrence and frequency data for 39 species on