DISSERTATION

USDA FOREST SERVICE RANGELAND RECREATION: SITE IDENTIFICATION, VISITOR CHARACTERISTICS AND ACTIVITIES, AND A TRAVEL COST MODEL

Submitted by

Kristie Maczko

Graduate Degree Program in Ecology

In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Summer 2006

COLORADO STATE UNIVERSITY

April 11, 2006

WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY KRISTIE MACZKO ENTITLED USDA FOREST SERVICE RANGELAND RECREATION: SITE IDENTIFICATION, VISITOR CHARACTERISTICS AND ACTIVITIES, AND A TRAVEL COST MODEL BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

Committee on Graduate Work

Dr. Mark T. Fiege

Dr. John B. Loomis

Dr. Michael J. Manfredo

Adviser – Dr. Melinda J. Laituri

Department Head – Dr. Daniel E. Binkley

ABSTRACT OF DISSERTATION

USDA FOREST SERVICE RANGELAND RECREATION:

SITE IDENTIFICATION, VISITOR CHARACTERISTICS AND ACTIVITIES,

AND A TRAVEL COST MODEL

Little is known about rangeland recreation (The Heinz Center 2002). The Society for Range Management (2005) defines rangelands as areas dominated by self-propagating grasses, grass-likes, forbs, shrubs, and dispersed trees. The United States Department of Agriculture (USDA) Forest Service (FS) National Forest System (NFS) uses this description as a working definition of rangelands (Bryant, pers. comm., 2005), applicable to agency land management decisions. Vavra (1995) identified social aspects, such as recreation, as the least studied component of rangeland science and management. Disparate sustainability assessment efforts have cited the need for rangeland recreation information (The Heinz Center 2002, Tanaka et al. 2003, USDA Forest Service 2004). Monitoring recreation demand will become increasingly important as competing stakeholder pressures on public rangelands expand.

This study assesses recreational activities pursued on NFS rangelands; analyzes demographic information associated with people recreating on NFS rangelands; and estimates benefits of NFS rangeland recreation. A prerequisite for achievement of these objectives was identification of NFS rangeland recreation sites in the USDA Forest Service National Visitor Use Monitoring (NVUM) program (English et al. 2002).

Given the need to maximize inclusion of NVUM rangeland recreation sites, and varying size of NFS rangeland recreation sites, a 200-meter grid was chosen for classifying vegetation types within which NFS developed rangeland recreation sites

occur. The top three NFS rangeland recreation activities, in order, are hiking or walking, hunting, and viewing scenery. Most individuals recreating on rangelands are white and male, with more than 50 percent between the ages of 31 and 50. The average per trip consumer surplus for NFS rangeland recreation in the western United States was $65.68. This figure rose to $104.48 for the Pacific Coast region but fell to $62.68 for the Rocky Mountain region.

Analyses results reported in this study provide the first assessment of NFS rangeland recreation. Percentages and values reported in this study are very likely lower than actual numbers for several reasons. Issues include incomplete data, vegetation type generality within the NLCD information, and ambiguity associated with definitions of rangelands. These issues must be addressed for improved assessment of NFS rangeland recreation.

Kristie Maczko
Graduate Degree Program in Ecology
Colorado State University
Fort Collins, CO 80523
Summer 2006

ACKNOWLEDGEMENTS

I am indebted to the many people for suggestions and support offered throughout this process. I would like to express my appreciation to my committee members - Dr. Melinda Laituri, Dr. Mark Fiege, Dr. John Loomis, and Dr. Mike Manfredo - for their guidance and flexibility. Special thanks to my advisor, Dr. Melinda Laituri, for her patience, good humor and direction. I am also grateful to Dr. John Loomis, whose generous advice and assistance made the model component of this project possible.

The USDA Forest Service (FS) funded this research; many thanks to that organization and to Dr. John Mitchell. In addition to financial support, Dr. Mitchell offered much input about rangeland science, as well as extensive editorial comments on this document. Mike Knowles provided National Land Cover Dataset (NLCD) files and assisted with GIS analyses. Dr. Don English made FS National Visitor Use Monitoring (NVUM) program data available, extracted rangeland site information, and promptly answered many questions. Dr. Rudy King guided statistical analyses of the NVUM data.

Thanks also to Dr. Dennis Child for a flexible work schedule with the Sustainable Rangelands Roundtable (SRR), allowing me time to finish this project. Additionally, I appreciate input of SRR colleagues and friends. Dennis Thompson offered editorial ideas, sought opportunities to apply study results in agency programs, and regularly reminded me about proper prioritization of academic and professional obligations.

I am especially thankful for the understanding and assurances of family and friends. My grandfather believed I could do whatever I was willing to attempt, and my parents made sure I received an undergraduate education that ultimately laid the

foundation for this project. Friends commiserated about stress, and tolerated my difficult schedules, gracefully accommodating research, work, and continuous travel, in our plans.

I owe an enormous debt of gratitude to my dear friend and mentor, Dr. Larry Bryant, for his good-natured guidance and patience, as well as his unwavering support and encouragement, without which I would not have completed this project. Dr. Bryant shared insights on NFS rangeland management, reviewed written materials, and provided constant counsel, compelling me to "git 'er done" whenever I hesitated; I shall be forever grateful.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I: INTRODUCTION

Little is known about recreational use of rangelands (The Heinz Center 2002). Vavra (1995) identified social aspects, such as recreation, as the least studied component of the rangeland science and management field. Monitoring recreation use and demand will become increasingly important as visitation increases and competing stakeholder pressures on public rangelands expand. Therefore, this study seeks to provide initial assessment of the types of recreational activities pursued on rangelands administered in the public trust by the United States Department of Agriculture (USDA) Forest Service (FS); analyze basic demographic information associated with people recreating on these public rangelands; and estimate non-market values of rangeland recreation. A prerequisite step necessary for achievement of these study goals was identification of rangeland recreation sites in the USDA Forest Service National Visitor Use Monitoring (NVUM) program (English et al. 2002) for recreation data collection on National Forest System (NFS) lands.

This chapter describes additional background information about rangelands and the need for rangeland recreation information. Study objectives and content of subsequent chapters presenting the three study components and their results are discussed. A concluding chapter summarizing content of the first four chapters is also outlined.

Rangelands Background

Rangelands in the U.S. cover approximately 770 million acres of grasslands, savannas, deserts, shrublands, alpine meadows, wetlands, and tundra (Sustainable Rangelands Roundtable 2003). Worldwide, rangelands cover from 50 to 70 percent of the earth's surface, with the difference depending on whether rangelands are defined as being grazed by domestic animals or whether they include all uncultivated land with the potential to support grazing by domestic animals (Holechek et al. 2001).

The Society for Range Management (SRM) (2005) defines rangelands as areas dominated by self-propagating vegetation comprised predominantly of grasses, grass-likes, forbs, shrubs, and dispersed trees. The NFS currently uses this description as a working definition of rangelands (Bryant, pers. comm., 2005), applicable to agency land management decisions affecting forests and grasslands.

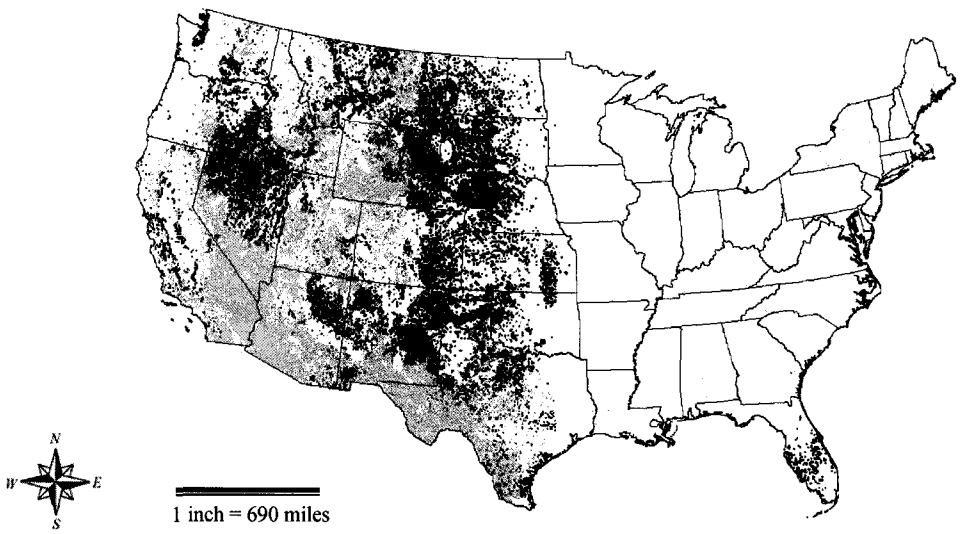


Figure 1.1. Distribution of rangelands in the continental United States, showing grasslands (purple), shrublands (orange), and mixed shrub-steppe vegetation (green). Map courtesy of USDA Forest Service.

The USDA Forest Service has been custodian of grassland reserves since 1954. At that time, nearly 4 million acres of rehabilitated rangelands administered by the Soil Conservation Service (now the Natural Resources Conservation Service) under the Land Utilization Project (LUP) were transferred to the USDA Forest Service and designated as National Grasslands, to be managed as part of the National Forest System (Mitchell et al. 2005). These lands were originally purchased by the US Department of Agriculture under authority of the Bankhead-Jones Farm Tenant Act of 1937, which allowed for government purchase of agricultural lands abandoned during the Dust Bowl.

Need for Rangeland Recreation Information

Projections suggest that rangeland available for traditional uses such as livestock forage production will decrease over the next 50 years, with the actual rate depending upon environmental issues, government policies, and competing uses. However, grazing land use for wildlife-related recreation activities is predicted to increase during the same period (Van Tassel et al. 2001).

Disparate sustainability assessment efforts have independently identified the need for baseline rangelands recreation information (The Heinz Center 2002, Tanaka et al. 2003, USDA Forest Service 2004). Comprehensive data collection and analyses focusing upon rangeland recreation have not been conducted. Although surveys exist to assess national recreation trends, they do not address rangelands specifically. The U.S Census Bureau conducts the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation every five years, last in 2001. The USDA Forest Service administers the National Survey on Recreation and Environment (NSRE) to meet Forest and Rangeland

Renewable Resources Planning Act of 1974 (RPA) assessment requirements. Both instruments provide reliable recreation data, but neither survey identifies whether activities take place on rangelands, in forests, on farmland, or in other natural resource settings. Therefore, it is currently not possible to discuss value of recreational uses of USDA Forest Service rangelands.

Previous assessments of national and regional overall National Forest recreation value, encompassing forest, rangeland, and water activities, have been meta-analyses of previously published value estimates (Walsh et al., 1992; Rosenberger and Loomis, 2001). Bowker et al. (2005) have recently completed the first analysis for estimation of overall National Forest recreation values using a comprehensive data set from the National Visitor Use Monitoring (NVUM) program, developed solely from observations collected on NFS lands. This study uses rangeland recreation information extracted from the NVUM data to provide the first estimate of recreation value of NFS rangelands, as distinct from NFS forests and waterbodies.

It is anticipated that the current need for adequate information to support NFS rangeland management decisions will be exacerbated in the future by increases in use of national forests and grasslands for recreational activities, resulting in an associated increased need to manage such recreational use. For example, ranchers recently identified impacts of recreation on livestock operations operating under Forest Service grazing permits in Arizona and Bureau of Land Management permits in Idaho. Damage attributed to recreational users of these federal lands included: fence cutting by off-highway vehicle (OHV) users, horseback riders, and hikers; disruption of herd movements by OHV users; equipment theft; and damage to water tanks and pipes from

shooting. The Public Lands Council (2005) has passed a formal resolution to encourage agencies to regulate OHV use on federal lands.

Outdoor recreation also figured in current Forest Service Chief Dale Bosworth's (2003) identification of four critical threats to National Forest System forests and grasslands. Unmanaged recreation shares top billing, along with fire, invasive species, and loss of open space. In 2001, Americans made almost 200 million visits to the National Forest System, and the USDA Forest Service expects these numbers to grow dramatically. The U.S. population is expected to more than double within the next century, and a parallel increase in the number of visits to NFS forests and rangelands is likely (Cordell and Overdevest 2001). Improved management of recreation on the national grasslands based upon quantifiable data will better serve all users.

Agencies and landowners must quantify both production and non-market values of rangelands, including recreation use. Traditional market products derived from rangelands, such as livestock forage, as well as non-market goods and services such as wildlife habitat and forage, water storage and filtration, plant pollination, nutrient cycling, erosion control, mitigation of droughts and floods, carbon sequestration, maintenance of biodiversity, and provision of recreation opportunities can be categorized as ecosystem services (Ecological Society of America 2000). Numerous economic valuation techniques, including the travel cost method implemented in this study, potentially can be used to quantify non-market values of NFS rangelands.

Study Objectives and Organization

Balancing federal land management objectives among commodity and amenity values must be predicated upon accurate information about demand for recreation activities pursued on NFS rangelands, and monetary values associated with such non-market activities. While grazing use of NFS lands is closely monitored and managed, comparable data about recreation uses is lacking. Therefore, this study will identify rangeland recreation sites in the USDA Forest Service National Visitor Use Monitoring (NVUM) program for recreation data collection on NFS lands; assess visitor demographics and activities; and estimate benefits associated with rangeland recreation on USDA National Forests and Grasslands using a basic travel cost model.

This document contains three separate sections, one for each phase of the analysis, organized as follows. All research completed for this project was conducted in conjunction with the USDA Forest Service Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA) reporting requirements. Four USDA Forest Service RPA regions (Figure 1.2) are: the Pacific Coast (Washington, Oregon, California, Alaska, and Hawaii), the Rocky Mountains (Montana, Idaho, North Dakota, South Dakota, Nebraska, Kansas, Wyoming, Colorado, Utah, Nevada, Arizona, and New Mexico), the South (Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, Georgia, Tennessee, Kentucky, Virginia, North Carolina, South Carolina, Florida, and Puerto Rico), and the North (Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana, Ohio, West Virginia, Pennsylvania, New York, New Jersey, Delaware, Maryland, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine) (Joyce 1989). Data sets used were 1992 US Geological Survey (USGS) – Environmental Protection Agency

(EPA) National Land Cover Dataset (NLCD) (Vogelmann et al. 1998) and USDA Forest Service 2000-2002 National Visitor Use Monitoring (NVUM) information (English et al. 2002). The NVUM dataset was not collected specifically for this study, or for analysis of NFS rangeland recreation as distinct from overall NFS recreation.

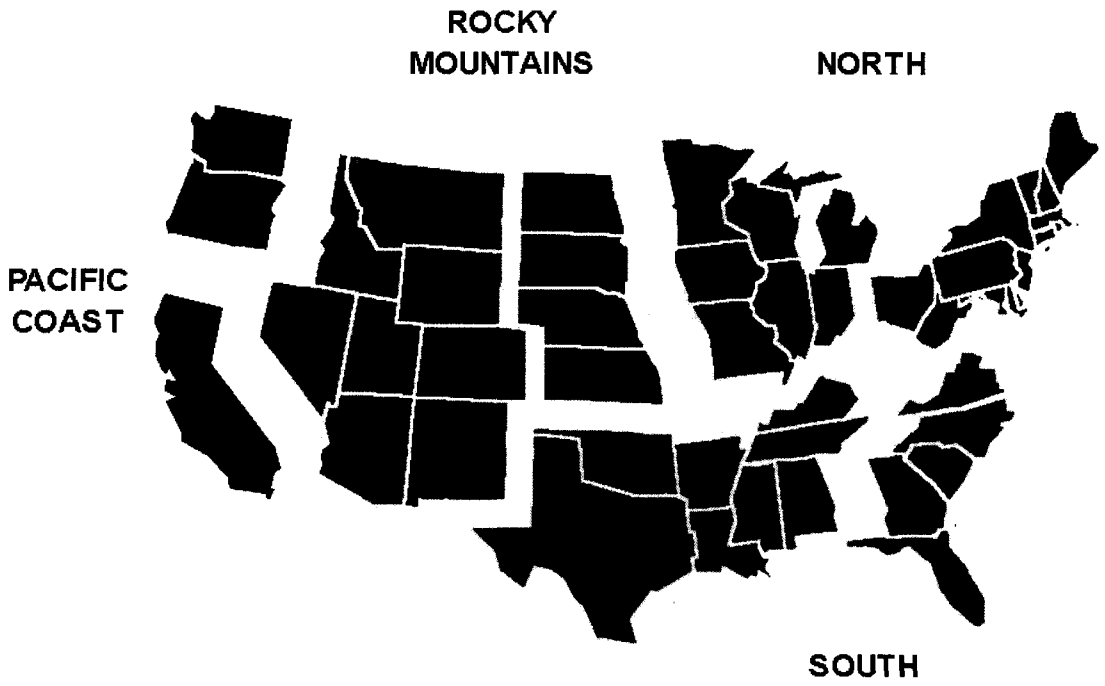


Figure 1.2. USDA Forest Service RPA assessment regions and subregions. Map courtesy USDA Forest Service.

The first paper, Chapter 2, describes the grid-based geographic information system (GIS) procedure used to integrate the NLCD vegetation data with the USDA Forest Service NVUM recreation sample points to identify rangeland recreation sites within the USDA Forest Service NFS NVUM sample. The NFS rangeland recreation sites were identified for the entire United States, the western United States, and each of the four RPA assessment regions in the continental United States. The NLCD vegetation coverage does not include Hawaii, Alaska, or Puerto Rico; therefore NFS NVUM

recreation sites in those areas were not analyzed. This paper will be submitted to *Environmental Monitoring and Assessment.*

The next paper, Chapter 3, analyzes NVUM recreation information extracted from the overall NFS data set for rangeland recreation sites. Recreation activities and rangeland visitor demographics are analyzed for the western United States, and the two RPA assessment regions that comprise the western United States, the Pacific Coast RPA assessment region and the Rocky Mountain assessment region. This paper will be submitted to *Leisure Sciences.*

The final paper, Chapter 4, incorporates information collected at NVUM rangeland recreation sample sites into a travel cost model for NFS rangeland recreation in the western United States, the Pacific Coast RPA assessment region, and the Rocky Mountain assessment region to estimate benefits associated with specific NFS rangeland recreation activities. Averaged consumer surpluses associated with NFS rangeland recreation in the western United States, the Rocky Mountain RPA assessment region, and the Pacific Coast RPA assessment region are also calculated and discussed. Consumer surpluses are benefits received by visitors above the cost of recreation fees and travel costs paid to access a recreation site. This paper will be submitted to *Rangeland Ecology and Management.*

A concluding chapter, Chapter 5, summarizes findings and future research suggestions based upon the three aforementioned analyses of NFS rangeland recreation. Taken together, these sections provide an initial assessment of rangeland recreation on NFS lands from which the state of knowledge about NFS rangeland recreation will only improve.

LITERATURE CITED

Bosworth, D. 2003. Speech to the San Francisco Commonwealth Club. April 23, 2003. San Francisco, CA.

Bowker, J.M., D.B.K. English, J.C. Bergstrom, C.M. Starbuck, R. Rosenberger, and D. McCollum. 2005. Towards Estimation of US National Forest Recreational Value: National Visitor Use Monitoring System Results. Unpublished USDA Forest Service Working Paper.

Bryant, L.D. 2005. Personal Communication.

Cordell H.K. and C. Overdevest. 2001. Footprints on the Land: An Assessment of Demographic Trends and the Future of Natural Lands in the United States. Sagamore Publishing, Champaign, IL.

Ecological Society of America. 2000. Ecosystem Services: A Primer. Ecosystem Services Fact Sheet. Ecological Society of America. Washington D.C.

English, D.B.K., S.M. Kocis, S.J. Zarnoch, and J.R. Arnold. 2002. Forest Service National Visitor Use Monitoring Process: Research Method Documentation. General Technical Report SRS-57. USDA Forest Service Southern Research Station. Asheville, NC.

Holechek, J.L., R.D. Pieper, and C.H. Herbel. 2001. Range Management: Principles and Practices. Prentice Hall, Upper Saddle River, NJ.

Public Lands Council. 2005. Resolutions for the September Public Lands Council Meeting. September 12-15, 2005. Cottonwood, Arizona.

Rosenberger, R.S. and J.B. Loomis. 2001. Benefit transfer of outdoor recreation use values: a technical document supporting the Forest Service strategic plan. General Technical Report RMRS-GTR-72. USDA Forest Service, Rocky Mountain Research Station.

Society for Range Management. 2005. Rangelands and Global Change. http://www.rangelands.org/pdf/Global_Issue_Paper.pdf. Denver, CO.

Sustainable Rangelands Roundtable. 2003. Criteria and Indicators of Sustainable Rangelands: Executive Summary. http://SustainableRangelands.cnr.colostate.edu. Colorado State University, Fort Collins, CO.

Tanaka, J., L.A. Torell, L.V. Swanson, M. Brunson, D. McCollum, and H.T. Heintz, Jr. 2003. Indicators for maintenance and enhancement of multiple economic and social benefits to current and future generations, p 171-199. In: Sustainable Rangelands Roundtable (ed.) Criteria and indicators for sustainable rangelands: a first approximation

report. Available at http://SustainableRangelands.cnr.colostate.edu. Colorado State University, Fort Collins, CO.

The H. John Heinz III Center for Science, Economics and the Environment. 2002. The state of our Nation's ecosystems. Cambridge University Press, New York, NY.

USDA Forest Service. 2004. National report on sustainable forests – 2003. FS-766. USDA Forest Service, Washington, DC.

Van Tassell, L.W., E.T. Bartlett and J.E. Mitchell. 2001. Projected use of grazed forages in the United States: 2000 to 2050. USDA Forest Service Rocky Mountain Research Station General Technical Report RMRS-GTR-82. Fort Collins, CO.

Vavra, M. 1995. Rangeland Research: strategies for providing sustainability and stewardship to the rangelands of America and the world. Rangelands 17(6): 200-214.

Vogelmann, J.E., T.L. Sohl, P.V. Campbell, and D.M. Shaw. 1998. Regional land cover chacterization using Landsat thematic mapper data and ancillary data sources, Environmental Monitoring and Assessment, 51: 415 - 428.

Walsh, R., D.M. Johnson, and J.R. McKean. 1992. Benefit transfer of outdoor recreation demand studies, 1968-1988. Water Resources Research 28:707-713.

Chapter II: USDA Forest Service Developed Recreation Sites Located on Rangelands: A Grid-based GIS Analysis

Abstract:

While public lands recreation opportunities in their entirety have received evaluation and assessment, little is known about recreational use of rangelands in specific (The Heinz Center, 2002). This study identifies developed rangeland recreation sites located on United States Department of Agriculture (USDA) Forest Service (FS) National Forest System (NFS) lands by incorporating a vegetation coverage comprised of the 1992 National Land Cover Dataset (NLCD) and 2000-2002 USDA Forest Service National Visitor Use Monitoring (NVUM) program recreation sample sites in a geographic information system (GIS). Environmental Systems Research Institute, Inc. (ESRI) ArcMap Spatial Analyst version 8.3 is used to determine which NVUM sample points occur within a rangeland context. The Society for Range Management (SRM) (2005) defines rangelands as areas dominated by self-propagating vegetation comprised predominantly of grasses, grass-likes, forbs, shrubs, and dispersed trees. The NFS currently uses this description as a working definition of rangelands (Bryant, 2005, pers. comm.), applicable to agency land management decisions affecting forests and grasslands.

Results are compared across multiple grid sizes using measures of association including McNemar's test statistic and simple Kappa coefficients. Given the need to maximize representation of NVUM recreation sites located on rangelands, combined with the varying size of developed NFS rangeland recreation sites, a 200-meter grid was chosen as the most appropriate size for use in classifying the vegetation type within which Forest Service developed recreation sites occur. Using this standard, NFS developed rangeland recreation sites from the NVUM program are identified for the entire United States; the western United States; and the four USDA Forest Service Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA) assessment regions.

Rangelands provide a setting for at least 30 percent of the USDA Forest Service NVUM developed recreation site sample points in the Rocky Mountains, and more than 25 percent of these NVUM developed recreation site sample points in the Pacific Coast region. Analyses results reported in this study provide the first assessment of NFS rangeland NVUM developed recreation sites. Percentages reported in this study are very likely lower than actual numbers for several reasons. Issues include incomplete data, vegetation type generality within the NLCD information, and ambiguity associated with definitions of rangelands.

Key words: rangeland recreation, USDA Forest Service recreation, grid size, unit of analysis, rangeland management, Forest and Rangeland Renewable Resources Planning Act (RPA) assessment

USDA Forest Service Developed Recreation Sites Located on Rangelands: A Grid-based GIS Analysis

1. Introduction

While public lands recreation opportunities in their entirety have received much evaluation and assessment, little is known about recreational use of rangelands in specific (The Heinz Center, 2002). Indeed, social aspects have been identified as the least studied component of the rangeland science and management field (Vavra, 1995); monitoring social components such as recreation utility will become more important as competing stakeholder pressures on rangelands grow.

Rangelands have been defined by the Society for Range Management (SRM) as areas dominated by self-propagating vegetation comprised predominantly of grasses, grass-likes, forbs, shrubs, and dispersed trees (Society for Range Management, 2005). This description of rangelands is currently used by the USDA Forest Service National Forest System (NFS) as a working definition of rangelands (Bryant, 2005, pers. comm.), applicable to agency management of forests and grasslands.

Decisions to balance federal land management objectives among commodity and amenity values must be predicated upon accurate information about types and levels of recreation use of rangelands within the NFS. While grazing use of NFS lands is closely monitored and managed, recreation information is lacking. Therefore, it is the objective of this

study to identify NFS developed rangeland recreation sites included in the USDA Forest Service National Visitor Use Monitoring (NVUM) program.

Projections suggest that land available for traditional uses such as livestock forage production will decrease over the next 50 years, with the actual rate depending upon environmental issues, government policies, and competing uses. However, grazing land use for wildlife-related recreation activities is predicted to increase during the same period (Van Tassel et al., 2001). While disparate sustainability assessment programs have independently identified the need for baseline rangelands recreation information (The Heinz Center, 2002; Tanaka et al., 2003; USDA Forest Service, 2004), comprehensive data collection and analyses have not been conducted.

Although surveys exist to assess national recreation trends, they do not address rangelands specifically. The U.S Census Bureau conducts the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation every five years, last in 2001. The USDA Forest Service administers the National Survey on Recreation and Environment (NSRE) to meet Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA) assessment requirements. Both instruments provide reliable recreation data, but neither survey identifies whether these activities are taking place on rangelands, in forests, on farmland, or in other natural resource settings. Therefore, it is currently not possible to accurately assess recreational uses of rangelands, associated characteristics of rangelands recreation stakeholders, and potential for conflicts among rangeland recreation participants and other rangeland users.

It is anticipated that the need for adequate information as a basis for USDA Forest Service NFS rangeland recreation management decisions will be exacerbated in the future by increases in use of the national forests and grasslands for recreational activities, resulting in an associated need to manage such recreational use. In 2001, Americans made almost 200 million visits to the NFS, and the USDA Forest Service expects these numbers to grow (Bosworth, 2003). It is everyone's right to use the national forests and grasslands in multiple ways, including outdoor recreation, and the U.S. population is expected to more than double within the next century (Cordell and Overdevest, 2001). A parallel increase in visits to NFS forests and rangelands is likely.

Moreover, the American appetite for outdoor recreation opportunities has not been sated. A recent analysis of United States' natural resource trends by Cordell and Overdevest (2001) found that overwhelming majorities of survey respondents indicated that they care deeply about the environment and a sustaining future for natural lands. Indeed growing demand for outdoor recreation opportunities figured in current Forest Service Chief Dale Bosworth's (2003) identification of four critical threats to National Forest System forests and grasslands. Unmanaged recreation shares top billing, along with fire, invasive species, and loss of open space. Improved recreation management on rangelands based upon quantifiable data will better serve all users.

Consistent data about land uses including recreation are necessary for improved land management decision-making. With this in mind, this analysis is designed to provide baseline information about rangeland recreation within the NFS. To address this issue, this study will quantify numbers of NVUM developed recreation sample sites that occur upon NFS rangelands. This paper will review relevant rangeland recreation and management literature, along with literature addressing use of GIS, size of USDA Forest Service recreation sites and related GIS grid cell size for analyses, NLCD information, and the USDA Forest Service NVUM program. Results focusing on selection of the appropriate grid cell size for analyses will be presented, as well as percentages of NFS NVUM developed recreation sample sites occurring in RPA regions. Discussion will focus on limitations of the study, potential uses, and alternative analyses methods.

2. Rangeland Recreation & Management Background

As the Industrial Age ended in the early 1900s, American priorities shifted to include a growing emphasis on recreational pursuits. John Muir introduced people to the pleasures of hiking and camping, leading to creation of the Sierra Club in 1892. Americans embraced a newfound appreciation for natural environments (Petulla, 1988). This new outdoor recreation focus coincided with a movement to preserve natural resources, including establishment of federal reserves and later formation of the USDA Forest Service (1905) and National Park Service (1916). While mandates varied between conservation and preservation, maintenance of natural resources for the benefit of future generations was a clear goal. The Forest Service 1905 enabling legislation characterized benefit in terms of multiple uses, and a "Wise Use" book issued by the agency's first

chief, Gifford Pinchot, dealt primarily with watershed protection, mining, timber production, and livestock grazing (Driver et al., 1994).

At the same time, U.S. western rangelands were intensively used for grazing. In combination with conversion to croplands, overgrazing negatively impacted U.S. rangelands as a result of legislation such as the Homestead Act, designed to settle the west (Holechek et al., 2001). In 1890, cattle numbers for the western United States approximated 27 million. The Stockraising Homestead Act of 1916 parceled out 640 acre tracts of land and mandated a 50-cow stocking rate; more than rangeland resources could support. However, high cattle prices during World War I exacerbated the problem, as did severe drought from 1931 to 1936. With resource conditions deteriorating, in 1934 the Taylor Grazing Act was passed to regulate livestock grazing (Holechek et al., 2001).

Similarly, the Bankhead-Jones Farm Tenant Act of 1937 authorized the US Department of Agriculture to purchase agricultural lands abandoned during the Dust Bowl. Following years of seeding and formation of grazing associations to emphasize proper grazing management, the USDA Forest Service became custodian of these large grassland reserves in 1954. Nearly 4 million acres of rangelands previously administered under the Land Utilization Project (LUP) were transferred from the Soil Conservation Service (now the Natural Resources Conservation Service) to the USDA Forest Service. These LUP lands were formally designated as National Grasslands, to be managed as part of the National Forest System (Mitchell et al., 2005).

As the twentieth century progressed, public concern and associated land management priorities focused increasingly on problems of environmental degradation and depletion of finite natural resources. Publication of *Silent Spring* (Carson, 1962) educated a worldwide audience about integral environmental linkages among predators, prey, habitat, and humans. Awareness expanded in subsequent decades through environmental advocacy events such as Earth Day, designed to call attention to natural resource condition and associated human impacts. At the same time, anti-grazing sentiment and opposition to grazing on federals lands grew (Holechek et al., 2001).

Concurrent changing social values associated with increased income, mobility, leisure time, and knowledge about outdoor recreation opportunities, led to growth in public demand for non-commodity, amenity services (Driver et al., 1994). Indeed, a national committee convened to assess United States' amount and availability of outdoor recreation resources and infrastructure. Reports by the Outdoor Recreation Resources Review Commission (1962) led to expansion of facilities and recreation areas in response to ever-increasing demand. Legislatively, this expansion was manifested through passage of the Multiple Use and Sustained Yield Act of 1968 and the National Forest Management Act of 1976, which formalized Forest Service responsibilities to include amenity values such as recreation in land management and planning activities.

Twenty-first century survey results suggest that the public continues to support this expanded management focus (Shields et al., 2002). Respondents exhibited majority consensus on importance of maintaining diverse land uses such as grazing, recreation, and wildlife habitat, as well as using natural resources to support communities dependent on grazing, mining, or timber harvesting. Additionally, a majority of respondents think that decisions to develop natural resources should not be based solely on economic factors (Shields et al., 2002). Therefore, federal land managers are expected to strive to achieve a sustainable balance among social, economic, and environmental concerns in order to provide a desired mix of commodity and amenity benefits for present and future generations. Consistent data about land uses including recreation are necessary for improved land management decision-making. With this in mind, this analysis is designed to provide baseline information about rangeland recreation within the NFS.

3. Relevant Literature

Papers collectively addressing rangelands and recreation are relatively rare. Extant articles frequently focus on recreator perceptions of grazing (Brower, 2000; Brunson and Gilbert, 2003; Mitchell et al., 1996; Sanderson et al., 1986) in the context of recreational use of rangelands, or the economic benefits of recreation for ranchers in terms of diversifying income (Butler, 1990; Berger, 1973) and increasing property values (Rowan and Workman, 1992).

Rangelands have also featured in site-specific impact analyses (Cole et al., 2004; Cole

and Spildie, 1998; Cole and Monz, 2003; Cole and Landres, 1996; Cole, 1987; Cole, 1988; Gordon et al., 2002; Sun and Walsh, 1998) conducted to explore interactions of environmental characteristics such as climate, geomorphology, hydrology, soil classification, vegetation type, slope, aspect, with season, intensity and type of recreational use. Studies document the superior resistance and recovery of grasslands from recreation impacts when compared to forests (Cole, 1988; Cole and Monz, 2003), although susceptibility of rangelands to damage from recreational packstock grazing is also noted (Cole et al., 2004).

However, literature detailing the number, type, and/or distribution of recreation sites located on or immediately adjacent to rangelands in the United States is lacking (The Heinz Center, 2002). While the Forest Service keeps track of overall numbers of picnic areas, campgrounds, and other developed recreation facilities located within management units, vegetation types within which these recreation sites occur, have not been identified for the National Forest System. It is difficult to accurately assess the magnitude of potential conflicts, economic profits, and recreational impacts potentially resulting from recreation on developed rangeland sites at regional and/or national scales. It is currently not possible to correctly quantify the importance of rangelands resources for recreation.

Outdoor recreation participation in the United States is growing at unprecedented rates, and US Census Bureau predicts this country's human population will double by 2100 (Cordell and Overdevest, 2001). The most rapidly growing activities include birdwatching, hiking, backpacking, primitive camping, off-road driving, sightseeing, and

developed camping (Cordell and Overdevest, 2001), much of which is probably occurring on rangelands. Indeed, 1995 NSRE results showed the highest percentages of participants across activities recreating within the West (Cordell and Overdevest, 2001), where the majority of rangelands also are located. Thus, rangelands likely provide significant recreation opportunities for the American public. However, because NSRE results focus on where a respondent lives, rather than where they recreate, it is not possible to conclusively determine how many people pursue their chosen outdoor recreation activities on rangelands without addition of specific questions to the survey instrument (Cordell, 2003, pers. comm.).

3.1 Geographic Information Systems and Recreation Monitoring

A national assessment of the importance of rangeland resources for recreation has not been completed. At the national level, the Forest Service has just begun to identify linkages between where people recreate and characteristics of recreation sites through the NVUM program. Spatially explicit information is helpful in associating recreation site characteristics with use levels. Applications of geographic information systems (GIS) for recreation analyses are relatively common at local scales, but national applications are rare. Indeed, recreation research has been identified as a field that would benefit from additional GIS analyses (Cole, 1989; Confer et al., 1992; Meighen and Volger, 1997; Wing and Shelby, 1999).

At local scales, GIS has been used for examination of recreation use levels (Wing and

Shelby, 1999), recreation planning in forests and nature areas (de Vries and Goossen, 2002), analysis of equity and social need for parks (Wicks et al., 1993), exploration of environmental justice questions in relation to tourism (Porter and Tarrant, 2001), simulation of human recreation behavior (Itami et al., 2003), examination of wilderness perceptions (Kliskey, 1994), recreation terrain suitability mapping (Kliskey, 2000), modeling demand for woodland recreation (Bateman et al., 1999), zoning review in and around a national park (Lin, 2000), and habitat diversity assessment for prioritization of land acquisitions (Wright and Tanimoto, 1998). In contrast, at the national scale, GIS applications for recreation information are uncommon. While Cordell and Overdevest (2001) utilized GIS to evaluate and depict county-level population pressures, land cover, wilderness, degree of development, and recreation demand, rangelands are not distinguished from other natural lands.

3.2 USDA Forest Service Developed Recreation Site Size

Information required for this study about average sizes of USDA Forest Service developed recreation sites, such as campgrounds and picnic areas, is also lacking in the literature. During the 1960s, researchers found that a variety of different-sized campgrounds appealed to visitors (Wager, 1963; Burch, 1964; Burch and Wenger, 1967; Lucas, 1970; and Lime, 1971). A study of 13 private campgrounds in Iowa determined that sizes ranged widely, from ½ acre to 26 acres (Dawson et al., 1978), but public campgrounds were not studied. While campgrounds were classified as travelers camps, central camps, forest camps, peak-load camps, long-term camps (Wagar, 1963), social-oriented camps, and environment-oriented camps (Lime 1974), characterized as larger or

smaller relative to other site types, no standard or average size for USDA Forest Service campground sites is documented. Indeed, Lime (1974, p. 63) stated, "it would appear to be a mistake for any public agency to make campgrounds a standard size," thus, supporting the concept of varying recreation site size. Information is also lacking about size of picnic areas. While guidelines exist for site slope, and distances between picnic sites and restrooms or water (Hedges, 1991), information about overall size of picnic grounds is elusive. The literature offered little guidance in terms of an appropriate analysis scale to capture spatial characteristics of developed recreation sites such as campgrounds and picnic areas.

4. Methods

This study was designed to explore preliminary analyses of the magnitude and importance of rangeland recreation developed sites on NFS lands, in conjunction with mandated USDA Forest Service reporting required by the Forest and Rangeland Resources Planning and Assessment Act of 1974 (RPA). For compatibility with previous RPA rangelands reports, recreation site analyses were conducted by RPA region (Figure 2.1) and the nation as a whole. Four RPA regions are: Pacific Coast (Washington, Oregon, California, Alaska, and Hawaii), Rocky Mountains (Montana, Idaho, North Dakota, South Dakota, Nebraska, Kansas, Wyoming, Colorado, Utah, Nevada, Arizona, and New Mexico), South (Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, Georgia, Tennessee, Kentucky, Virginia, North Carolina, South Carolina, Florida, and Puerto Rico), and North (Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana, Ohio, West Virginia, Pennsylvania, New York, New Jersey, Delaware,

Maryland, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine) (Joyce, 1989). Data sets used were 1992 NLCD information and USDA Forest Service 2000-2002 National Visitor Use Monitoring (NVUM) data. Note that the NLCD vegetation coverage does not include Hawaii, Alaska, or Puerto Rico; therefore, recreation sites in those areas were not analyzed.

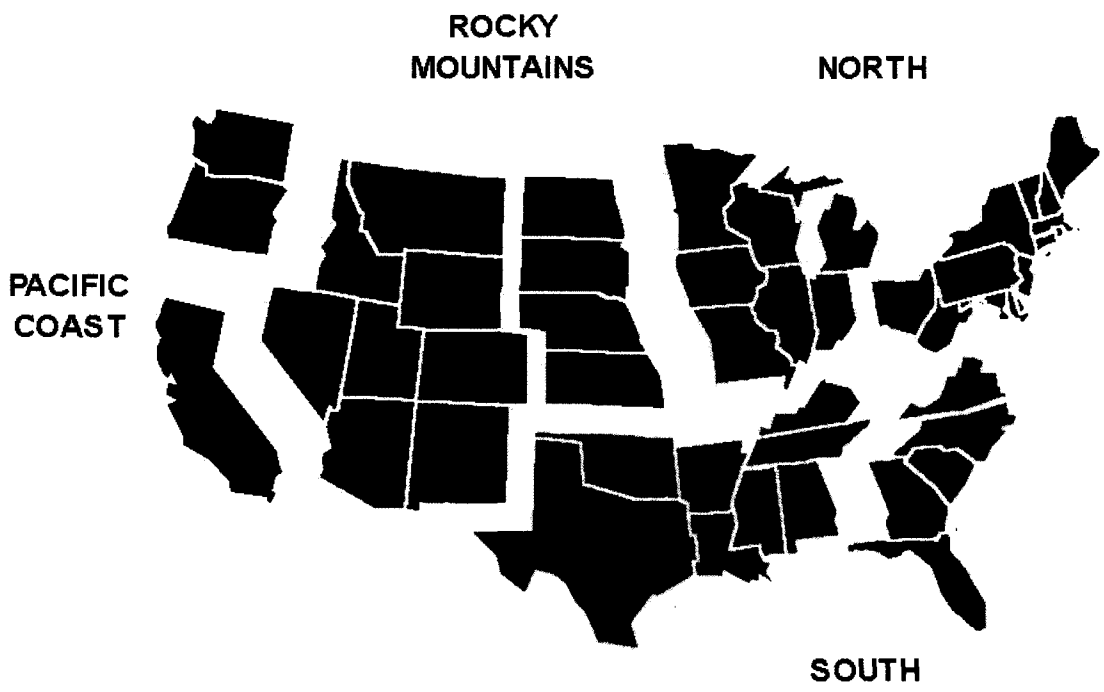


Figure 2.1: USDA Forest Service RPA assessment regions and subregions. Map courtesy USDA Forest Service.

4.1 National Visitor Use Monitoring Program

NVUM information was collected to address the need for statistically reliable recreation use estimates required by Congress and the Government Accountability Office (GAO) in association with USDA Forest Service budget allocations and strategic planning. NVUM data were not collected specifically for this study or to address rangeland recreation questions. Exiting recreation traffic, along with measures including fee envelopes and

concessionaire reports, was monitored for recreation sites stratified by type, location, and time period of recreation visits. Visitation periods were identified as low, medium, or high use to ensure adequate representation of all visitation periods in the survey. The study design relied upon a double sampling technique developed specifically for use on national forests, and provided for estimation of visitation to a given national forest, but was not meant for use at finer scales such as specific sites or districts (English et al., 2002).

Data used pertained to two of the five recreation sites types – day-use developed sites (DUDS) and overnight-use developed sites (OUDS). Both DUDS and OUDS show moderate to heavy degrees of modification and/or development. The former include picnic areas, interpretative sites, observation sites, visitor centers, and museums, while the latter includes campgrounds, fire lookouts, lodges, and horsecamps. Sample location coordinates were recorded during the data collection process (English et al., 2002).

4.2 National Land Cover Dataset Usage

Discussion of vegetation cover type is rare in conjunction with recreation, beyond localized evaluation and management of recreation impacts. While national forests and grasslands may have detailed spatial databases for management units, the 1992 US Geological Survey – Environmental Protection Agency National Land Cover Dataset (NLCD) provides standardized, consistent, fine-grained vegetation maps at a national scale (Vogelmann et al., 1998). In the eastern United States, where rangelands are less

pervasive, Anderson I Level mapping accuracies range from 70 percent in the Mid-Atlantic region to 83 percent in the Southeast (Stehman et al., 2003). User accuracy of grassland/shrubland mapping at an Anderson I Level was 84 percent in the Rocky Mountains, 91 percent in the Southwest, and 84 percent in the Pacific Northwest (Wickham et al., 2004) where rangeland vegetation classes are dominant. These numbers indicate that the NLCD accurately represents rangeland vegetation at an Anderson I Level.

Anderson I and II information is of interest to users who desire data on a nationwide, interstate, or statewide basis. More detailed data at Anderson III and IV levels is typically for use at county, municipal, or regional levels (Anderson et al., 1976). For example, Anderson I is "rangeland," and Anderson II represents more detail; "herbaceous rangeland," "shrub and brush rangeland," and "mixed rangeland" (Anderson et al., 1976).

While NLCD was designed for regional and/or national applications, at least half of the users have applied the data at state and county levels (Vogelmann et al., 2001). Theobald et al. (2003) focused on utility of enhanced land cover data to assess fire hazard risk in Colorado. Wardlow and Egbert (2003) compared Gap Analysis Program and NLCD accuracy in Kansas and discussed it's applicability at local and regional scales to support management, monitoring and modeling activities in areas such as agriculture, forestry, disease control, water quality and wildlife; recreation should be added to the list.

4.3 Grid Cell Size

Literature is equally scant regarding appropriate grid cell size for identification of vegetation types in which developed recreation sites occur. Choice of grid size depends upon availability of data at specific spatial resolutions, since use of grid cell sizes smaller than the specified resolution falsely implies greater accuracy. Conversely, grid cell sizes larger than the specified resolution may be chosen for practical reasons (Hessel, 2005).

Grid-based modeling to estimate local soil moisture (Florinsky and Kuryakova, 2000), hydrologic flows (Kuo et al., 1999), soil erosion (Hessel, 2005), and non-point source pollution (Vieux and Needham, 1993) through use of digital elevation models (DEM) resulted in exploration of effects of grid size on representation of terrain, water discharge, and soil loss (Hessel, 2005). Grid sizes used in these studies varied widely. Florinsky and Kuryakova (2000) experimented with values between one and seven meters; Kuo et al. (1999) used grid sizes ranging from 10 to 600 meters; Hessel (2005) worked with grids between five and 100 meters in size; and Vieux and Needham (1993) varied their grid size from one to 16 hectares. Due to emphases on complex interactions among numerous factors influencing local and regional phenomena, associated grid cell size recommendations did not adequately inform selection of appropriate grid cell size for rangeland recreation site identification. Indeed, Hessel (2005) cites grid size selection as an arbitrary process to attain a subjective balance between acceptable accuracy and practical concerns such as analysis time, hard disk space, processor speed and capacity.

4.4 GIS Point Coverage and Grid Size

Point coordinates for DUDS and OUDS were incorporated into a GIS, then transformed to a raster-based coverage. Although the raster format generalizes the specificity of a point location, a single point does not accurately represent the geographic area or bounds of a campground or picnic area. This study was designed (Figure 2.2) to characterize the vegetation type in which DUDS and OUDS are situated, and transformation to raster format allowed estimation of the boundaries of each site to more accurately capture the surrounding vegetation context. Thus, each point was transformed to a cell in the raster coverage. Predictably, smaller cell sizes have smaller area, and are more similar to the original point feature. However, in this case, the original points did not accurately represent the full areal extent of DUDS and OUDS features.

Selection of an appropriate cell size to approximate the geographic extent of recreation sites such as picnic areas and campgrounds involved both the aforementioned unsuccessful survey of site design literature for a suggested minimum mapping unit and experimentation with drop out rates associated with various cell sizes. For point features representing sites within close proximity to each other, certain cell sizes encompass multiple points. Only one point value can be assigned to the generated cell, typically the value of the first point encountered when processing, which means that other point values falling within a given cell drop out. Cells that do not contain a point are given a value of NoData (Kopp et al., 2001).

4.5 GRID Calculation

Within the NLCD data, several vegetation classes can be unambiguously considered "rangelands." These are grasslands, shrublands, and emergent herbaceous wetlands. However, research assessing vegetation misclassifications found that these rangelands categories registered as croplands and/or pasture with some frequency (Theobald et al., 2003; Wardlow and Egbert, 2003; Wickham et al., 2004; Stehman et al., 2003). Since the primary goal of this study was to identify rangeland recreation sites, and there was minimal likelihood of the Forest Service situating DUDS or OUDS sites, such as picnic areas or campgrounds, in agricultural fields or pastures, recreation sites mapped within crop or pasture vegetation were included in the rangeland recreation site count.

The calculation used for this classification generalizes the analyzed cell size to the largest cell size of an input data set. For example, if recreation feature points were converted to a grid coverage with a cell size of 100 meters, then the 30-meter NLCD information automatically would be transformed to the same 100-meter resolution by the Environmental Systems Research Institute, Inc. (ESRI) Spatial Analyst version 8.3 software utilized for this analysis. The scale transformation for categorical data such as the NLCD vegetation coverage is performed using a nearest neighbor analysis. This resampling technique does not alter the value of the original input cells. Rather, it involves plotting the new output raster cell's center on the original input raster coverage, then using nearest neighbor assignment to determine the location of the closest cell center from the original input raster and assigning the value of that cell to the corresponding cell on the new, larger resolution output raster (Kopp et al., 2001).

An additional concern with study design was the 30-meter cell size of the NLCD vegetation coverage. While such fine-grained data depicts detailed vegetation information, recreation sites such as campgrounds and picnic areas can be expected to cover more than 30 meters. Therefore, analyses were run at different grid sizes – 50 meters, 100 meters, 200 meters, 400 meters, and 1000 meters - to explore drop out rates and effects upon vegetation class assignments attached to DUDS and OUDS through use of a raster map calculation.

4.6 Comparison Statistics

A simple Kappa coefficient was used to assess consistency of results across grid sizes.

The simple Kappa coefficient measures agreement of rangeland classifications for recreation sites beyond that expected by chance (The SAS Institute, 1990) with comparison of results from different sized grids. For example, recreation sites classified as occurring on rangelands with a 50-meter grid were compared against recreation sites identified with a rangeland location in the 100-meter, 200-meter, 400-meter, and 1000-meter grids, respectively. A zero value indicates chance agreement, while a value of 1 represents complete agreement between grids; values above .4 depict moderate agreement, while .8 and above show high agreement (The SAS Institute, 1990).

A more specific measure that produces a testable p-value was also applied to cross-grid comparisons of rangeland recreation sites. The McNemar statistic tests the null

hypothesis that there is no association between the two grids being compared; smaller p-values indicate a high likelihood that the two grids are associated. This statistic is used for analysis of frequency data (The SAS Institute, 1990).

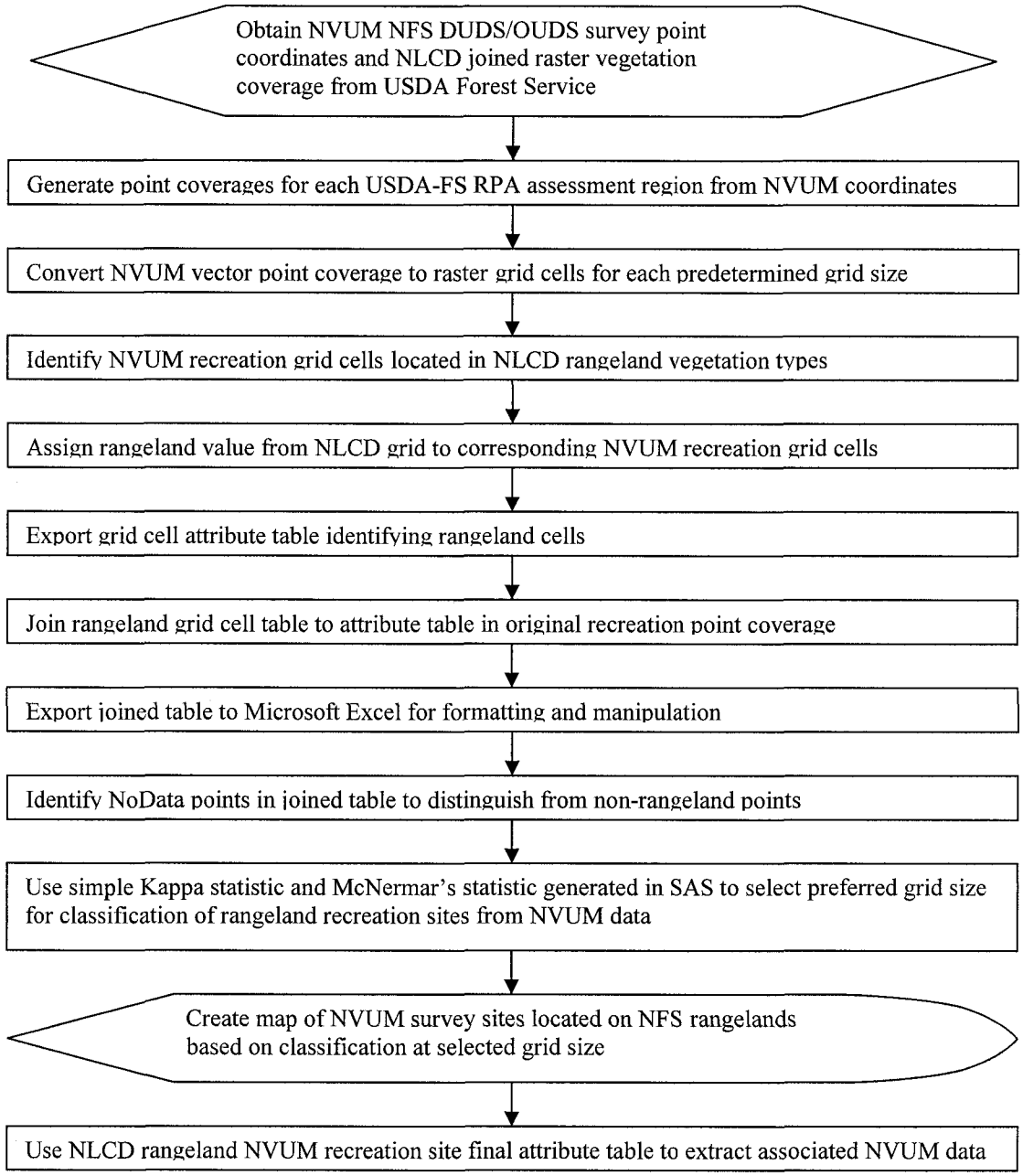


Figure 2.2: Process to identify USDA Forest Service NVUM survey sites located on NFS rangelands.

5. Results

Despite variation in appropriate cell size for representation of DUDS and OUDS, results were relatively consistent across cell sizes ranging from 50 meters to 400 meters, and less so for 1000-meter grids. Raw results and percentages derived from raster calculations performed for each RPA region appear in Tables 2.1-2.4. Results are also summed for the West (Table 2.5) and the nation as a whole (Table 2.6). Relatively minimal amounts of rangelands in the Northern and Southern Regions decrease significance of national figures; therefore, neither the simple Kappa coefficient nor McNemar's test statistic were generated for these two regions. NVUM sample sites that were classified as occurring on rangelands in the Pacific Coast and Rocky Mountain Regions are shown in Figure 2.3.

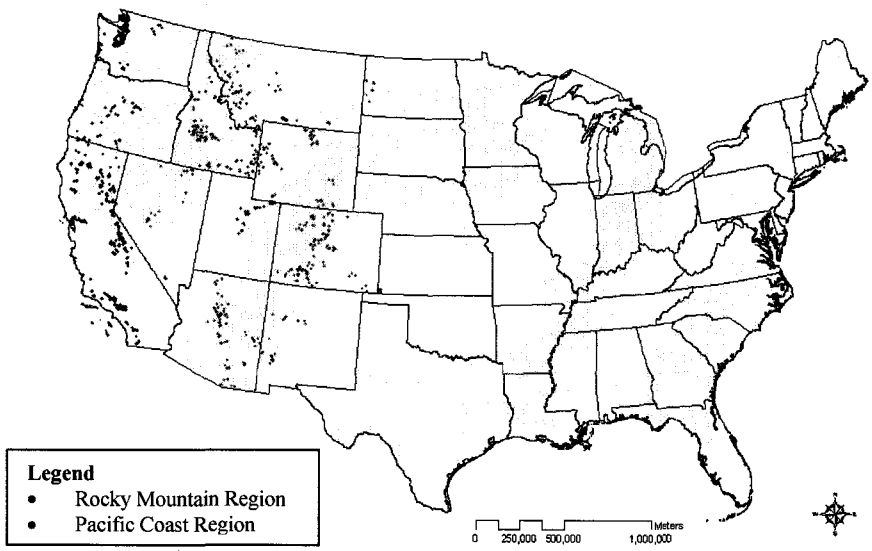


Figure 2.3: NVUM developed recreation sites occurring on rangelands in the USDA Forest Service Pacific Coast and Rocky Mountain RPA assessment regions.

Percentages of DUDS and OUDS on rangelands were highest in the Rocky Mountain Region, ranging from 29 to 31 percent, depending on cell size (Table 2.2). Numbers in the Pacific Coast Region varied with cell size from 21 to 23 percent (Table 2.1). When combined to represent the West in its entirety, percentages range from 26 to 28 percent; just over one quarter of western NFS DUDS and OUDS are situated on rangelands. As previously mentioned, figures for the North and South Regions were distinctly lower, only ranging from 4 to 6 percent (Table 2.3 and Table 2.4).

	ORIGINAL POINT COUNT	RANGELAND CELL COUNT	OTHER CELL COUNT	CONVERSION DROP OUT	PERCENT RANGELAND CELLS
50m Cells	1599	355	1217	27	23%
100m Cells	1599	343	1220	36	22%
200m Cells	1599	340	1183	76	22%
400m Cells	1599	338	1105	156	23%
1000m Cells	1599	281	1032	286	21%

Table 2.1. Number and Percentage of DUDS and OUDS on NFS rangelands in Pacific Coast Region.

	ORIGINAL POINT COUNT	RANGELAND CELL COUNT	OTHER CELL COUNT	CONVERSION DROP OUT	PERCENT RANGELAND CELLS
50m Cells	2133	652	1422	59	31%
100m Cells	2133	619	1434	80	30%
200m Cells	2133	606	1412	115	30%
400m Cells	2133	611	1341	181	31%
1000m Cells	2133	524	1274	335	29%

Table 2.2. Number and Percentage of DUDS and OUDS on NFS rangelands in Rocky Mountain Region.

	ORIGINAL POINT COUNT	RANGELAND CELL COUNT	OTHER CELL COUNT	CONVERSION DROP OUT	PERCENT RANGELAND CELLS
50m Cells	629	37	575	17	6%
100m Cells	629	37	572	20	6%
200m Cells	629	35	562	32	6%
400m Cells	629	30	549	50	5%
1000m Cells	629	30	499	100	6%

Table 2.3. Number and Percentage of DUDS and OUDS on NFS rangelands in Southern Region.

	ORIGINAL POINT COUNT	RANGELAND CELL COUNT	OTHER CELL COUNT	CONVERSION DROP OUT	PERCENT RANGELAND CELLS
50m Cells	482	27	437	18	6%
100m Cells	482	27	436	19	6%
200m Cells	482	21	437	24	5%
400m Cells	482	16	427	39	4%
1000m Cells	482	24	383	75	6%

Table 2.4. Number and Percentage of DUDS and OUDS on NFS rangelands in Northern Region.

	ORIGINAL POINT COUNT	RANGELAND CELL COUNT	OTHER CELL COUNT	CONVERSION DROP OUT	PERCENT RANGELAND CELLS
50m Cells	3732	1007	2639	86	28%
100m Cells	3732	962	2654	116	27%
200m Cells	3732	946	2595	191	27%
400m Cells	3732	949	2446	337	28%
1000m Cells	3732	805	2306	621	26%

Table 2.5. Number and Percentage of DUDS and OUDS on NFS rangelands in the western United States.

	ORIGINAL POINT COUNT	RANGELAND CELL COUNT	OTHER CELL COUNT	CONVERSION DROP OUT	PERCENT RANGELAND CELLS
50m Cells	4843	1071	3651	121	23%
100m Cells	4843	1026	3662	155	22%
200m Cells	4843	1002	3594	247	22%
400m Cells	4843	995	3422	426	23%
1000m Cells	4843	859	3188	796	21%

Table 2.6. Number and Percentage of DUDS and OUDS on NFS rangelands in the continental United States.

5.1 Grid Size Selection

The simple Kappa coefficient showed moderate agreement among results from all grid sizes with the exception of the 1000-meter grid. Simple Kappa coefficient values for the western United States, excluding 1000-meter grid results, ranged from .50 to .68, representing moderate agreement among classifications of recreation sites occurring on rangelands using 50-meter, 100-meter, 200-meter, and/or 400-meter grids.

Grid Sizes Compared *(meters)*	**Rocky Mountain Region (RMR) Simple Kappa Coefficients**	**Pacific Coast Region (PCR) Simple Kappa Coefficients**	**Western United States Simple Kappa Coefficients**
50x100	0.69	0.66	0.68
50x200	0.59	0.49	0.56
50x400	0.52	0.44	0.50
50x1000	0.37	0.33	0.36
100x200	0.65	0.55	0.62
100x400	0.53	0.46	0.51
100x1000	0.38	0.39	0.38
200x400	0.57	0.52	0.55
200x1000	0.41	0.34	0.39
400x1000	0.38	0.38	0.39

Table 2.7. Degree of agreement between recreation sites occurring in rangeland vegetation types derived from various grid sizes, shown by simple Kappa coefficients.

This pattern was also evidenced for the Pacific Coast RPA region and Rocky Mountain RPA region; Pacific Coast RPA region simple Kappa coefficients ranged from .44 to .66, and numbers in Rocky Mountain RPA region fell between .52 and .70. Simple Kappa coefficients for pairwise grid comparisons including the 1000-meter grid results consistently showed low agreement, ranging from a low of .33 to .39, just below the threshold for moderate agreement. Table 2.7 shows the simple Kappa coefficients for pairwise grid comparisons in Pacific Coast RPA region, Rocky Mountain RPA region, and the western United States as a whole.

Kappa coefficient values supported elimination of the 1000-meter grid results from consideration, because they showed low agreement with output from other grid sizes. Although no body of literature documents a standard size for developed recreation areas, 1000 meters is likely larger than most sites. A final consideration is the high number of recreation points that drop out when using 1000-meter grid cells, since 1000-meter cells subsume all points located within that area, resulting in fewer actual data points for analysis. Identification of recreation sites located on rangelands was a preliminary step to facilitate extraction of demographic and economic data associated with each sample point, so minimizing loss of sample points was also a concern.

Of the four remaining grid sizes available, 50 meters was assumed to be smaller than a typical developed recreation site. McNemar's statistic produced p-values for the western United States, Rocky Mountain Region, and Pacific Coast Region showing that there was no significant difference between recreation site classification results from 100-meter and

200-meter grids. Values of McNemar's test statistic were .02, .03, and .00, respectively, indicating that recreation sites classified as occurring on rangeland from 100-meter and 200-meter grids were closely associated. Given the need to minimize drop out rates, the varying size of developed recreation sites, and the above analyses, a 200-meter grid was chosen as the most appropriate size for use in classifying the vegetation type within which Forest Service developed recreation sites occur. Thus, demographic and economic information associated with visits to developed rangeland recreation sites was then generated from rangeland points based upon classification at a 200-meter grid size through use of an ESRI GRID geographic information system analysis protocol.

6. Discussion

This study provides the first assessment of NFS DUDS and OUDS occurring on rangelands. Information derived may help serve as a basis for regional and national management decisions that affect NFS forests and grasslands, as well as demonstrating the importance of rangelands for various recreation opportunities.

6.1 Regional and National Utility

At the regional level, information about amounts of DUDS and OUDS may impact budget allocations and staffing levels and assignments. For example, previous studies have discussed the applicability of range management knowledge and skills, such as assessment of grazing pressure and impacts, to recreation management (McClaran, 2000). Also, prediction and resolution of potential conflicts before they happen, based on

information about location of high use rangeland recreation sites in proximity to active grazing allotments, may alleviate investment of staff time in conflict resolution required after problems occur (Wallace et al. 1996). Quantifying rangeland recreation DUDS and OUDS may assist managers in determining and justifying whether additional staff trained in range management is necessary to adequately deal with both production and recreation use of rangeland resources.

Nationally, the results of this study highlight the importance of DUDS and OUDS to a diverse group of stakeholders. While producer groups representing the cattle industry and wildlife groups with habitat concerns are typically characterized as rangeland constituent groups to be considered regarding NFS management decisions and legislation changes, ability to emphasize recreation values of rangelands will engage a broader audience in these processes.

6.2 Caveats to Consider

Although analyses results for this study are adequate for an initial assessment of NFS rangeland DUDS and OUDS, percentages reported in this study are very likely lower than actual numbers for several reasons. These issues include incomplete data, vegetation community generality within the NLCD information, and ambiguity associated with definitions of rangelands.

6.2.1 NVUM Dataset

The list of DUDS and OUDS in the overall NVUM database is not yet complete. Although the sampling design provided for completion of the initial sample of visitor use monitoring on all NFS forests and grasslands by 2004 (English et al., 2002), not all units have provided data with coordinates for geo-referencing. Sample points representing OUDS and DUDS on many national grasslands, rangeland-dominated forests such as Oregon's Malheur, Umatilla, and Wallowa-Whitman National Forests (Mitchell 2004, pers. comm.), and rangeland-specialized units such as the Midewin Tallgrass Prairie were absent at the time of analysis. Addition of recreation points located within rangelands of these management units would logically increase percentages of DUDS and OUDS points occurring on rangelands.

6.2.2 Classification of Rangelands

With regard to limitations of the NLCD information, issues to note deal with representation of vegetation types depicted in remotely sensed data as a forest cover type, but commonly recognized as rangeland. Aspen and pinion-juniper ecosystems fall into this category. For example, aspen may be classified as a forest vegetation type; however, the understory vegetation present in an aspen grove may contain as much as 3800 pounds of air-dried forage per acre (Mueggler, 1988). Also, exclusion of fire by livestock grazing and active fire suppression helped hasten expansion of pinion-juniper woodlands across open savannas and grasslands in the late 19th and early 20th centuries (Tausch and Tueller, 1990; Miller and Rose, 1999). The precise point at which rangelands become woodlands is subjective, dealing with between-tree spacing and groundcover. These

communities are difficult to accurately classify from remotely sensed data such as NLCD.

As of 2002, pinion-juniper covered approximately 13.6 million acres of USDA Forest Service lands in the western United States (Smith et al., 1994); recreation areas including DUDS and OUDS that fall in these areas may be inaccurately identified as occurring on woodlands rather than rangelands. Increases in traditional recreational use of pinion-juniper woodlands, such as camping and nut-gathering, has risen with population growth and is expected to continue (Gottfried and Pieper, 2000).

6.2.3 Definition of Rangelands

This forest versus rangeland debate is directly associated with definitional issues that must be resolved to provide more clarity to any discussion of rangeland use and value. The various federal government agencies have been unable to reach a technical definition of rangelands, though standardized definitions of forest and rangeland are essential if indicators of sustainable rangeland management and use are to be monitored. In one example, overlaps between these definitions resulted in addition of total rangeland area plus total forest area summing to more than the total land area. The Oregon Demonstration Project found 10 to 15 percent difference in areas of forests and rangelands depending on definitions (Goebel et al., 1998).

Several groups involved in development of monitoring and reporting frameworks have previously identified this problem. Both the Sustainable Rangelands Roundtable

(Maczko et al., 2004) and the USDA Forest Service (2004) national report on sustainable forests discussed the differing operational definitions of forests and rangelands. Although members of the Roundtable on Sustainable Forests, the Sustainable Rangelands Roundtable, the Federal Geographic Data Committee (FGDC) Sustainable Forest Data Working Group, FGDC Vegetation Subcommittee, FGDC Sample Inventory and Monitoring of Natural Resources and the Environment Working Group, Bureau of Land Management, Forest Service, Natural Resources Conservation Service, US Geological Survey, Society for Range Management, Society of American Foresters, and NatureServe acknowledged the need to develop standard definitions of forest and rangeland (Bartlett et al., 2003), in 2004, the agencies suspended efforts to resolve this ambiguity (Geissler and Radloff, 2004, pers. comm.). Until rangelands are definitively described, description of any activity or site, recreational or otherwise, occurring on rangelands will remain ambiguous.

6.3 Alternative Methods

Alternate methodologies that can potentially be applied to analysis of national point data and NLCD vegetation coverages. While this study utilized an ESRI ArcMap version 8.3 grid-based assessment through Spatial Analyst, it is also possible to conduct a similar analysis with an ESRI ArcInfo vector-based protocol. Tradeoffs occur between having all data in the same environment for analyses, and maintaining data in its original form but conducting individual analyses for each point in the national data set. With regard to integration of NVUM and NLCD data, the former offers a simpler, faster classification protocol while the latter is more time consuming and maintains more detail to be used in

the classification process. Though this study is national in scope, it is foreseeable that individual forests and/or districts may wish to perform localized iterations of this analysis. Therefore, Forest Service scientists requested design of a simple analysis and classification protocol, rather than generation of more complex details about relative proportions of vegetation types within grid cells for percentage-based classifications (English, 2005, pers. comm.).

Due to the large size of both the NLCD data set and the NVUM recreation data set, as well as lack of site area representation within vector point coverages, the grid-based system was deemed more appropriate for application to DUDS and OUDS information. Use of the grid-based system assigned estimated area values to recreation points, as well as extrapolating vegetation information from a 30-meter grid cell to larger areas. Permitting the ESRI ArcMap Spatial Analyst software to automatically generalize original 30-meter NLCD data to larger grid cell sizes removed risk of inconsistencies in analyst-assigned vegetation classifications for a nationwide set of larger grid cells based on expert opinion about assessment of proportional vegetation types' relative contributions to categorization. Due to the uncertainties and ambiguities associated with expert opinions about what amounts of which vegetation types constitute rangelands, the automated classification embedded in ESRI ArcMap Spatial Analyst minimized potential for disagreements over rangeland definition and classification associated with this study.

However, USDA Forest Service Rocky Mountain Research Station analysts are experimenting with more general, non-rangeland-specific integration of bird survey data

and NLCD information using point coverage buffers and area calculations in a vector environment (Knowles, 2005, pers. comm.). This information has not yet been reviewed and/or published. Nonetheless, vector-based analyses offer a potential alternative operation for consideration and/or comparison.

7. Conclusions

Rangelands provide a setting for at least 30 percent of the USDA Forest Service NVUM developed recreation site sample points in the Rocky Mountain RPA region, and more than 25 percent of these sites in the Pacific Coast RPA region. It is clear that rangelands are valuable for increasing recreation activities, as well as traditional production uses. Identification of amount and distribution of rangeland recreation occurring on NFS lands is necessary for effective land management and legislatively mandated monitoring and reporting. Current USDA Forest Service Chief Dale Bosworth's (2003) concern about unmanaged recreation accentuates the need for improved information.

Despite the catalog of caveats outlined in the discussion section, this study is distinctive as the first quantification of the number of USDA Forest Service NVUM DUDS and OUDS sample points occurring on NFS rangelands. As demand for recreation increases, use of finite rangeland resources will also increase. The public looks to the Forest Service to provide responsive, responsible management of these resources. Therefore, regional and national inventory and monitoring of rangeland recreation sites is a central component of ensuring adequate rangeland recreation opportunities for the American

public. These resources must also be protected and conserved for consumptive and production uses, as prescribed in USDA Forest Service enabling legislation.

Sustainable land management, promoted by the USDA Forest Service as an appropriate public land management paradigm since the mid-1990s (Dombeck, 1998), requires equal consideration of economic, social, and ecological elements (Bryant et al., 2003). Successful management plans that address varied uses and values of public lands, balancing and incorporating stakeholder interests, can help to avoid legal challenges. Accurate information about rangeland recreation is essential for efficient allocation of staff and financial resources.

As previously stated, geographic information for NFS DUDS and OUDS points not currently in the NVUM database must be obtained and analyzed to more accurately quantify sites located on rangelands. Rangelands must be unambiguously defined, and remote sensing interpretative technology improved. Comparisons may be done to assess accuracy of raster versus vector based GIS analyses for recreation. Also, additional information about NFS rangeland recreation activities beyond DUDS and OUDS is needed. Future research will identify demographic characteristics of individuals recreating on USDA Forest Service rangelands. This study represents a valuable starting point from which knowledge about rangeland recreation on USDA Forest Service National Forest System lands will only improve.

8. Literature Cited

Anderson, J.R., Hardy, E.E., Roach, J.T., Witmer, R.E.: 1976, 'A land use and land cover classification system for use with remote sensor data', *Professional Paper*, Geological Survey Professional Paper 964. US Geological Survey, Reston, VA.

Bateman, I.J., Lovett, A.A., and Brainard, J.S.: 1999, 'Developing a methodology for benefit transfers using geographic information systems: modeling demand for woodland recreation', *Regional Studies* **33**(3), 191-205.

Bartlett, E.T., Maczko, K.A., and Mitchell, J.E.: 2003, 'Ecological, economic, and social indicators: assessing rangeland sustainability', in: N., Allsopp, A.R. Palmer, S.J. Milton, K.P. Kirkman, G.I.H. Kerley, and C.R. Hurt (eds) *Proceedings of the VIIth International Rangeland Congress*, 26th July-1st August 2003, Durban, South Africa, p. 1897-1908. Document Transformation Technologies, Irene, South Africa.

Berger, M.E.: 1973, 'Recreation Potential of Texas Rangelands,' *Journal of Range Management* **26**(2), 92-93.

Bosworth, D.: 2003, '*Speech to the San Francisco Commonwealth Club*,' April 23, 2003, San Francisco, CA.

Brower, B.: 2000, 'Sheep grazing in national forest wilderness: a new look at an old fight', *Mountain Research and Development* **20**(2), 126-129.

Brunson, M.W. and Gilbert, L.: 2003, 'Recreationist responses to livestock grazing in a new national monument', *Journal of Range Management* **56**(6), 570-576.

Burch, W.R.: 1964, 'Two concepts for guiding recreation management decisions', *Journal of Forestry* **62**(10), 707-712.

Burch, W.R. and Wenger, W.D.: 1967, 'The social characteristics of participants in three styles of family camping', *USDA Forest Service Research Paper* PNW-48. Pacific Northwest Forest and Range Experiment Station. Portland, OR.

Bryant, L.D: 2005, '*Personal Communication*'.

Bryant, L.D., Maczko, K.A., and Thompson, D.W.: 2004, 'Rangeland sustainability: integrating social, ecological, and economic indicators', in: Peterson, J.W. (ed.) *Proceedings of the 2nd National Conference on Grazing Lands*, December 7-10, 2003. Nashville, Tenn. Grazing Lands Conservation Initiative. Bryan, Texas.

Butler, L. D.: 1990, 'Nontraditional uses of rangelands for income producing activities', in Grafton, W.N. (ed.) Conference proceedings : *Income Opportunities for the Private Landowner Through Management of Natural Resources and Recreational Access*, p. 122-127, West Virginia University Extension Service, Morgantown, WV.

Carson, R.: 1962, *Silent Spring*, Houghton Mifflin, New York.

Cole, D.N., Van Wagtendonk, J.W., McClaran, M.P., Moore, P.E., and McDougald, N.K.: 2004, 'Response of mountain meadows to grazing by recreational packstock, *Journal of Range Management* **57**(2), 153-160.

Cole, D.N.: 1989, 'Recreation ecology: What we know, what geographers can contribute', *Professional Geographer* **41**(2), 143-48.

Cole, D.N.: 1988, 'Disturbance and recovery of trampled Montana grassland and forests in Montana', *USDA Forest Service Research Paper* INT-389. Ogden, UT.

Cole, D.N.: 1987, 'Effects of three seasons of experimental trampling on five montane forest communities and grassland in western Montana, USA', *Biological Conservation* **40**, 219-244.

Cole, D.N. and Landres, P.B.: 1996, 'Threats to Wilderness Ecosystems: Impacts and Research Needs', *Ecological Applications* **6**(1), 168-184.

Cole, D.N. and Monz, C.A.: 2003, 'Impacts of camping on vegetation: response and recovery following acute and chronic disturbance', *Environmental Management* **32**(6), 693-705.

Cole, D.N. and Spildie, D.R.: 1998, 'Hiker, horse, and llama trampling effects on native vegetation in Montana, USA', Journal of Environmental Management **53**, 61-71.

Confer, J.J., Graefe, A.R. and Falk, J.M.: 1992, 'A geographic information systems approach to analysis of the spatial relationships between recreational boating uses and

perceived impacts', in Proceedings of the 1992 Northeastern Recreation Research Symposium, pp. 103-110. *General Technical Report* NE-176. USDA Forest Service Northeastern Forest Experiment Station. Radnor, PA.

Cordell, H.K.: 2003, *Personal Communication.*

Cordell H.K. and Overdevest, C.: 2001, *Footprints on the Land: An Assessment of Demographic Trends and the Future of Natural Lands in the United States*, Sagamore Publishing, Champaign, IL.

De Vries S. and Goossen, M.: 2002, 'Modeling recreational visits to forests and nature areas', *Urban Forestry and Urban Greening* **1,** 5-14.

Dombeck, M.: 1998, '*A gradual unfolding of a national purpose: a natural resource agenda for the 21st century'*, Speech to USDA Forest Service employees on 2 March 1998. USDA Forest Service, Washington DC.

Driver, B.L., Dustin, D., Baltic, T. Elsner, G., and Peterson, G. (eds.): 1994, '*Nature and the Human Spirit: Toward an Expanded Land Management Ethic*', Venture Publishing, Inc. State College, PA.

English, D.B.K.: 2005, *Personal communication.*

English, D.B.K., Kocis, S.M., Zarnoch, S.J., and Arnold, J.R.: 2002, 'Forest Service National Visitor Use Monitoring Process: Research Method Documentation', *General Technical Report* SRS-57, USDA Forest Service Southern Research Station, Asheville, NC.

Florinsky, I.R. and Kuryakova, G.A.: 2000, 'Determination of grid size for digital terrain modeling in landscape investigations – exemplified by soil moisture distribution at a micro-scale.' *International Journal of Geographical Information Science* **14**(8), 815-832.

Goebel, J.J., Shreder, H.T., House, C.C., Geissler, P.H., Olsen, A.R. and Williams, W.R.: 1998, 'Integrating surveys of terrestrial natural resources: the Oregon demonstration project', *Inventory and Monitoring Report No. 2.* USDA Forest Service, Washington DC.

Geissler, P. and Radloff, D.: 2004, *Personal communication.*

Gordon, J.E., Dvorak, I.J., Jonasson, C., Josefsson, M., Kocianova, M., and Thompson, D.B.A.: 2002, 'Geo-ecology and management of sensitive montane landscapes', *Geografiska Annaler* **84**: 193-203.

Gottfried, G.J. and Pieper, R.D.: 2000, 'Pinyon Juniper Rangelands', in R. Jemison and C. Raish (eds), *Livestock Management in the American Southwest,* Elsevier Science B.V. Amsterdam, The Netherlands, pp. 153-212.

Hedges, M.A.: 1991, '*Parks and Recreation Series: Planning Picnic Areas*', Cooperative Extension Service, University of Arkansas, United States Dept.of Agriculture and county governments cooperating. Little Rock, AR.

Hessel, R.: 2005, 'Effects of grid cell size and time step length on simulation results of the Limburg soil erosion model (LISEM)', *Hydrological Processes* **19**, 3037-3049.

Holechek, J., Pieper. R., and Herbel, C.H..: 2001, *Range Management: Principles and Practices*, Prentice Hall, Upper Saddle River, NJ.

Itami, R., Raulings, R., MacLaren, G., Hirst, K., Gimblett, R., Zanon, D., and Chladek, P.: 2003, 'RBSim 2: simulating the complex interactions between human movement and the outdoor recreation environment, *Journal for Nature Conservation* **11**, 278-286.

Joyce, L.A.: 1989, 'An analysis of the range forage situation in the United States: 1989-2040', *General Technical Report* RM-180, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Kliskey, A.D.: 2000, 'Recreation terrain suitability mapping: a spatially explicit methodology for determining recreation potential for resource use assessment', *Landscape and Urban Planning* **52**, 33-43.

Kliskey, A.D: 1994, 'Mapping multiple perceptions of wilderness in southern New Zealand, II: an alternative multivariate approach', *Applied Geography* **14**, 308-326.

Knowles M.: 2005, *Personal communication.*

Kopp, S., Borup, B., Willison, J., and Payne, B.: 2001, '*Using ArcGis Spatial Analyst*', ESRI, Redlands, CA.

Kuo, W., Steenhuis, T.S., McCulloch, C.E., Mohler, C.L., Weinstein, D.A., DeGloria, S.D., and Swaney, D.P.: 1999, 'Surface Water and Climate – Effect of grid size on runoff and soil moisture for a variable-source-area hydrology model', *Water Resources Research* **35**(11), 3419-3429.

Lin, F.T.: 2000, 'GIS-based information flow in a land-use zoning review process', *Landscape and Urban Planning* **52,** 21-32.

Lime, D.W.: 1974, 'Locating and designing campgrounds to provide a full range of camping opportunities' in *USDA Forest Service General Technical Report* 9, p. 56-66. North Central Forest Experiment Station, St. Paul, MN.

Lucas, R.C.: 1970, 'User evaluation of campgrounds on two Michigan National Forests', *USDA Forest Service Research Paper* NC-44. North Central Forest Experiment Station. St. Paul, MN.

McClaran, M.P.: 2000, 'Improving Livestock Management in Wilderness', *USDA Forest Service Proceedings*. RMRS-P-15-Vol 5, Rocky Mountain Research Station, Ogden, UT.

Maczko, K.A., Bryant, L.D., Thompson, D.W., and Borchard, S.J.: 2004, 'Putting the pieces together: assessing social, ecological, and economic rangeland sustainability', *Rangelands* **26**(3), 3-14.

Meighen, E. and Volger, E.: 1997, 'Spatial solutions to recreation use', in *Proceedings of the International Conference of Hydropower*, Atlanta, Georgia. New York: American Society of Civil Engineers.

Miller, R.F., and Rose, J.A.: 1999, 'Fire history and western juniper encroachment in sagebrush steppe', *Journal of Range Management* **52**: 550-559.

Mitchell, J.E., Wallace, G.N., and Wells, M.D.: 1996, 'Visitor perceptions about cattle grazing on National Forest land', *Journal of Range Management* **49**:81-86.

Mitchell, J.E., Folliott, P.F., and Patton-Mallory, M.: 2005, 'Back to the Future: Forest Service Rangeland Research and Management' *Rangelands* **27**(3), 19-28.

Mitchell, J.E.: 2004, *Personal communication.*

Mueggler, W.F.: 1988, 'Aspen community types of the Intermountain Region', USDA Forest Service *General Technical Report* INT-250. Intermountain Research Station, Ogden, UT.

Petulla, J.M.: 1988, '*American Environmental History*', MacMillan Publishing Co., New York, NY.

Porter, R. and Tarrant, M.: 2001, 'A case study of environmental justice and federal tourism sites in southern Appalachia: a GIS application', *Journal of Travel Research* **40**, 27-40.

Rowan R.C. and Workman, J.P.: 1992, 'Factors Affecting Utah Ranch Prices', *Journal of Range Management* **45**(3), 263-266.

Sanderson, R.H., Meganch, R.A., and Gibbs, K.C.: 1986, 'Range management and scenic beauty as pereceived by dispersed recreationists', *Journal of Range Management* **39**, 464-469.

Shields, D., Martin, I., Martin, W., and Haefele, M.: 2002, 'Survey Results of the American Public's Values, Objectives, Beliefs, and Attitudes Regarding Forests and Rangelands', *General Technical Report*, RMRS-GTR-95. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Smith, W.B., Miles, P.D., Vissage, J.S., and Pugh, S.A.: 2004, 'Forest Resources of the United States, 2002', *General Technical Report*, GTR-NC-241. USDA Forest Service, North Central Research Station, St. Paul, MN.

Society for Range Management: 2005, *Rangelands and Global Change.* http://www.rangelands.org/pdf/Global_Issue_Paper.pdf. Denver, CO.

Stehman, S.V., Wickham, J.D., Smith, J.H., and Yang, L.: 2003, 'Thematic accuracy of the 1992 National Land Cover Data for the eastern United States: Statistical methodology and regional results', *Remote Sensing of Environment* **86**, 500-516.

Sun, D. and Walsh, D.: 1998, 'Review of studies on environmental impacts of recreation and tourism in Australia', *Journal of Environmental Management* **53**, 323-338.

Tanaka, J., Torell, L.A., Swanson, L.V., Brunson, M., McCollum, D., and Heintz, H.T. Jr.: 2003, 'Indicators for maintenance and enhancement of multiple economic and social benefits to current and future generations', in: Sustainable Rangelands Roundtable (ed) *Criteria and indicators for sustainable rangelands: a first approximation report*, p 171-199. Available at http://SustainableRangelands.cnr.colostate.edu. Colorado State Univ., Fort Collins, Colo.

Tausch, R. and Tueller, P.: 1990, 'Foliage biomass and cover relationships between tree and shrub-dominated communities in pinyon-juniper woodlands', *Great Basin Naturalist* **50**, 121-134.

The H. John Heinz III Center for Science, Economics and the Environment: 2002, '*The state of our Nation's ecosystems*', Cambridge University Press, New York, NY.

The SAS Institute: 1990, '*SAS/STAT User's Guide, Volume 1*', SAS Publishing, Cary, NC.

Theobold, D., Peterson, N., Romme, W.: 2003, 'The Colorado vegetation model: using National Land Cover Data and ancillary spatial data to produce a high resolution, fine-classification map of Colorado', *Report to the Colorado State Forest Service.* Fort Collins, CO.

USDA Forest Service: 2004, '*National report on sustainable forests – 2003*', FS-766. USDA Forest Service, Washington, DC.

Van Tassell, L.W., Bartlett, E.T., and Mitchell, J.E.: 2001, 'Projected use of grazed forages in the United States: 2000 to 2050', USDA Forest Service Rocky Mountain Research Station *General Technical Report*, RMRS-GTR-82, Fort Collins, Colo.

Vavra, M.: 1995, 'Rangeland Research: strategies for providing sustainability and stewardship to the rangelands of America and the world', *Rangelands* **17**(6), 200-214.

Vieux, B.E. and Needham, S.: 1993, 'Nonpoint pollution model sensitivity to grid-cell size', *Journal of Water Resources Planning and Management* **119**(2), 141-152.

Vogelmann, J.E., Howard, S.M., Yang, L., Larson, C.F., Wylie, B.K., and Van Driel, N.: 2001, 'Completion of the 1992 national land cover data set for the conterminous United States from Landsat Thematic Mapper data and ancillary data sources', *Photogrammetric Engineering and Remote Sensing* **67**, 650-662.

Vogelmann, J.E., Sohl, T.L., Campbell, P.V., and Shaw, D.M.: 1998, 'Regional land cover characterization using Landsat thematic mapper data and ancillary data sources', *Environmental Monitoring and Assessment* **51**(1-2), 415-428.

Wagar, J.A.: 1963, 'Campgrounds for many tastes', USDA Forest Service *Research Paper* INT-6, USDA Forest Service Intermountain Forest and Range Experiment Station, Ogden, UT.

Wallace, G.N., Mitchell, J.E., and Wells, M.D.: 1996, 'Visitor perceptions about grazing on a Forest Service allotment', *Research Paper* RM-RP-321. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Wardlow B.D. and Egbert, S.L.: 2003, 'A state-level comparative analysis of the GAP and NLCD land cover data sets', *Photogrammetric Engineering and Remote Sensing* **69**(12), 1387-1397.

Wickham, J.D., Stehman, S.V., Smith, J.H., and Yang, L.: 2004, 'Thematic accuracy of the 1992 National Land Cover Data for the western United States', *Remote Sensing of Environment* **92**, 452-468.

Wicks, B.E., Backman, K.F., Allen, J., and Van Blaricom, D.: 1993, 'Geographic information systems (GIS): a tool for marketing, managing, and planning municipal park systems', *Journal of Park and Recreation Administration* **11**(1), 9-23.

Wing M. and Shelby, B.: 1999, 'Using GIS to integrate information on Forest Recreation', *Journal of Forestry* **97**(1), 12-16.

Wright, R.G. and Tanimoto, P.D.: 1998, 'Using GIS to prioritise land conservation actions: integrating factors of habitat diversity, land ownership, and development risk', *Natural Areas Journal*, **18**, 38-44.

Chapter III: Characteristics and Activities of Visitors at USDA Forest Service Rangeland Recreation Sites

Abstract:

Public lands recreation has been the subject of considerable evaluation and assessment, however, little is known specifically about recreational use of rangelands (The Heinz Center, 2002). The Society for Range Management (SRM) (2005) defines rangelands as areas dominated by self-propagating vegetation comprised predominantly of grasses, grass-likes, forbs, shrubs, and dispersed trees. The United States Department of Agriculture (USDA) Forest Service (FS) National Forest System (NFS) currently uses this description as a working definition of rangelands (Bryant, 2005, pers. comm.), applicable to agency land management decisions affecting forests and grasslands.

This study assesses NFS rangeland recreation activities and NFS rangeland visitor characteristics using information extracted from the USDA Forest Service National Visitor Use Monitoring (NVUM) program. Custom weights are calculated to accurately depict the influence of each observation in the NVUM NFS rangeland recreation data set. Summary statistics and frequencies are generated to identify common NFS rangeland recreation activities and characterize visitor demographics. Results are presented for the western United States as a whole, as well as the USDA Forest Service Pacific Coast and Rocky Mountain Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA) assessment regions, and four NVUM rangeland recreation survey site types.

The top three NFS rangeland recreation activities, in order, are hiking or walking, hunting, and viewing scenery on the National Forest or Grassland. Most individuals recreating on rangelands are white and male, with more than 50 percent between the ages of 31 and 50. Relationships between demographic factors including age and gender and the three most common rangeland recreation activities were explored using chi-square tests. With the exception of results for gender and viewing nature and scenery on the National Forest and Grasslands, null hypotheses of independence between variation in activity participation and age or gender were rejected.

Key words: rangeland recreation participant demographics, rangeland visitor characteristics, rangeland recreation activities, USDA Forest Service recreation, rangeland management, Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA) assessment

Characteristics and Activities of Visitors at USDA Forest Service Rangeland Recreation Sites

Introduction

Public lands recreation has been the subject of considerable evaluation and assessment, however, little is known specifically about recreational use of rangelands (The Heinz Center, 2002). Vavra (1995) identified social aspects, including recreation, as the least studied component of rangeland science and management. Monitoring recreation utility will become more important as competing stakeholder pressures on rangelands increase.

The Society for Range Management (SRM) (2005) defines rangelands as areas dominated by self-propagating vegetation comprised predominantly of grasses, grass-likes, forbs, shrubs, and dispersed trees. The United States Department of Agriculture (USDA) Forest Service (FS) National Forest System (NFS) currently uses this description as a working definition of rangelands (Bryant, 2005, pers. comm.), applicable to agency land management decisions affecting forests and grasslands.

Balancing federal land management objectives among commodity and amenity values works best if predicated upon accurate information about national forest and grassland visitors and recreation activities pursued on NFS rangelands. While grazing use on NFS rangelands is closely monitored and managed, recreation information is lacking. Specifically, information about NFS rangeland recreation activities and socio-demographic characteristics of NFS rangeland visitors has not been compiled. Therefore, the objectives of this study are to describe socio-demographic characteristics of

individuals recreating on NFS rangelands, as well as linkages among these factors and recreation activities in which visitors engage.

USDA Forest Service Rangelands and Recreation

The Forest Service has been custodian of grassland reserves since 1954. At that time, nearly 4 million acres of rehabilitated rangelands administered by the Soil Conservation Service (now the Natural Resources Conservation Service) under the Land Utilization Project (LUP) were transferred to the Forest Service and designated as National Grasslands, to be managed as part of the National Forest System (Mitchell et al., 2005). These lands were originally obtained by the US Department of Agriculture under authority of the Bankhead-Jones Farm Tenant Act of 1937, which allowed for government purchase of agricultural lands abandoned during the Dust Bowl.

Projections suggest that the area of U.S. rangeland available for traditional uses such as livestock forage production will decrease over the next 50 years, with the actual rate depending upon environmental issues, government policies, and competing uses. However, grazing land use for wildlife-related recreation activities is predicted to increase during the same period (Van Tassel et al., 2001).

Need for Rangeland Recreation Information

Disparate sustainability assessment efforts have independently identified the need for baseline rangelands recreation information (The Heinz Center 2002; Tanaka et al., 2003; USDA Forest Service 2004), because comprehensive data collection and analyses have not been conducted. Although surveys exist to assess national recreation trends, they do not address rangelands specifically. The U.S Census Bureau conducts the

National Survey of Fishing, Hunting, and Wildlife-Associated Recreation every five years, last in 2001. The USDA Forest Service administers the National Survey on Recreation and Environment (NSRE) to meet Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA) assessment requirements. Both instruments provide reliable recreation data, but neither survey identifies whether these activities are taking place on rangelands, in forests, on farmland, or in other natural resource settings. Therefore, it is currently not possible to accurately assess recreational uses of rangelands, or characteristics of NFS visitors who recreate on rangelands.

It is likely that the current need for adequate information to support Forest Service NFS rangeland recreation management planning will be exacerbated in the future by increases in use of national forests and grasslands for recreational activities, resulting in an associated increased need to manage such recreational use. For example, ranchers recently identified impacts of recreation on livestock operations operating under Forest Service grazing permits in Arizona and Bureau of Land Management permits in Idaho (Public Lands Council 2005). Damage attributed to recreational users of these federal lands included: fence cutting by off-highway vehicle (OHV) users, horseback riders, and hikers; disruption of herd movements by OHV users; equipment theft; and damage to water tanks and pipes from shooting. The Public Lands Council (2005) has passed a formal resolution to encourage agencies to regulate OHV use on federal lands.

Outdoor recreation also figured in current Forest Service Chief Dale Bosworth's (2003) identification of four critical threats to National Forest System forests and grasslands. Unmanaged recreation shares top billing, along with fire, invasive species, and loss of open space. In 2001, Americans made almost 200 million visits to the

National Forest System, and the USDA Forest Service expects these numbers to grow dramatically. It is everyone's right to use the national forests and grasslands in multiple ways, including outdoor recreation. The U.S. population is expected to more than double within the next century, and a parallel increase in the number of visits to NFS forests and rangelands is likely (Cordell & Overdevest, 2001). Improved NFS rangeland recreation management based upon quantifiable data will better serve all users.

Relevant Literature

Importance of Recreation Monitoring

The importance of tracking trends in use of parks, forests, and other recreational sites and facilities for planning and budget processes has been well documented (Cope et al., 1999; Harnik & Kimball, 2005; Sorge, 2000; Beckendorff & Pearce, 2003). Managing visitors requires information about their numbers, composition, and distribution, as well as activities (Janowsky & Becker, 2003). Knowledge of visitor characteristics is useful for recreation planning and management. Understanding visitor characteristics also is critical to sustainable ecotourism. Facility development, visitor management, monitoring trends, and predicting recreation demand require substantial information (Obua & Harding, 1996). Design of effective interpretative exhibits, signs, and materials also requires knowledge of visitors who comprise the target audience for these products (Hood & Roberts, 1994; Boisvert & Slez, 1994).

Additionally, facilities on federally managed lands are being contracted out to concessionaires for every day operations. Familiarity with visitor preferences, spending habits and consumption patterns will facilitate more efficient contract specifications

between the agencies and concessionaires operating campgrounds, stores, resorts, and outfitting services.

Absence of periodic monitoring of visitor characteristics and activities may negatively impact management decisions (Reynolds & Elson, 1996). Lack of data leads to ambiguity and inaccuracy in estimation and prediction of recreation demand; improved understanding of the demand and need for varied recreation opportunities would in turn improve effectiveness of planning efforts (Cope et al., 1999).

Public lands experts note that many managers neglect monitoring recreation demand and use because public lands management is not typically viewed as a profit business (Harnik & Kimball 2005). However, Harnik and Kimball (2005) contend that private sector tenets of investment and profit must be matched in the public sector by attentiveness to benefits and appropriations. Visitor use numbers derived from comprehensive activity monitoring influence ability to successfully seek Congressional budget appropriations. Studies show that incorporation of long-term strategic planning into site management is associated with factors including higher visitor numbers and more gross revenue and total profit (Benckendorff & Pearce, 2003).

Knowledge about how, when, and where people recreate also is useful for management decisions regarding staff time and funding (Harnik & Kimball, 2005). Sorge (2000) contends that an effective management plan begins with evaluation of demographics and recreational trends to allow provision of opportunities to meet recreational demand. For example 20 percent of the nation's population will be aged 65 and over in the next 20 years, increasing the need for recreation areas and facilities that accommodate activities for older visitors (Sorge, 2005).

Demographic Factors and Visitor Characteristics

Age is one of several key demographic factors typically associated with recreation use patterns. Moore and Graefe (1994) investigated user attachment to recreation settings in the context of rail-trails, abandoned railway beds that have been converted to trails. Results showed that trail use was strongly related to participants' age. Authors contended that visitor satisfaction may be linked to specific places (Moore & Graefe, 1994). Users with strong attachments to specific places may deserve special consideration during management planning to maximize public benefits. Such users also would be likely participants in public involvement processes associated with planning activities (Moore & Graefe, 1994).

Age also has been identified as a significant factor affecting visitor interest and attentiveness (Hood & Roberts, 1994), and holding power of interpretative exhibits (Boisvert & Slez, 1994). Informal education conducted with signs and exhibits at museums, zoos, gardens, nature centers, and other recreation areas is an important mechanism for sharing information with the public. Visitor characteristics influence attraction to exhibits, thus knowledge of characteristics including age and gender, would assist site managers in designing more effective interpretative exhibits. Once differences between participant groups have been identified, interpretative exhibit designers must decide who to target and how to target them with their displays (Hood & Roberts, 1994).

Findings regarding significance of visitor characteristics may vary with recreation setting. Research of Moore and Graefe (1994), Hood and Roberts (1994) and Boisvert and Slez (1994) found age to be statistically significant on trails, in gardens, and science museums, respectively.

In contrast, Raymore and Scott (1998) concluded that age was not important in determining types of recreational activities that older adults pursued in urban parks. However, the same study showed that gender and employment were predictive of the activities in which these older adults participated, and urban park visitation declined with age more for females than males (Raymore & Scott, 1994).

Similarly, Schrader & Wann (1999) considered degree of involvement in high-risk recreation activities in terms of participant characteristics. The survey focused upon college students, where age was relatively consistent, varying between late teens and early twenties. Gender was found to be a significant predictor of involvement in high-risk recreation activities for this group (Schrader & Wann, 1999). Males were more likely than females to participate in high-risk recreation activities.

More generally, researchers have found that relationships exist between benefits sought by recreators, recreation activities, and user group characteristics (Wisnom, 1999). Female groups and groups containing women consistently rated nature enjoyment higher than male groups, while male-only groups focused more on excitement as a primary benefit (Wisnom, 1999).

Similar results were seen in a survey of public parks (McKenzie et al., 2005). Males were more commonly observed than females, and males were almost twice as likely to engage in vigorous activity as females. One third of public park recreators were children, 19 percent were teenagers, 43 percent were adults, and 5 percent were senior citizens. Most common activities included sitting/picnicking, basketball, observing organized sports, soccer, and using playgrounds (McKenzie et al., 2005).

Other socio-demographic characteristics commonly monitored, in addition to age, race, and gender, include education, income, occupation, marital status, and number of children. Crossley (1994) used such socio-demographic information to explore differences among ecotourists and more traditional mass tourists. While there was no difference in gender between the two groups, factors including age, education, income, and occupation distinguished ecotourists (Crossley, 1994).

Researchers have also investigated relationships between trip and visitor characteristics, and environmental attitude (Uysal et al., 1994). Factors explored included age, gender, marital status, and education, and assorted trip characteristics. Analyses showed that older travelers more strongly supported balance between human and environmental needs, and females held more ecocentric attitudes than males. However, Uysal et al. (1994) concluded that demographics were not wholly successful in identifying environmentally sensitive visitors in the US Virgin Islands National Park.

International Visitors and Demographic Information

Visitor characteristics also influence perceived images of vacation destinations. Factors including gender, age, education, and social class are related to cognitive and affective components of image, though some differences exist between first-time and repeat visitors (Beerli & Martin, 2004). This study demonstrated that demographics impact visitor recreation experiences and perceptions of recreation sites in Spain's Canary Islands.

Relationships among socio-demographics and vacation factors for Japanese leisure travelers have also been explored (Heung et al., 2001). While gender and age were statistically related to vacation factors, occupation and income were not significant.

Benefits sought and vacation factors, such as exploration, attractions and climate, varied with age and gender for Japanese leisure travelers.

In addition, travel motivations have been assessed for visitors to Hong Kong in relation to visitor's country of origin and demographic profiles (Kim & Prideaux, 2005). Results showed that American, Chinese, and Australian tourists were more likely to be male, while proportions of female Japanese visitors were higher. Most survey respondents were less than 39 years old. Over 50 percent of respondents were college graduates. Researchers also found that tourists from Australia and America showed high levels of motivation for culture and history in contrast to Asian groups who were more interested in food and shopping. Such differences may impact marketing strategies used to attract visitors of different nationalities and demographic backgrounds to various tourist sites.

More generally, differences have been documented among visitors from countries with varying cultural dimensions. Pizam and Fleischer (2005) surveyed students from 11 countries and found that cultural dimensions including uncertainty avoidance, masculinity/femininity, and individualism/collectivism affected respondents' choice of active or passive activities. Active and dynamic pursuits were favored by subjects from countries with low levels of uncertainty avoidance, respondents from masculine cultures, and people from individualist cultures (Pizam & Fleischer, 2005). These patterns can inform both provision of activities and design of recreation promotional efforts for national forests and grasslands.

Differences in visitor characteristics may be important, particularly in situations where foreign visitors outnumber local individuals. For example, almost 92 percent of

visitors to a national park in Uganda were from overseas, with half coming from Europe and others from Australia, New Zealand, and North America (Obua & Harding, 1996). The remaining 8 percent were from Uganda. Visitors were mostly between 25 and 44 years old; half were single; 52 percent were university graduates; and more than 50 percent of the park visitors were female. Major activities included wildlife viewing, bird watching, nature walks, hiking, and relaxing. Visitors also evaluated park facilities and recommended changes to be considered in park planning and management decisions to foster sustainable ecotourism (Obua & Harding, 1996).

National Forest Recreation and Visitor Characteristics

In the United States, a survey examined mountain-biking in National Forests through collection of information on participant demographics, participation rates, behaviors, and preferences (Hollenhorst et al., 1995). Demographic data included age, gender, education, and income. Forests surveyed were located in Texas, California, and West Virginia. Researchers found that there were less female mountain bikers in Texas than in West Virginia or California; no regional differences existed in education. California bikers tended to be older than riders from other regions. Most respondents did not bike alone; rode more often on trails instead of paved roads; and cycled for enjoyment and fun, choosing national forests because of nature and the environment. Findings are significant because mountain biking has been criticized for negative impacts on soil and vegetation, and conflicting with other forms of recreation (Hollenhorst et al., 1995). Managers should incorporate provisions for cyclist needs and potential conflicts into forest and grassland management planning.

Demographic factors were also included in profiles of users surveyed to assess differences between motorized and nonmotorized trail users (Andereck et al., 2001). Andereck et al. (2001) found that motorized trail users had lower education levels than mixed users, with highest education levels found among nonmotorized users. The same pattern held for income levels. All respondent age groups across three use categories were similar, ranging from 46 years of age for mixed users, to 49 years of age for both motorized and nonmotorized users. Fifty-four percent of respondents were female, though more women than men typically respond to surveys (Andereck et al., 2001).

Respondents participating in a survey to assess influence of ecological impacts and campsite characteristics on wilderness visitors' campsite choices were also profiled based on age and gender (White et al., 2001). More than two thirds of the respondents were male, the most common age bracket reported was 30 to 35 years old, and just one quarter of wilderness campers were alone. Findings showed that ecological impacts did not influence wilderness campsite selection; rather, locational features and social conditions were site choice determinants. White et al. (2001) stated that managers might benefit from further studies that incorporate additional demographic variables to help distinguish among types of users.

While wilderness users typically care about the environment, this study suggested that they are not adversely affected by ecological impacts. Managers must balance visitors' desires and preferences with potentially conflicting management directives designed to mitigate ecological impacts. Better understanding of visitor characteristics could assist in such efforts.

Behavior Patterns and Demographics to Guide Programs

Relationships among activity participation, travel behavior, and socio-demographics have been modeled using structural equations (Lu and Pas, 1998). Socio-demographic variables important in explaining variations in activity participation included age, gender, employment, and number of children (Lu and Pas, 1998).

Extension of these relationships to account for consumer behavior patterns was only partially successful. Researchers also have explored linkages among visitor demographics, travel activities, and souvenir consumption (Swanson & Horridge, 2004). While visitor activities were positively correlated with souvenir consumption, Swanson and Horridge (2004) found no relationship between tourist demographics, such as age and gender, with purchase patterns.

Accurate assessment of visitor characteristics enhances agency ability to match staff characteristics to special user needs. In an era of shrinking budgets, partnerships have been encouraged as a means to maximize resources. Public agency and university needs can be combined to provide recreation services to culturally diverse populations while preparing students for professional positions after graduation (Kunstler, 1997). Kunstler (1997) identified benefits derived from collaboration between a university and a recreation agency exploring matching student employee skills to public needs, resulting in increased recognition of recreation needs and provision of bilingual services to the culturally diverse public. Such partnerships may also be useful to the USDA Forest Service as cultural diversity of recreation participants increases.

Methods

This study was designed to explore possible relationships among visitor demographic characteristics and interactions with recreation activities on rangeland sites within the National Forest System. Data analyses were conducted in conjunction with mandated USDA Forest Service reporting required by the Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA). The USDA Forest Service divides NFS lands into four RPA regions and eight subregions (Figure 3.1).

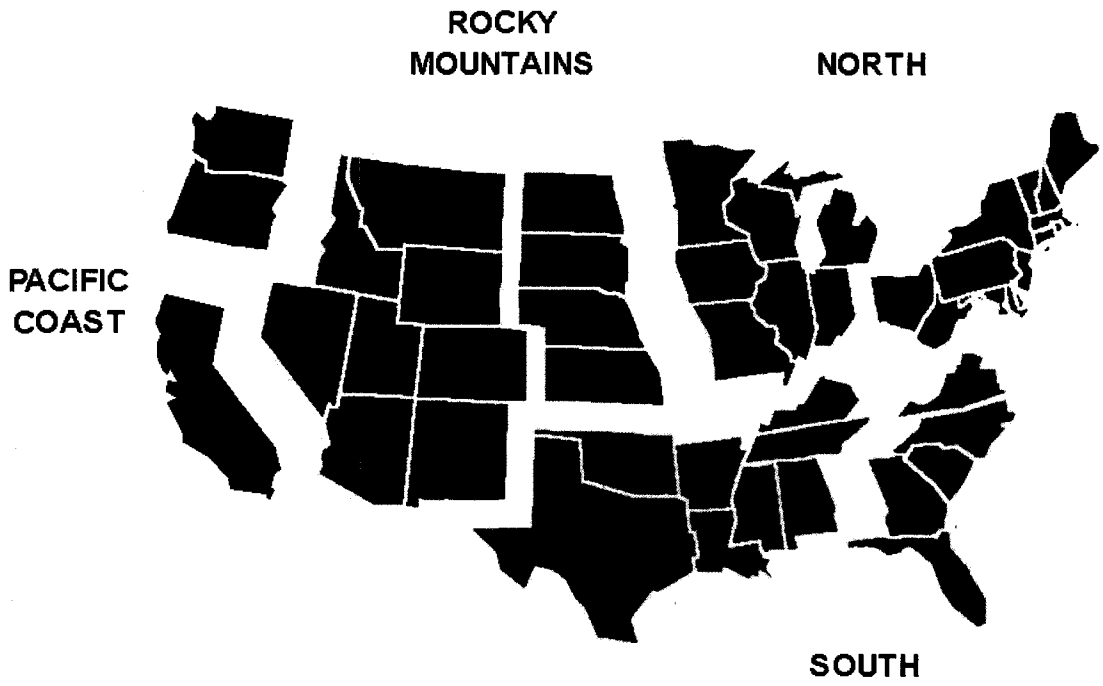


Figure 3.1: USDA Forest Service RPA assessment regions and subregions. Map courtesy USDA Forest Service.

USDA Forest Service RPA Regions

To enhance compatibility with previous RPA rangelands reports, recreation site analyses were conducted for RPA regions in the western United States. Insufficient NFS

rangelands existed to carry out analyses for the North and South assessment regions (J. Mitchell, 2004, pers. comm.). The four RPA regions are: Pacific Coast (Washington, Oregon, California, Alaska, and Hawaii), Rocky Mountains (Montana, Idaho, North Dakota, South Dakota, Nebraska, Kansas, Wyoming, Colorado, Utah, Nevada, Arizona, and New Mexico), South (Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, Georgia, Tennessee, Kentucky, Virginia, North Carolina, South Carolina, Florida, and Puerto Rico), and North (Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana, Ohio, West Virginia, Pennsylvania, New York, New Jersey, Delaware, Maryland, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine) (Joyce, 1989). As stated above, analyses in this study focused on the Pacific Coast and Rocky Mountain RPA regions.

Data Preparation and Exclusions

Demographic and activity data for 15,118 rangeland recreation respondents were extracted from the USDA Forest Service National Visitor Use Monitoring (NVUM) program, based upon a geographic information system (GIS) grid-based rangeland site classification procedure described in Chapter 2. Several sets of custom weights were calculated using SAS statistical software version 9.1 to accurately represent the relative contributions of respondent information associated with each sample point (King, 2006, pers. comm.; English, 2005, pers. comm.). Analyses did not include Hawaii, Alaska, or Puerto Rico, since vegetation data used to identify NFS rangeland recreation sites within the NVUM program does not cover these areas.

Additionally, respondents who identified either water recreation activities (fishing, motorized boating, or non-motorized boating) or snow-based pursuits (skiing or

snowmobiling) as their main activity were excluded from the analysis to focus more specifically on respondents whose recreation was more closely associated with rangeland resources. Inclusion of skiers and ski areas was technically appropriate based on the GIS-based classification, since vast tracts of ski resorts are maintained as grasslands. However methodical removal of dense forests to create these grasslands suggested a finer filter for identification of rangeland recreation.

National Visitor Use Monitoring Dataset

The NVUM system was designed to address the need for statistically reliable recreation use estimates required by Congress and the Government Accountability Office (GAO) in association with USDA Forest Service budget allocations and strategic planning. The NVUM survey was not designed for this study, or to address rangeland recreation as distinct from forest and/or water recreation. Exiting recreation traffic, along with measures including fee envelopes and concessionaire reports, was monitored for recreation sites stratified by type, location, and time period of recreation visits. Visitation periods were identified as low, medium, or high use to ensure adequate representation of all visitation levels. The study design relied upon a double sampling technique developed specifically for use on national forests, and provided for statistically-reliable estimation of visitation at the national forest scale. The NVUM survey data were not meant for use at finer scales such as specific sites or ranger districts (English et al., 2002).

Data used here were derived from four of the five recreation sites types – day-use developed sites (DUDS), overnight-use developed sites (OUDS), general forest areas (GFA), and wilderness (WILD). Both DUDS and OUDS show moderate to heavy degrees of modification and/or development. The former include picnic areas,

interpretative sites, observation sites, visitor centers, and museums, while the latter includes campgrounds, fire lookouts, hotels, lodges, resorts and horsecamps. General forest areas include trailheads, forest entrance and exit points along roads, and other undeveloped, non-wilderness sample sites within the national forests and grasslands. Wilderness sample sites were predominantly trailheads providing access to designated wilderness areas within national forests and grasslands (English et al., 2002).

Statistical Analyses

Simple frequency statistics were generated in SAS version 9.1 statistical software, quantifying gender, age, and race of USDA Forest Service NFS rangeland visitors for the western United States as a whole, as well as the Pacific Coast and Rocky Mountain RPA regions. These demographic factors were also assessed by sample site type (DUDS, OUDS, GFA, and WILD) across and within these regions. Participation frequencies and percentages were calculated for 22 recreation activities (Table 3.7), after removal of water and snow-based activities, across and within RPA regions.

Following analyses of visitor characteristics and activities, chi-square tests of independence were used to investigate associations among age and gender with activity participation. Since more than 75 percent of visitors to USDA Forest Service rangeland sites were white, race effects on activities were not explored.

Variables Analyzed

Demographic variables extracted from the USDA Forest Service National Visitor Use Monitoring (NVUM) data set included age, gender, and race. Other common variables such as income, education, employment, and marital status were not collected

during the initial iteration of the NVUM surveys; however such data may be available from future NVUM surveys (English, 2006, pers. comm.). A total of 15,118 survey responses were collected from rangeland NVUM wilderness, developed day use area, overnight use area, and general forest area sample sites. Exclusion of those observations that indicated water or snow recreation as main activities left 12,772 responses.

NFS Rangeland Visitor Age Category Classes

Surveys were conducted over a period of several years across all national forests and grasslands, and age category class choices available on the survey instruments varied across years. In some cases, the age category classes overlapped, therefore, responses associated with the more abundant set of categories were used for analyses. Approximately 2/3 of the total surveys were based upon this more common set of age category classes. Therefore, analyses involving age excluded approximately 1/3 of responses that used the less common set of age category classes.

Frequencies and percentages of participants by age, gender, and race were analyzed for NFS NVUM rangeland respondents in the western United States, the Pacific Coast region, and the Rocky Mountain region. Frequencies and percentages also were generated for age, gender, and race in each of the NVUM sample site types; developed day use and overnight developed areas, wilderness sites and general forest areas.

Results

NFS Rangeland Visitor Age Patterns

Age patterns were generally consistent across regions and NVUM survey site types. For most regions and site types, the largest percentage of rangeland recreators was

within the 41-50 year-old age class, followed by the 31-40 year-old category, with 21-30 year-olds generally being the third largest group (Tables 3.1 and 3.2).

Table 3.1. Rangeland recreators on the National Forest System by age class for the western United States, Rocky Mountain region, and Pacific Coast region.

Age class (years)	Western United States (%)	Rocky Mountain Region (%)	Pacific Coast Region (%)
16-20	3.3	3.5	2.8
21-30	17.2	17.2	17.1
31-40	23.4	21.9	26.8
41-50	28.4	28.8	27.5
51-60	15.0	15.3	14.3
61-70	9.8	10.4	8.5
> 70	2.9	2.8	2.9

Table 3.2. Rangeland recreators on the National Forest System by age class for the western United States by NVUM survey site class, developed day use areas, overnight use developed areas, general forest areas, and wilderness sites.

Age class (years)	Developed Day Use Areas (%)	Overnight Use Developed Areas (%)	General Forest Areas (%)	Wilderness Sites (%)
16-20	3.1	1.8	3.4	3.6
21-30	17.1	22.4	16.8	18.2
31-40	24.7	24.0	23.2	21.2
41-50	25.8	26.2	29.1	29.2
51-60	16.0	15.1	14.8	16.2
61-70	9.0	8.2	10.1	9.3
> 70	4.4	2.2	2.6	2.2

However, for the Pacific Coast region, age distributions of respondents associated with developed areas deviated from this pattern. In developed day-use areas, 31.1 percent of respondents were within the 31-40 year-old age class, followed by 27.5 percent in the 41-50 year-old age class, and 18.3 percent in the 21-30 year old class. For overnight developed areas, 34.6 percent of respondents fell within the age class of 21-30 years of

age, followed by 25.4 percent in the 31-40 year old class, and 23.4 percent in the 41-50 year old class.

NFS Visitors by Gender

Percentages by gender of NFS visitors surveyed at NVUM rangeland sites were also calculated. The majority of NFS visitors surveyed at NVUM rangeland sites were male across the western United States, the Pacific Coast RPA region and the Rocky Mountain RPA region (Tables 3.3 and 3.4).

Table 3.3. Rangeland recreators on the National Forest System by gender for the western United States Rocky Mountain region, and Pacific Coast region.

Gender	Western United States (%)	Rocky Mountain Region (%)	Pacific Coast Region (%)
Male	73.5	74.0	72.2
Female	26.5	26.0	27.8

Table 3.4. Rangeland recreators on the National Forest System by gender for the western United States by NVUM survey site class, developed day use areas, overnight use developed areas, general forest areas, and wilderness sites.

Gender	Developed Day Use Areas (%)	Overnight Use Developed Areas (%)	General Forest Areas (%)	Wilderness Sites (%)
Male	63.6	70.8	75.8	66.3
Female	36.4	29.2	24.2	33.7

General forest area sites had the highest percentages of male users, with 76.4 percent in the Rocky Mountain region and 74.2 percent in the Pacific Coast region. Overall, across the western United States, Rocky Mountain region, and Pacific Coast region, NVUM wilderness sample sites showed slightly higher percentages of female visitors, with 33.1 percent in the Rocky Mountain region and 35.4 percent in the Pacific Coast region. More

females, 39.2 percent, were also recorded at developed areas in the Rocky Mountain region. However, this pattern was not evidenced in the Pacific Coast region.

NFS Rangeland Visitors and Racial Patterns

Survey results for rangeland sites extracted from the NVUM data set show that the vast majority of visitors to rangeland sites in the National Forest System are white (Tables 3.5 and 3.6), with percentages ranging from 86.2 in the Pacific Coast region to 92.7 in the Rocky Mountain region. Hispanics are the second most likely to visit NFS rangeland sites, with percentages ranging from 4.6 percent in the Rocky Mountain region to 6.9 percent in the Pacific Coast region. Developed sites, both day use and overnight areas, appear to be more popular than general forest areas and wilderness sites with minority visitors. For example, percentage of Hispanics using developed day use areas was 8.5 percent, though that number dropped to 7.4 percent for overnight developed areas within NFS rangelands. Percentages of Hispanic visitors to general forest areas and wilderness sites were 4.7 percent and 2.4 percent, respectively.

Table 3.5. Rangeland recreators on the National Forest System by race for the western United States Rocky Mountain region, and Pacific Coast region.

Race	Western United States (%)	Rocky Mountain Region (%)	Pacific Coast Region (%)
American Indian	1.2	1.0	1.5
Asian	.9	.4	1.9
Black	.4	.3	.7
Hispanic	5.3	4.6	6.9
Other	1.3	1.0	2.1
Pacific Islander	.2	.1	.6
White	90.8	92.7	86.2

Across all NVUM survey site categories, percentages of Hispanic visitors were consistently higher in the Pacific Coast region than the Rocky Mountain region or western United States as whole. In comparison to the cumulative percentages listed by NVUM survey site type in Table 3.6, for the Pacific Coast region, percentages of Hispanic visitors are 14.7 percent in developed day use areas, 9.9 percent in overnight developed areas, 4.8 percent in general forest areas, and 2.2 percent for wilderness sites. Percentages of white visitors to NVUM rangeland survey sites in the Pacific Coast region are correspondingly lower; 72.2 percent for developed day use areas, 81.9 percent in overnight developed areas, 90.2 percent in general forest areas, and 89.1 percent at wilderness sites.

Table 3.6. Rangeland recreators on the National Forest System in the western United States by race for each NVUM survey site class, developed day use areas, overnight use developed areas, general forest areas, and wilderness sites.

Race	Developed Day Use Areas (%)	Overnight Use Developed Areas (%)	General Forest Areas (%)	Wilderness Sites (%)
American Indian	1.6	.5	1.2	.4
Asian	1.6	1.5	.7	1.0
Black	.7	.1	.4	.4
Hispanic	8.5	7.4	4.7	2.4
Other	2.0	1.5	1.1	2.7
Pacific Islander	.8	.5	.1	.2
White	84.9	88.5	92.0	92.9

NFS Rangeland International Visitors

Presence of international visitors at NFS rangeland recreation sites was also explored. However, just over 1 percent of 12,772 survey respondents were of international origin, so no additional analyses were conducted.

Table 3.7. Percentage participation for main NFS rangeland recreation activities in the western United States, Rocky Mountain region, and Pacific Coast region (*first most common activity, **second most common activity, ***third most common activity).

Main Recreation Activity	Western United States (%)	Rocky Mountain Region (%)	Pacific Coast Region (%)
Biking	4.66	3.5	7.31
Backpacking	1.06	.99	1.24
Camping	5.20	5.40	4.73
Driving	6.62	7.79	3.89
Gathering Wood, Nuts, Berries, etc.	2.14	2.15	2.11
General Relaxing	9.50	8.42	12.13**
Hiking or Walking	19.90*	18.12*	24.06*
Visiting Historic Sites	1.46	1.81	.64
Horseback Riding	2.17	2.38	1.69
Hunting	11.92**	14.47**	5.95
Nature/Visitor Centers	.50	.62	.21
Nature Study	.51	.35	.87
OHV Use	4.41	4.81	3.51
Other Motorized Activity	.12	.03	.35
Other Non-Motorized Activity	3.27	2.80	4.35
Primitive Camping	2.36	2.78	1.41
Picnicking, Family Activity	2.92	2.56	3.76
Resorts, Cabins, etc.	.48	.44	.57
Sightseeing	9.74	12.16	4.25
View Nature/Scenery on NFS	10.45***	11.26***	8.56***
Viewing Off-NFS	1.15	.13	3.02
View Wildlife/Birds on NFS	3.19	3.53	2.38

Main Recreational Activities on NFS Rangelands

All NVUM respondents were asked to identify their main recreation activity from 28 possibilities (English et al. 2002). After exclusion of snow and water-based

recreation, 22 possible activity choices remained. The three most popular recreation activities in the western United States at NVUM NFS rangeland survey sites, after exclusion of water and snow-based activities, were hiking or walking, hunting, and viewing nature and scenery (Table 3.7). While hiking or walking was also the most common rangeland recreation activity in both the Rocky Mountain region and the Pacific Coast region, second and third most popular activities differed between regions. In the Rocky Mountain region, hunting was the second most common main activity identified by NVUM survey respondents at rangeland sites, while viewing nature and scenery on the National Forest or Grassland ranked third. In the Pacific Coast region, general relaxing was the second most common main activity for NVUM survey respondents, followed by viewing nature and scenery.

Contingencies between Age and NFS Rangeland Recreation Activities

To investigate variation in the top three main recreation activities pursued on NFS rangelands with age and gender, chi-square tests of independence were conducted. All analyses were performed using SAS version 9.1 statistical software.

Statistically significant contingencies were found between age and selection of each of the three most common main recreation activities – hiking or walking, hunting, and viewing nature and scenery on the National Forest or Grassland - pursued on NFS rangelands, both in the western United States as a whole and in the Pacific Coast and Rocky Mountain regions. In all cases, the null hypothesis of no variation in selection of hiking or walking as his/her main activity with age category was rejected at an alpha level of .05, with p-values ranging from .0193 to less than .0001 (Table 3.8).

Contingencies between Gender and NFS Rangeland Recreation Activities

Gender also exhibited statistically significant contingencies with respondents' choice of main recreation activity on NFS rangelands (Table 3.9). In general, greater percentages of men recreate on rangelands. However, for the western United States as a whole, as well as in the Pacific Coast and Rocky Mountain regions, a larger percentage of women than men (32.9 percent vs. 18.6 percent in the western United States), identified hiking or walking as their main recreation activity.

This pattern reversed itself with regard to hunting, the second most commonly identified main recreation pursuit identified as a main activity by those recreating on NFS rangelands. In the western United States, 17.1 percent of men engaged in hunting as a primary recreation activity while this is true of just 2.9 percent of female NVUM rangeland respondents. Therefore, the null hypothesis of no variation in selection of hiking or walking and hunting as main recreation activities with gender on NFS rangelands was rejected.

Gender did not exhibit a statistically significant dependency for the third most common rangeland recreation activity, viewing nature and scenery on the National Forest or Grassland, in the Rocky Mountain region. While the results for the Pacific Coast region and the western United States as a whole were statistically significant, this pattern was not evidenced in the Rocky Mountain region. Although a slightly larger percentage of female than male respondents selected viewing nature or scenery on the National Forest or Grassland as their main recreation activity in the western United States and Pacific Coast region, participation by gender in the Rocky Mountain region was generally

equal (Table 3.9). Approximately 12.8 percent of females and 12.5 percent of males identified viewing nature or scenery on the National Forest or Grassland as their main recreation activity. Thus, the null hypothesis of no variation in selection of viewing nature and scenery on the National Forest or Grassland as a main recreation activity with gender could not be rejected for the Rocky Mountain region, although it was rejected for the Pacific Coast region and the western United States as a whole.

Table 3.8. Percent selection of main NFS rangeland recreation activity by respondent age category for the Pacific Coast region, Rocky Mountain region, and western United States as a whole ($p<.0001$*, $p=.0027$**, $p=.0006$***, $p=.0193$****).

Region/Main Activity	Age 16-20 (%)	Age 21-30 (%)	Age 31-40 (%)	Age 41-50 (%)	Age 51-60 (%)	Age 61-70 (%)	Age 70+ (%)	Chi-Square Statistic
Western United States								
Hiking or Walking	21.55	21.13	23.47	21.53	24.47	27.96	26.57	20.10**
Hunting	10.92	18.71	13.62	15.88	12.22	16.80	4.10	53.98*
Viewing Nature or Scenery on the National Forest and/or Grassland	12.76	8.65	9.50	14.12	15.82	13.24	20.31	65.85*
Pacific Coast Region								
Hiking or Walking	44.69	23.85	29.81	25.43	28.94	42.37	25.53	37.45*
Hunting	6.54	11.74	6.30	5.37	9.77	6.29	1.98	23.79***
Viewing Nature or Scenery on the National Forest and/or Grassland	4.64	3.86	8.00	13.47	15.19	7.66	10.59	45.37*
Rocky Mountain Region								
Hiking or Walking	13.34	19.91	19.99	19.86	22.59	22.67	27.05	15.13****
Hunting	12.48	21.83	17.64	20.38	13.24	20.65	5.07	52.98*
Viewing Nature or Scenery on the National Forest and/or Grassland	15.64	10.79	10.32	14.39	16.08	15.29	24.76	41.93*

Contingencies between Race and NFS Rangeland Recreation Activities

Relationships between race of NFS rangeland recreation participants and main activity selected were not analyzed due to dominance of white respondents. More than 85 percent of respondents in the Pacific Coast region were white, while almost 93 percent of Rocky Mountain region results came from white people, and over 90 percent of people surveyed in the western United States as a whole were white.

Table 3.9. Percent selection of main NFS rangeland recreation activity by respondent gender for the Pacific Coast region, Rocky Mountain region, and western United States as a whole ($p<.0001$*, $p=.0246$**).

Region/Main Activity	Male (%)	Female (%)	Chi-Square Statistic
Western United States			
Hiking or Walking	18.57	32.87	232.48*
Hunting	17.04	2.91	341.77*
Viewing Nature or Scenery on the National Forest and/or Grassland	11.40	13.03	5.05 **
Pacific Coast Region			
Hiking or Walking	25.21	35.76	32.21*
Hunting	9.24	.90	63.32*
Viewing Nature or Scenery on the National Forest and/or Grassland	8.51	13.63	17.13*
Rocky Mountain Region			
Hiking or Walking	15.95	31.63	212.85*
Hunting	20.12	3.79	277.26*
Viewing Nature or Scenery on the National Forest and/or Grassland	12.54	12.78	.07

Discussion

This study provides the first comprehensive assessment of visitor characteristics and recreation activities pursued on USDA Forest Service NFS rangelands. Information derived may help serve as a basis for regional and national strategic planning objectives that affect NFS forests and grasslands, since management decisions are negatively impacted by absence of monitoring (Reynolds & Elson, 1996). Managing visitors effectively requires information about their numbers, composition, distribution, and activities (Janowsky & Becker, 2003). Information herein may alter perceptions of the importance of rangelands for various recreation opportunities. These results can also augment extant regional planning activities, consistent with contentions of Cope et al. (1999) regarding improved regional planning as a result of better understanding of demand for various recreation opportunities.

Utility at Regional, Local, and National Levels

At the regional level, information about types of recreation activities pursued may impact budget allocations and staffing levels and assignments. Knowledge about how, when, and where people recreate is critical to management decisions regarding staff time and funding (Harnik & Kimball, 2005). Previous studies also have discussed the applicability of range management knowledge and skills, such as assessment of grazing pressure and impacts, to recreation management (McClaran, 2000).

Additionally, prediction and resolution of potential conflicts before they happen, based on information about location of high use rangeland recreation sites in proximity to active grazing allotments, may alleviate investment of staff time in conflict resolution required after problems occur (Wallace et al. 1996). As recreational use of rangelands

increases, conflicts with traditional production interests will likely increase too. National Cattlemen's Beef Association leaders already have noted damage to land improvements and water distribution systems resulting from recreational use of FS grazing allotments (Groseta, 2005).

Knowledge of visitor characteristics may improve design and content of both behavior modification and interpretative information provided to visitors in leaflets, exhibits, and signs, as demonstrated by Hood and Roberts (1994) and Boisvert and Slez (1994). Quantifying availability of rangeland recreation opportunities also can assist agency line officers in determining and justifying the mix of staff needed to adequately deal with both production and recreation use of rangeland resources. Matching visitor characteristics with employee skills, as demonstrated by Kuntsler's (1997) work with internships for bilingual college students, may also be facilitated through collection of information about visitor characteristics.

Nationally, data pertaining to rangeland recreation highlights the importance of this unique resource to a diverse group of stakeholders. Producer groups representing the cattle industry and wildlife groups with habitat concerns are typically characterized as rangeland constituent groups to be considered regarding NFS management decisions and legislation changes. Ability to emphasize recreation values of rangelands may engage a broader audience in these processes. Moore and Graefe (1994) posit that users with attachments to specific recreation sites would be likely to participate in public involvement processes associated with these sites. Harnik and Kimball (2005) stated that public interests in benefit and appropriations are analogous to private sector emphasis on investment and profit.

Consistency with Previous Recreation Research

Results generated by this study of NFS rangeland visitor characteristics and activities are consistent with findings of more localized studies. Sorge (2005) emphasized the increasing need for recreation areas that accommodate activities including walking as the population ages. Hiking and walking are already the most typical main activity of those recreating on NFS rangelands. The strong relationship between trail use and user's age described by Moore and Graefe (1994) is reinforced by this study.

Study results showing significance variation in main recreation activity with respondent age contrast findings of Raymore and Scott (1998), who found that age was not related to recreational activities in urban parks, although gender could be predictive. Differences in results may be an effect of recreation setting, national forests and grasslands versus urban parks, or the scale of study, regional and national versus local.

Raymore and Scott's (1998) conclusions regarding the effects of gender on recreation activity participation are consistent with this study's results. Shrader and Wann (1999), Wisnom (1999), McKenzie et al. (2005), Beerli and Martin(2004), Hueng et al. 2001, Uysal et al. (1994), Kim and Prideaux (2005), Hollenhorst et al. (1995), and Lu and Pas (1998) have also found significant dependencies between gender and travel, activities, opinions and beliefs, perceptions, and benefits sought. While results of this study focus solely upon linkages between gender and main rangeland recreation activity choices, other informative connections between visitor gender and a variety of factors affecting recreation choices remain to be explored.

In addition to demographic information analyzed for this project, other demographic variables including marital status, employment, education, income, social class, and number of children also have been shown to be significantly related to recreation behavior and participant beliefs (Crossley, 1994; Uysal et al., 1994; Beerli & Martin, 2004; Kim & Prideaux, 2005; Pizam & Fleisher, 2005; Obua & Harding, 1996; Hollenhorst et al., 1995; Andereck et al., 2001; White et al., 2001; Lu & Pas, 1998). Paraphrasing White et al. (2001), who studied visitor perceptions of wilderness campsites, it is likely that collection and analysis of a more extensive set of socio-demographic information from NFS rangeland recreators, as time and resources permit, also could be a fruitful endeavor.

Caveats to Consider

Although analyses of visitor characteristics and activities are adequate for an initial assessment of NFS rangeland visitor characteristics and recreation activities, the visitor participation numbers reported in this study are very likely smaller than actual visitation numbers for several reasons. These issues include extraction of data from a sample designed generally for forests and rangelands instead of specifically for rangelands, incomplete data reporting from national forests, and ambiguity associated with definitions of rangelands.

First, it is important to note that the list of sample sites (DUDS, OUDS, GFA, and WILD) represented in the NVUM database is not yet complete. Although the sampling design provided for completion of the initial sample of visitor use monitoring on all NFS forests and grasslands by 2004 (English et al., 2002), not all units have provided data with coordinates for geo-referencing. Addition of recreation points located within

rangelands of management units that have yet to report could logically increase percentages of NVUM points occurring on rangelands.

Also, inclusion of a NVUM survey question that defines rangelands for respondents, and then asks whether the respondent recreated on rangelands while visiting the National Forest or Grassland could provide more clarity to classification of observations as associated with rangeland recreation sites. At present, participation in the NVUM survey at a sample site located on rangelands is presumed to represent rangeland recreation. Explicitly asking NVUM survey participants whether they recreated on rangelands would negate the need for this assumption.

With regard to limitations of the 1992 US Geological Survey (USGS) – Environmental Protection Agency (EPA) National Land Cover Dataset (NLCD) used to classify NVUM sample sites as occurring on rangelands, issues to note deal with representation of vegetation types depicted in remotely sensed data as a forest cover type, but commonly recognized as rangeland. Aspen and pinion-juniper ecosystems fall into this category. For example, aspen may be classified as a forest vegetation type; however, the understory vegetation present in an aspen grove may contain as much as 3800 pounds of air-dried forage per acre (Mueggler, 1988). Also, exclusion of fire by livestock grazing and active fire suppression helped hasten expansion of pinion-juniper woodlands across open savannas and grasslands in the late 19th and early 20th centuries (Tausch and Tueller, 1990; Miller and Rose, 1999). The precise point at which rangelands become woodlands is subjective, dealing with between-tree spacing and groundcover. These communities are difficult to accurately classify from remotely sensed data such as NLCD.

As of 2002, pinion-juniper covered approximately 13.6 million acres of USDA Forest Service lands in the western United States (Smith et al., 1994); NVUM recreation sites that fall in these areas may be inaccurately identified as occurring on woodlands rather than rangelands. Increases in traditional recreational use of pinion-juniper woodlands, such as camping and nut-gathering, has risen with population growth and is expected to continue (Gottfried and Pieper, 2000). Until rangelands are definitively described, description of any activity or site, recreational or otherwise, occurring on rangelands will remain ambiguous.

Conclusions and Future Research

Rangelands are valuable for a number of different recreation activities, as well as traditional production uses. Identification of amount and distribution of NFS rangeland recreation, as well as user characteristics and activity preferences, can help managers with effective land management and legislatively mandated monitoring and reporting. Study results regarding visitor characteristics and activity preferences of NFS rangeland recreators represent the first comprehensive assessment of NFS rangeland recreator demographics and recreational pursuits.

Summary of Study Results

More than half of rangeland recreators are between 31 and 50 years of age, with the majority of that group falling into the 41-50 year-old age category. Only in overnight use developed sites located in the Pacific Coast region were these numbers different, with younger dominant users; more than 58 percent of users at these sites were between 21 and 40 years of age. Most NVUM survey respondents queried at rangeland sites were male, with slightly higher numbers of females represented in the Pacific Coast region.

Higher percentages of female visitors also were recorded at wilderness sites and developed day use and overnight sites, as compared to general forest areas. Over 90 percent of rangeland NVUM respondents were white, with Hispanics the next most frequent NFS rangeland visitors at 5.3 percent. Approximately 1 percent of respondents were from other countries.

Among NVUM survey respondents contacted at NFS rangeland sites in the western United States, the three most popular main activities were hiking or walking, followed by hunting, with viewing nature and scenery on the National Forest or Grassland ranking third. While hiking or walking was the dominant main rangeland recreation activity in both the Rocky Mountain and Pacific Coast regions, differences existed in the second and third main activities across regions. Main rangeland recreation activities identified by NVUM survey respondents at NFS rangeland sample sites varied significantly with both age and gender.

Additional Research Needs

This study represents the first comprehensive assessment of NFS rangeland visitor demographics and recreational pursuits. Additional research is needed to more fully develop knowledge about NFS rangeland visitor characteristics and activity preferences. In the short term, geographic information for NFS rangeland points not currently in the NVUM database must be obtained and analyzed to more accurately quantify rangeland recreation. As the NVUM survey process continues, additional demographic elements such as income, education, occupation, marital status, and number of dependents may be added to provide a more complete picture of rangeland recreators.

In addition, as budgets and staffing permit, further sampling and surveys should be designed specifically to capture information about rangeland recreation participants and activities, rather than relying upon extraction of data from more comprehensive sets encompassing forest and rangeland user information. Rangelands also must be unambiguously defined, to better identify rangeland recreation sites, and, by association user characteristics and activity preferences.

Concluding Comments

Current USDA Forest Service Chief Dale Bosworth's (2003) concern about unmanaged recreation accentuates the need for such improved information. As demand for rangeland recreation increases, use of and competition for finite rangeland resources will also increase. The public demands responsive, responsible management of this country's grasslands and shrublands. Therefore, regional and national inventory and monitoring of NFS rangeland recreation sites, visitor characteristics, and activity preferences is critical to ensuring provision of adequate rangeland recreation opportunities for the American public.

These resources also must be protected and conserved for traditional consumptive and production uses, as prescribed in USDA Forest Service enabling legislation. Better understanding of rangeland recreation demand will assist land managers in balancing among competing uses and social, economic, and ecological elements. Principles of sustainable resource management, espoused by the USDA Forest Service as an appropriate public land management paradigm since the mid-1990s (Dombeck, 1998), require parity in consideration of these aspects of sustainability.

Successful management plans must address varied uses and values of public lands, balancing and incorporating stakeholder interests to avoid legal challenges. Accurate information about rangeland recreation is useful for efficient allocation of staff and financial resources. This study represents a valuable starting point from which knowledge about rangeland recreation on NFS lands will only improve.

Literature Cited

Andereck, K.L., Vogt, C.A., Larkin, K., and Freye, K. (2001). Differences between Motorized and Nonmotorized Trail Users. Journal of Park and Recreation Administration, 19(3), 62-77.

Beckendorff, P.J. and Pearce, P.L. (2003). Australian Tourist Attractions: the links between organizational characteristics and planning. Journal of Travel Research, 42, 24-35.

Beerli, A. and Martin, J.D. (2004). Tourists' characteristics and the perceived image of tourist destinations: a quantitative analysis - a case study of Lanzarote, Spain. Tourism Management, 25, 623-636.

Boisvert, D.L. and Slez, B.J. (1994). The relationship between visitor characteristics and learning-associated behaviors in a science museum discovery space. Science Education, 78(2), 137-148.

Bosworth, D. (2003). Speech to the San Francisco Commonwealth Club. April 23, 2003. San Francisco, CA.

Bryant, L.D. (2005). Personal Communication.

Cope, A., Doxford, D., and Millar, G. (1999). Counting users of informal recreation facilities. Managing Leisure, 4, 229-244.

Cordell H.K. and Overdevest, C. (2001). Footprints on the Land: An Assessment of Demographic Trends and the Future of Natural Lands in the United States. Champaign, IL: Sagamore Publishing.

Crossley, J., and Lee, B. (1994). Characteristics of Ecotourists and Mass Tourists. Visions in Leisure and Business, 13(2), 4-12.

English, D.B.K. (2006). Personal communication.

English, D.B.K., Kocis, S.M., Zarnoch, S.J., and Arnold, J.R. (2002). Forest Service National Visitor Use Monitoring Process: Research Method Documentation. General Technical Report SRS-57. Asheville, NC: USDA Forest Service Southern Research Station.

Gottfried, G.J. and Pieper, R.D. (2000). Pinyon Juniper Rangelands. pp. 153-212 in R. Jemison and C. Raish (eds.). Livestock Management in the American Southwest. Amsterdam, The Netherlands: Elsevier Science B.V.

Groseta, A. (2005). Technical Tour Presentation to the National Public Lands Council. National Public Lands Council Annual Meeting Technical Tour, September 15, 2005. Cottonwood, Arizona.

Harnik, P. and Kimball, A. (2005). If you don't count, your park won't count: estimating the numbers of city park users can be difficult, but it is important to receive funding. Parks and Recreation, June 2005, 8-14.

Hollenhorst, S., Schuett, M.A., Olson, D., and Chavez, D. (1995). An examination of the characteristics, preferences, and attitudes of mountain bike users of the national forests. Journal of Park and Recreation Administration, 13(3), 41-51.

Hood, M.G. and Roberts, L.C. (1994). Neither too young nor too old: a comparison of visitor characteristics. Curator, 37(1), 36-45.

Hueng, V.C.S, Qu, H., and Chu, R. (2001). The relationship between vacation factors and socio-demographic and traveling characteristics: the case of Japanese leisure travelers. Tourism Management, 22, 259-269.

Janowsky D.V. and Becker G. (2003). Characteristics and needs of different user groups in the urban forest of Stuttgart. Journal of Nature Conservation, 11, 251-259.

Joyce, L.A. 1989. An analysis of the range forage situation in the United States: 1989-2040. General Technical Report RM-180. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station.

Kim, S.S. and Prideaux, B. (2005). Marketing implications arising from a comparative study of international pleasure tourist motivations and other travel-related characteristics of visitors to Korea. Tourism Management, 26, 347-357.

Kunstler, R. 1997. Matching Staff and Client Charcteristics: A Public-Public Partnership as a Response to Cultural Diversity. Journal of Park and Recreation Administration, 15(4), 79-91.

Lu, X. and Pas, E.I. (1999). Socio-demographics, activity participation, and travel behavior. Transportation Research, Part A, 33, 1-18.

McClaran, M.P. (2000). Improving Livestock Management in Wilderness. USDA Forest Service Proceedings. RMRS-P-15-Vol 5. Ogden, UT: Rocky Mountain Research Station.

McKenzie, T., Cohen, D., Sehgal, A., Williamson, S., Golinelli, D., Sturm, R. and Lurie, N. (2005). Public Parks as Exercise Venues: Analysis of Park and User Characteristics. Medicine and Science in Sports and Exercise, 37(5), Supplement S198-S199.

Miller, R.F., and Rose, J.A. (1999). Fire history and western juniper encroachment in sagebrush steppe. Journal of Range Management, 52, 550-559.

Mitchell, J.E. (2004). Personal communication.

Mitchell, J.E., Folliott, P.F., and Patton-Mallory, M. (2005). Back to the Future: Forest Service Rangeland Research and Management. Rangelands, 27(3),19-28.

Moore, R.L. and Graefe, A.R. (1994). Attachments to recreation settings: the case of rail-trail users. Leisure Sciences, 16, 17-31.

Mueggler, W.F. 1988. Aspen community types of the Intermountain Region. USDA Forest Service General Technical Report INT-250. Intermountain Research Station, Ogden, UT.

Obua, J. and Harding, D.M. (1996). Visitor characteristics and attitudes towards Kibale National Park, Uganda. Tourism Management, 17(7), 495-505.

Pizam, A. and Fleischer, A. (2005). The relationship between cultural characteristics and preference for active vs. passive tourist activities. Journal of Hospitality and Leisure Marketing, 12(4), 5-25.

Public Lands Council (2005). Resolutions for the September Public Lands Council Meeting. September 12-15, 2005. Cottonwood, Arizona.

Raymore, L. and Scott, D. (1998). The characteristics and activities of older adult visitors to a metropolitan park district. Journal of Park and Recreation Administration, 16(4), 1-21.

Reynolds, G. and Elson, M.J. (1996). The sustainable use of sensitive countryside sites for sport and active recreation. Journal of Environmental Planning and Management, 39(4), 563-76.

Schrader, M.P. and Wann, D.L. (1999). High-Risk Recreation: the relationship between participant characteristics and degree of involvement. Journal of Sport Behavior, 22(3), 426-441.

Smith, W.B., Miles, P.D., Vissage, J.S., and Pugh, S.A. (2004). Forest Resources of the United States, 2002. General Technical Report, GTR-NC-241. USDA Forest Service, North Central Research Station, St. Paul, MN.

Society for Range Management. (2005). Rangelands and Global Change. http://www.rangelands.org/pdf/Global_Issue_Paper.pdf. Denver, CO.

Sorge, G. (2000). Focus on Master Plans. Public Works, 131(12), 40-43.

Swanson K.K. and Horridge, P.E. (2004). A structural model for souvenir consumption, travel activities, and tourist demographics. Journal of Travel Research, 42, 372-380.

Tanaka, J., Torell, L.A., Swanson, L.V., Brunson, M., McCollum, D., and Heintz, H.T. Jr. (2003). Indicators for maintenance and enhancement of multiple economic

and social benefits to current and future generations, p 171-199. *In:* Sustainable Rangelands Roundtable (ed.) Criteria and indicators for sustainable rangelands: a first approximation report. Available at http://SustainableRangelands.cnr.colostate.edu. Fort Collins, CO: Colorado State University.

Tausch, R. and Tueller, P. (1990). Foliage biomass and cover relationships between tree and shrub-dominated communities in pinyon-juniper woodlands. Great Basin Naturalist, 50, 121-134.

The H. John Heinz III Center for Science, Economics and the Environment (2002). The state of our Nation's ecosystems. New York, NY: Cambridge University Press.

USDA Forest Service. (2004). National report on sustainable forests – 2003. FS-766. Washington, DC: USDA Forest Service.

Uysal, M., Jurowski, C., Noe, F.P., and McDonald, C.D. (1994). Environmental attitude by trip and visitor characteristics: US Virgin Islands National Park. Tourism Management, 15(4), 284-294.

Van Tassell, L.W., Bartlett, E.T., and Mitchell, J.E. (2001). Projected use of grazed forages in the United States: 2000 to 2050. General Technical Report RMRS-GTR-82. Fort Collins, CO: USDA Forest Service Rocky Mountain Research Station.

Vavra, M. (1995). Rangeland Research: strategies for providing sustainability and stewardship to the rangelands of America and the world. Rangelands, 17(6), 200-214.

Wallace, G.N., Mitchell, J.E., and Wells, M.D. (1996). Visitor perceptions about grazing on a Forest Service allotment. Research Paper RM-RP-321. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

White, D., Hall, T.E., and Farrell, T.A. (2001). Influence of Ecological Impacts and Other Campsite Characteristics on Wilderness Visitors' Campsite Choices. Journal of Park and Recreation Administration, 19(2), 83-97.

Wisnom, M.S. (1999). Recreation benefits sought by activity and user groups. Visions in Leisure and Business, 18, 36-47.

Chapter IV: A Travel Cost Model for Estimation of Rangeland Recreation Values for USDA Forest Service lands in the Western United States

Abstract:

Little is known specifically about recreational use of rangelands (Heinz Center 2002). Vavra (1995) identified social aspects, such as recreation, as the least studied component of the rangeland science and management field. Monitoring recreation demand will become increasingly important as competing stakeholder pressures on public rangelands expand. The Society for Range Management (SRM) (2005) defines rangelands as areas dominated by self-propagating vegetation comprised predominantly of grasses, grass-likes, forbs, shrubs, and dispersed trees. The United States Department of Agriculture (USDA) Forest Service (FS) National Forest System (NFS) currently uses this description as a working definition of rangelands (Bryant, October 2005, personal communication), applicable to agency land management decisions affecting forests and grasslands.

This study assesses demand for NFS rangeland recreation activities based upon information extracted from the USDA Forest Service National Visitor Use Monitoring (NVUM) program and individual travel cost models. The Poisson distribution for count data and the Huber-White correction for heteroskedasticity are incorporated into the model, and associated consumer surpluses are also calculated. Travel cost models and consumer surpluses are presented for the western United States as a whole, as well as the USDA Forest Service Pacific Coast and Rocky Mountain Forest and Rangeland

Renewable Resources Planning Act of 1974 (RPA) assessment regions, since coefficient differences existed across regions.

The average per trip consumer surplus for NFS rangeland recreation in the western United States was $65.68. This figure rose to $104.48 for the Pacific Coast RPA assessment region, but fell to $62.28 for the Rocky Mountain RPA assessment region.

Key words: rangeland recreation, travel cost model, rangeland recreation consumer surplus, USDA Forest Service recreation, rangeland management, Forest and Rangeland Resources Planning Act of 1974 (RPA) assessment

A Travel Cost Model for Estimation of Rangeland Recreation Values for USDA Forest Service lands in the Western United States

INTRODUCTION

Little is known specifically about recreational use of rangelands (The Heinz Center 2002). Vavra (1995) identified social aspects, such as recreation, as the least studied component of the rangeland science and management field. Monitoring recreation demand will become increasingly important as competing stakeholder pressures on public rangelands expand.

The Society for Range Management (SRM) (2005) defines rangelands as areas dominated by self-propagating vegetation comprised predominantly of grasses, grass-likes, forbs, shrubs, and dispersed trees. The United States Department of Agriculture (USDA) Forest Service (FS) National Forest System (NFS) currently uses this description as a working definition of rangelands (Bryant, October 2005, personal communication), applicable to agency land management decisions affecting forests and grasslands.

Balancing federal land management objectives among commodity and amenity values must be predicated upon accurate information about demand for recreation activities pursued on NFS rangelands, and monetary values associated with such non-market activities. While grazing use of NFS lands is closely monitored and managed, comparable data about recreation uses is lacking. Specifically information about the benefits of NFS rangeland recreation is lacking. Therefore, the objective of this study is to estimate benefits associated with NFS rangeland recreation using a basic travel cost model.

Need for USDA Forest Service Rangeland Recreation Information

The USDA Forest Service has been custodian of grassland reserves since 1954. At that time, nearly 4 million acres of rehabilitated rangelands administered by the Soil Conservation Service (now the Natural Resources Conservation Service) under the Land Utilization Project (LUP) were transferred to the USDA Forest Service and designated as National Grasslands, to be managed as part of the National Forest System (Mitchell et al., 2005). These lands were originally purchased by the US Department of Agriculture under authority of the Bankhead-Jones Farm Tenant Act of 1937, which allowed for government purchase of agricultural lands abandoned during the Dust Bowl.

Projections suggest that rangeland available for traditional uses such as livestock forage production will decrease over the next 50 years, with the actual rate depending upon environmental issues, government policies, and competing uses. However, grazing land use for wildlife-related recreation activities is predicted to increase during the same period (Van Tassel et al., 2001).

Disparate sustainability assessment efforts have independently identified the need for baseline rangelands recreation information (Heinz Center 2002, Tanaka et al. 2003, USDA Forest Service 2004), because comprehensive data collection and analyses focusing upon rangelands have not been conducted. Although surveys exist to assess national recreation trends, they do not address rangelands specifically. The U.S Census Bureau conducts the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation every five years, last in 2001. The USDA Forest Service administers the National Survey on Recreation and Environment (NSRE) to meet Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA) assessment requirements. Both

instruments provide reliable recreation data, but neither survey identifies whether these activities are taking place on rangelands, in forests, on farmland, or in other natural resource settings. Therefore, it is currently not possible to accurately assess recreational uses of rangelands.

Previous assessments of national and regional overall National Forest recreation value, encompassing forest, rangeland, and water activities, have been meta-analyses of previously published value estimates (Walsh, Johnson and McKean, 1992; Rosenberger and Loomis, 2001). Bowker et al. (2005) have recently completed the first analysis for estimation of overall National Forest recreation values using a comprehensive data set from the National Visitor Use Monitoring (NVUM) program developed solely from observations collected on National Forest System lands. This study uses rangeland recreation information extracted from the NVUM data to provide the first estimate of recreation value of NFS rangelands, as distinct from NFS forests and waterbodies.

It is anticipated that the current need for adequate information to support USDA Forest Service NFS rangeland management decisions will be exacerbated in the future by increases in use of national forests and grasslands for recreational activities, resulting in an associated increased need to manage such recreational use. For example, ranchers recently identified impacts of recreation on livestock operations operating under Forest Service grazing permits in Arizona and Bureau of Land Management permits in Idaho. Damage attributed to recreational users of these federal lands included: fence cutting by off-highway vehicle (OHV) users, horseback riders, and hikers; disruption of herd movements by OHV users; equipment theft; and damage to water tanks and pipes from shooting. The Public Lands Council (2005) has passed a formal resolution to encourage

agencies to regulate OHV use on federal lands.

Outdoor recreation also figured in current Forest Service Chief Dale Bosworth's (2003) identification of four critical threats to National Forest System forests and grasslands. Unmanaged recreation shares top billing, along with fire, invasive species, and loss of open space. In 2001, Americans made almost 200 million visits to the National Forest System, and the USDA Forest Service expects these numbers to grow dramatically. The U.S. population is expected to more than double within the next century, and a parallel increase in the number of visits to NFS forests and rangelands is likely (Cordell and Overdevest 2001). Improved management of recreation on the national grasslands based upon quantifiable data will better serve all users.

NFS Rangeland Management and Recreation

Federal land management laws directing use of the National Forests and Grasslands have shifted focus in response to changes in society's values during the last 70 years. Management of natural resources, including rangelands, directly reflects society's values as embodied in laws, policies, budgets, litigation and appeals, demand for various consumptive and non-consumptive goods and services (Quigley 2005). To fully appreciate the magnitude of the change in administration of federal lands, it is necessary to understand the origins and intent of early National Forest management legislation.

From 1905 to 1910, grazing revenues on the National Forests exceeded those from timber harvesting, and this pattern continued sporadically until the 1920s (Mitchell et al. 2005). Establishment of the USDA Forest Service in 1905 led to initiation of a process for forage allotment and grazing regulation on national forest lands, augmenting

Department of Interior grazing permits introduced to limit livestock numbers on federal lands in 1898 (Holechek et al. 2001). Regulatory efforts were a manifestation of public concern with overgrazing, associated abuses of natural resources including erosion and water quality issues resulting from timber management practices, and a desire to maintain a balance with nature (Loomis 2002). Throughout the early 1900s, American values continued to reflect this growing concern over destruction of natural resources in the West, as well as increased interest in recreational pursuits.

The 1905 Forest Service enabling legislation characterized public values and benefits in terms of multiple uses. A "Wise Use" book issued by the agency's first chief, Gifford Pinchot, dealt primarily with watershed protection, mining, timber production, and livestock grazing (Driver et al. 1994); recreation was not an explicit focus. The Weeks Act of 1911 authorized Forest Service purchase of private lands to expand watershed protection, and the Clark-McNary Act of 1924 broadened this authority to include purchases for timber values (Loomis 2002).

As the twentieth century progressed, public concern and interest in recreation and associated land management priorities were temporarily derailed by the outbreak of World War I. Public values focused solely on supporting the war effort. Effects of war years' overgrazing, in combination with effects of the Dust Bowl in the Great Plains, again caused concern over range deterioration, resulting in passage of the Taylor Grazing Act in 1934. The Taylor Grazing Act made the Grazing Service (later the Bureau of Land Management) responsible for allocation of grazing privileges on unsold federal lands, based upon landowner ability to provide water in the southwest and ability to provide hay in the northwest. Associated erosion in the Midwest also led to creation of

the Soil Erosion Service in 1933, renamed the Soil Conservation Service in 1935 (Holechek et al. 2001).

Changes in Public Perceptions and Values of Rangelands

Public attentiveness to environmental degradation problems and depletion of finite natural resource reserves continued to grow for the next 30 years. Publication of *Silent Spring* (Carson 1962) educated a worldwide audience about integral environmental linkages among animals, habitat, and humans. Awareness expanded in subsequent decades through environmental advocacy events like Earth Day, designed to call attention to human relationships with the natural environment. At the same time, social changes including increased income, mobility, leisure time, and knowledge about outdoor recreation opportunities resulted in attendant growth in public demand for such, non-commodity, amenity services (Driver et al. 1994). Indeed, a national committee convened to assess United States' amount and availability of outdoor recreation resources and infrastructure. Reports by the Outdoor Recreation Resources Review Commission (1962) led to expansion of facilities and recreation areas in response to increasing demand.

Legislatively, these public values were manifested through passage of the Multiple Use and Sustained Yield Act of (1960) which called for a balance among uses, including grazing, wildlife, timber, and recreation (Holechek et al. 2001). Loomis (2002) notes that the mandate to balance among competing uses based on their relative values recognized that not all uses could be supported on every acre; explicit guidance to ensure sustainability by avoiding impairment of the land's productivity was also included. This

dual theme of protection and sustainable use for forests and grasslands was also embodied in the Wilderness Act of 1964, the National Wildlife Refuge System Administration Act of 1966, the National Trails System Act and National and Wild Scenic Rivers Act of 1968, National Environmental Policy Act of 1969, the Endangered Species Act of 1973, the Resources Planning Act of 1974, the Federal Lands Policy and Management Act of 1976, the National Forest Management Act of 1976, and the National Wildlife Refuge System Improvement Act of 1997. In recognition of this multiple use mandate, livestock grazing decreased 25 percent between 1960 and 1992, and this trend has continued (Holechek et al. 2001). Federal land management agencies traditionally responsible for overseeing production uses for grazing and timber were instructed to include society's growing non-consumptive amenity values for forests and rangelands, such as recreation, in land management and planning activities.

Twenty-first century survey results suggest that the public continues to support this expanded management focus. Respondents exhibited majority consensus on importance of maintaining diverse land uses such as grazing, recreation, and wildlife habitat, as well as using natural resources to support communities dependent on grazing, mining, or timber harvesting (Shields et al. 2002). American values for outdoor recreation opportunities also continued to grow, and a recent analysis of United States' natural resource trends by Cordell and Overdevest (2001) found that overwhelming majorities of survey respondents indicated that they care deeply about the environment and a sustaining future for natural lands. Additionally, a majority of respondents think that decisions to develop natural resources should not be based solely on economic grounds (Shields et al. 2002). Therefore, federal land managers are expected to balance

social, economic, and environmental concerns in order to provide a desired mix of benefits for present and future generations.

Clearly, agencies and landowners must quantify these new non-market values of rangelands. Rangelands in the U.S. cover approximately 770 million acres of grasslands, savannas, deserts, shrublands, alpine meadows, wetlands, and tundra (Sustainable Rangelands Roundtable 2003). Worldwide, rangelands cover from 50 to 70 percent of the earth's surface, with the difference depending on whether rangelands are defined as being grazed by domestic animals or whether they include all uncultivated land with the potential to support grazing by domestic animals (Holechek et al. 2001). Traditional market products derived from rangelands, such as livestock forage, as well as non-market goods and services such as wildlife habitat and forage, water storage and filtration, plant pollination, nutrient cycling, erosion control, mitigation of droughts and floods, carbon sequestration, maintenance of biodiversity, and provision of recreation opportunities can be categorized as ecosystem services (Ecological Society of America 2000). Numerous economic valuation techniques, including the travel cost method implemented in this study, potentially can be used to quantify non-market values of NFS rangelands.

Non-market Valuation of Natural Resources

A recent National Research Council (NRC) report evaluated methods for assessing services and their associated economic values for aquatic and related terrestrial environments (National Research Council 2005). Although applicability of the valuation methods to rangeland goods and services was not explicitly discussed by NRC, some of the 'related terrestrial environments' for which they conducted their evaluation doubtless

could be categorized as rangelands, so outcomes of their review provide a fair starting point for transfer of these economic valuation techniques to nontraditional rangeland uses and values.

Potentially viable valuation techniques for rangelands use and non-use values may be direct or indirect and utilize revealed or stated preferences. Direct methods may involve observation of monetary estimates for competitive or simulated market prices. Direct stated preference models using open-ended questions in a contingent valuation also may be used. Indirect methods rely on inferred estimates of values through household production function models, such as random utility and travel cost, or hedonics. Indirect stated preference models using discrete choice contingent valuation, contingent behavior, or conjoint analysis may also be used (National Research Council 2005). According to the NRC report (2005), indirect methods are most commonly used for valuing aquatic ecosystem services; therefore these methods may offer the best utility for similar applications in assessing rangeland use and non-use values.

Contingent Valuation and Hedonic Models. Contingent valuation methods have been used extensively to assess recreation values associated with elk hunting in Montana and fishing from Maine to Michigan to assess potential values derived from management actions that would result in improved kills or catches (Loomis 2002, National Research Council 2005). Contingent valuation also has been applied to quantify value of agricultural landscapes, in some cases including rangelands. For example, using contingent valuation: Rosenberger and Walsh (1997) assessed residents' willingness to pay for ranchland preservation; Rosenberger and Loomis (1999) used observed behavior and contingent valuation to measure tourists' values of ranch open space; Willis and

Garrod (1993) assessed values of assorted agricultural landscapes in the Britain; Drake (1992) estimated willingness to pay for preservation of agricultural lands in Sweden; Bowker and Didychuk (1994) analyzed non-market benefits of agricultural lands in Eastern Canada; Ready et al. (1997) measured amenity benefits of farmland; and Beasley et al. (1986) estimated amenity values of urban fringe farmland.

In addition to contingent valuation techniques, hedonic models have been applied successfully to value western ranches, both private lands and associated public land grazing permits, by incorporating dummy variables to assess scenic and recreation potential (Rowan and Workman 1992), and analysts have attempted to include aesthetic values, again using dummy variables to assess terrain, population density, and quality of life characteristics (Torell and Bailey 2000),

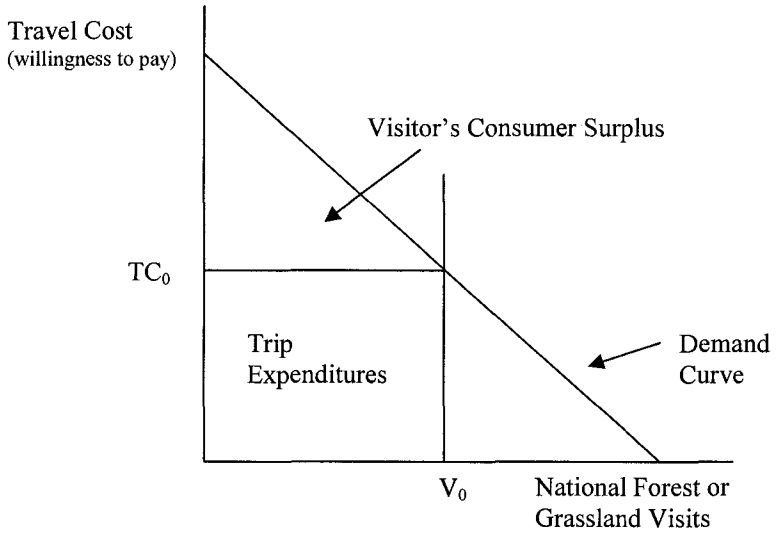
However, Bartlett et al. (2002) contend that past valuations of grazing on public lands have focused solely on the forage value for livestock production, and, as a result, underestimated total forage value and rancher's willingness to pay for forage and grazing permits. Specifically, Bartlett et al. (2002) point out that the research efforts reviewed in their paper consistently failed to recognize amenity and lifestyle attributes associated with ranch ownership and leased forage. The importance of non-market values, such as recreation, cultural experiences, open spaces, scenic views, and solitude, is highlighted and valuation of these aspects are recommended for future valuations of public land grazing (Bartlett et al. 2002).

Travel Cost Models. Although recreation value of public rangelands has not been quantified, travel cost models for recreation demand have been used commonly in the United States and around the world since their introduction during the 1940s, when

Hotelling wrote to the National Park Service Director suggesting the travel cost approach to recreation demand estimation for valuation of natural resources (Shrestha et al. 2002). The National Park Service solicited advice on quantifying value of park properties to show that outdoor recreation sites have benefits that exceed the cost of tax payer expenses to maintain them, and Hotelling suggested travel cost as a reflection of visitors' values for an outdoor recreation site (Kolstad 2000).

Recent applications have expanded to include both zonal and individual travel cost models applicable for valuation of clean air, water, wetlands (Ward and Beal 2000) and agricultural landscapes (Fleischer and Tsur 2000). The basic premise of the travel cost model is that visitors travel a given distance and incur certain expenses to recreate at a specific site. Site visits represent demand, and trip expenditures represent price. The area under the demand curve shown in Figure 4.1, above the specified travel cost, allows estimation of a visitor's consumer surplus, or benefits received by visitors in addition to travel costs and fees paid to recreate in a given area (Loomis and Walsh 1997).

Figure 4.1 Graphic representation of the relationship between the number of trips an individual takes to a National Forest or Grassland and the price for each trip expressed as travel cost.



More traditional recreation examples include studies to: value impacts of forest fires on recreation (Englin et al. 1996, Englin et al. 2001); quantify effects of fire on hiking demand (Hesseln et al. 2003), mountain biking (Fix et al. 1997, Fix et al. 2000), and hiking and biking (Hesseln et al. 2003, Loomis et al. 2001); measure tourism value and river quality in a South African national park (Turpie and Joubert 2001); value trail quality in North Carolina (Siderelis et al. 2000); quantify economic benefits of snowmobiling (Coupal et al. 2001); assess recreational fishing in Brazil (Shrestha et al. 2002); calculate recreation value of dam removal on the Snake River (Loomis 2002); measure economic value of viewing vultures in Israel (Becker et al. 2005); value duck hunting in Australia (Whitten and Bennett 2002); measure values of overall National Forest recreation (Bowker et al. 2005); value camping in Alberta (Boxall et al. 1996); assess demand for flat water recreation on the Snake River (McKean et al. 2003); measure whitewater rafting consumer surpluses (English and Bowker 1996); compute recreation value of a forested estate in India (Gera et al. 2005); assess tourism value of agricultural landscapes in Israel (Fleischer and Tsur 2000); and value a rural cultural heritage site in Maryland (Poor and Smith 2004). Application of travel cost models is clearly extensive, and this model has been recommended for use by the US Water Resources Council (1983). However, travel cost models have not been applied to public rangeland recreation; this study demonstrates such an application.

Utility of Non-market Valuation. The National Research Council report (2005) emphasized that the advantage of using economic valuation to assess ecosystem services is that it provides analysts with a common value system and framework for comparison of overall values associated with each element of an environmental management

decision, allowing comparison of market priced commodities such as forage value with non-market attributes like open space. As federal land management agencies continue to transition from traditional production-oriented emphases to management for recreation and other non-consumptive uses, similar non-market valuations, like those derived from the travel cost model used in this study, should be integrated into their planning processes to assist in decision-making among the multiple uses which they are mandated to administer. While expansion of relatively new land uses must be worked into agency planning and management, non-market values of traditional production uses of federal lands also must be integrated (Bartlett et al. 2002, Fleischer and Tsur 2000).

Such modifications will be particularly important to the Forest Service, which historically has tied planning to economic linear programming and regional economic analysis models (Loomis 2002). Once valued, agencies can incorporate ecosystem services into access fees, special use permits, and Congressional appropriation requests. In addition, ability of private landowners to capture or collect on new economic values produced by rangelands will be contingent, to some degree, upon public paradigm shifts away from the perception that these non-market goods and services are "free."

METHODS

This study was designed to estimate value, expressed as net willingness to pay for access or consumer surplus, of rangeland recreation within the National Forest System using a travel cost method, geographic information system (GIS), and data collected as part of the USDA Forest Service NVUM program. Analyses were conducted in conjunction

with mandated USDA Forest Service reporting required by the Forest and Rangeland Renewable Resources Reporting Act of 1974 (RPA).

USDA Forest Service RPA Regions

To enhance compatibility with previous RPA rangelands reports, recreation site analyses were conducted by RPA regions within the western continental United States, since a minimal amount of rangeland occurs in the Eastern United States (Mitchell, February 2004, personal communication). Figure 4.2 shows the four RPA regions and eight subregions.

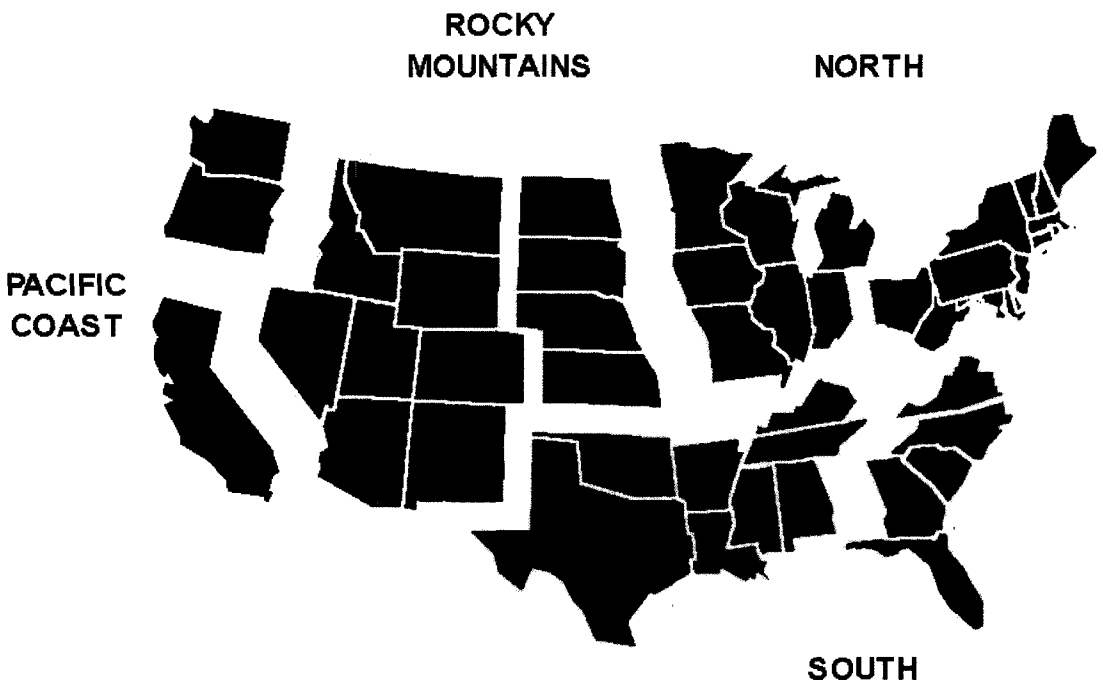


Figure 4.2: USDA Forest Service RPA assessment regions and subregions. Map courtesy USDA Forest Service.

Four RPA regions are: the Pacific Coast (Washington, Oregon, California, Alaska, and Hawaii), the Rocky Mountains (Montana, Idaho, North Dakota, South Dakota, Nebraska,

Kansas, Wyoming, Colorado, Utah, Nevada, Arizona, and New Mexico), the South (Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, Georgia, Tennessee, Kentucky, Virginia, North Carolina, South Carolina, Florida, and Puerto Rico), and the North (Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana, Ohio, West Virginia, Pennsylvania, New York, New Jersey, Delaware, Maryland, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, and Maine) (Joyce 1989). Analyses in this study focused on the Pacific Coast and Rocky Mountain RPA assessment regions, where the majority of NFS rangelands are located.

NVUM Dataset, Variables and Exclusions

Demographic and activity data for 15118 rangeland recreation respondents was extracted from the broader USDA Forest Service National Visitor Use Monitoring (NVUM) program, based upon a GIS grid-based rangeland site classification procedure described in Chapter 2. As a first delimiter, NVUM survey respondents who recreated on the national forests and grasslands, but did not identify these areas as their primary travel destination were excluded from the analysis. Respondents who identified water recreation, motorized boating, non-motorized boating, or fishing, as their main recreation activity in a NFS grassland setting also were removed from the sample, as were those who selected snow-based activities, such as skiing or snowmobiling.

For compatibility with a travel cost method designed to quantify value of recreation across all USDA Forest Service lands, including forest as well as rangeland and water resources, but not distinguishing the rangeland component, additional observations were removed from the data set. These observations include: survey

participants who stated that they visited the National Forest or Grassland where they were interviewed more than 52 times within a 12-month period; individuals who traveled more than 720 miles to reach the site where they were interviewed; people who were traveling with more than 10 passengers in their vehicle; visitors from foreign countries; and observations with missing responses for number of visits during a 12-month period, travel distance, overnight stays, gender, or age (Bowker et al. 2005). Analyses did not include Hawaii, Alaska, or Puerto Rico, leaving an effective model sample size for NFS rangeland recreation of 1603 observations. Variables included in the travel cost model or its component variable calculations are listed in Table 4.1.

Table 4.1. Model variables and descriptions.

Variable	Description
ESCORTRIPS	Primary purpose recreation trips taken to rangelands on a National Forest or Grassland in the past 12 months, with 1 subtracted to account for endogenous stratification associated with on-site sampling
AGE	Respondent age as median of NVUM age class
GENDER1	Dummy variable, 1 for female respondent, 0 for male respondent
INCES	IRS average after tax income for RPA region in which respondent's zip code occurs
ONITE	Dummy variable, 1 if respondent stayed overnight on the National Forest or Grassland
PEOPVEH	Number of people traveling in the respondent's vehicle when surveyed
PRACTDIS	One way travel distance from centroid of respondent's zip code to NVUM sample site geographic coordinates
PRACTIME	One way travel time for distance described in PRACTDIS
TCWH	Travel cost variable calculated per individual in vehicle, including opportunity cost as 1/3 the IRS annual average income as wage rate for RPA region in which respondent's zip code occurs
ROADDIST	Distance from NVUM sample site geographic coordinates to closest state or interstate highway
STRMDIST	Distance from NVUM sample site geographic coordinates to closest stream or river
LKODIST	Distance from NVUM sample site geographic coordinates to closest lake, reservoir, or ocean

CAMP_AGG	Activity aggregate for respondents whose NVUM main activity was camping or staying at resorts within the National Forest or Grassland
DRIVE_AGG	Activity aggregate for respondents whose NVUM main activity was driving or other motorized recreation on the National Forest or Grassaland
GENERAL_AGG	Activity aggregate for respondents whose NVUM main activity was general recreation or other nonmotorized recreation on the National Forest or Grassland
HIKE7	Activity variable for respondents whose NVUM main activity was hiking on the National Forest or Grassland
HUNTING7	Activity variable for respondents whose NVUM main activity was hunting on the National Forest or Grassland
NATURE_AGG	Activity aggregate for respondents whose main NVUM activity was gathering, history, nature center, or nature study on the National Forest or Grassland
OHVUSE7	Activity variable for respondents whose main NVUM activity was OHV use on the National Forest or Grassland
PBCAMP_AGG	Activity aggregate for respondents whose main NVUM activity was primitive camping or backpacking on the National Forest or Grassland
PICNIC7	Activity variable for respondents whose main NVUM activity was picnicking on the National Forest or Grassland
TRAIL_AGG	Activity aggregate for respondents whose main NVUM activity was biking or horseback riding
VIEW_AGG	Activity aggregate for respondents whose main NVUM activity was viewing nature, viewing wildlife, or viewing off-forest scenery for the National Forest or Grassland
RPA_RGN	Dummy variable for Pacific Coast Resource Planning Act assessment region or Rocky Mountain Resource Planning Act assessment region.
TC_CAMP_AGG	Interaction between travel cost TCWH and CAMP_AGG variable
TC_DRIVE_AGG	Interaction between travel cost TCWH and DRIVE_AGG variable
TC_GEN_AGG	Interaction between travel cost TCWH and GEN_AGG variable
TC_HIKE	Interaction between travel cost TCWH and HIKE7 variable
TC_HUNT	Interaction between travel cost TCWH and HUNTING7 variable
TC_NAT_AGG	Interaction between travel cost TCWH and NAT_AGG variable
TC_OHV	Interaction between travel cost TCWH and OHVUSE7 variable
TC_PBCAMP_AGG	Interaction between travel cost TCWH and PBCAMP_AGG variable
TC_PIC	Interaction between travel cost TCWH and PICNIC7 variable
TC_TRAIL_AGG	Interaction between travel cost TCWH and TRAIL_AGG variable
TC_VIEW_AGG	Interaction between travel cost TCWH and VIEW_AGG variable
TC_RPA_RGN	Interaction between travel cost TCWH and RPA_RGN variable

The NVUM information was collected to address the need for statistically reliable recreation use estimates required by Congress and the Government Accountability Office

(GAO) in association with USDA Forest Service budget allocations and strategic planning. The NVUM survey was not designed to collect information for this study, or assessment of NFS rangeland recreation as distinct from forest and water recreation. Exiting recreation traffic, along with measures including fee envelopes and concessionaire reports, was monitored for recreation sites stratified by type, location, and time period of recreation visits. Visitation periods were identified as low, medium, or high use to ensure adequate representation of all visitation periods in the survey. The study design relied upon a double sampling technique developed specifically for use on national forests, and provided for estimation of visitation to a given national forest, but was not meant for use on specific sites or districts (English et al. 2002).

Data for this study were derived from four of the five recreation sites types – day-use developed sites (DUDS), overnight-use developed sites (OUDS), general forest areas (GFA), and wilderness (WILD). Both DUDS and OUDS show moderate to heavy degrees of modification and/or development. The former include picnic areas, interpretative sites, observation sites, visitor centers, and museums, while the latter includes campgrounds, fire lookouts, hotels, lodges, resorts and horsecamps. General forest areas include trailheads, forest entrance and exit points along roads, and other undeveloped, non-wilderness sample sites within the national forests and grasslands. Wilderness sample sites were predominantly trailheads providing access to designated wilderness areas within national forests and grasslands (English et al. 2002).

Travel Cost Model Distance Variables

Travel distances and times were calculated by USDA Forest Service researchers using the

centroid of respondents home zip codes and the geographic coordinates of the NFS site were the respondent was interviewed (English, February 2006, personal communication). A match item comprised of the survey site region, forest, site number, and respondent zip code was used to attach travel distances and times to the larger NVUM data set.

Distances from rangeland recreation sites to the nearest streams or rivers, lakes or reservoirs or oceans, and state or interstate highways also were incorporated into the NFS rangeland recreation travel cost model, in response to USDA Forest Service request for exploration of the potential importance of these factors (Mitchell, February 2004, personal communication). These distances were calculated using Environmental Systems Research Institute, Inc. (ESRI) ArcMap version 8.3 GIS software with rangeland recreation site point coverages generated for an earlier analysis (Chapter 2) and US Geological Survey 1999 road and water body coverages. Distances were then matched and merged back into the more comprehensive NVUM data set based on unique site codes to associate distances with corresponding rangeland recreation sites.

Travel Cost Model

The NVUM surveys were conducted at NFS recreation sites, and the dependent variable for this travel cost model is the number of trips a respondent has taken to the National Forest or Grassland, where s/he was interviewed, during a 12-month period. Therefore, use of a count data estimator is more appropriate for statistical analyses, since number of trips taken is not a continuous variable as assumed in a normal distribution, but rather a non-negative integer; selection to participate in the NVUM survey indicates that all

respondents made at least one visit to a National Forest or Grassland during a 12-month period.

Whereas continuous distribution estimators based upon a normal distribution give positive probability to fractional and potentially negative dependent variable values, count data estimators restrict positive probability assignment to possible events (Creel and Loomis 1990). Thus, the Poisson distribution is more consistent for count data. Although the Poisson model assumes that the data set's mean and variance are equal, use of the Huber-White correction minimizes problems of heteroskedasticity in the event that this assumption is violated. Ignoring potential heteroskedasticity or overlooking it may bias standard errors and p-values and diagnostic tests often fail to detect it. Therefore, rather than testing for heteroskedasticity and applying a correction if detected, Long and Ervin (2000) recommend using the correction whenever heteroskedasticity is possible; the Huber-White Correction was used in developing this travel cost model.

All statistical analyses associated with this travel cost model and consumer surplus calculations were conducted using QMS Eviews software. The count data model estimated for this study presumes a Poisson distribution with the general demand function specification:

$$R = (P_r, P_s, M, T, H, Q) \qquad [1]$$

where R is the number of visits demanded during a 12-month period, P_r is the per visit recreation price, P_s is price for substitute site visits, M is annual income, H refers to

individual socio-demographic measures, and Q captures site quality variables characterizing the recreation site.

The count data model used here also corrects for endogenous stratification associated with on-site sampling as implemented by the NVUM survey. A relationship exists between the likelihood of a person being selected during an on-site sampling procedure and the frequency of that person's visits to that site. When the Poisson model is used, subtracting one from the reported number of trips during a 12-month period corrects for this endogenous stratification (Englin and Shonkwiler 1995). Subtracting one from the reported number of trips taken during a 12-month period adjusts this annual number of trips downward to reflect the increased likelihood of those who take more trips being sampled. Without this correction, the dependent variable, number of trips taken during a 12-month period, contains an upward bias. That is, someone who takes 5 trips during a 12-month period is more likely to be sampled on any given day than a person who takes just 2 trips during that same 12-month period. By subtracting one, the dependent variable more accurately depicts the entire population in this Poisson model (Loomis, March 2006, personal communication).

To maximize consistency and comparability with the travel cost model generated by Bowker et al. (2005) for the comprehensive National Forest recreation valuation, the travel cost model used in this study was specified as:

$$\text{Visits}_r = \exp\left(TC_r, TC_r ACT^i_{r,k}, ACT^i_{r,k}, PEOPVEH_r, ONITE_r, \right. \quad \textbf{[2]}$$
$$\left. LKODIST_r, STRMDIST_r, ROADDIST_r, GENDER1_r, AGE_r \right)$$

Where r = 0..2 a western United States NFS rangeland model and the two western RPA regions, Pacific Coast and Rocky Mountain region; and k=1…13 for the aggregated recreation activities derived from the NVUM data set. The dependent variable in this equation is the number of recreation visits during a 12-month period to a National Forest or Grassland for rangeland recreation. Visit demand is calculated as a function of respondent price, travel cost-recreation activity interaction terms ($TCACT^{i}_{k}$) for each of the 13 activity aggregates, primary rangeland recreation activity indicator ACT^{i}_{k}, number of people in the respondent's vehicle (PEOPVEH), variable indicating whether the respondent stayed overnight (ONITE), distance from lakes, reservoirs, or oceans (LKODIST), distance from streams or rivers (STRMDIST), distance from state or interstate highway (ROADDIST), gender (GENDER1), and age (AGE).

Travel Cost Model Variations

Due to a combination of data limitations and availability of additional data describing site characteristics in terms of distance from water and highways, several differences between this NFS rangeland recreation travel cost model and that developed by Bowker et al. (2005). These variations include: absence of an income variable, since the travel cost variable used here was constructed using the average IRS income for RPA regions developed by Bowker et al., (2005) rather than individual IRS income averages for each respondent's zip code; omission of the high frequency visitation variable due to association with the dependent variable, number of visits during a twelve-month period; omission of water and snow-based recreation activities from activity aggregates to focus more closely on rangeland recreation activities; and inclusion of variables for distance

from rangeland recreation sites to streams or rivers, lakes, reservoirs, or oceans, and state or interstate highways.

According to Bowker et al. (2005), this demand function includes activity variables and travel cost interaction terms to facilitate estimation of consumer surplus for various rangeland recreation activities as well as to capture differences in demand associated with types of primary activities. Pooling observations from rangeland recreation sites across National Forests and Grasslands in the western United States for use in a single equation model, including dummy variables and dummy interaction terms, characterizes a varying parameters approach (Bowker et al. 2005). Such a structure permits estimation by 13 activity aggregates of demand for NFS rangeland recreation for RPA regions and the western United States as a whole.

Travel Cost Variable and Consumer Surplus Calculation

As previously stated, the travel distance and time used to calculate the travel cost variable were derived by USDA Forest Service researchers using geographic coordinates of the NVUM sample sites recorded by USDA Forest Service personnel administering the NVUM survey and the centroid of respondent's zip codes (English, March 2006, personal communication). After integrating travel time and travel cost variables into the comprehensive NVUM data set, the travel cost variable was calculated after Bowker et al. (2005) as:

$$TCWH = 2(.12*PRACTDIS) + 2[.33\ (INCE/2000)*PRACTIME]+RECFEES \quad [3]$$

where PRACTDIS is specified as the one-way travel distance, PRACTIME is the one-way travel time associated with the calculated one-way travel distance, INCE in this instance is the average annual after tax income for the RPA region (Pacific Coast or Rocky Mountain region) in which the respondent's zip code occurs, and RECFEES are the on-site recreation fees reported by the respondents.

While the same per mile cost $0.12 and opportunity cost, one-third of the individual wage rate, selected by Bowker et al. (2005) was used for this travel cost variable, a slight difference in the INCE variable exists. This travel cost variable illustrated above differs from that used by Bowker et al. (2005) in that INCE as incorporated by Bowker et al. (2005) was the annual after tax income for the zip code of origin for each respondent, whereas this study uses the average annual after tax income for each RPA region that Bowker et al. (2005) derived. In both analyses, the INCE value was divided by 2000 hours to obtain an approximate individual wage rate, and then multiplied by .33 for the overall opportunity cost. This is consistent with recommendations from the U.S. Water Resources Council (1983), as well as transportation planning literature noted by Loomis and Walsh (1997), which values travel time at ¼ to ½ of the wage rate.

Due to data limitations, representation of substitute sites is absent from this travel cost variable. The NVUM data set did not contain useable information about substitute sites, respondent behaviors, or prices. It is noted that this omission potentially biases estimated coefficients (Bowker et al. 2005); this is a topic of ongoing discussion in economics literature (Haab and McConnell 2002, Kling 1989, Rosenthal 1987).

For the Poisson travel cost model, per trip consumer surplus (CS) can be calculated as $CS= 1/(B_1TC+B_iTCACT_i)$. Since the cost per mile is already in per person terms, this formula provides individual per trip consumer surpluses. Per trip consumer surplus refers to the economic benefits received per person, in excess of their trip costs, from an average rangeland recreation trip to a NFS site.

RESULTS

Western United States Travel Cost Model

While the travel cost variable TCWH, number of people in the vehicle PEOPVEH, whether respondents stayed overnight ONITE and distance to highways ROADDIST were significant at the .05 level, gender GENDER1, age AGE, distance to streams or rivers STRMDIST, and distance to lakes, reservoirs, or oceans LKODIST were not significant (Table 4.2). Although the R-squared for this model was .146 and the Likelihood Ratio Index (LRI, Psuedo-R^2) for this model was just .131, this is not uncommon for models based upon individual responses, due to the great variability among respondents (Loomis, March 2006, personal communication). This LRI value is consistent with that obtained by Bowker et al. (2005) for all recreation activities across all USDA National Forest lands; forest, rangeland, and waterbodies.

A basic travel cost model for NFS rangelands in the western United States generated in QMS Eviews statistical software produced an average consumer surplus of $65.68 for a rangeland recreation trip to NFS sites. Activity aggregates, associated travel cost interaction variables, and RPA region variables were incorporated into the travel cost

model to explore utility of calculation of per trip consumer surpluses for specific recreation activities pursued on NFS rangelands in specific RPA regions. However, neither the RPA region variable nor its travel cost interaction term was significant. Table 4.3 shows the regression coefficients and significance levels associated with activity aggregates and travel cost interaction variables in the full model with insignificant RPA variables removed.

Table 4.2. General travel cost model coefficients and significance for NFS rangeland recreation in the western United States.

Variable	Coefficient	Significance (p)
TCWH	-0.015230	0.0000
PEOPVEH	-0.111990	0.0000
ONITE	-0.428474	0.0000
GENDER1	-0.088385	0.1754
AGE	0.000962	0.6515
ROADDIST	-7.07E-06	0.0345
STRMDIST	3.52E-06	0.6565
LKODIST	2.33E-07	0.9067
C	3.105988	0.0000

This iteration of the rangeland travel cost model again showed that gender GENDER1 and age AGE1 remained insignificant after incorporation of additional variables. The number of people in the vehicle PEOPVEH and whether they had stayed overnight ONITE remained significant, as did the average travel cost variable TCWH. With regard to activity aggregates and travel cost interaction variables, several were not significant in the travel cost model. Activity aggregates that were insignificant as demand shifters include: viewing VIEW_AGG, camping CAMP_AGG, driving DRIVE_AGG, general recreation GENERAL_AGG, hiking HIKE7, and hunting HUNTING7. Travel cost activity interaction terms that were not significant include those associated with primitive camping and backpacking TC_PBCAMP_AGG, hunting

TC_HUNT, and picnicking TC_PIC. The R-square for this expanded model increased to .176, and the LRI rose to .167, showing improved explanatory power with additional variables incorporated.

Table 4.3. Travel cost model for NFS rangeland recreation in the western United States including modified RPA activity aggregates and associated travel cost interaction terms.

Variable	Coefficient	Significance (p)
TCWH	-0.005212	0.0237
PEOPVEH	-0.082736	0.0016
ONITE	-0.281333	0.0063
GENDER1	-0.081337	0.2202
AGE	0.003443	0.1155
TC_CAMP_AGG	-0.019152	0.0100
TC_DRIVE_AGG	-0.024720	0.0918
TC_GEN_AGG	-0.010826	0.0117
TC_NAT_AGG	-0.019851	0.0667
TC_HIKE	-0.009940	0.0568
TC_PBCAMP_AGG	0.002019	0.8511
TC_OHV	-0.027368	0.0004
TC_HUNT	-0.004606	0.6596
TC_PIC	0.001952	0.8460
TC_VIEW_AGG	-0.024743	0.0002
TC_TRAIL_AGG	-0.014970	0.0176
VIEW_AGG	-0.062698	0.6425
CAMP_AGG	-0.117356	0.6812
DRIVE_AGG	-0.018873	0.9348
GENERAL_AGG	0.051176	0.7026
HIKE7	0.067107	0.5766
HUNTING7	-0.099634	0.6629
NATURE_AGG	0.382415	0.0399
OHVUSE7	0.376618	0.0163
PBCAMP_AGG	-0.825723	0.0421
PICNIC7	-0.681188	0.0038
TRAIL_AGG	0.298279	0.0294
C	2.879648	0.0000

The final iteration of the rangeland travel cost model incorporated activity and travel cost interaction variables which were significant in the second model, as well as the ROADDIST variable, which was significant in the original model. Table 4.4 illustrates the regression coefficients and significance levels derived from the final NFS rangeland recreation travel cost model for the western United States. Table 4.4 also suggests that as the number of people in the vehicle increases, the number of trips taken

during a 12-month period decreases. This is true too, with regard to whether the respondent stayed overnight on the National Forest or Grassland; people who stayed overnight took less trips during a 12-month period than those who did not. Lastly, and predictably, as the distance from the NVUM rangeland recreation survey site to the nearest state or interstate highway increased, number of trips taken to that site decreased. Participation in the activities that comprise the NATURE_AGG variable, the TRAIL_AGG variable, and the OHVUSE7 activity term were significant demand shifters for the western United States NFS rangeland recreation travel cost model.

Table 4.4. Final model of significant coefficients for NFS rangeland recreation in the western United States without inclusion of snow-based recreation activities.

Variable	Coefficient	Significance (p)
TCWH	-0.015225	0.0000
PEOPVEH	-0.100766	0.0003
ONITE	-0.296800	0.0039
TC_CAMP_AGG	-0.010693	0.0069
TC_OHV	-0.017817	0.0216
NATURE_AGG	0.372475	0.0132
OHVUSE7	0.550777	0.0001
TRAIL_AGG	0.219735	0.0341
ROADDIST	-9.50E-06	0.0092
C	3.025901	0.0000

After modeling exercises showed that inclusion of snow activities including skiing and snowmobiling did not alter significant variable coefficients, snow activities were dropped from the data set to focus more specifically on values for grassland activities. With regard to snowmobiling, observations reporting this pursuit as a main activity were restricted to the Rocky Mountain RPA region; absence of observations from the Pacific Coast RPA region with identification of snowmobiling as a main activity further justified its omission from the overall rangeland recreation data set for the western United States.

Regional NFS Rangelands Travel Cost Models

As previously stated, the RPA region variable and its travel cost interaction term were not significant in the travel cost model for rangeland recreation on NFS lands in the western United States. However, application of a likelihood ratio test, based on the chi-square statistic, incorporating results of regional versions of the final western United States NFS rangeland recreation travel cost model, and the pooled results from the overall western United States model, indicated that more than one model coefficient was different across RPA regions. Therefore, individual NFS rangeland recreation travel cost models were calculated for both the Pacific Coast (Table 4.5) and Rocky Mountain (Table 4.6) RPA assessment regions. Since snowmobiling did not occur in the Pacific Coast RPA assessment region, such snow-based recreation activities were again omitted from the data set used to generate these regional models.

Table 4.5. Final travel cost model for recreation on USDA Forest Service rangelands in the Pacific Coast RPA assessment region.

Variable	Coefficient	Significance (p)
TCWH	-0.009571	0.0013
PEOPVEH	-0.209926	0.0001
ONITE	-0.546112	0.0028
TC_CAMP_AGG	-0.015426	0.0111
TC_NAT_AGG	-0.086613	0.0166
NATURE_AGG	1.092383	0.0021
ROADDIST	-1.85E-05	0.0026
C	3.323665	0.0000

Pacific Coast Region NFS Rangelands Travel Cost Model. Travel cost model results shown in Table 4.5 illustrate that as the number of people in the vehicle increases, the number of trips taken during a 12-month period decreases. This is also true with regard to whether the respondent stayed overnight on the National Forest or Grassland;

people who stayed overnight took less trips during a 12-month period than those who did not. Again, as in the western United States NFS rangeland recreation travel cost model, as the distance from the NVUM rangeland recreation survey site to the nearest state or interstate highway increased, number of trips taken to that site decreased. Participation in the activities that comprise the NATURE_AGG variable was a significant demand shifter for the Pacific Coast RPA assessment region NFS rangeland recreation travel cost model.

As indicated by the likelihood ratio test, several variables differ between the two regional rangeland recreation travel cost models. In addition to the travel cost variable TCWH, significant coefficients in the Pacific Coast model include: the number of people in the vehicle PEOPLEVEH, whether the respondent stayed overnight on the National Forest or Grassland ONITE, the travel cost interaction term for camping TC_CAMP_AGG, the travel cost interaction term for nature activities TC_NATURE_AGG, the demand shifter for nature activities NATURE_AGG, and the distance from the NVUM site where the respondent was surveyed and the nearest state or interstate highway ROADDIST.

Rocky Mountain Region NFS Rangelands Travel Cost Model. In contrast, different and slightly more significant activity and travel cost interaction variables were retained in the Rocky Mountain RPA assessment region travel cost model for NFS rangeland recreation. In addition to the travel cost coefficient, which was still significant, remaining variables for this model include: whether the respondent stayed overnight on the National Forest or Grassland ONITE, the travel cost interaction term for viewing activities TC_VIEW_AGG, the travel cost interaction term for hiking TC_HIKE, the travel cost interaction term for driving activities TC_DRIVE_AGG, the travel cost term

for off-highway vehicle use (OHV) TC_OHV, the activity demand shifters for hiking HIKE7, OHV use, OHVUSE7, and general recreation/relaxation activities GENERAL_AGG. For the Rocky Mountain RPA assessment region, neither the number of people traveling in the respondent's vehicle PEOPVEH nor the distance from the NVUM survey site to the nearest state or interstate highway ROADDIST was significant.

Table 4.6. Final travel cost model for recreation on USDA Forest Service rangelands in the Rocky Mountain RPA assessment region.

Variable	Coefficient	Signficance (p)
TCWH	-0.016056	0.0136
ONITE	-0.254696	0.0784
TC_VIEW_AGG	-0.017525	0.0349
NATURE_AGG	0.489084	0.0025
TC_HIKE	-0.022880	0.0128
HIKE7	0.293035	0.0388
TC_OHV	-0.018492	0.1008
OHVUSE7	0.534826	0.0017
TC_DRIVE_AGG	-0.018708	0.0565
GENERAL_AGG	0.220044	0.0636
C	2.680445	0.0000

NFS Rangelands Recreation Consumer Surpluses

Differences in significant coefficients and associated model variables across regions suggest that consumer surpluses, both on average and for individual activities, also would vary across the three analysis areas. Table 4.7 illustrates average consumer surplus for activities not explicitly itemized in the respective travel cost models for NFS rangeland recreation in the western United States, Pacific Coast RPA assessment region, and Rocky Mountain RPA assessment region. Average consumer surplus was highest in the Pacific Coast region at $104.48 and lowest in the Rocky Mountain region at $62.28.

This regional difference may be due to the fact that hiking is implicitly included in the Pacific Coast travel cost model, and explicitly factored into the Rocky Mountain

region model. Since hiking is the most common recreation activity on NFS rangelands in all three areas, it heavily influences average consumer surplus outcomes in the Pacific Coast model, whereas a consumer surplus for hiking is figured separately for the Rocky Mountain region. The consumer surplus, in the Rocky Mountain region may be influenced more by hunting, which was the second most common rangeland recreation activity in that area, but was not individually significant in the travel cost model.

Table 4.7. Consumer Surpluses for the western United States, Pacific Coast RPA assessment region, and Rocky Mountain RPA assessment region for significant travel cost model terms.

Activity Variables	Western United States	Pacific Coast RPA Region	Rocky Mountain RPA Region
Average Travel Cost Variable (applicable to included activities not listed separately below) TCWH	$65.68	$104.48	$62.28
Camping TC_CAMP_AGG	$38.58	$40.00	-
Nature Study/ Visitor Center TC_NAT_AGG	-	$10.40	-
Hiking TC_HIKE	-	-	$25.68
OHV Use TC_OHV	$30.26	-	$28.95
Driving TC_DRIVE_AGG	-	-	$28.77
Viewing TC_VIEW_AGG	-	-	$29.78

Additionally, confidence intervals around the average consumer surpluses are quite wide. While the average consumer surplus for the western United States is $65.68, the 90 percent confidence interval upper bound is $100.41 and the lower bound is $48.78. Regional confidence intervals are even broader. In the Rocky Mountain RPA assessment region, where the average consumer surplus for NFS rangeland recreation is $62.28, the upper bound for a 90 percent confidence interval is $188.41 and the lower bound is $37.46. For the Pacific Coast RPA assessment region, where the average consumer

surplus is $104.48, the upper bound for a 90 percent confidence interval is $213.40 and the lower bound is $69.18. Although the average consumer surpluses from rangeland recreation differ, the bounds of the 90 percent confidence intervals suggest that the values may overlap.

DISCUSSION

This study provides the first estimate of the value and consumer surpluses associated with rangeland recreation activities pursued on NFS rangelands. Therefore, information derived may help serve as a basis for regional and national management decisions that affect NFS forests and grasslands, since management decisions are negatively impacted by absence of monitoring (Reynolds and Elson 1996). Managing visitors effectively requires information about their numbers, composition, distribution, and activities (Janowsky and Becker 2003). Information herein may alter perceptions of the importance of rangelands for various recreation opportunities. It is also anticipated that data will augment extant forest planning efforts, policies, and decision-making at regional and national levels, consistent with contentions of Cope et al. (1999) regarding improved regional planning as a result of improved understanding of demand and need for various recreation opportunities.

Utility of Model Results

At the regional level, information about values associated with various rangeland recreation activities may impact budget allocations and staffing levels and assignments. Knowledge about how, when, and where people recreate is critical to management

decisions regarding staff time and funding (Harnik and Kimball 2005). Previous studies also have discussed the applicability of range management knowledge and skills, such as assessment of grazing pressure and impacts, to recreation management (McClaran 2000).

Calculation of consumer surpluses for recreation activities engaged in within the context of specific vegetation types, such as rangeland or forest, may provide more accurate measurements of the value people place upon recreation sites with certain characteristics. Table 4.8 compares consumer surpluses derived by Bowker et al. (2005) for all recreation (including water, snow, rangeland, and forest activities) taking place on National Forests and Grasslands with more specific NFS rangelands recreation consumer surpluses generated in this study.

Table 4.8. Consumer surpluses calculated for activities or activity aggregates represented in the final NFS rangeland recreation travel cost models in comparison to national overall National Forest recreation consumer surpluses (*Western United States, **Rocky Mountain RPA assessment region, ***Pacific Coast RPA assessment region).

Recreation Activity or Activity Aggregate	Consumer Surplus per visit for Rangeland Recreation on National Forests and Grasslands	Consumer Surplus per visit for Overall National Forest Recreation in the Entire United States (from Bowker et al. 2005)
CAMP	*$38.58	$40.02
DRIVE	**$28.77	$98.82
NATURE	***$10.40	$54.42
HIKE	**$25.68	$118.70
OHVUSE	*$30.26	$89.87
VIEW	**$29.78	$51.51

Although the values associated with overall recreation are higher than those for rangeland recreation, lumping high dollar water and snow pursuits with less costly

recreation activities may artificially inflate overall recreation consumer surpluses, potentially hindering effective management planning for specific resources and recreation settings. For example, the $25.68 consumer surplus derived for hiking on NFS rangelands in the Rocky Mountain RPA assessment region is similar to Walsh et al.'s (1992) estimate of the national average of hiking at $29, and only slightly lower than the $37 average value generated by Rosenberger and Loomis (2000) when they updated the Walsh et al. (1992) study. The Bowker et al. (2005) national average consumer surplus estimate of $118.70 is well above this range of values.

Additionally, non-market values attached to specific recreation resources may assist with resolution of potential conflicts among competitive uses. For example, information about relative values attached to areas with both recreation sites and active grazing allotments may provide a basis for balancing among potentially incompatible uses. Prediction and resolution of potential conflicts before they happen, based on information about location of rangeland recreation sites that produce large benefits, in proximity to active grazing allotments, may alleviate investment of staff time in conflict resolution required after problems occur (Wallace et al. 1996). As recreational use of rangelands increases, conflicts with traditional production interests will likely increase too. National Cattlemen's Beef Association leadership already have noted damage to land improvements and water distribution systems resulting from recreational use of FS grazing allotments (Groseta 2005); information about production and recreation values of rangeland will assist managers with critical decisions about land use in the future. Given the low consumer surpluses associated with NFS rangeland recreation in this study,

perhaps public lands grazing may be a more economically viable land use under certain circumstances.

Nationally, data pertaining to rangeland recreation values will highlight the importance of this unique resource to a diverse group of stakeholders. Producer groups representing the cattle industry and wildlife groups with habitat concerns are typically characterized as rangeland constituent groups to be considered regarding NFS management decisions and legislation changes. Ability to also emphasize recreation values of rangelands may engage a broader audience in these processes. Moore and Graefe (1994) posit that users with attachments to specific recreation sites would be likely to participate in public involvement processes associated. Harnik and Kimball (2005) stated that public interests in benefit and appropriations are analogous to private sector emphasis on investment and profit.

Results generated by this study of national and regional NFS rangeland recreation and activity values are consistent with findings of more localized studies. Sorge (2005) emphasized the increasing need for recreation areas that accommodate activities including walking as the population ages. Hiking and walking are already the most typical main activity of those recreating on NFS rangelands; expansion of this demand and associated consumer surpluses are likely in the future.

Caveats to Consider

Although analyses of travel costs and consumer surpluses described here are adequate for an initial assessment of NFS rangeland recreation, numbers reported in this study are likely lower than actual numbers for several reasons. These issues include: extraction of

data from a sample designed for forests, rangelands, water, and snow activities, instead of exclusively for rangelands; incomplete data reporting from national forests and grasslands, leaving gaps in the information; scant demographic data and substitute site information, which is important for travel cost modeling; and ambiguity associated with definitions of rangelands.

The list of sample sites (DUDS, OUDS, GFA, and WILD) represented in the NVUM database is not yet complete. Although the sampling design provided for completion of the initial sample of visitor use monitoring on all NFS forests and grasslands by 2004 (English et al., 2002), not all units have provided data with coordinates for geo-referencing. Addition of travel cost data from NVUM rangeland sample points located within management units yet to report could affect consumer surpluses.

Also, inclusion of a NVUM survey question that defines rangelands for respondents, and then asks whether the respondent recreated on rangelands while visiting the National Forest or Grassland could provide more clarity to classification of observations as associated with rangeland recreation sites. At present, participation in the NVUM survey at a sample site located on rangelands is presumed to represent rangeland recreation. Explicitly asking NVUM survey participants whether they recreated on rangelands would negate the need for this assumption.

Rangeland Classification Issues. With regard to limitations of the 1992 US Geological Survey – Environmental Protection Agency National Land Cover Dataset (NLCD) information used to identify NVUM rangeland sample sites, issues to note deal with representation of vegetation types depicted in remotely sensed data as a forest cover

type, but commonly recognized as rangeland. Aspen and pinion-juniper ecosystems fall into this category. For example, aspen may be classified as a forest vegetation type; however, the understory vegetation present in an aspen grove may contain as much as 3800 pounds of air-dried forage per acre (Mueggler 1998). Also, exclusion of fire by livestock grazing and active fire suppression helped hasten expansion of pinion-juniper woodlands across open savannas and grasslands in the late 19th and early 20th centuries (Tausch and Tueller 1990; Miller and Rose 1999). The precise point at which rangelands become woodlands is subjective, dealing with between-tree spacing and groundcover. These communities are difficult to accurately classify from remotely sensed data such as NLCD.

As of 2002, pinion-juniper covered approximately 13.6 million acres of USDA Forest Service lands in the western United States (Smith et al. 1994); recreation sites that fall in these areas may be inaccurately identified as occurring on woodlands rather than rangelands. Increases in traditional recreational use of pinion-juniper woodlands, such as camping and nut-gathering, has risen with population growth and is expected to continue (Gottfried and Pieper 2000).

Rangeland Definition Issues. This forest versus rangeland debate is directly associated with definitional issues that must be resolved to provide more clarity to any discussion of rangeland use and value. Indeed, overlaps between these definitions results in addition of total rangeland area plus total forest area summing to more than existing total land area. The Oregon Demonstration Project found 10 to 15 percent difference in areas of forests and rangelands depending on definitions (Goebel *et al.* 1998). Several groups involved in development of monitoring and reporting frameworks have previously

identified this problem. Both the Sustainable Rangelands Roundtable (Maczko 2004) and the USDA Forest Service (2004) national report on sustainable forests discussed the differing operational definitions of forests and rangelands. Although members of the Roundtable on Sustainable Forests, the Sustainable Rangelands Roundtable, the Federal Geographic Data Committee (FGDC) Sustainable Forest Data Working Group, FGDC Vegetation Subcommittee, FGDC Sample Inventory and Monitoring of Natural Resources and the Environment Working Group, Bureau of Land Management, Forest Service, Natural Resources Conservation Service, US Geological Survey, Society for Range Management, Society of American Foresters, and NatureServe acknowledge the need to develop standard definitions of forest and rangeland (Bartlett et al. 2003), in 2004, the agencies suspended efforts to resolve this ambiguity (Geissler and Radloff 2004, pers. comm.). Until rangelands are definitively described, description of any activity or site, recreational or otherwise, occurring on rangelands remains ambiguous.

Demographic Data Augmentation. Additionally, while basic demographic information such as age and gender was not significant in these rangeland recreation travel cost models, additional data including marital status, employment, education, income, social class, rural or urban residence, and number of children have been shown to be significantly related to recreation behavior (Crossley 1994, Uysal et al. 1994, Beerli and Martin 2004, Kim and Prideaux 2005, Pizam and Fleisher 2005, Obua and Harding 1996, Hollenhorst et al. 1995, Andereck et al. 2001, White et al. 2001). As asserted by White et al. (2001) regarding visitor perceptions of NFS wilderness campsites, it is likely that collection and analyses of a more extensive set of socio-demographic information

from USDA Forest Service NFS rangeland recreators, as time and resources permit, would be fruitful.

Lastly, incorporation of site substitute information in future National Forest and Grassland recreation surveys would enhance travel cost modeling. While use of substitute sites with NVUM data caused collinearity problems for Bowker et al. (2005), exploration of their effectiveness in the context of a vegetation-specific travel cost model would be useful.

CONCLUSIONS AND FUTURE RESEARCH

While rangeland use and management has changed greatly since the 1800s, as evidenced by increasing attention being paid to non-production uses of rangelands, and Bartlett et al.'s (2002) discussion of valuation of these non-market goods and services, additional modifications in federal lands planning and management are doubtless in the offing. Adaptive management embodied in federal land management agencies planning practices (Loomis 2002) will continue to integrate evolving societal values, as well as accommodating more traditional production activities, blending social, economic, and ecological aspects of rangeland sustainability to balance these multiple uses for current and future generations.

Although this study offers an initial assessment of benefits associated with rangeland recreation, further research is needed. A survey designed to collect information about rangeland recreation, rather than extracting rangeland information from a comprehensive survey, could improve analysis results. A larger rangeland sample would facilitate comparisons of rangeland recreation values across the four NVUM site

types (DUDS, OUDS, GFA, and Wilderness). Also, this study quantified very diverse consumer surplus values associated with NFS rangeland recreation, with larger average surpluses in the Pacific Coast RPA assessment region. While this variation may be associated with population densities, a more comprehensive NFS rangeland recreation survey could further explore these regional differences.

Additionally, for comparison purposes, a similar travel cost model should be generated for NVUM forest recreation sites, with high-cost water recreation activities (Brown, March 2006, personal communication) excluded, to provide a comparable estimate of forest recreation values. While consumer surpluses for rangeland recreation derived here appear low in comparison to all-inclusive National Forest recreation numbers, a forest-specific model may produce lower numbers too. A model of NFS rangeland production values that explicitly enumerates non-market benefits to ranchers would also be informative, as proposed by Bartlett et al. (2002).

In the interim, results presented here provide a baseline from which to continue analyses and discussions of non-market values of NFS rangeland recreation. Expanding uses, projected increasing use intensities, and diverse rangeland stakeholders ensure that the debate will be interesting and ongoing.

LITERATURE CITED

ANDERECK, K.L, C.A. VOGT, K. LARKIN, AND K. FREYE. 2001. Differences between Motorized and Nonmotorized Trail Users. *Journal of Park and Recreation Administration* 19(3): 62-77.

BARTLETT E.T., L.A. TORELL, N.R. RIMBEY, L.W. VAN TASSELL, AND D.W. MCCOLLUM. 2002. Valuing grazing use on public land. *Journal of Range Management* 55(5): 426-438.

BARTLETT, E.T., K.A. MACZKO, AND J.E. MITCHELL. 2003. Ecological, economic, and social indicators: assessing rangeland sustainability, p. 1897-1908. *In:* Allsopp, N. A.R. Palmer, S.J. Milton, K.P. Kirkman, G.I.H. Kerley, and C.R. Hurt (eds.) Proc. VIIth Int. Rangeland Congress, 26th July-1st August 2003, Durban, South Africa. Document Transformation Technologies, Irene, South Africa.

BEASLEY, S.D., W.C. WORKMAN, AND N.A. WILLIAMS. 1986. Estimating amenity values of urban fringe farmland: a contingent valuation approach: note. *Growth and Change* 17(4): 70-78.

BECKER, N., M. INBAR, O. BAHAT, Y. CHORESH, G. BEN-NOON, AND O. YAFFE. 2005. Estimating the economic value of viewing griffon vultures Gyps fulvus: a travel cost model study at Gamia Nature Reserve, Israel. *Oryx* 39(4) 429-434.

BEERLI, A. AND J.D. MARTIN. 2004. Tourists' characteristics and the perceived image of tourist destinations: a quantitative analysis - a case study of Lanzarote, Spain. *Tourism Management* 25: 623-636.

BOSWORTH, D. 2003. Speech to the San Francisco Commonwealth Club. April 23, 2003. San Francisco, CA.

BOWKER, J.M., D.B.K. ENGLISH, J.C. BERGSTROM, C.M. STARBUCK, R. ROSENBERGER, AND D. MCCOLLUM. 2005. Towards Estimation of US National Forest Recreational Value: National Visitor Use Monitoring System Results. Unpublished USDA Forest Service Working Paper.

BOWKER, J.M. AND D.D. DIDYCHUK. 1994. Estimation of the nonmarket benefits of agricultural land retention in Eastern Canada. *Agricultural and Resource Economics Review* 23: 218-225.

BOXALL, P.C., B.L. MCFARLANE, AND M. GARTRELL. 1996. An aggregate travel cost approach to valuing forest recreation at managed sites. *The Forestry Chronicle* 72(6): 615-621.

BROWN, T. 2006. Personal Communication.

BRYANT, L.D. 2005. Personal Communication.

CARSON, R. 1962. Silent Spring. Houghton Mifflin, New York.

COPE, A., D. DOXFORD, AND G. MILLAR. 1999. Counting users of informal recreation facilities. *Managing Leisure* 4: 229-244.

CORDELL H.K. AND C. OVERDEVEST. 2001. Footprints on the Land: An Assessment of Demographic Trends and the Future of Natural Lands in the United States. Sagamore Publishing, Champaign, IL.

COUPAL, R.H., C. BASTIAN, J. MAY, AND D.T. TAYLOR. 2001. The economic benefits of snowmobiling to Wyoming residents: a travel cost approach with market segementation. *Journal of Leisure Research* 33(4): 492-510.

CREEL, M.D. AND J.B. LOOMIS. 1990. Theorestical and empirical advantages of truncated count data estimators for analysis of deer hunting in Califonia. *American Journal of Agricultural Eocnomics*. 72:434-441.

CROSSLEY, J., AND B. LEE. 1994. Characteristics of Ecotourists and Mass Tourists. *Visions in Leisure and Business* 13(2): 4-12.

DRAKE, L. 1992. The non-market value of the Swedish agricultural landscape. *European Review of Agricultural Economics* 19: 351-364.

DRIVER, B.L., D. DUSTIN, T. BALTIC, G. ELSNER, AND G. PETERSON (EDS.). 1994. Nature and the Human Spirit: Toward an Expanded Land Management Ethic. Venture Publishing, Inc. State College, PA.

ECOLOGICAL SOCIETY OF AMERICA. 2000. Ecosystem Services: A Primer. Ecosystem Services Fact Sheet. Ecological Society of America. Washington D.C.

ENGLIN, J., P.C. BOXALL, K. CHAKRABORTY, AND D.O. WATSON. 1996. Valuing the impacts of forest fires on backcountry forest recreation. *Forest Science* 42(4): 450-455.

ENGLIN, J., J. LOOMIS, AND A. GONZALEZ-CABAN. 2001. The dynamic path of recreation values following a forest fire: a comparative analysis of states in the Intermountain West. *Canadian Journal of Forestry Research* 31: 1837-1844.

ENGLIN, J. AND J.S. SHONKWILER. 1995. Estimating social welfare using count data models: an application to long-run recreation demand under conditions of endogenous stratification and truncation. *Review of Economics and Statistics*. 77:104-112.

ENGLISH, D.B.K. 2006. Personal communication.

ENGLISH, D.B.K., AND J.M. BOWKER. 1996. Sensitivity of whitewater rafting consumers surplus to pecuniary travel cost specifications. *Journal of Environmental Management* 47: 79-91.

ENGLISH, D.B.K., S.M. KOCIS, S.J. ZARNOCH, AND J.R. ARNOLD. 2002. Forest Service National Visitor Use Monitoring Process: Research Method Documentation. General Technical Report SRS-57. USDA Forest Service Southern Research Station. Asheville, NC.

FIX, P., J. LOOMIS, AND R. EICHHORN. 2000. Endogenously chosen travel costs and the travel cost model: an application to mountain biking at Moab, Utah. *Applied Economics* 32: 1227-1231.

FIX, P. AND J. LOOMIS. 1997. The economic benefits of mountain biking at one of its meccas: an application of the travel cost method to mountain biking in Moab, Utah. *Journal of Leisure Research* 29(3): 342-352.

FLEISCHER A. AND Y. TSUR. 2000. Measuring recreational value of agricultural landscape. *European Review of Agricultural Economics*. 27(3): 385-398.

GEISSLER, P. AND D. RADLOFF. 2004. Personal communication.

GERA, M., G. MOHAN, AND N.S. BISHT. 2005. Recreation value of the Fri estate – an application of travel cost method. *Indian Forester*, June: 765-772.

GOEBEL, J.J., SHREDER, H.T., HOUSE, C.C., GEISSLER, P.H., OLSEN, A.R. AND WILLIAMS, W.R. 1998. Integrating surveys of terrestrial natural resources: the Oregon demonstration project. Inventory and Monitoring Report No. 2. USDA Forest Service, Washington DC.

GOTTFRIED, G.J. AND R.D. PIEPER. 2000. Pinyon Juniper Rangelands. pp. 153-212 in R. Jemison and C. Raish (eds.). Livestock Management in the American Southwest. Elsevier Science B.V. Amsterdam, The Netherlands.

GROSETA, A. 2005. Technical Tour Presentation to the National Public Lands Council. National Public Lands Council Annual Meeting Technical Tour, September 15, 2005. Cottonwood, Arizona.

HAAB, T.C. AND K.E. MCCONNELL. 2002. Valuing Environmental and Natural Resources: the Econometrics of Non-Market Valuation. Edward Elgar, Northampton, MA.

HARNIK, P. AND A. KIMBALL. 2005. If you don't count, your park won't count: estimating the numbers of city park users can be difficult, but it is important to receive funding. *Parks and Recreation*, June 2005: 8-14.

HESSELN, H., J.B. LOOMIS, A. GONZALEZ-CABAN, AND S. ALEXANDER. 2003. Wildlife effects on hiking and biking demand in New Mexico: a travel cost study. *Journal of Environmental Management* 69: 359-368.

HESSELN, H., J.B. LOOMIS, AND A. GONZALEZ-CABAN. 2003. The effects of fire on hiking demand: a travel cost study of Colorado and Montana. USDA Forest Service Proceedings RMRS-P-29.

HOLECHEK, J.L., R.D. PIEPER, AND C.H. HERBEL. 2001. Range Management: Principles and Practices. Prentice Hall, Upper Saddle River, NJ.

HOLLENHORST, S., M.A. SCHUETT, D. OLSON, AND D. CHAVEZ. 1995. An examination of the characteristics, preferences, and attitudes of mountain bike users of the national forests. *Journal of Park and Recreation Administration* 13(3): 41-51.

JANOWSKY D.V. AND G. BECKER. 2003. Characteristics and needs of different user groups in the urban forest of Stuttgart. *Journal of Nature Conservation* 11: 251-259.

KIM, S.S. AND B. PRIDEAUX. 2005. Marketing implications arising from a comparative study of international pleasure tourist motivations and other travel-related characteristics of visitors to Korea. *Tourism Management* 26: 347-357.

KLING, C.L. 1989. A note on the welfare effects of omitting substitute prices and qualities from travel cost models. *Land Economics* 65(3): 290-296.

KNUDSON, D.M. 1984. Outdoor Recreation. Macmillan Publishing. New York, New York.

KOLSTAD, C.D. 2000. Environmental Economics. Oxford University Press. New York, New York.

LANDSELL, N. AND L. GANGADHARAN. 2003. Comparing travel cost models and the precision of their consumer surplus estimates: Albert Park and Maroondah Reservoir. *Australian Economic Papers*, December: 399-417.

LONG, J.S. AND L.H. ERVIN. 2000. Using heteroscedasticity consistent standard errors in the linear regression model. *The American Statistician* 53: 217-224.

LOOMIS, J.B. 2006. Personal Communication.

LOOMIS, J.B. 2002. Integrated Public Lands Management. Columbia University Press, New York, New York.

LOOMIS, J. 2002. Quantifying recreation use values from removing dams and restoring free-flowing rivers: a contingent behavior travel cost demand model for the Lower Snake River. *Water Resources Research* 38(6): 2-1 – 2-8.

LOOMIS, J., A. GONZALEZ-CABAN, AND J. ENGLIN. 2001. Testing for differential effects of forest fires on hiking and mountain biking demand and benefits. *Journal of Agricultural and Resource Economics* 26(2): 508-522.

LOOMIS, J.B. AND R.G. WALSH. 1997. Recreation Economic Decisions: Comparing Benefits and Costs. Venture Publishing, Inc. State College, PA.

MCCLARAN, M.P. 2000. Improving Livestock Management in Wilderness. USDA Forest Service Proceedings. RMRS-P-15-Vol 5. Rocky Mountain Research Station. Ogden, UT.

MCKEAN, J.R., D. JOHNSON, AND R.G. TAYLOR. 2003. Measuring demand for flat water recreation using a two-stage/disequilibrium travel cost model with adjustment for overdispersion and self-selection. *Water Resources Research* 39(4): WES6-1 – WES6-8.

MILLER, R.F. AND J.A. ROSE. 1999. Fire history and western juniper encroachment in sagebrush steppe. *Journal of Range Management* 52: 550-559.

MITCHELL, J.E. 2004. Personal communication.

MITCHELL, J.E. AND R.H. HART. 1987. Winter of 1886-87: The Death Knell of the Open Range. *Rangelands* 9(1): 3-8.

MITCHELL J.E., P.F. FOLLIOTT, AND M. PATTON-MALLORY. 2005. Back to the Future: Forest Service Research and Management. *Rangelands* 27(3): 19-28.

MOORE, R.L. AND A.R. GRAEFE. 1994. Attachments to recreation settings: the case of rail-trail users. *Leisure Sciences* 16: 17-31.

MUEGGLER, W.F. 1988. Aspen community types of the Intermountain Region. USDA Forest Service General Technical Report INT-250. Intermountain Research Station, Ogden, UT.

NATIONAL RESEARCH COUNCIL. 2005. Valuing Ecosystem Services: Toward Better Environmental Decision-making. The National Academies Press, Washington D.C.

OBUA, J. AND D.M. HARDING. 1996. Visitor characteristics and attitudes towards Kibale National Park, Uganda. *Tourism Management* 17(7): 495-505.

PIZAM, A. AND A. FLEISCHER. 2005. The relationship between cultural characteristics and preference for active vs. passive tourist activities. *Journal of Hospitality and Leisure Marketing* 12(4): 5-25.

POOR, P.J. AND J.M. SMITH. 2004. Travel cost analysis of a cultural heritage site: the case of historic St. Mary's City of Maryland. *Journal of Cultural Economics* 28:217-229.

PUBLIC LANDS COUNCIL. 2005. Resolutions for the September Public Lands Council Meeting. September 12-15, 2005. Cottonwood, Arizona.

QUIGLEY, T.M. 2005. Evolving Views of Public Lands Values and Management of Natural Resources. *Rangelands* 27(3): 37-44.

READY, R.C., M.C. BERGER, AND G.C. BLOMQUIST. 1997. Measuring Ameinty Benefits from Farmland: Hedonic Pricing vs. Contingent Valuation. *Growth and Change* 28(4): 438-458.

REYNOLDS, G. AND M.J. ELSON. 1996. The sustainable use of sensitive countryside sites for sport and active recreation. *Journal of Environmental Planning and Management* 39(4): 563-76.

ROSENBERGER, R.S. AND J.B. LOOMIS. 2001. Benefit transfer of outdoor recreation use values: a technical document supporting the Forest Service strategic plan. General Technical Report RMRS-GTR-72. USDA Forest Service, Rocky Mountain Research Station.

ROSENBERGER, R.S. AND J.B. LOOMIS. 1999. The value of ranch open space to tourists: combining observed and contingent behavior data. *Growth and Change* 30(3): 366-383.

ROSENBERGER, R.S. AND R.G. WALSH. 1997. Nonmarket value of western valley ranchland using contingent valuation. *Journal of Agricultural and Resource Economics* 22(2): 296-309.

ROSENTHAL, D.H. 1987. The necessity of substitute prices in recreation demand analyses. *American Journal of Agricultural Economics*. November: 828-837.

ROWAN, R.C. AND J.P. WORKMAN. 1992. Factors affecting Utah ranch prices. *Journal of Range Management* 45:263-266.

SHIELDS, D., I. MARTIN, W. MARTIN, AND M. HAEFELE. 2002. Survey Results of the American Public's Values, Objectives, Beliefs, and Attitudes Regarding Forests and Rangelands. Gen. Tech. Rep. RMRS-GTR-95. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

SHRESTHA, R.K., A.F. SEIDL, AND A.S. MORAES. 2002. Value of recreational fishing in the Brazilian Pantanal: a travel cost analysis using count data models. *Ecological Economics* 42: 289-299.

SIDERELIS, C. AND R. MOORE. 2000. Incorporating users' perceptions of site quality in a recreation travel cost model. *Journal of Leisure Research* 32(4): 406-414.

SMITH, W.B., P.D. MILES, J.S. VISSAGE, AND S.A. PUGH. 2004. Forest Resources of the United States, 2002. General Technical Report, GTR-NC-241. USDA Forest Service, North Central Research Station, St. Paul, MN.

SOCIETY FOR RANGE MANAGEMENT. 2005. Rangelands and Global Change. http://www.rangelands.org/pdf/Global_Issue_Paper.pdf. Denver, CO.

SORGE, G. 2000. Focus on Master Plans. *Public Works* 131(12): 40-43.

SUSTAINABLE RANGELANDS ROUNDTABLE. 2003. Criteria and Indicators of Sustainable Rangelands: Executive Summary. Available at http://SustainableRangelands.cnr.colostate.edu. Colorado State Univ., Fort Collins, Colo.

TANAKA, J., L.A. TORELL, L.V. SWANSON, M. BRUNSON, D. MCCOLLUM, AND H.T. HEINTZ, JR. 2003. Indicators for maintenance and enhancement of multiple economic and social benefits to current and future generations, p 171-199. *In:* Sustainable Rangelands Roundtable (ed.) Criteria and indicators for sustainable rangelands: a first approximation report. Available at http://SustainableRangelands.cnr.colostate.edu. Accessed March 23, 2006. Colorado State Univ., Fort Collins, Colo.

TAUSCH, R. AND TUELLER, P. 1990. Foliage biomass and cover relationships between tree and shrub-dominated communities in pinyon-juniper woodlands. *Great Basin Naturalist.* 50: 121-134.

THE H. JOHN HEINZ III CENTER FOR SCIENCE, ECONOMICS AND THE ENVIRONMENT. 2002. The state of our Nation's ecosystems. Cambridge University Press, New York, NY.

TORRELL, L.A. AND S.A. BAILEY. 2000. Is the profit motive an important determinant of grazing land use and rancher motive? Selected Papers of the western Agricultural Economics Association Annual Meeting. Vancouver B.C. June 29-July 1, 2000. Agricultural Economics Research: Research in Agriculture and Applied Economics.

TURPIE, J. AND A. JOUBERT. 2001. Estimating potential impacts of a change in river quality on the tourism value of Kruger National Park: an application of travel

cost, contingent, and conjoint valuation methods. *Water South Africa* 27(3): 387-398.

USDA FOREST SERVICE. 2004. National report on sustainable forests – 2003. FS-766. USDA Forest Service, Washington, DC.

US WATER RESOURCES COUNCIL. 1983. Economic and environmental principles and guidelines for water and related land resources implementation studies. US Government Printing Office, Washington DC.

UYSAL, M., C. JUROWSKI, F.P. NOE, AND C.D. MCDONALD. 1994. Environmental attitude by trip and visitor characteristics: US Virgin Islands National Park. *Tourism Management* 15 (4) 284-294.

VAN TASSELL, L.W., E.T. BARTLETT AND J.E. MITCHELL. 2001. Projected use of grazed forages in the United States: 2000 to 2050. USDA For. Serv. Rocky Mountain Res. Sta. Gen. Tech. Rep. RMRS-GTR-82. Fort Collins, Colo.

VAVRA, M. 1995. Rangeland Research: strategies for providing sustainability and stewardship to the rangelands of America and the world. *Rangelands* 17(6): 200-214.

WALLACE, G.N., MITCHELL, J.E., AND WELLS, M.D. 1996. Visitor perceptions about grazing on a Forest Service allotment. Research Paper RM-RP-321. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

WALSH, R., D.M. JOHNSON, AND J.R. MCKEAN. 1992. Benefit transfer of outdoor recreation demand studies, 1968-1988. *Water Resources Research* 28:707-713.

WARD, F.A. AND D. BEAL. 2000. Valuing Nature with Travel Cost Models. Edward Elgar Publishing, Cheltenham, UK.

WHITE, D., T.E. HALL, AND T.A. FARRELL. 2001. Influence of Ecological Impacts and Other Campsite Characteristics on Wilderness Visitors' Campsite Choices. *Journal of Park and Recreation Administration* 19(2): 83-97.

WHITTEN, S.M. AND J.W. BENNETT. 2002. A travel cost study of duck hunting in the upper south east of South Australia. *Australian Geographer* 33(2): 207-221.

WILLIS, K.G. AND G.D. GARROD. 1993. Valuing landscape: a contingent valuation approach. *Journal of Environmental Management* 37: 1-22.

WORLD RESOURCES INSTITUTE. 1998. World Resources 1998-99: Environmental change and human health. A joint publication by the World Resources Institute, the United Nations Environment Programme, the United Nations Development Programme, and The World Bank.

CHAPTER V: CONCLUSIONS

This study identifies rangeland recreation sites in the USDA Forest Service National Visitor Use Monitoring (NVUM) program (English et al. 2002) for recreation data collection on National Forest System (NFS) lands; assesses rangeland visitor demographics and activities; and estimates benefits associated with rangeland recreation on National Forests and Grasslands using a basic travel cost model. Thus, this study provides the first approximation of rangeland activities, user characteristics, and non-market values of rangeland recreation. Information derived may help serve as a basis for regional and national management decisions that affect NFS forests and grasslands, since management decisions are negatively impacted by absence of monitoring (Reynolds and Elson 1996). Managing visitors effectively requires information about their numbers, composition, distribution, and activities (Janowsky and Becker 2003).

Information herein may alter perceptions of the importance of rangelands for various recreation opportunities. It is also anticipated that data will augment extant forest strategic planning, policies, and decision-making at regional and national levels, consistent with contentions of Cope et al. (1999) regarding improved regional planning as a result of improved understanding of demand and need for various recreation opportunities.

Utility at Multiple Spatial Scales

Nationally, data pertaining to rangeland recreation values will highlight the importance of this unique resource to a diverse group of stakeholders. Producer groups representing the cattle industry and wildlife groups with habitat concerns are typically characterized as rangeland constituent groups to be considered regarding NFS management decisions and legislation changes. Ability to also emphasize recreation values of rangelands will engage a broader audience in these processes. Moore and Graefe (1994) posit that users with attachments to specific recreation sites would be likely to participate in public involvement processes associated with these sites. Harnik and Kimball (2005) state that public interests in benefits and appropriations are analogous to private sector emphases on investment and profit.

At the regional level, information about values associated with various rangeland recreation activities may impact budget allocations, staffing levels and assignments. Knowledge about how, when, and where people recreate is critical to management decisions regarding staff time and funding (Harnik and Kimball 2005). Previous studies also have discussed the applicability of range management knowledge and skills, such as assessment of grazing pressure and impacts, to recreation management (McClaran 2000).

Locally, knowledge of visitor characteristics may improve design and content of both behavior modification and interpretative information provided to visitors in leaflets, exhibits, and signs, as demonstrated by Hood and Roberts (1994) and Boisvert and Slez (1994). Quantification of the availability of rangeland recreation opportunities also will assist managers in determining and justifying whether additional staff with range management training are necessary to adequately deal with both production and

recreation use of rangeland resources. Matching visitor characteristics with employee skills, as demonstrated by Kuntsler's (1997) work with recreation internships for bilingual college students, may also be facilitated through collection of information about visitor characteristics.

Additionally, non-market values attached to specific recreation resources may assist with resolution of potential conflicts among competitive uses. Prediction and resolution of potential conflicts before they happen, based on information about location of high use rangeland recreation sites in proximity to active grazing allotments, may alleviate investment of staff time in conflict resolution required after problems occur (Wallace et al. 1996). Information about relative values attached to areas with both recreation sites and active grazing allotments may provide a basis for balancing among potentially incompatible uses.

As recreational use of rangelands increases, conflicts with traditional production interests will likely increase too. National Cattlemen's Beef Association leadership already have noted damage to land improvements and water distribution systems resulting from recreational use of FS grazing allotments (Groseta 2005). Information about production and recreation values of rangeland will assist managers with critical decisions about land use in the future. Given the low consumer surpluses associated with NFS rangeland recreation in this study, perhaps public lands grazing may be a more economically viable land use under certain circumstances.

Summary of Study Results

Rangelands provide a setting for at least 30 percent of the USDA Forest Service NVUM developed recreation sample sites in the Rocky Mountains, and more than 25 percent of these sites in the Pacific Coast. It is clear that rangelands are valuable for increasing recreation activities, as well as traditional production uses. Identification of amount and distribution of rangeland recreation occurring on NFS lands is necessary for effective land management, and legislatively mandated monitoring and reporting. Study results regarding visitor characteristics and activity preferences of NFS rangeland recreators represent the first national assessment of rangeland user demographics and recreational pursuits. Current USDA Forest Service Chief Dale Bosworth's (2003) concern about unmanaged recreation accentuates the need for improved information.

More than half of rangeland recreators are between 31 and 50 years of age, with the majority of that group falling into the 41 to 50 year-old age category. Only in developed day use and overnight developed sites located in the Pacific Coast region were these numbers different, with younger dominant users; more than 58 percent of users at overnight developed sites were between 21 and 40 years of age. Most NVUM survey respondents queried at rangeland sites were male, with slightly higher numbers of females represented in the Pacific Coast region. Higher percentages of female visitors also were recorded at wilderness sites and developed day use and overnight sites, as compared to general forest areas. A majority of rangeland NVUM respondents, over 90 percent, were white, with Hispanics the next most frequent NFS rangeland visitors at 5.3 percent. Approximately 1 percent of respondents were from other countries.

Among NVUM survey respondents contacted at NFS rangeland sites in the Western United States, the three most popular main activities were hiking or walking, followed by hunting, with viewing nature and scenery on the National Forest or Grassland ranking third. While hiking or walking was the dominant main rangeland recreation activity in both the Rocky Mountain and Pacific Coast regions, differences existed in the second and third main activities across regions. Main rangeland recreation activities identified by NVUM survey respondents varied with both age and gender.

Results generated by this study of NFS rangeland recreation are consistent with findings of more localized studies. Sorge (2005) emphasized the increasing need for recreation areas that accommodate activities including walking as the population ages. Hiking and walking are already the most typical main activity of those recreating on NFS rangelands; expansion of this demand and associated consumer surpluses are likely in the future.

Calculation of consumer surpluses for recreation activities engaged in within the context of specific vegetation types, such as rangeland or forest, may provide more accurate measurements of the value people place upon recreation sites with certain characteristics. Although the values associated with overall recreation are higher than those for rangeland recreation generated in this study, lumping high dollar water and snow pursuits with less costly recreation activities may artificially inflate overall recreation consumer surpluses, potentially hindering effective management planning for specific resources and recreation settings. For example, the $25.68 consumer surplus derived for hiking on NFS rangelands in the Rocky Mountain region is similar to Walsh et al.'s (1992) estimate of the national average of hiking at $29, and only slightly lower

than the $37 average value generated by Rosenberger and Loomis (2000) when they updated the Walsh et al. (1992) study. The Bowker et al. (2005) national average consumer surplus estimate of $118.70 is well above this range of values.

Caveats to Consider

It must be noted that although analyses of rangeland recreation activities, user demographics, travel costs and consumer surpluses described here are adequate for an initial assessment of NFS rangeland recreation, numbers reported in this study are likely lower than actual numbers for several reasons. These issues include: extraction of data from a sample designed for forests, rangelands, water, and snow activities, instead of exclusively for rangelands; incomplete data reporting from national forests and grasslands, leaving gaps in the information; scant demographic data and substitute site information, which is important for travel cost modeling; and ambiguity associated with definitions of rangelands.

The list of sample sites (DUDS, OUDS, GFA, and WILD) represented in the NVUM database is not yet complete. Although the sampling design provided for completion of the initial sample of visitor use monitoring on all NFS forests and grasslands by 2004 (English et al., 2002), not all units have provided data with coordinates for geo-referencing. Addition of data from NVUM rangeland sample points located within management units that have yet to report could logically increase participant numbers and could also affect consumer surpluses.

Also, inclusion of a NVUM survey question that defines rangelands for respondents, and then asks whether the respondent recreated on rangelands while visiting

the National Forest or Grassland could provide more clarity to classification of observations as associated with rangeland recreation sites. At present, participation in the NVUM survey at a sample site located on rangelands is presumed to represent rangeland recreation. Explicitly asking NVUM survey participants whether they recreated on rangelands would negate the need for this assumption.

With regard to limitations of the 1992 US Geological Survey – Environmental Protection Agency National Land Cover Dataset (NLCD) information used to identify rangeland NVUM sample sites, issues to note deal with representation of vegetation types depicted in remotely sensed data as a forest cover type, but commonly recognized as rangeland. Aspen and pinion-juniper ecosystems fall into this category. For example, aspen may be classified as a forest vegetation type; however, the understory vegetation present in an aspen grove may contain as much as 3800 pounds of air-dried forage per acre (Mueggler 1988). Also, exclusion of fire by livestock grazing and active fire suppression helped hasten expansion of pinion-juniper woodlands across open savannas and grasslands in the late 19th and early 20th centuries (Tausch and Tueller 1990; Miller and Rose 1999). The precise point at which rangelands become woodlands is subjective, dealing with between-tree spacing and groundcover. These communities are difficult to accurately classify from remotely sensed data such as NLCD.

As of 2002, pinion-juniper covered approximately 13.6 million acres of USDA Forest Service lands in the western United States (Smith et al. 1994); recreation sites that fall in these areas may be inaccurately identified as occurring on woodlands rather than rangelands. Increases in traditional recreational use of pinion-juniper woodlands, such as

camping and nut-gathering, has risen with population growth and is expected to continue (Gottfried and Pieper 2000).

This forest versus rangeland debate is directly associated with definitional issues that must be resolved to provide more clarity to any discussion of rangeland use and value. Indeed, overlaps between these definitions results in addition of total rangeland area plus total forest area summing to more than existing total land area. The Oregon Demonstration Project (Goebel et al. 1998) found 10 to 15 percent difference in areas of forests and rangelands depending on definitions.

Several groups involved in development of monitoring and reporting frameworks have previously identified this problem. Both the Sustainable Rangelands Roundtable (Maczko 2004) and the USDA Forest Service (2004) national report on sustainable forests discussed the differing operational definitions of forests and rangelands. Although members of the Roundtable on Sustainable Forests, the Sustainable Rangelands Roundtable, the Federal Geographic Data Committee (FGDC) Sustainable Forest Data Working Group, FGDC Vegetation Subcommittee, FGDC Sample Inventory and Monitoring of Natural Resources and the Environment Working Group, Bureau of Land Management, Forest Service, Natural Resources Conservation Service, US Geological Survey, Society for Range Management, Society of American Foresters, and NatureServe acknowledge the need to develop standard definitions of forest and rangeland (Bartlett et al. 2003), in 2004, the agencies suspended efforts to resolve this ambiguity (Geissler and Radloff 2004, pers. comm.). Until rangelands are definitively described, description of any activity or site, recreational or otherwise, occurring on rangelands remains ambiguous.

Lastly, it is also worth mentioning alternate methodologies that can potentially be applied to analysis of national point data and NLCD vegetation coverages. While this study utilized an Environmental Systems Research Institute, Inc. (ESRI) ArcMap version 8.3 grid-based assessment through Spatial Analyst, it is also possible to conduct a similar analysis with an ESRI ArcInfo vector-based protocol.

Tradeoffs occur between having all data in the same environment for analyses, and maintaining data in its original form but conducting individual analyses for each point in the national data set. With regard to integration of NVUM and NLCD data, the former offers a simpler, faster classification protocol while the latter is more time consuming and maintains more detail to be used in the classification process. Though this study is national in scope, it is foreseeable that individual forests and/or management districts may wish to perform localized iterations of this analysis. Therefore, Forest Service scientists requested design of a simple analysis and classification protocol, rather than generation of more complex details about relative proportions of vegetation types within grid cells for percentage-based classifications (English, December 2005, personal communication).

Additional data including marital status, employment, education, income, social class, rural or urban residence, and number of children also have been shown to be significantly related to recreation behavior (Crossley 1994, Uysal et al. 1994, Beerli and Martin 2004, Kim and Prideaux 2005, Pizam and Fleisher 2005, Obua and Harding 1996, Hollenhorst et al. 1995, Andereck et al. 2001, White et al. 2001), however the initial round of NVUM surveys did not collect such detailed data. As asserted by White et al. (2001) regarding visitor perceptions of NFS wilderness campsites, it is likely that

collection and analyses of a more extensive set of socio-demographic information from USDA Forest Service NFS rangeland recreators, as time and resources permit, would be fruitful.

Lastly, incorporation of site substitute information in future National Forest and Grassland recreation surveys would enhance travel cost modeling. While use of substitute sites with NVUM data caused collinearity problems for Bowker et al. (2005), exploration of their effectiveness in the context of a vegetation-specific travel cost model would be useful.

Future Research

Although this study offers an initial assessment of rangeland recreation sites in the USDA Forest Service National Visitor Use Monitoring (NVUM) program for recreation data collection on National Forest System (NFS) lands; visitor demographics and activities; and consumer surpluses associated with rangeland recreation on USDA National Forests and Grasslands, further research is needed. A survey designed specifically for collection of information about rangeland recreation, rather than extraction of rangeland information from a more comprehensive survey conducted across land cover types, could improve analysis results. A larger rangeland sample would facilitate comparisons of rangeland recreation values across the four NVUM site types (DUDS, OUDS, GFA, and Wilderness). Also, this study quantified very diverse consumer surplus values associated with NFS rangeland recreation, with larger average surpluses in the Pacific Coast region. While this variation may be associated with population densities, a more comprehensive NFS rangeland recreation survey could further explore these regional differences.

Additionally, for comparison purposes, a similar travel cost model should be generated for NVUM forest recreation sites, with high-cost water recreation activities (Brown, pers. comm., 2006) excluded, to provide a comparable estimate of forest recreation values. While consumer surpluses for rangeland recreation derived here appear low in comparison to all-inclusive National Forest recreation numbers, a forest-specific model may produce lower numbers too. A model of NFS rangeland production values that explicitly enumerates non-market benefits to ranchers would also be informative, as proposed by Bartlett et al. (2002).

Concluding Thoughts

Despite the catalog of caveats outlined above, this study is distinctive as the first attempt to quantify NFS rangeland recreation. As demand for recreation increases, use of finite rangeland resources will also increase. The public demands responsive, responsible management of these resources. Therefore, regional and national inventory and monitoring of rangeland recreation is critical to ensuring provision of adequate rangeland recreation opportunities for the American public. These resources must also be protected and conserved for consumptive and production uses, as prescribed in USDA Forest Service enabling legislation.

Sustainable land management, espoused by the USDA Forest Service as an appropriate public land management paradigm since the mid-1990s (Dombeck 1998), requires equal consideration of economic, social, and ecological elements (Bryant et al. 2004). Successful management plans must address varied uses and values of public lands, balancing and incorporating stakeholder interests to avoid legal challenges.

Accurate information about rangeland recreation is essential for efficient allocation of staff and financial resources.

While rangeland use and management has changed greatly since the 1800s, as evidenced by increasing attention being paid to non-production uses of rangelands, and Bartlett et al.'s (2002) discussion of valuation of these non-market goods and services, additional modifications in federal lands planning and management are doubtless in the offing. Adaptive management embodied in federal land management agencies planning practices (Loomis 2002) will continue to integrate evolving societal values, as well as accommodating more traditional production activities. Effective management should blend social, economic, and ecological aspects of rangeland sustainability to balance these multiple uses for current and future generations.

Results presented here provide a baseline from which to continue analyses and discussions of NFS rangeland recreation. Expanding uses, projected increasing use intensities, and diverse rangeland stakeholders ensure that the debate will be interesting and ongoing. This study represents a valuable starting point from which knowledge about rangeland recreation on USDA Forest Service National Forest System lands will only improve.

LITERATURE CITED

Andereck, K.L, C.A. Vogt, K. Larkin, and K. Freye. 2001. Differences between Motorized and Nonmotorized Trail Users. Journal of Park and Recreation Administration 19(3): 62-77.

Bartlett E.T., L.A. Torell, N.R. Rimbey, L.W. Van Tassell, and D.W. McCollum. 2002. Valuing grazing use on public land. Journal of Range Management 55(5): 426-438.

Beerli, A. and J.D. Martin. 2004. Tourists' characteristics and the perceived image of tourist destinations: a quantitative analysis - a case study of Lanzarote, Spain. Tourism Management 25: 623-636.

Boisvert, D.L. and B.J. Slez. 1994. The relationship between visitor characteristics and learning-associated behaviors in a science museum discovery space. Science Education 78(2): 137-148.

Bosworth, D. 2003. Speech to the San Francisco Commonwealth Club. April 23, 2003. San Francisco, CA.

Bowker, J.M., D.B.K. English, J.C. Bergstrom, C.M. Starbuck, R. Rosenberger, and D. McCollum. 2005. Towards Estimation of US National Forest Recreational Value: National Visitor Use Monitoring System Results. Unpublished USDA Forest Service Working Paper.

Brown, T. 2006. Personal communication.

Bryant, L.D., K.A. Maczko, and D.W. Thompson. 2004. Rangeland sustainability: integrating social, ecological, and economic indicators. In: Peterson, J.W. (ed.) Proc. 2nd Nat. Conf. on Grazing Lands, December 7-10, 2003. Nashville, Tenn. Grazing Lands Conservation Initiative. Bryan, Texas.

Cope, A., D. Doxford, and G. Millar. 1999. Counting users of informal recreation facilities. Managing Leisure 4: 229-244.

Crossley, J., and B. Lee. 1994. Characteristics of Ecotourists and Mass Tourists. Visions in Leisure and Business 13(2): 4-12.

Dombeck M 1998. A gradual unfolding of a national purpose: a natural resource agenda for the 21st century. Speech to USDA Forest Service employees on 2 March 1998. USDA Forest Service, Washington DC.

English, D.B.K. 2005. Personal communication.

English, D.B.K., S.M. Kocis, S.J. Zarnoch, and J.R. Arnold. 2002. Forest Service National Visitor Use Monitoring Process: Research Method Documentation. General Technical Report SRS-57. USDA Forest Service Southern Research Station. Asheville, NC.

Geissler, P. and D. Radloff 2004. Personal communication.

Goebel, J.J., Shreder, H.T., House, C.C., Geissler, P.H., Olsen, A.R. and Williams, W.R. 1998. Integrating surveys of terrestrial natural resources: the Oregon demonstration project. Inventory and Monitoring Report No. 2. USDA Forest Service, Washington DC.

Gottfried, G.J. and R.D. Pieper. 2000. Pinyon Juniper Rangelands. pp. 153-212 in R. Jemison and C. Raish (eds.). Livestock Management in the American Southwest. Elsevier Science B.V. Amsterdam, The Netherlands.

Groseta, A. 2005. Technical Tour Presentation to the National Public Lands Council. National Public Lands Council Annual Meeting Technical Tour, September 15, 2005. Cottonwood, Arizona.

Harnik, P. and A. Kimball. 2005. If you don't count, your park won't count: estimating the numbers of city park users can be difficult, but it is important to receive funding. Parks and Recreation, June 2005: 8-14.

Hollenhorst, S., M.A. Schuett, D. Olson, and D. Chavez. 1995. An examination of the characteristics, preferences, and attitudes of mountain bike users of the national forests. Journal of Park and Recreation Administration 13(3): 41-51.

Hood, M.G. and L.C. Roberts. 1994. Neither too young nor too old: a comparison of visitor characteristics. Curator 37(1): 36-45.

Janowsky D.V. and G. Becker. 2003. Characteristics and needs of different user groups in the urban forest of Stuttgart. Journal of Nature Conservation 11: 251-259.

Kim, S.S. and B. Prideaux. 2005. Marketing implications arising from a comparative study of international pleasure tourist motivations and other travel-related characteristics of visitors to Korea. Tourism Management 26: 347-357.

Kunstler, R. 1997. Matching Staff and Client Charcteristics: A Public-Public Partnership as a Response to Cultural Diversity. Journal of Park and Recreation Administration 15(4): 79-91.

Loomis, J.B. 2002. Integrated Public Lands Management. Columbia University Press, New York, New York.

McClaran, M.P. 2000. Improving Livestock Management in Wilderness. USDA Forest Service Proceedings. RMRS-P-15-Vol 5. Rocky Mountain Research Station. Ogden, UT.

Maczko, K.A., L.D. Bryant, D.W. Thompson, and S.J. Borchard. 2004. Putting the pieces together: assessing social, ecological, and economic rangeland sustainability. Rangelands 26(3):3-14.

Miller, R.F. and J.A. Rose. 1999. Fire history and western juniper encroachment in sagebrush steppe. Journal of Range Management 52: 550-559.

Mitchell, J.E. 2004. Personal communication.

Moore, R.L. and A.R. Graefe. 1994. Attachments to recreation settings: the case of rail-trail users. Leisure Sciences 16: 17-31.

Mueggler, W.F. 1988. Aspen community types of the Intermountain Region. USDA Forest Service General Technical Report INT-250. Intermountain Research Station, Ogden, UT.

Obua, J. and D.M. Harding. 1996. Visitor characteristics and attitudes towards Kibale National Park, Uganda. Tourism Management 17(7): 495-505.

Pizam, A. and A. Fleischer. The relationship between cultural characteristics and preference for active vs. passive tourist activities. Journal of Hospitality and Leisure Marketing 12(4): 5-25.

Reynolds, G. and M.J. Elson. 1996. The sustainable use of sensitive countryside sites for sport and active recreation. Journal of Environmental Planning and Management 39(4): 563-76.

Rosenberger, R.S. and J.B. Loomis. 2001. Benefit transfer of outdoor recreation use values: a technical document supporting the Forest Service strategic plan. General Technical Report RMRS-GTR-72. USDA Forest Service, Rocky Mountain Research Station.

Smith, W.B., P.D. Miles, J.S. Vissage, and S.A. Pugh. 2004. Forest Resources of the United States, 2002. General Technical Report, GTR-NC-241. USDA Forest Service, North Central Research Station, St. Paul, MN.

Sorge, G. 2000. Focus on Master Plans. Public Works 131(12): 40-43.

Tausch, R. and P. Tueller. 1990. Foliage biomass and cover relationships between tree and shrub-dominated communities in pinyon-juniper woodlands. Great Basin Naturalist. 50: 121-134.

USDA Forest Service. 2004. National report on sustainable forests – 2003. FS-766. USDA Forest Service, Washington, DC.

Uysal, M., C. Jurowski, F.P. Noe, and C.D. McDonald. 1994. Environmental attitude by trip and visitor characteristics: US Virgin Islands National Park. Tourism Management 15(4): 284-294.

Wallace, G.N., Mitchell, J.E., and Wells, M.D. 1996. Visitor perceptions about grazing on a Forest Service allotment. Research Paper RM-RP-321. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Walsh, R., D.M. Johnson, and J.R. McKean. 1992. Benefit transfer of outdoor recreation demand studies, 1968-1988. Water Resources Research 28:707-713.

White, D., T.E. Hall, and T.A. Farrell. 2001. Influence of Ecological Impacts and Other Campsite Characteristics on Wilderness Visitors' Campsite Choices. Journal of Park and Recreation Administration 19(2): 83-97.