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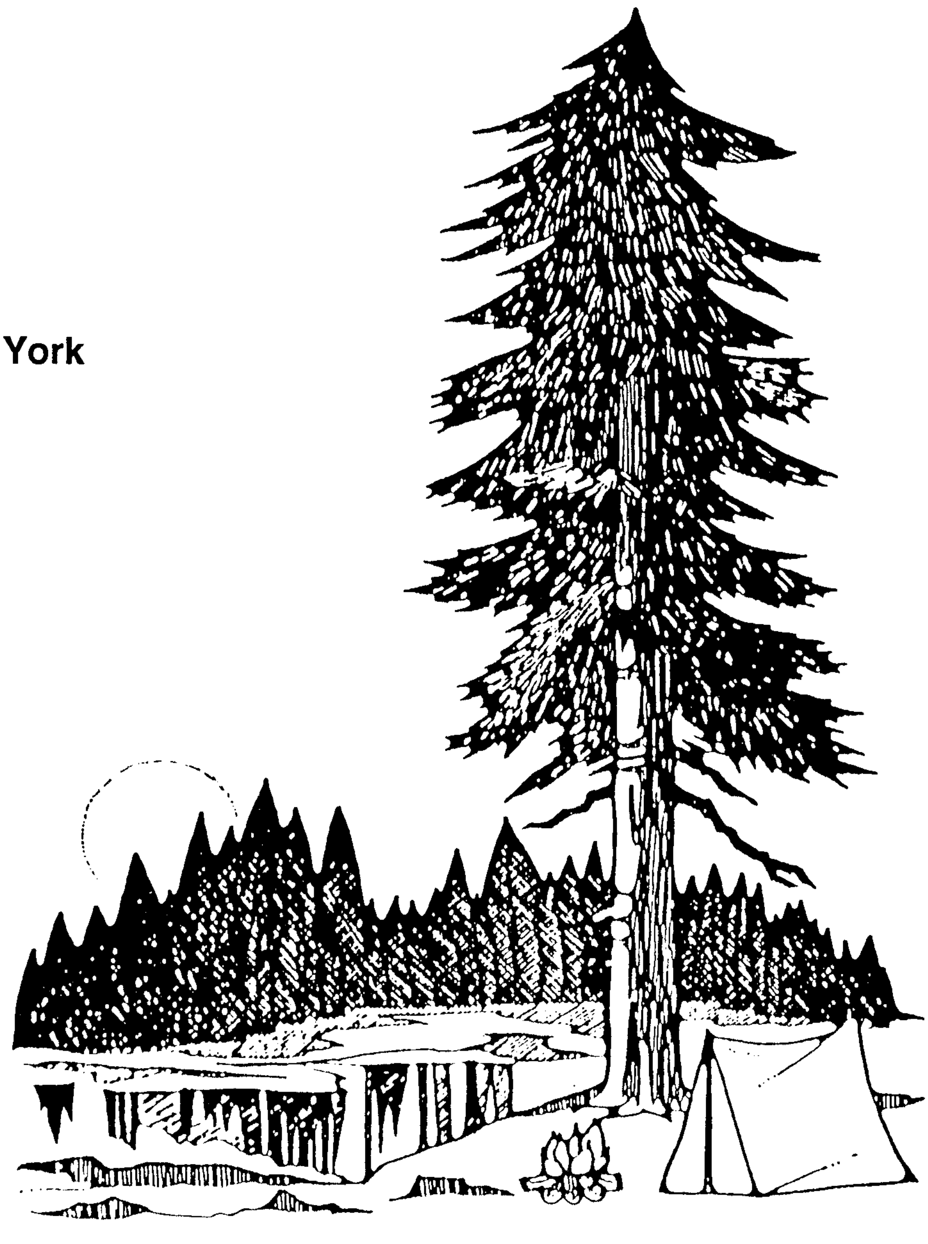

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The Northeastern Recreation Research meeting seeks to foster quality information exchange between recreation and travel resource managers and researchers throughout the Northeast. The forum provides opportunities for managers from different agencies and states, and from different governmental levels, to discuss current issues and problems in the field. Students and all those interested in continuing education in recreation and travel resource management are particularly welcome.

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PROCEEDINGS of the 1991 NORTHEASTERN RECREATION RESEARCH SYMPOSIUM

April 7-9, 1991
State Parks Management and Research Institute
Saratoga Springs, New York

Compiled and Edited by:

Gail A. Vander Stoep, University of Massachusetts

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TABLE OF CONTENTS

Page

KEYNOTES and GENERAL SESSIONS

Social Science in the National Park Service: An Evolving Mission and Program 3
DR. RICHARD H. BRICELAND, Assistant to the Director for Science and Technology, USDA National Park Service

Gardening as a Subversive Activity 6
DANIEL L. DUSTIN, Professor, Department of Recreation, Parks & Tourism, San Diego State University

The Grassroots Reach for the Sky 10
ANNE LUSK, Chair, Vermont Trails and Greenways Council

OUTDOOR RECREATION

OUTDOOR RECREATION I

An Exploratory Study of the Changes in Benefits sought during an Outward Bound Experience 15
STEVEN W. BURR, Instructor, and RICHARD J. GITELSON, Associate Professor, The Pennsylvania State University, Department of Leisure Studies

Black/White Outdoor Recreation Preferences and Participation: Illinois State Parks 20
JOHN F. DWYER, Research Forester, and PAUL H. GOBSTER, Research Social Scientist, USDA Forest Service, North Central Forest Experiment Station

The Spiritual Aspect of Nature: A Perspective from Depth Psychology 25
HERBERT W. SCHROEDER, Research Social Scientist, North Central Forest Experiment Station

The Extent and Types of Recreational Opportunities within the State of Maine for People with Disabilities 31
DEBORAH SUGERMAN, Associate Professor, Outdoor Recreation Department, Unity College

Implications of Boy Scout Group Use of Public Lands for Natural Resource Managers: A Regional Comparison 36
GAIL A. VANDER STOEP, Assistant Professor, Leisure Studies and Resources,University of Massachusetts

OUTDOOR RECREATION II

Recreational Programming in a Family Campground: An Exploratory Study 45
STUART P. COTTRELL, Research Assistant, and ALAN R. GRAEFE, Associate Professor, The Pennsylvania State University, Department of Leisure Studies

Fear in the Outdoor Environment: Description and Modification through Recreation Programs 51
ALAN EWERT, USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, and ANDERSON B. YOUNG, Professor and Chair, Department of Recreation and Leisure Studies, State University College at Cortland

Monitoring Visitor Experiences at Buck Island Reef National Monument 55
ALAN R. GRAEFE, Associate Professor, and ROGER MOORE, Research Assistant, The Pennsylvania State University, Department of Leisure Studies

OUTDOOR RECREATION PLANNING

Shorebird and Boater Impact Management Planning ... 61
ROBERT D. DEBLINGER, Associate Director for Natural Science, The Trustees of Reservations; JERRY J. VASKE, Associate Professor, Department of Resource Economics & Development, University of New Hampshire; MAUREEN P. DONNELLY, Assistant Professor, Department of Leisure Management & Tourism, University of New Hampshire; RUSS HOPPING, Research Assistant, College of the Atlantic

Vermont Lakes and Ponds: A Pilot Recreation Planning Process ... 66
DANIEL T. MALONE, Graduate Student, and JOHN J. LINDSAY, Associate Professor, Natural Resources Planning Program, University of Vermont

Environmental Glasnost: Protecting a Resource You Do Not Own ... 70
MALCOLM ROSS, JR., Resource Specialist, Upper Delaware Scenic and Recreation River, National Park Service

Lakes and Ponds Recreation Management: A State-wide Application of the Visitor Impact Management Process ... 72
JERRY J. VASKE, Associate Professor, Department of Resource Economics and Development, University of New Hampshire; RODNEY R. ZWICK, Assistant Professor, Department of Recreation Resource Management, Lyndon State College; MAUREEN P. DONNELLY, Assistant Professor, Department of Leisure Management and Tourism, University of New Hampshire

INNOVATIONS IN OUTDOOR RECREATION

River Recreation Management Opportunities in Hydroelectric Relicensing ... 81
JAMES R. BERNIER, Assistant Ranger, USDA Forest Service, Cadillac Ranger District

How the White Mountain National Forest Is Addressing Accessible Recreation Opportunities for Everyone ... 83
FRED KACPRZYNSKI, Recreation Specialist, White Mountain National Forest

Maryland Department of Natural Resources Camp Initiatives Program ... 86
KELLY SCHAEFFER, Graduate Student, The Pennsylvania State University

STATE PARKS

What Makes Dissatisfied State Park Campers? ... 91
MALCOLM I. BEVINS, Extension Professor, University of Vermont

Resident Perceptions of Vermont State Parks ... 94
HERBERT E. ECHELBERGER and THOMAS A. MORE, Northeastern Forest Experiment Station, USDA Forest Service

Measuring Users' Response to Higher Recreation Fees ... 98
STEPHEN D. REILING, Associate Professor; HSIANG TAI CHENG, Assistant Professor; CHERYL TROTT, Graduate Research Assistant, Department of Agricultural and Resource Economics, University of Maine

Economic Effects of State Park Recreation in Pennsylvania ... 102
CHARLES H. STRAUSS, Professor, and BRUCE E. LORD, Research Assistant, School of Forest Resources, The Pennsylvania State University

Impact of User Fees on Day Use Attendance at New Hampshire State Parks ... 106
ALLISON RECHISKY, Information Officer, New Hampshire Division of Parks & Recreation, and BRAD WILLIAMSON, Assistant Administrator, New Hampshire Division of Parks & Recreation

MANAGEMENT OF RECREATION RESOURCES

Counting Visitors at National Parks: Concepts and Issues ... 111
JAY BEAMAN, Director, Socio-Economic Branch, and DICK STANLEY, Chief, Socio-Economic Information Division, Canadian Parks Service

The Effect of Trends in Forest and Ownership Characteristics on Recreational Use of Private Forests ... 116
DONALD F. DENNIS, Research Forester, USDA Forest Service, Northeastern Forest Experiment Station

Page

Wilderness Management Through Voluntary Behavior Change: An Evaluation of the Pemigewasset Wilderness Management Plan 118
JOHN M. HALSTEAD, Assistant Professor; CINDY M. BROWN, Former Graduate Assistant; and BRUCE E. LINDSAY, Associate Professor, Department of Resource Economics and Development, University of New Hampshire; and ALBERT E. LULOFF, Associate Professor, Department of Agricultural Economics and Rural Sociology, The Pennsylvania State University

Use of Paired Management Action Grids for Ease in Depicting Differences Between Users' and Managers' Perceptions of Problems 122
R. J. STEELE, Assistant Professor, Department of Recreation and Leisure Services, Springfield College, and JAMES E. FLETCHER, Professor and Chair, Department of Recreation and Park Management, California State University-Chico

FISHERIES AND WILDLIFE

FISHERIES AND WILDLIFE MANAGEMENT

Anglers' Beliefs About Tag-and-Release Programs 129
MAUREEN P. DONNELLY, Assistant Professor, Department of Leisure Management & Tourism, and JERRY VASKE, Associate Professor, Department of Resource Economics & Development, University of New Hampshire

Trappers in New York and Vermont: Comparisons of Social Characteristics and Motivations 134
RONALD J. GLASS and THOMAS A. MORE, USDA Forest Service, Northeastern Forest Experiment Station,; WILLIAM F. SIEMER and TOMMY L. BROWN, Department of Natural Resources, Cornell University; GORDON R. BATCHELLER, New York State Department of Environmental Conservation; JAMES J. DISTEFANO, Vermont Department of Fish and Wildlife

New Hampshire Recreational Oyster Harvesters: Profile, Perceptions, and Attitudes 139
ALBERTO B. MANALO, Assistant Professor; BRUCE E. LINDSAY, Associate Professor; and GEORGE E. FRICK, Lecturer, Department of Resource Economics and Development, University of New Hampshire

Measuring the Economic Value of Wildlife: A Caution 142
THOMAS H. STEVENS, Professor of Resource Economics, University of Massachusetts

FISHING SPECIALIZATION

Toward a Comprehensive Understanding of Angler Involvement 149
TOMMY L. BROWN, Senior Research Associate, and WILLIAM F. SIEMER, Research Support Specialist, Department of Natural Resources, Cornell University

The Angler Specialization Concept Applied: New York's Salmon River Anglers 153
CHAD P. DAWSON, Assistant Professor, SUNY College of Environmental Science and Forestry, ; TOMMY L. BROWN, Senior Research Associate, and NANCY CONNELLY, Research Support Specialist, Department of Natural Resources, Cornell University

A Reassessment of the Angler Specialization Concept 156
CHAD P. DAWSON, Assistant Professor, and MIKLOS GRATZER, Professor, College of Environmental Science and Forestry, and ROBERT BUERGER, Assistant Professor , Department of Recreation and Leisure Studies, SUNY Cortland

Recreation Specialization and the Analysis of Angler Differences According to Age Cohort 160
DAVID K. LOOMIS, Assistant Professor, and RODNEY B. WARNICK, Associate Professor, Recreation Resources Management Program, University of Massachusetts

Page

TRAVEL, TOURISM AND COMMUNITY DEVELOPMENT I & II

Effects of Alternative Silvicultural Methods on Scenic and Recreational Quality 169
MARK BRUNSON, Graduate Research Assistant, and BO SHELBY, Associate Professor, Department of Forest Resources, Oregon State University

Opportunity Potential Matrix for Atlantic Canadians 173
GREG DANCHUK and ED THOMSON, Canadian Parks Service, Atlantic Region, Historic Properties

Family Structure and Its Relationship to Travel 177
CHRISTINE CORNELL MCCREEDY, Graduate Research Assistant, and JOSEPH T. O'LEARY, Professor, Department of Forestry and Natural Resources, Purdue University; and DANIEL FESENMAIER, Associate Professor, Department of Recreation and Park Administration, Indiana University

Observing the Differences Between West German Overseas Pleasure Travel Markets to the U.S. and Canada through the Novelty vs Familiarity Theory 182
GEORGIA L. O'MALLEY, Research Assistant, and JOSEPH T. O'LEARY, Professor, Purdue University

The Substantive Knowledge Base for Travel and Tourism: A Systems Model 187
DAVID S. SOLAN, Associate Professor, Tourism Program, Mansfield University

Outdoor Recreation Activity Trends by Volume Segments: U.S. AND Northeast Market Analyses, 1982-1989 190
RODNEY B. WARNICK, Associate Professor, Leisure Studies and Resources Program, University of Massachusetts

Rural Community Values and Community Type: A Study of Attitudes Toward Tourism 197
RODNEY R. ZWICK, Assistant Professor, Department of Recreation Resource Management, Lyndon State College

Tourism Measurements Based on Traffic Volume 203
RODNEY R. ZWICK, Assistant Professor, Department of Recreation Resource Management, Lyndon State College, and MALCOLM I. BEVINS, Extension Professor, Department of Agricultural and Resource Economics, The University of Vermont

URBAN RECREATION

Forest Vegetation in Urban Parks: Perceptions of Inner City Children 209
PAUL H. GOBSTER, Research Social Scientist, USDA Forest Service, North Central Forest Experiment Station

Urban Park Trail Use: An Observational Approach 215
PAUL H. GOBSTER, Research Social Scientist, USDA Forest Service, North Central Forest Experiment Station

GEOGRAPHIC INFORMATION SYSTEMS (GIS)

Greenway Planning: An Application of a Geographic Information System 225
ROBERT S. BRISTOW, Assistant Professor, Department of Geography and Regional Planning, Westfield State College

MassGIS and SCORP Planning Process: The Cape Cod Pilot Project 228
LAWRENCE KLAR, Professor, and RODNEY B. WARNICK, Associate Professor, Leisure Studies and Resources, University of Massachusetts; GAIL SWETT, Corridor Planner, Massachusetts Department of Environmental Management; STEPHEN JOHNSON, SCORP Planner, Massachusetts Executive Office of Environmental Affairs

The Representation of Error in Visibility Modeling 230
JAMES F. PALMER and JOHN P. FELLEMAN, SUNY College of Environmental Science and Forestry

AUTHOR INDEX 234

URBAN RECREATION

FOREST VEGETATION IN URBAN PARKS: PERCEPTIONS OF INNER CITY CHILDREN

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A series of three interrelated studies showed that Chicago inner city children generally disliked dense forest vegetation in urban park and play areas. Trees and forested areas can appeal to children, however, if the natural landscape does not appear too wild. Guidelines are given for increasing the naturalness of urban parks in ways that will encourage children to enjoy and learn about nature.

Childhood is a critical time in the development of a person's environmental perceptions and attitudes. During the years 6-12, children learn to distinguish the animate and inanimate characteristics of their environment, they develop cognitive abilities of place recognition and wayfinding, and they begin to understand the differences between the human-made world and the world of nature (Chawla 1988, Kellert 1985). Children at this age also spend a great deal of time outside, and the outdoor environment they experience can have a profound effect on how they will perceive and relate to nature in later years (Moore 1977, Tanner 1980).

In urban areas, parks can provide important opportunities for city children to enjoy and learn about wild nature. But most urban parks are managed for active recreation, and forests and other natural plant communities either are highly simplified in their vegetative diversity and structure or are missing altogether (Adams and Dove 1989). Thus, unlike those who grow up in suburban and rural areas, children who live in the densely developed inner city may not have readily available opportunities to experience natural areas (Ladd 1977). This may be particularly true for urban minorities and for those whose families may lack time and money to travel to where natural areas are more prevalent (Metro, Dwyer, and Dreschler 1981).

If it is assumed that exposure to nature is an important part of growing up (some, e.g., Holcomb 1977, might argue to the contrary), one important way to increase the opportunities for city children to experience nature is to bring more of it into the parks and play areas they use. But to be more effective, those who manage park landscapes and conduct interpretive programs to promote wild nature need to better understand how city children perceive and enjoy natural landscapes. This paper attempts to identify how forest vegetation in urban park environments is perceived by young inner city children, and suggests how nature-oriented park management and programming might better appeal to this important user group.

Children and Environmental Preference

Most of the research on environmental preference has been conducted with adult populations, which have generally shown a preference for natural environments over those that are developed (Wohlwill 1980). This pattern holds true in urban environments as well as in rural and wildland areas. In urban parks, for example, adults tend to prefer trees and forested areas, water, good maintenance, and peace and quiet, and tend to dislike buildings, poor maintenance, and large open areas (Schroeder 1982).

This same pattern of preferences may not follow for young children, for some environmental preference studies have uncovered substantial divergences in perceptions among different age groups. Rutz and Miller (1980) found that adults were more critical than children in what they regarded as scenic. Zube, Pitt, and Evans (1983) found that children did not seem to judge the scenic quality of a place on the basis of whether it was natural or developed for use by humans. Balling and Falk (1982) and Lyons (1983) also found substantial differences between children and adults in response to natural scenes, and suggested there may be an innate, biological basis for preferences that is modified with age and the indoctrination of cultural tastes. Finally, Medina (in Kaplan 1989) found that environmental educators' preferences for natural scenery were not shared by a group of predominantly black Detroit 12-to-14-year-olds, who tended to prefer urban scenes featuring residential and commercial buildings.

Studies focusing specifically on children's environmental preferences are rare, but the few that have addressed forest environments are illuminating. In surveying Chicago fifth-graders, Metro, Dwyer, and Dreschler (1981) found that although the students generally liked visiting or the idea of visiting forests, they expressed many fears about going there. Similarly, Kaplan (1976) found that the inner city children in her study exhibited a high degree of anxiety about being in a wooded area. This feeling of fear may not be particular to urban children, for Hart (1979) also found that small town Vermont children were apprehensive about entering a wooded area in their neighborhood.

How do children come to appreciate forest environments in the face of their initial fears? Two factors that may play important roles are knowledge and accessibility. In a study of 8-11-year-olds, Harvey (1989) found that students whose school grounds had a large amount and diverse mix of vegetation generally had a greater botanical knowledge and a greater appreciation for vegetation than students whose school grounds were lacking in vegetation. In a similar type of study that focused on animals rather than vegetation, Kellert (1985) found that knowledge and living in a rural environment reduced young children's fears of animals. And in hypothesizing how fears about nature may be overcome, Driver and Greene (1977: 68-69) stated that: "Inner-city children, in particular, often have little exposure to or opportunity to experience forest or other areas that are predominantly natural. Familiarizing experiences are especially needed by these youths who could be missing a very important dimension of being human."

The focus of this present research deals with a third factor that could play an important role in urban children's appreciation of natural areas-- design. Urban parks offer many exciting opportunities to create wild landscapes that minimize children's feelings of fear and offer them chances to explore and enjoy nature's wonders. Some authors have discussed how to incorporate natural elements into the design of children's play areas (e.g. Moore 1977, Kirby 1989), but there is little empirical information available on how to manipulate forest vegetation to create more pleasing landscapes for children. Because the amount of forest vegetation appears to be a key element relating to children's environmental perceptions, a series of studies was designed to look in detail at preferences for urban park and play areas with varying amounts of tree vegetation. More specifically, the objectives of this research were to:

1) Assess the role that forest vegetation plays in young urban children's preferences for urban parks;

2) Test whether children's perceptions of forest vegetation are affected by the type of park setting;

3) Examine gender differences.

Overview of Methods

Three sequential studies examined the role of forest vegetation in children's preferences for urban parks. A photo-rating approach common to environmental preference research (e.g., Daniel and Boster 1976) was modified for children's use. As employed, this approach proved to be a simple and fun way for young children to be involved in a research study.

Study Population

The children who participated in these studies were visitors to the North Park Village Nature Center, located in and run by the City of Chicago. The children ranged in age from 6 to 10 years. The groups selected for study were from low-income housing or public schools in the inner city, and were either all black or predominantly minority (black, Hispanic, and Asian). The groups came to the center for a program that included both indoor exhibits and a walking tour of the nature trail. For Study 1 participants, the photo-rating task was administered before the nature program; for the participants in Studies 2 and 3, the photo-rating took place after the program. This change in sequence was unavoidable, but as will be seen later, it did not seem to confound study results.

Because a major purpose of these studies was to better understand the needs of urban minority groups who visited the Nature Center, no comparisons were made with white groups or with those who lived in suburban or rural areas. Future comparative studies of this type could be insightful and could aid in improving programs and park opportunities for all children.

Procedure

In each study, a set of 25 or 30 color slides was used to depict park environments with a range of forest vegetation and developed features. The slides were evaluated by groups of 20 to 50 children, in which each child was asked to view and rate each slide according to the question: "how much would you like to be in the place pictured?" Ratings were made on three-point "smiley face" rating scales (Figure 1).

Figure 1. Rating scale used in the studies.

Reliability

A statistical test was used to estimate the level of agreement among the children's ratings. Mean observer-to-group correlations (Brown and Daniel 1990) ranged from r= .52 for Study 1 participants to r= .58 for Study 3 participants. This level of agreement was acceptable, and preference ratings for each scene were averaged across individuals to produce an overall group rating.

Analysis

To examine the relationship between forest vegetation and children's park preferences, the averaged group preference ratings were correlated with the amount of vegetation present in the scenes. To do this, the investigator measured the percent of forest vegetation present in each scene using a grid square overlay procedure (Shafer, Hamilton, and Schmidt 1969). Eight other scene features were also measured; grass, exposed soil or forest/weedy groundcover, and paved area were measured as percent-of-scene features, while playgrounds/athletic courts/play fields, water bodies and fountains, cars, buildings, and people were measured in terms of their presence or absence.

Study 1: Forest Vegetation in Park & Play Areas

The purpose of the first study was to examine the role of natural forest vegetation in urban children's preferences for park and playground areas. Study participants were 3 groups of black 6-to-9-year-olds from Chicago Housing Authority residences, 117 children in all. The study stimuli were 25 natural and developed park scenes, including playground equipment and areas of dense forest vegetation. Playground equipment settings ranged from few to many trees.

Results of the correlation analysis showed that scenes with playground equipment or play fields were the most preferred; large, open areas of grass were also highly preferred (Table 1). The densest tree vegetation received the lowest ratings; areas showing exposed soil or forest/weedy groundcover were also disliked. Children's preferences did not differ for scenes that showed playground equipment in forested versus open settings.

Table 1. Preference ratings/feature correlations, Studies 1-3.

Variable	Study 1(r)	Study 2 (r)	Study 3 (r)
Trees/forest[a]	-.78*	-.51*	.25
Grass[a]	.76*	.21	-.03
Dirt forest floor/weeds[a]	-.45*	-.56*	.17
Paved area[a]	-.20	-.02	-.11
Playgrounds/ courts/play fields[b]	.79*	.27*	-.08
Water[b]	.13	.51*	.34*
Cars[b]	.30	-.14	-.64*
Buildings[b]	.49*	.23	-.31*
People[b]	.13	.10	-.18

[a]Measured as percent-of-scene; [b]measured as presence-absence.
*Significant, $p < .05$

The strong, negative correlation between the children's preferences and the prominence of trees and forest areas was not initially expected. One hypothesis why it occurred was that the presence of the playground equipment in some of the scenes was so attractive to the children that scenes without equipment were rated negatively by default. This did not always happen, however; undeveloped park areas with large, open fields were also rated quite positively.

Study 2: Forest Vegetation in Park Landscapes

Because of the questions raised by the first study, a second study was devised to look at children's preferences for park landscapes in the absence of playground equipment. Participants in this study were 50 black 7-to-9-year-olds from a Chicago west side public school. The stimuli shown to the children were 30 natural and developed park scenes. Included were scenes with dense natural vegetation and scenes with open fields, ballfields, and athletic courts. No scenes depicting playground equipment were shown until the very end, when two scenes with swing sets were shown. The study design included a 12-scene overlap between this slide set and the set used in the previous study, 7 of which showed dense tree or forest vegetation.

Removing the "playground context" did not seem to greatly affect the children's ratings of forested park scenes. Forested park landscapes were still disliked, as indicated by the moderately strong negative correlations of preference ratings with forest and tree vegetation, and with exposed soil or forest/weedy groundcover (Table 1). Open grassy areas, scenes with ballfields, and play courts and playgrounds were still preferred, though somewhat less so than in the previous study. The new stimuli used in this study included several scenes of ponds and the City's Lake Michigan shoreline, which contributed to the moderately strong preference for water features.

Between-group rating differences were tested statistically to see if removal of the playground context might have influenced ratings. The 12 overlapping scenes were used in a repeated measures analysis of variance (Winer 1971); the main effects of the analysis showed no significant difference between groups. This is illustrated in Figure 2 by the relatively close, parallel lines in the plots of the group mean scores for the scenes. There was, however, a slightly significant group-by-scene interaction ($p = .051$), meaning that the two groups differed in how they rated certain scenes. Visual examination of Figure 2 shows that the largest between-group rating differences were for the dense forest scenes (those to the right of the dotted line in the figure). There is no clear pattern of differences, with some forested scenes rated higher by Study 1 participants and other forested scenes rated higher by Study 2 participants. T-tests of group mean differences on individual scenes showed that only two of these differences were statistically significant ("I" and "J" in the figure), but again there was no strong or consistent evidence to support the idea that removing the playground context increased the chance that forested scenes would be preferred.

This lack of significant change is especially noteworthy considering that Study 2 participants were also exposed to the nature center program before they rated the slides. One might expect that this exposure, if anything, would have increased ratings beyond the effects of removing the playground context. The findings do not show this to be the case.

Open-ended comments given by Study 2 participants reinforced the conclusions of the statistical analyses just mentioned. "Trees" as a category was only mentioned in 5 percent of the positive comments, but formed the bulk of negative comments. "Trees and bushes" were cited in 12 percent of the negative comments, with "forest and woods" cited in another 27 percent of the comments. Other frequently cited negative features included "dirt," "mud," and "puddles," (16 percent), and "cars" (12 percent). For the positive comments, "playgrounds" and other play courts were mentioned in 28 percent of the comments, followed by "the park" (22 percent) and the "beach" or the "lake" (15 percent). Students who further explained their preferences mentioned that they liked open areas and playgrounds because they could do things-- play and have fun -- but they disliked the forested areas because they could not play or ride bikes there, and because the forested areas were "scary" places where one could "get lost."

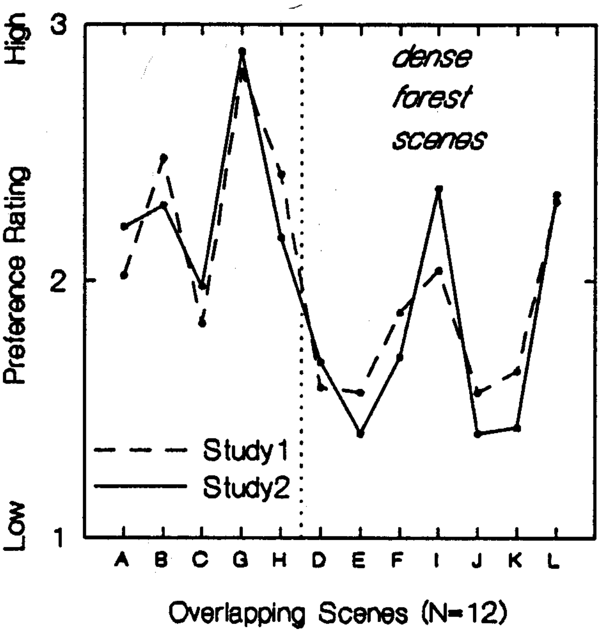

Figure 2. Group means for overlapping scenes, Studies 1-2.

Study 3: Trees & Forests in "Typical" Park Scenery

The stability of low preference ratings for heavily forested scenes in the absence of the playground context led to further speculation about the nature of forest vegetation in urban parks. Under what conditions do urban children like to see trees in parks? What specific characteristics of forested environments contribute most to their displeasure? The results of the first two studies offered some evidence that dense forest undergrowth and unkempt groundcover or areas of exposed soil could be major factors; if these areas were eliminated, would it change children's feelings about the attractiveness of wooded areas?

To address this question, a third study was designed to examine children's preferences for urban park scenes without natural forest vegetation and playground equipment. Study participants were 56 8-to-10-year-olds from a Chicago north side public school, most of whom were minority (black, Hispanic, and Asian). The scenes included in the study were 30 views of Lincoln Park, a large (1,200 acre) park along Chicago's lakefront. These varied landscape views included open grassy areas, developed facilities, and adjacent buildings and highway development. Tree cover still ranged from low to high, but no scenes were included with heavy undergrowth, and most of the wooded scenes had a grassy groundcover. There was a 16-scene overlap between Study 3 and Study 2, 4 scenes of which depicted heavy tree cover.

Without the sample of forested scenes included, the correlation between preference ratings and tree prominence changed from moderately negative to slightly positive (Table 1). The prominence of grassy areas was essentially uncorrelated with this group's preference ratings, while presence of water was positively related. The strongest negative features were presence/absence of cars and traffic, and buildings.

Mean scores comparisons between Study 3 and Study 2 participants for the 16 overlap scenes showed a highly significant between-group main effect ($p = .001$). The group-by-scene interaction was also highly significant ($p < .001$), indicating that the two groups differed in how they rated certain scenes. These differences could be largely attributed to how the groups responded to the 4 scenes with the heaviest tree cover; t-tests of the group mean differences for these individual scenes were highly significant (all $p < .001$). Figure 3 illustrates these results (the forest scenes are to the right of the dotted line).

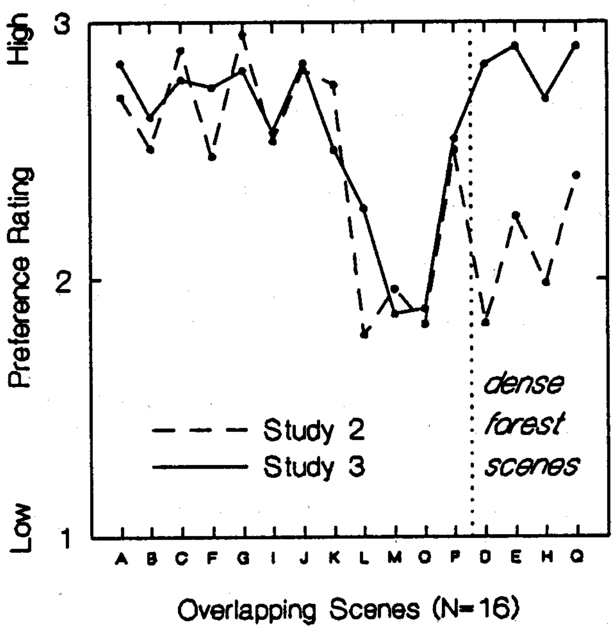

Figure 3. Group means for overlapping scenes, Studies 2-3.

Open-ended comments echoed the change in the children's sentiment for trees compared to Study 2, with 15 percent mentioning "trees" positively. Other features mentioned positively included "parks" in general (18 percent), "grassy areas" or "open space" (15 percent), "peace" (9 percent), and "sunshine" (6 percent). Features mentioned negatively were topped by "streets and paved areas" (35 percent) and "cars" (18 percent). This comparison, along with the changes in the correlations and the magnitude of preference ratings, tended to support the idea that children can like trees and forest-like vegetation if they are not "too wild" and unkempt looking.

There were no significant differences found in the mean ratings between the boys and girls, either within the Study 3 group or in a comparison between Study 2 and Study 3 participants.

Discussion and Recommendations

The findings of this research should be considered preliminary, and there are many further questions to explore before definitive guidelines can be made about the management of forest areas that will appeal to urban children. On the basis of these findings and those from previous research, however, some general recommendations can be offered for enhancing nature in urban park environments and for improving environmental education programs for inner city children:

Design Legible, Maintained Space

Based on the comparison of results across the three studies, it appears that forest vegetation can be a positive element in young children's appreciation of park environments (or at least not a negative one) as long as it is not "too wild." Providing areas within parks, nature centers, and urban forests where forests are "friendly" and inviting rather than foreboding may encourage children to appreciate and explore wild nature. This might be done by having areas with dense trees and shrubs that are well-maintained with defined pathways and small enough to provide easy visual and physical access to open areas. Kirby's (1989) suggestions for using the concept of "refuge" in play area design reinforce the results of this present research. Among her ideas are that successful play areas should provide enclosure through a ceiling or other elements that offer a sense of intimacy, privacy, and safety; should be of proper scale for the intended number of children and type of activity; should provide multiple access and "escape" routes; and should use materials, especially vegetative elements, that can be manipulated by children for creative and dynamic play.

Make Space "Familiar," but Encourage New Experiences

Part of making forest environments attractive to young urban children often means making them more like the park environments the children have previously experienced and feel comfortable in. The results of this research indicate that it may be important to have areas where there is a mowed grass understory so children can play under trees; it might also mean introducing meadows or openings into a predominantly forested setting. In some cases, to make the forest a more familiar environment, it may be appropriate to build play structures within or on the edge of natural settings. Nature education should also try to incorporate concepts and activities that are familiar to an urban child's view of the world (Lewis 1978).

The design of the environment and the programming that takes place there must also try to encourage children to explore new and different opportunities that only natural forest ecosystems can offer. Producing the right blend of the familiar and the exotic can give children options to gain experience with forest environments without producing fear or anxiety.

Provide an Activity Orientation

Young children's experiences in park settings center largely on active play, and activity-oriented settings that foster play are likely to be preferred over settings that are neutral or that inhibit active play. Nature programs should involve children in active games, experiences, and other activities in the natural environment that fulfill some of the same needs and desires children seek in non-nature oriented play. In some cases children's play areas could be designed and located so as to incorporate natural vegetation elements into the play setting. This might be an "adventure forest" that includes play structures like a tree fort or a "see-and-do" nature trail oriented towards young children.

Involve Parents and Educators in Nature Experiences

Adult role models can have an important impact on how children relate to the natural environment (Tanner 1980). Environmental education programs need to aim not only at young children but also at those adults who help children to form their first impressions of the environment. This is true not only for what adult role models say and do, but also for what visual and written information they select for their children. Fairy tales, for example, traditionally portray forests and animals to children as things of danger and fear (More 1977).

Positive messages communicated through direct experience or indirectly through books or television could very much improve the current state of environmental education for urban youth.

Understand Age, Gender, and Cultural Differences
Finally, research has shown that the environmental preferences acquired by mainstream American adults may not shared by children, and preferences may also differ due to gender and ethnicity. As environmental professionals, we must understand that our perceptions and preferences should not always be the sole criteria by which we develop our programs and policies (Holcomb 1977). Recognizing this will help us to better direct our education and management efforts in positive and productive directions. Future research in this area can also help us to more fully understand urban children's perceptions and preferences, and will give us a greater sensitivity in designing parks and building stronger environmental and nature education programs.

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URBAN PARK TRAIL USE:

AN OBSERVATIONAL APPROACH

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An observational study of trail users in an ethnically diverse Chicago neighborhood park showed moderate use levels on warm winter days, with use increasing substantially in spring and summer. The asphalt trail was used mostly by white adult walkers, but also included a diverse mix of age and ethnic groups for many different trail-related activities. Observation is presented as an important tool to use along with other research methods to understand trail use, user characteristics, and user and resource interactions.

Trails provide important recreation opportunities in urban park and forest settings. Trail use has increased rapidly in recent years, for a variety of recreational activities. State and national studies show high participation rates in such trail-related activities as walking, hiking, running, and bicycling (Van Horne et al. 1985; Illinois Department of Conservation 1988). While these activities often extend beyond trails, the demand for off-street trail facilities that furnish these opportunities has made urban trail development a high recreational priority.

Employing a variety of research methods, studies of urban trail users have produced some useful information for design, planning, and management. On-site questionnaires have identified the perceptions of trail users and examined their likes and dislikes about the physical, social, and managerial attributes of trails (Gobster 1988, 1990, 1991). Mail questionnaires have examined how people choose among trails with different attributes; models developed from this experimental technique can be used to predict which trails different groups will prefer (e.g., bicyclists vs. cross-country skiers), and how user "market segments" (e.g. racing cyclists vs. cycling families with young children) choose between trail opportunities (Louviere, et al. 1988, Gobster et al. 1990, Allton and Leiber 1983). Finally, monitoring of forest preserve bicycle trails with traffic counters has helped to explain levels and patterns of use as a function of time, weather, and seasons (Dwyer 1988a).

Although this research has given trail planners and managers needed information upon which to base decisions, gaps in our knowledge prevent a more complete understanding of trail users and how they interact with each other and with the environment. Past research has focused on trail use by bicyclists, but many urban park trails cater to a variety of trail users. We have a good understanding of the attributes of trail preference and choice, but do not know how these attributes actually influence on-site activities, behavior, and interactions. And we have incomplete knowledge of who is using trails, for what purposes, and under what conditions. Answering these and other related questions may require different methods of investigation to complement existing tools.

On-site observation is a little-used technique that holds promise for addressing some of these questions. Behavioral observation can be linked with information about the physical and management characteristics of trails, and can provide insights into planning and management not available through other methods. It also offers unique opportunities to analyze interactions between trail users and between users and the environment. Observation has been used successfully in urban settings to understand the use of parks (Hutchison 1987, More 1985), plazas (Whyte 1980), and street-side public spaces (Nasar and Yurdakul 1990), but has yet to receive much attention in urban trail research.

In this study, observation was used to identify use levels, user characteristics, and user and resource interactions taking place on an urban park trail. The trail in Chicago's Warren Park served as a case study. Specific objectives were to:

1) Identify <u>use levels</u> and examine how they vary seasonally, by time of day, and in relation to weather and other environmental conditions;
2) Identify <u>user characteristics</u> including age, race, gender, activities, and group size of those using the trail, and examine how important social and environmental factors might influence trail use;
3) Examine <u>user-user</u> and <u>user-resource interactions</u> to identify social and environmental determinants of use patterns, user conflicts, and resource degradation.

Methods

Observation is particularly well-suited to studying urban trail use. Short trails characteristic of those found in neighborhood parks receive a high proportion of pedestrian use (Gobster 1990); this limits the effectiveness of traffic counters, which are better suited for counting bicycles. On-site questionnaires are valuable for identifying user perceptions and attitudes, but require high participation to ensure a representative picture of who is on the trail, and can be unnecessarily complex for collecting basic user data such as age, gender, activity, and interactions. Furthermore, those who complete self-report behavioral surveys tend not report certain activities, especially those which might be socially unacceptable in nature. Lastly, when park users vary widely in age and racial-ethnic heritage, it is difficult for one survey form to be understood by all.

Observation is not without its disadvantages. There is a potential for error in classifying individuals on social and demographic variables. There may also be problems in interpreting observed behavior and making judgments about what a trail user might actually be doing. These problems can be minimized with training and by developing clear operational definitions for recording behavior. The method does, however, require a very substantial time commitment by the researcher or well-trained assistants.

The Study Site

Laurence C. Warren Park is an 82-acre park on Chicago's Far North Side, owned and managed by the Chicago Park District. The park is surrounded by residential and commercial development in an ethnically diverse neighborhood area. The park is recent compared to most of Chicago's parks--development began in 1976 when the State of Illinois purchased the land from a private country club. Today about half of the park is developed with playing fields and courts, while the other half is a 9-hole public golf course. Use is mainly local, and many who drive to the park come to golf. The main park trail is a 1.2-mile asphalt paved loop surrounding the golf course, with shorter spur trails extending to park facilities and neighborhood streets (Figure 1). The trail is actually two parallel trails, the inner one intended for bicyclists and the outer for pedestrians.

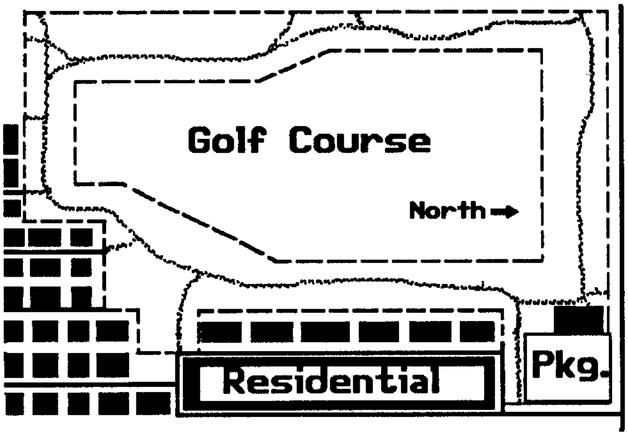

Figure 1. The study site.

Sampling Procedure

A sampling matrix was developed to ensure a representative sample of trail observations (Table 1). Cells were defined as follows: time of day ("morning" 6 a.m. - 10:00 a.m., "midday" 10 a.m. - 2:00 p.m., "midafternoon" 2 p.m. - 5:00 p.m., and "evening" 5 p.m. - 9 p.m.), day of week (weekday, weekend), and season ("winter" Jan 1 - March 20, "spring" Mar 21 - June 20, and "summer" June 21 - September 4). Following sampling methods described by More (1985), the plan was to visit the park at least three times within each cell. This goal was exceeded in most cases; summer observations were cut short because large numbers of trail users made data collection and coding very time consuming. Because of this and because by summer the investigation had not yielded new information sufficient to justify its continuance, sampling was discontinued before entering the fall season. The total sample (January 1 - September 4) was thus based on 151 observation periods.

Table 1. Sampling distribution of trail observations (N= 151).

	Winter		Spring		Summer	
Sample Strata	Wk day	Wk end	Wk day	Wk end	Wk day	Wk end
Morning	13	11	9	9	4	3
Midday	7	13	14	3	1	3
Afternoon	13	10	8	7	1	2
Evening	6	0	1	8	5	0

During each observation period, the investigator entered the park at one of five park entrances and made a full reconnaissance of the trail in a randomly chosen direction. The investigator either walked (20 minute period), jogged (15 minute period), or bicycled (10 minute period) the 1.2-mile trail loop around the golf course, and recorded the following information for everyone encountered on or near the trail:

1) Location on the trail (53 predetermined locations)
2) Number of individuals in the group
3) Race, sex, and age (9 categories) of each person
4) Primary activity of each person (e.g., walking, biking)
5) Secondary activity of each person (e.g., talking, eating)
6) What kind of clothes they were wearing
7) If they had a dog, size of dog, and if it was leashed
8) Direction they were travelling (with or against the investigator, or stationary)
9) Interactions between groups, and type of interaction
10) Was person seen before in the same observation period
11) If the person was seen before in the park

Spur trails near the main trail, grass and seating areas adjacent to the trail, the clubhouse area, and the sledding hill were included along with the trail proper. To minimize interrupting the activities of trail users and to facilitate accurate reporting, observations were recorded discreetly on a microcassette tape recorder.

The decision to record adjacent trail activities as well as those activities that occurred directly on the trail was made for two reasons: 1) in many cases adjacent trail activities occurred in conjunction with using the trail (e.g., doing calisthenics at the "parcourse" stations while jogging around the trail loop); 2) in other cases adjacent activities directly or indirectly affected those who were using the trail (e.g., throwing a ball or frisbee across the trail). A second decision was to record trail activities as "primary" and "secondary." A primary activity was defined as the individual's dominant physical posture or behavior (e.g., walking, sitting, bicycling), while a secondary activity was defined as any other behavioral or situational facet related to the primary activity (e.g., talking, carrying sports equipment, watching, listening to a radio).

In addition to information on each person, the following time, weather, and trail information was also recorded:

1) Month, day, date, and time
2) Temperature, wind direction, speed, and wind chill
3) Sky conditions (sunny, partly cloudy, heavy clouds/rain)
4) Light Conditions (dawn/dusk, daylight, darkness)
5) Trail Conditions (dry, wet, puddles)

User-user and user-resource interactions were recorded as they occurred (e.g., pedestrian-bicyclist conflict, gatherings of people) or as their traces were observed (e.g., litter, dog waste, vandalism). Other relevant observations or insights gained while on the trail were also recorded when they occurred.

The coding system was developed and refined over a two month period prior to data collection. The investigator practiced assigning individuals to categories of variables (e.g., age, race) until he was confident in making reliable assessments. When in doubt on certain variables, individuals were assigned to more general categories (e.g. "adult," "child") or coded as "not identifiable" (e.g. race). New activity codes were added as data collection progressed through the seasons.

Use Levels

The investigator encountered a total of 5,496 individuals during the 151 observations periods. Use level variations were examined in terms of time of day, seasons, and environmental factors. When temperatures were below freezing there were seldom more than 25 people encountered on the trail within an observation period (Figure 2). Use increased with temperature, sometimes dramatically. For example, on a sunny Tuesday afternoon in January when the temperature hit an unusually high 65 degrees, 66 people were observed on the trail at one time, while on a sunny Monday afternoon the week before with the temperature at 33 degrees there were only 38 people. Use levels peaked when temperatures were in the 70's, then dropped as the temperature rose into the 80's. Data on high temperature days (6 observation periods) is sketchy, however, and more information is needed to substantiate this pattern.

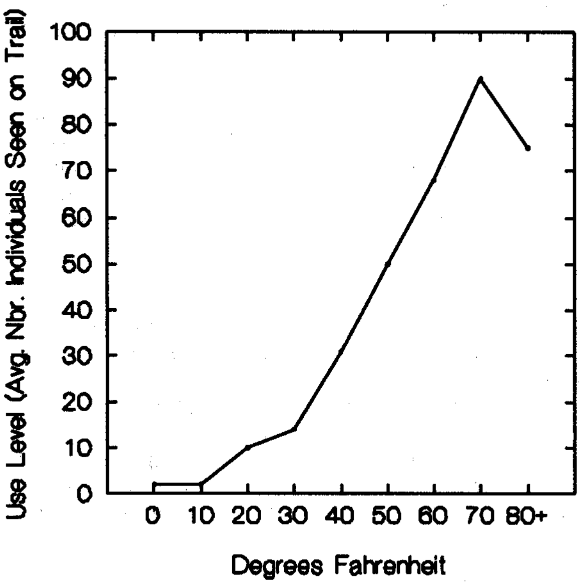

Figure 2. Trail use levels as a function of temperature.

Weekday use was highest in the evening, with smaller peaks in the early morning and around noon (Figure 3). Mid-morning and mid-afternoon were low points in weekday use. This pattern changed for weekends, when use climbed gradually throughout the day before dropping off sharply around sunset.

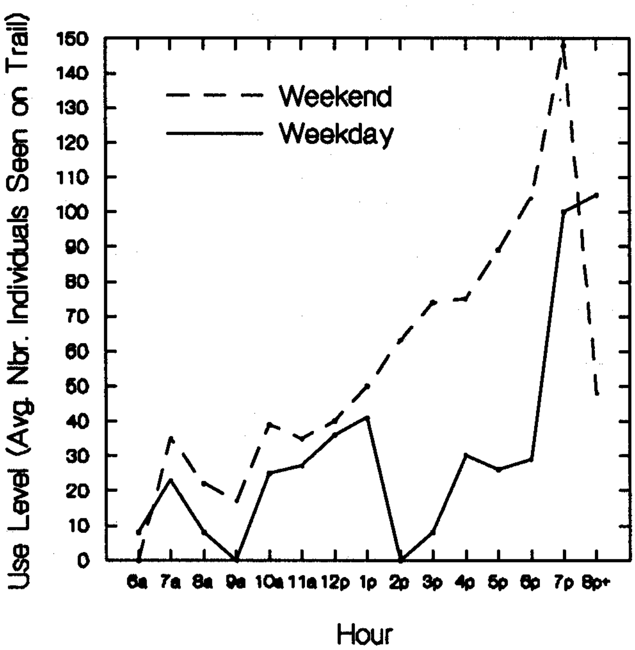

Figure 3. Hourly trail use levels, by weekday and weekend.

There were significant weekend and weekday use variations. To examine these more closely, a simple predictive model was constructed, patterned after Dwyer's (1988b) daily use model of auto traffic in urban forest preserve sites. The initial model for the Warren Park trail included variables for temperature, season (winter, spring, summer), time of day (morning, midday, midafternoon, evening), day of week (weekday, weekend), and cloud cover (sunny, partly cloudy, heavy clouds or rain). Temperature correlated r= .54 with use level but was intercorrelated with season so it was left out of the final model. In the final model, season (winter) accounted for the highest variance of any term, with R^2=.37. The other variables explained only slightly more of the variance, for a total R^2 of .43. The model estimates that use is highest on spring and summer weekend evenings, when skies are sunny or partly cloudy. While not approaching the R^2 of .90 estimated by Dwyer's forest preserve use model, the Warren Park trail model does show the combined importance of temporal and environmental factors in affecting trail use.

User Characteristics

Demographics

The typical Warren Park trail user is a white male adult age 26-39. "Typical" is somewhat misleading, for though "whites," "males," and "adults 26-39" were the categories with the highest frequencies, there was a broad range of trail users. The sample was 55 percent male and 38 percent female (7 percent unidentified). Whites accounted for 62 percent of the sample, Hispanics 20 percent, Asians 6 percent, African-Americans 5 percent, and Indian-Pakistanis 4 percent (4 percent unidentified).

Adults were the primary trail users, with those 26-69 years accounting for nearly 60 percent of total trail use (Figure 4). Adolescents (7-12 years) and teenagers (13-17 years) made up another 20 percent of the trail sample. There was a relatively high proportion of young children using the trail, with babies (0-2) and tots (3-6) accounting for almost 10 percent of the sample. The elderly (70+ years) were the age group seen least on the trail.

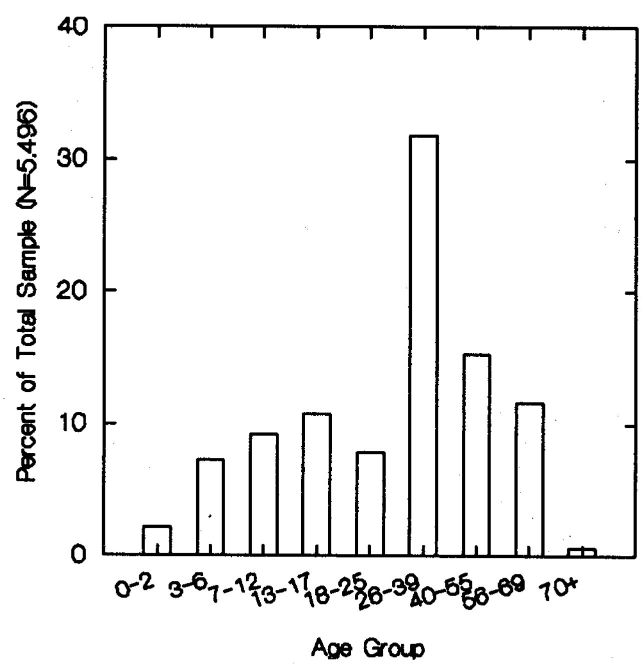

Figure 4. Frequency of trail users, by age group.

User Activities
Table 2 lists the frequency of primary and secondary activities observed on the trail, ordered by major activity type. For primary activities, casual walking or "strolling" far outweighed any other trail activity, with more than half of all individuals engaged in this activity. Other important activities included sitting, bicycling, standing, and jogging.

Secondary activities varied widely. They were difficult to group: "carrying things" was the only major category used to group activities. Nearly three-quarters of the sample was not observed in a secondary activity; of those who were, talking and dog walking were the most common. Other top ranked secondary trail activities included carrying golf equipment, pushing a baby stroller, listening to "Walkman" radios, and carrying groceries.

About a third of those who were talking when observed were speaking a foreign language. Often the language was Spanish, but there were also quite a few whites speaking Eastern European languages. Although most trail users were white, they also seemed to be from a variety of ethnic groups.

Social Groups
The 5,496 individuals were in 3,186 separate groups that ranged in size up to 16. Individuals accounted for 58 percent of all groups; 24 percent were on the trail in groups of two, 9 percent in groups of 3, and 7 percent in groups of 4 or more.

As might be expected, larger groups tended to be more demographically diverse than smaller ones. Individual trail users were more often males (69 percent), while groups of two were more likely to be male-female couples (43 percent) than all male (29 percent) or all female (20 percent). Groups of three or more averaged 40 percent mixed gender, 24 percent all male, and 13 percent all female (the remaining groups included young children who could not be identified by gender).

Table 2. Primary and secondary trail activities.

PRIMARY (N=5,496)		SECONDARY (N=5,496)	
Walking:		**No 2nd Activity:**	73.3
• Strolling	51.3	**Carrying Things:**	
• Fast Walking	1.4	• Groceries	1.6
• Walking Slow	.2	• Books	.3
• Jogging	5.2	• Newspapers	1.0
• In a Wheelchair	.2	• Golf Equipment	4.3
• In a Stroller	1.9	• Sleds	.3
Mechanized:		• Bicycle	.8
• Bicycling	9.2	**Other Activities:**	
• Rollerblading	.3	• Pushing Stroller	1.7
• Skiing	.1	• Push Wheelchair	.1
• Skateboarding	.2	• Talking	6.5
• Police/Maint.	.4	• Talk Foreign Language	3.0
Stationary:		• Walking Dog	8.0
• Standing	7.0	• Reading	.5
• Sitting	13.9	• Eating/drinking	1.2
• Calisthenics	1.0	• Alcohol	.2
• Picnicing	1.0	• Smoking	.3
• Laying Down	.7	• Affection	.2
Playing:		• Sunning	.6
• Free Play	2.3	• Watching	.8
• Ball	1.1	• Radio Listening	1.7
• Sledding Hill	.9	• Collecting Cans	.2
• Swinging	1.1	• Telephoning	.5
• Toy Airplane	.1	• Problem Behavior	.1
• Frisbee	.1		

The range in ages among group members also diversified with group size. Age categories were collapsed to "children" (12 years and under), "teens and young adults" (13-25 years), and "adults" (26 years+). All-adult groups were the most prevalent combination for two-person groups (58 percent), followed by all teens and young adults (17 percent) and children and adults (15 percent). This pattern changed for groups of three or more, with children and adults taking over as the most prevalent combination (39 percent), followed by all adult (25 percent) and all teens and young adults (13 percent). Along with the considerable number of single adult users, this information appears to show that the other principal trail groups include adult couples and families with young children.

The racial composition of groups stayed quite homogeneous with changes in group size. Groups of two, three, and four or more were all the same race more than 90 percent of the time.

Variations by Ethnic Group
Use levels on the trail varied by ethnic groups on a seasonal basis. Whites were most often seen on the trail during the winter season, with other ethnic groups beginning to show in greater numbers as the temperatures reached the 50's (Figure 5). As temperatures hit the 80's the only groups whose numbers tended to increase were blacks and Indian-Pakistanis.

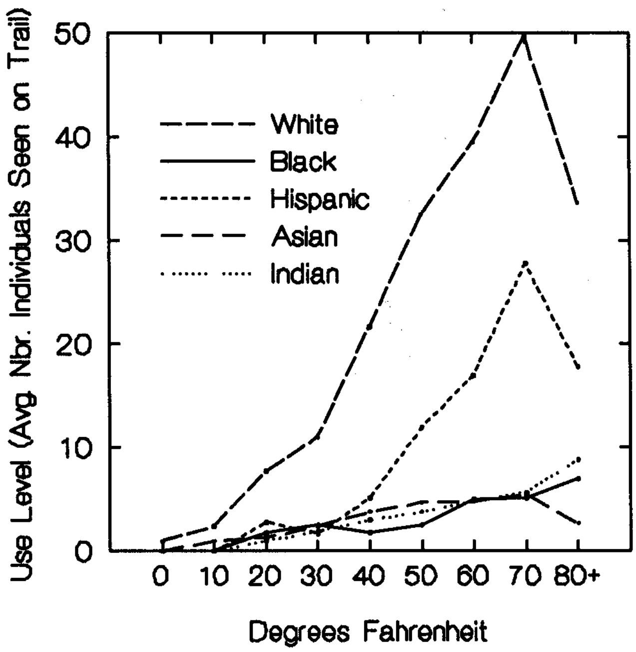

Figure 5. Trail use levels of ethnic groups, by temperature.

Walking, sitting, standing, and bicycling were among the five most frequent primary trail activities common to all ethnic groups. Among other top-ranked primary activities, whites jogged more and Hispanics picnicked more than other groups, while more Indian-Pakistanis were observed in free play and more Asians were seen playing ball than other groups. Top-ranked secondary activities common to all groups included talking and listening to radios. Whites and Asians were more often seen carrying golf equipment and blacks were more often seen carrying balls and other sports equipment than other groups. Hispanics watched others more (especially weekend soccer matches), and Asians did more calisthenics (including Tai Chi) than other groups. Group size also varied by ethnicity, with average group size highest for Indian-Pakistanis (2.6 persons per group) and Hispanics (2.5) and lowest for whites (1.5).

Some ethnic groups tended to concentrate at particular locations along the trail (Figure 6). Hispanics were often seen along the northwest section of the trail; they tended to be in large groups of mixed ages and were most often present on weekends picnicking and watching soccer games. They tended to use this section of the trail to bicycle and stroll along. The other was a concentration of white ethnics who were distinguished by their foreign language. This group concentrated on the southeast end of the trail and tended to be older adults who sat in the shade on benches along the trail and talked or read. They tended to come on weekdays and weekends in smaller, more homogeneous age groups, but were sometimes with small children who bicycled or played near the trail.

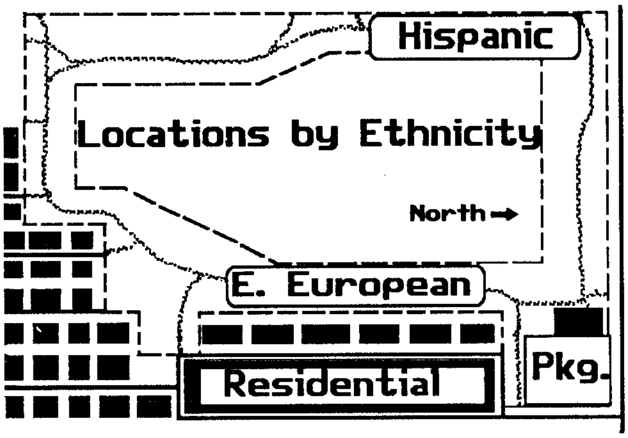

Figure 6. Trail use areas of different ethnic groups.

Variations by Season

During the winter months walking was the primary activity, engaged in by 63 percent of all trail users. Walking remained the top-ranked activity throughout the year, but dropped in relative importance to around 50 percent of total primary use in spring and summer. Jogging also dropped in importance, from 11 percent during the winter to 5 percent in the spring and 3 percent in the summer. These drops were accompanied by increases in other activities more suited to warm weather; sitting rose from 2 percent in winter to 15 percent in spring and 19 percent in summer, bicycling increased from 4 percent in winter to 11 percent in spring and 8 percent in summer, and free play rose from 1 percent in winter and 2 percent in spring to 3 percent in summer.

The most dramatic change in secondary activities by season was for dog walking. During the winter months a full 20 percent of trail users were accompanied by dogs. This percentage dropped to 6 percent in the spring and 4 percent in the summer. These statistics suggest that many winter trail users were in the park for reasons that extended beyond their own recreation. Most other changes in secondary activities were in terms of seasonal sports; youths in winter were seen carrying sleds while in summer they carried balls, and adults exchanged winter skis for golf clubs in spring and summer.

Winter groups also tended to be smaller in size, more often male than female, and more often adult, while spring and summer groups were larger and more mixed with respect to gender and age.

It is important to note that the changes noted are relative to total use, and may not reflect absolute numbers of users. For example, the number of groups encountered walking dogs during the winter averaged 3.1; in spring the average was 2.8 and in summer in was 2.9. When looked at in absolute terms, these figures suggest that for some activities there is a steady group of park users who are not affected by seasonal changes.

User and Resource Interactions

User-User Interactions

User-user interactions occurred both within and between groups. Compared to other common park activities like game playing and picnicking, major trail activities like walking, bicycling, and jogging do not generate much within-group interaction. This is in part a characteristic of the activity-- when you are jogging it is hard to carry on a conversation --but is also a function of average group size in which main trail activities takes place. For instance, the average group size for jogging was 1.1 persons, and group sizes averaged 1.6 for walking and 1.7 for bicycling. In contrast, group sizes for picnicking averaged 3.7, 4.3 for free play, and 3.7 for ball playing.

Perhaps more relevant to trail planning and management were the interactions that took place between groups. Between-group interactions were difficult to document because of their short duration; only 2 percent of the groups on the trail were observed interacting with other groups. More than half of these interactions were initiated because of dogs. In some cases, dogs from both groups brought the groups together; most of the time these interactions were amiable and resulted in conversations between the dog owners. At other times a dog (usually unleashed) came up to a group without a dog; this often seemed to be an annoyance to the dogless group.

The other major type of interaction was between-group conversation. Most conversations seemed to be short greetings or polite chatting between groups.

Finally, user interactions were looked at in a spatial context. Use was heaviest in front of the clubhouse and at intersections between the main loop trail and spur trails (Figure 7). These nodes were often congested during busy periods, to the point where they posed safety problems. This was especially troublesome where bicyclists and pedestrians mixed. Pedestrians strolling along or stopped in conversation were often unaware of bicyclists trying to move through the area. There are separate trails for each group, but users rarely paid attention to signs indicating which trail they should be on.

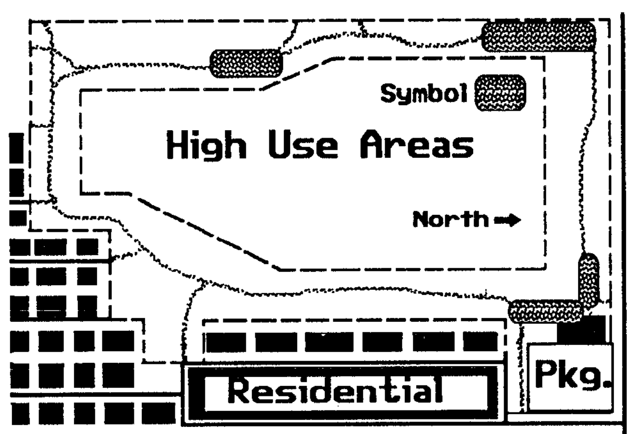

Figure 7. Areas of high use and high social interaction.

User-Resource Interactions
There were many kinds of interactions between users and the resource. Interactions were "bi-directional--" conditions in the environment affecting trail user behavior, and user behavior affecting the environment. The effects could be seen as positive: a sunny winter day bringing people out of their houses, or negative: a heavy snowstorm preventing all but the die-hards (and skiers) from using the trail. The following are a few examples of the kinds of user-resource interactions observed during the course of the study:

Shade and Park Benches. Because Warren Park is relatively new compared to most urban parks, large trees and the shade they provide are at a premium along the trail. Consequently, the demand for park benches in these areas is high, and on warm spring and summer days they are consistently occupied.

Trail Width and Vehicle Use. Police and maintenance vehicles were seen infrequently but regularly along the trail. The presence of these vehicles did not appear to conflict with recreational use of the trail, and might have added a dimension of perceived safety. However, trail width can barely accommodate full sized vehicles (especially utility and garbage trucks), and when the ground was wet they made ruts and muddy areas along the trail.

Seasonal Change and Dog Litter. As noted, winter use of the park by dogs is heavy. With spring snow melt and increased park use, the considerable amount of fecal material deposited by dogs near (and sometime on) the trail is visually offensive and could pose health hazards. This was particularly the case around major park entrance points, where in March the density of dog litter approached one pile per square foot.

Trail Maintenance and Problem Behavior. Incidents of littering, vandalism, and other behavior which could be considered dangerous or inappropriate were rarely observed directly in the course of data collection (.1 percent of all individuals). Signs of littering were apparent, but not as serious as in nearby commercial areas, and park management was generally diligent on cleaning up the trail proper. This was not always the case with gang graffiti, which was apparent on several of the benches and parcourse fitness stations. Damaged facilities were also noted.

Management Implications and Further Study Needs

Observations conducted over the three season period showed that trail use levels were tied closely to the time of day, weather conditions, and the season itself. This information will help park managers understand use flows and enable them to anticipate when to expect use peaks. When compared to data collected on other trails and forest preserve sites, these patterns will also help to understand how use levels vary among different kinds of sites. Additional use level data needs to be collected on the Warren Park trail and other urban park trails before further progress can be made.

The leisure and social characteristics of trail users can help park managers better understand their clientele. The Warren Park trail is used directly and indirectly for a wide variety of activities, and by a diverse mix of age, group sizes, and ethnic groups. Information of the type presented in this paper can be used as a basis for determining priorities for facilities development, for promoting trails to current and potential users, and for documenting trail usership for budgetary reasons. This information could also be compared to the 1990 U.S. Census data for neighborhoods surrounding Warren Park, to get an idea of how well the park serves its nearby clientele.

Recreational activities, age, and group size of trail users vary by season and in some cases by ethnic group, and information from this study can be used to plan for the specific needs of these market segments. For example, in winter there is a demand for cleared trails for walking and jogging but also a demand for snow-covered ski trails. This entails different management strategies that may include special winter signage to direct use. Golfing establishments in some cities have opened their courses for cross-country skiing, and both the course and clubhouse in Warren Park could be looked at for expanding winter park recreation opportunities.

Observing user-user interactions can help define management problems and solutions. For example, park managers could facilitate greater social interaction in places where it is desirable by placing park benches facing each other. In other locations it might be desirable to minimize interactions, such as at high use nodes along the trail. In these areas larger signs might help direct users to the bicycling or pedestrian trails, and park benches could be located further away from the trail. Considering the ethnic diversity of Warren Park's users, multilingual or pictorial signs could also help, and could highlight the multicultural diversity of the trail's users.

Observation of user-resource interactions can also identify management problems and solution. The high use of park benches indicates that park managers may wish to increase seating to accommodate additional trail users, especially along shady stretches. With regard to trail maintenance, future trail development should either plan for large utility vehicles or trail managers should restrict patrol and maintenance operations to smaller vehicles. Greater owner responsibility in policing dogs should be advertised and enforced where possible. Evidence of vandalism and gang graffiti can encourage more of the same, and for this reason it is important for park management to keep trail facilities in good appearance and working condition. At the same time it may be a good idea to post signs notifying trail users about penalties for littering and vandalism, and provide those who see others damaging trail facilities with a phone number they can call to alert park authorities.

Trail user observation, when used in conjunction with other research methods, is a valuable tool for identifying use patterns, user characteristics, and user and resource interactions. Based on this case study, observation appears particularly well-adapted for use on urban trails. Further use of this technique should be extended to other urban trail settings to increase its utility for management and research.

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GEOGRAPHIC INFORMATION SYSTEMS (GIS)

GREENWAY PLANNING: AN APPLICATION OF A GEOGRAPHIC INFORMATION SYSTEM

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This paper describes the implementation of a Geographic Information System (GIS) for greenway planning. Based on McHarg's seminal work, Design With Nature, a GIS incorporates layers of data referenced to a common coordinate system. Thus, the interrelationships between various aspects of the bio-physical and social environment can be identified and utilized in planning.

Introduction

Greenway designation has occurred nationwide in an attempt to provide recreation opportunities for the public while protecting the natural, cultural and historical resources. The President's Commission on Americans Outdoors recommendation has spurred the recent revival in greenway planning (PCAO 1987). As a planning strategy, greenways link resources together, while still permitting a variety of land use in the area. Several types of Greenways have been established, often found along rivers, mountain ridges and replacing the abandoned railroads.

One of the early and ongoing phases of greenway planning is the creation of a data base (Little 1990). This data base tabulates information on the human and the physical resources. Data of this type are found in a variety of formats. The problem remaining for recreation planners is to compile and utilize the data efficiently.

The purpose of this paper is to illustrate the steps for developing a Geographic Information System (GIS) for greenway planning. A GIS permits recreation planners to move from the collection and analysis of data to the decision-making process. Specifically, this paper will introduce the establishment of a GIS for the implementation of the Westfield River Greenway Plan.

Literature

Ian McHarg can be credited as the "Father of contemporary resource planning". His efforts have formulated the creation of a geographic information system based on a series of map overlays, which when placed on a common coordinate system, enable planners to recognize the interrelationships between features on the landscape (McHarg 1969).

A Geographic Information System approach to resource planning is well documented (Burrough 1986). Recent recreation studies include national park planning (Fleet 1987) and a Boy Scout Camp (Wikle and Bryant 1991). In the Northeast, a coordination of a GIS and the State Comprehensive Outdoor Recreation Plan (SCORP) in Massachusetts is being established (Klar et al. 1991).

As one can see, land use studies coupled with socio- economic analysis are presently incorporated in many planning projects. A GIS has an advantage over traditional maps and overlays in that a configuration of computer hardware and software enables the planner to access, compile and analyze a variety of alternative scenarios quickly and efficiently. For example, a recreation planner may be interested in identifying all the publicly owned land, having a slope that does not exceed six percent, is removed from fragile habitats and wetlands, yet accessible to a paved road and a drinking water pipeline. This land may then be made into campsites. A GIS can answer that inquiry in the matter of seconds. Furthermore, several other constraints can be evaluated and the best alternative chosen.

Greenway Planning

A greenway, or greenbelt as it is sometimes called, is a linear park that connects natural areas and open spaces. These greenways provide the public with access to open spaces for leisure pursuits. The concept of greenway planning can be attributed to Olmstead. His efforts established New York's Central Park and Boston's Emerald Necklace. These parks serve the public by providing relief from the urban pressures and preserving some of the natural environments. The open space may be publicly or privately owned and are found along abandoned railroads and canals, along utility corridors or scenic roads and in flood plains Little (1987) contends that the historical trend to separate humans from the natural environment and enclose them in a built one can be reversed with the "revolutionary" establishment of greenways in urban areas.

In summary, Greenway planning is a conservation strategy enabling recreation managers to protect natural resources and wildlife habits. Land that may be unsuitable for construction, such as a flood plain, are fine for a greenway.

Westfield River Greenway Plan

The Westfield River Greenway Plan was prepared by the Pioneer Valley Planning Commission and the Westfield River Watershed Association in 1990. The plan seeks "to protect the special and unique natural character of the Westfield river" (PVPC 1990:v). The goals of the plan are consistent with state and regional plans for Massachusetts waterways.

The Westfield River watershed is found the western part of the Commonwealth and drains a portion of the Berkshires before reaching the Connecticut River. Encompassing an area of 517 square miles, the river flows over a variety of landscape ranging from the Two thousand foot Berkshires to slightly above sea level in the Connecticut River Valley. The watershed has three main branches: East, Middle and West Branches and one major tributary: the Little River.

Most of the watershed is natural second and third growth forest. A timber economy still exists in the hill towns. Large tracts of public land are found and are administered by the U. S. Army Corps of Engineers, Commonwealth of Massachusetts and local towns. Upstream, the rural nature of the river encourages excellent water quality, while downstream, the urban land use threatens the river with pollution.

Methods

A typical GIS employs five steps: 1) data acquisition, 2) data input and preprocessing, 3) data management, 4) modeling, and 5) graphic output (Star and Estes 1990). Each of these steps are described below.

The first phase of a GIS is to collect data. This data serves as the basis for all geographic analysis and is available from a variety of sources. Maps, archives, remote sensed data from aerial photography and satellites and field checks are some of the types of information a GIS uses. Specifically, information pertaining to the administration of the land (ownership, land use etc.), abiotic and biotic (geology, flora and fauna), and infrastructure (transportation, utility, zoning etc.) can be tabulated. Once the data are collected, it must be encoded into a digital data base.

A GIS employs two forms of data structures to represent the environment. The first, called a Vector, encodes landscape features by a pair of X and Y coordinates that are joined together to form lines. These line segments represent the features on the terrain. A third value (Z) defines the attribute.

An alternative means to represent mapped data is to use a Raster method. Here, the data are found in a grid cell network, with each cell taking on a unique X, Y, and Z coordinate. Raster systems tend to be data intensive since each cell has a value, whether a feature is found there or not. However, data "packing" is available to speed up processing and reduce the size of the data file. Raster systems are appropriate for analysis while vector systems are designed for database management and network computations (Eastman 1990).

The data must be inputed into a digital data base next. This process may be achieved by simple keyboard entry, or may incorporate scanners and digitizing tablets. Alternatively, one can purchase or otherwise acquire data bases that have already been created.

The third phase of a GIS is the data management requirements. Here, the computer and software come into play. Computers can range in power from laptops to mainframes. The software utilized may dictate to a large extent the type of hardware requirements. Further, one should recognize that it is not the size of the system that should direct the implementation but the compatibility and specific needs of the organization. Colleges and Universities may provide GIS labs for planning purposes and therefore increase the effectiveness of the planning process. For example, one cooperative agreement is found between Towson State University, the Baltimore County Department of Environmental Protection and Resource Management and the Baltimore County Office of Planning and Zoning (Johnson et al. 1991). Under this arrangement, the combined strengths of the three departments create a large GIS facility to work on planning issues.

Data modeling is the fourth part of a GIS. This step involves the manipulation and analysis of the planning alternatives. Because computers can work faster than humans, recreation planners can interpret a host of alternative scenarios and choose the best one to suit their needs. One should be cautioned at this point, since a tendency to try to investigate all possibilities may be undertaken, without serious thought to the consequences of the analysis. This attempt to discover relationships may lead the planners down a wrong path. In the Westfield River Greenway project, the goals of the greenway plan direct the analysis phase of the GIS.

The final part of the GIS is graphic output and presentation. The most important, yet essentially invisible part is the data file that has been created. Jack Dangermond, founder of Environmental Systems Research Institute, identified several deficiencies in digital data bases (Dangermond 1991). For example, most of the Earth's geology has yet to be digitized. Compilation of digital data bases and the cataloging of this information is imperative. Beyond the data files, graphic output in the form of maps, charts and tables present the information to a variety of audiences.

Discussion

The establishment of a Geographic Information System can be a laborious project. For the Westfield River Greenway Plan, all five phases are currently underway. The Data acquisition phase is ongoing and several data layers have been created. The feasibility of the project has been supported by the concentration of analysis for one small area northwest of Westfield. The area, named for the prominent peak called Tekoa Mountain has served as a demonstration site for the project. A terrain model has been compiled, showing the topography of the landscape. Hydrologic features, roads and trails, and vegetation have also been digitized for the Tekoa region.

Several problems have been encountered with this project that deserve some attention. One problem lies with the accuracy of data sources. This requires extensive field checks supported by recent aerial photography interpretation. In the creation of an overlay showing wetlands and residential zoning for Westfield, the roads and streams did not line up properly. Are the Town's maps incorrect or does the error lie with the USGS topographic map? Since zoning changes along streets and other cultural features on the landscape, the overlay maps had to be "rubber sheeted" or stretched and shrunk for the information to fit together.

Other problems are expected, but will be dealt with as the occurrences arise. These facts of life are but a part of the establishment of a GIS for resource planning and emphasize the need for accuracy in spatial data (Goodchild and Gopal 1989). If recreation planners have an accurate source of information to work with, a reduction of problems can be anticipated.

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MASSGIS AND SCORP PLANNING PROCESS: THE CAPE COD PILOT PROJECT

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Statewide Comprehensive Outdoor Recreation Plans (SCORP) serve as the means for states to qualify for Land and Water Conservation Funds (LWCF). With the support of the National Park Service, the Cape Cod and Islands Region in Massachusetts was utilized as a case study to determine if SCORP and digitized GIS data could be integrated into a single data set. Portions of both data sets were successfully integrated and this study will serve as a guide for incorporating a Geographic Information System (GIS) into the completion of the 1993 SCORP.

Introduction

The primary purpose of this research was to determine the feasibility of linking data obtained during the completion of the 1988-92 Massachusetts Statewide Comprehensive Outdoor Recreation Plan (SCORP) and GIS data of conservation areas in the Cape Cod and Islands region of the Commonwealth. Conservation inventory data were obtained for all 23 Cape/Island communities. A complete account of the processes are contained in the 1988-1992 SCORP: *Massachusetts Outdoors: For Our Common Good.* The inventory contains the following information about each site:

Site Description. Descriptors include site name, site address, site ownership and management attributes, including types of access to the site.

Facility Inventory. Information on many types of facilities has been documented plus the number of those facilities which are accessible to physically disabled persons.

Special and Unique Features. A number of physical characteristics relating to each site have been described including the number and types of water bodies that are present, miles of tidal frontage, coastal zone protection, and specialized trail-use including motorized vehicular trail-use and trails designed for the physically disabled.

Activity Information. Outdoor recreational activities that occur on each site have been identified independently of whether or not facilities for each activity are present.

Site Assessment Information. Assessment information focuses on whether sites could be expanded for recreational use, if parking could be expanded, general descriptions of the site-type (general outdoor recreation area, natural environment area and historic/cultural area) and use-levels (optimal, under, over).

Coding Information. Coding includes town identification codes, regional and county codes, site extension codes (if site extends into another town) and site identification number.

Method

Geographic Information System (GIS) data were gathered primarily from municipal tax maps, recompiled and digitized from 1:25,000 USGS Topographic Quadrangles). Sites were assigned the same code numbers that were used in the 1988 SCORP site inventory. By matching SCORP and digitized sites, it was possible to map exact boundaries and visually present information related to the characteristics of the sites. For example, the number of camp sites available at state-owned campgrounds could be graphically displayed by either colors or shadings in black-and-white. Graphic coding could also be used to represent other site features such as the number of fresh water fishing sites, miles of hiking trails, number of significant cultural features, and so forth.

It is important to note that the primary search could begin with the type of activity, the type of site or the type of agency that manages the site, or any combination thereof. For example, one could search for all of the *state-owned* and managed *beaches* on Cape Cod by selecting *owner type* and *administrative agency equal to state*; and *usable beach frontage* which is greater than "0." On the other hand one could also select simply all *usable salt water beach* frontage which is greater than "0" without reference to *owner* or *management type.* This would yield information on *all* salt water beaches on the Cape. In another scenario, one could simply select the activity *salt water swimming.* This would identify sites where *salt water swimming* occurs whether or not a salt water beach facility is owned or managed by a particular agency. The answers to these queries of information would be somewhat different and yield some useful insights. For example, the second query, *where are the salt water beaches*, would identify all such facilities, regardless of owner type or which agencies manages them. But, by including information about the site management and ownership of these sites, one would be able to identify the distribution of beach areas on the Cape which there is *public access.* By integrating such information with the GIS system, distributions could then be depicted graphically for any particular town, cluster of towns or for the region as a whole.

More than 5,000 Cape/Island sites were identified during the SCORP data collection process. The major purpose of the study, then, was to determine the extent to which site information within the SCORP data set could be matched with sites identified through the GIS digitizing process.

Results

Although not insurmountable, GIS mapping difficulties emerged early in the study. Specifically, there was some loss in accuracy in situations in which assessor's maps at a scale of 1:1000 had to be "shrunk" to 1:25,000.

At the time GIS data were being gathered, one of the limiting factors of the software was that point data and line data could not be used for the same data layer. Version 5.0 software for ArcInfo software later became available which makes it possible to integrate line data with point data in the same data layer. Until the time when all Cape/Islands data have been sorted out between line and point data, small squares will continue to be used to represent the parcels too small to show up accurately at a 1:25,000 scale. Within this particular region, this is a significant problem since there are so many small sites (e.g., those containing boat ramps) which are less than one acre in area.

The GIS data collection process was labor intensive. It involved identifying site information sources, mapping sites on master quads, assigning identification numbers to each site, and digitizing site information into the Geographic Information System. Conservatively, these tasks required approximately 600 person hours.

The matching of SCORP records to mapped polygons and entry of the SCORP ID number into the GIS open space polygon attribute table (PAT) involved the following sequence of steps:

- The creation of a SCORP listing organized similarly to the GIS data which concatenated town codes and site numbers in the SCORP ID.

- The production of plots of the open space data with the open space ID, facility name and owner type as labels for each polygon.

- The recording of the SCORP ID on the GIS plot and on the polygon attribute worksheets.

- Updating the GIS by entering the SCORP ID in the polygon attribute table of the GIS coverage.

A relatively low percentage of the open space polygons were matched with appropriate SCORP records for the following reasons:

- SCORP sites included all conservation, recreation and historic sites whereas the GIS open space inventory included only "dedicated conservation lands" which greatly narrowed opportunities for matches.

- There were many isolated tracts of state-owned undeveloped land which do not appear in the SCORP site inventory. Many of these are lands associated with fire towers or other conservation lands with no formal public access.

- The SCORP site inventory was completed by municipal staff officials who had good information about municipal facilities but not about non-profit lands. Conversely, the GIS open space inventory was compiled by staff members of non-profit organizations who had good information about the land holdings of their particular agencies but not thorough knowledge of municipally held lands.

- In many instances, sites could not be matched either because they were not named identically in both data sets or because it was not always possible to determine the exact name of the area which contained certain GIS mapped facilities (such as boat ramps). In such situations, separate site ID numbers were given for the same site in the two different data sets.

Recommendations

An on-going system for updating existing site records should be developed and put in place. Ideally, legislation would be passed which would require municipalities to update state records on an annual basis. In addition, a larger number individuals within each community should become involved in completing site inventory sheets. This would ease the burden, increase accuracy and strengthen the planning processes associated with updating and completing the SCORP document. In general, a data collection system should be developed which promotes *community processes* for problem solving, particularly related to community open space plans and master planning.

For a complete integration of SCORP and GIS to take place, individual SCORP sites must be accurately plotted and mapped. This will be a long-term project that should begin with the more significant sites that are completely within the boundary of each town. Eventually it will probably be necessary to change the current SCORP method of assigning all site acreage that extends into another community to the community in which the administrative headquarters of that site is located.

As a result of insights gained by holding two workshops for Cape/Island planners, a number of points became apparent. First, many planners and administrators did not know exactly how the presentation of findings through GIS might be of assistance to them. Second, and somewhat related, they did not always know what research questions should be asked of that could be addressed through GIS. Third, without encouragement and guidance, most planners will either forget that the state Data Center exists as a resource or will feel that obtaining data from the Center is too complicated to pursue.

Even if data requests are formulated and submitted to the Data Center, it will be necessary for the state to hire one or more individuals who have knowledge of SPSSX and the ArcInfo software systems. Without such assistance, staff at the EOEA Data Center will be limited to providing descriptive information in report formats rather than reports and maps that are generated by a fully integrated SCORP-GIS system.

This study process has served several purposes. First, it actively involved planners within the Cape Cod and Islands region. New relationships between state and local planners were formed, local planners learned about the availability of data sets that will be of help to them and their communities, and they gained insights about the power of GIS and how it will be used increasingly in state planning in the years to come. Second, a number of barriers to the matching of SCORP and GIS sites were identified. In future SCORP-GIS studies, these can be avoided thereby greatly increasing the power of the data. Third, this study will serve as a model for other regions within the Commonwealth. As the time for completing the 1993 Massachusetts SCORP draws near, the intent is to actively incorporate GIS into the SCORP process.

Finally, aerial photogrammetry may soon play a role in the GIS digitizing process. If aerial data can be scanned and converted into a digitized form, there will be major savings in the data entry process.

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THE REPRESENTATION OF ERROR IN VISIBILITY MODELING [1]

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Visibility analysis has been a significant tool used in recreation planning for 30 years or more. Computer applications assume a deterministic model and apply the visibility algorithm only once, resulting in a classification of visible or not visible areas. The sensitivity of this assumption is investigated using a Monte Carlo approach where a digital elevation model is perturbed within the map's accuracy standards. This process is repeated several times to create a summary map that indicates error or sensitivity.

Visibility Analysis

A visual analysis is one of the few professional services that is normally performed only by landscape architects. It could be argued that much of this "analysis" is very subjective in nature, and that the results would vary from professional to professional. However, most of us would expect visibility or viewshed analyses to be very objective--since they are a simple matter of geometry--with little variation among the findings of different professionals (Palmer 1983). This expectation of objectivity is only enhanced with the reliance on computerized geographic informations systems (GIS) to perform the calculations. However, computers give us a false sense of confidence and are particularly subject to uncertainty errors related to the phenomenon known colloquially as "garbage-in-garbage-out" or GIGO.

A typical visibility map is shown in figure 1. What do you see? What information can it provide a decision-maker? What is left out or is even misleading? A decision-maker interested in the bottom line would reasonably draw conclusions about whether some location in the landscape is seen or not seen from the selected viewpoint. In their reviews of approximately 100 major planning and project impact reports, Felleman (1982) and Griffin (1989) found maps that looked very much like figure 1, with little or no documentation of methods or parameters used. For instance, figure 1 was calculated using a 30-meter digital elevation model (DEM) derived from a USGS 7.5 minute quadrangle topography map. The elevation of the viewer's eye is two meters, the visible points are at ground level, and there is no consideration made for land cover. The program used is MAP II (Pazner 1989), a derivative of Tomlin's (1983) Map Analysis Package, which does not document the algorithm used from among the many available (Sutherland et al. 1974).

1/ This project was funded in part by Cooperative Agreement No. 23-88-27 from the U.S. Forest Service, North Central Experiment Station

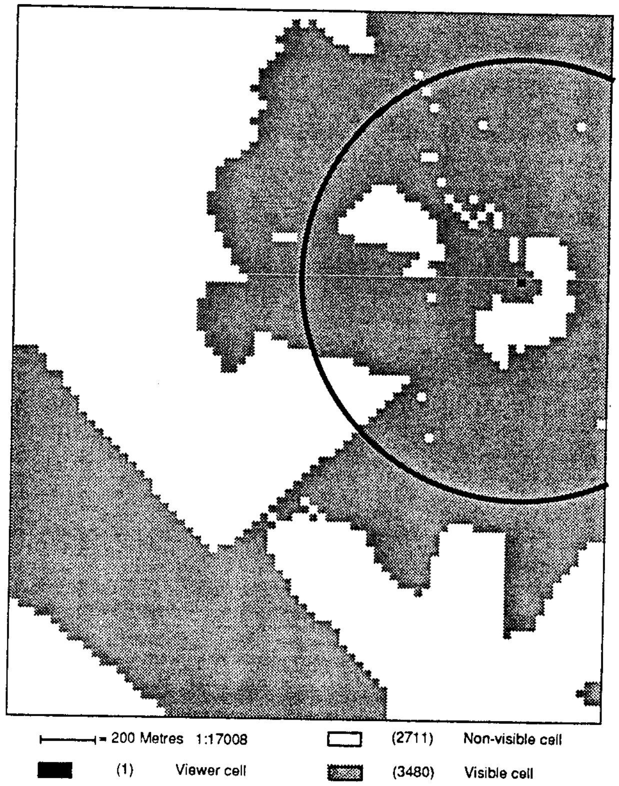

Figure 1. A typical visibility map showing areas seen and not seen from a viewpoint with an arc indicating the boundary between foreground from the middle ground.

Why be Concerned with Accuracy and Precision in Decision-Making?

It is the nature of our political system that those responsible for making decisions demand answers to questions that they know little about. The professional staff who advise about alternative positions can wax eloquently about the subtleties of various options until they are "blue in the face," but decisions will still be made based on a few "bottom line" characteristics. It is, therefore, very important that the professionals develop tools that allow decision-makers to visualize the complexity and subtlety of their options in an accurate and easily understood way.

While most decision-makers see questions of accuracy and precision as technical considerations about which they need not be concerned, there is nothing further from the truth. Self-interest leads any person in a position of authority to seek responses that are tightly focused and right on target. The importance of this situation is graphically portrayed in figure 2, where the desired response has both high accuracy and precision. Frequently, decision-makers find themselves following the fuzziness strategy to protect themselves from making firm proclamations that entirely miss the mark --low accuracy and high precision. When advising decision-makers, we should present our results with a stated precision --degree of focus or fuzziness-- that is appropriate to the accuracy of our data.

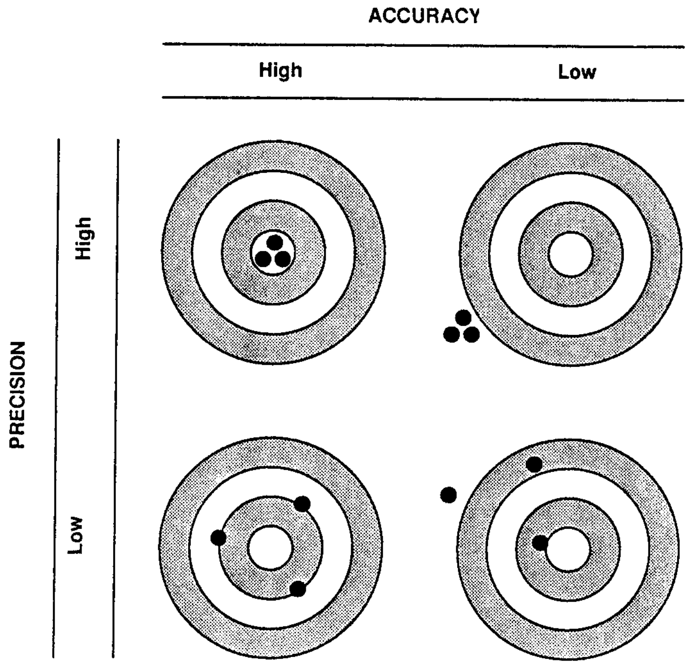

Figure 2. These targets graphically portray the meaning of high and low accuracy and precision.

The sharp lines of the visibility map shown in figure 1 are a delusion that, as professionals, we should not support because they can lead to poor decisions. The remainder of this article outlines one approach to preparing a visibility map that better represents the uncertainty inherent in the analysis.

Evaluating Visibility Accuracy

The U.S. Geological Survey is the source of most topographic data used for visibility analyses. Most of their products conform to the National Map Accuracy Standard "that no more than 10 percent of the points tested shall be in error by more than a certain tolerance" (Thompson, 1988). By assuming that the error at any point is independent of the error at any other point and that these errors are normally distributed, this standard can be can be implemented statistically using the standard error or root-mean-square-error (RMSE):

$$\text{RMSE} = \sqrt{\frac{\sum x^2}{n}}$$

where $x_1, x_2, \ldots, x_n$ are the errors at n checkpoints.

Thompson (1988) show that the allowable tolerance in the elevation contours (in feet) for a 1:24,000–scale map with a horizontal tolerance of 40 feet on the ground for 90 percent of the horizontal test points and a vertical tolerance of one-half contour for 90 percent of the vertical test points is:

allowable RMSE $= 0.3\,CI + 24\,t$
where CI = contour interval, and t = tangent of slope angle.

Because it is related to the normal distribution which is one of the foundations of most parametric statistics, the RMSE provides a convenient method for evaluating map accuracy in statistical terms.

Method for Modeling Probabilistic Visibility

A Monte Carlo approach is used to evaluate the effect of possible map error on the results of a visibility analysis. Monte Carlo methods provide approximate solutions to complex problems by investigating a series of models based on the random sampling of simulated data. The topographic database used for this paper is of Howe Hill near Worcester, Massachusetts. It comes bundled with IDRISI, a GIS for MS-DOS PCs distributed by the Department of Geography at Clark University. It was manually digitized from a 7.5 quadrangle map, but is in the format of a USGS DEM for the quadrangle series. The data base is 86 rows by 72 columns with a cell resolution of 30 meters. The elevation has been converted from ten foot contour intervals to the nearest meter. It ranges from 294 to 360 meters, with a mean of 330 and a standard deviation of 16.0 meters.

A group of fifty separate DEMs for Howe Hill were created, with each one introducing a different set of random normal perturbation to the topography based on the RMSE for each cell. A viewpoint was chosen near the crest of a hill of moderate elevation within the site.

The data for the fifty elevation maps with random normal perturbations were prepared in Wingz (Informix, 1988) using the NORMAL(*standard deviation*) function. The RSME as described by Thompson (1988) for a 1:24,000 series topographic map and adjusted for the change in scale from feet to meters was used as the standard deviation in NORMAL function. The "tangent of the angle of slope" was calculated in MAP II using the GRADIENT operation with the maximum option. This gives a percent slope map, and was divided by 100 to arrive at the tangent of the angle. The random error was added to the original control elevation of each cell. The 3–by–3 cell area surrounding the viewer cell was reset to the original control elevation on the assumption that the error in the immediate foreground relative to the elevation of the viewpoint would be marginal or absent. A visibility map is created for each of the fifty randomly perturbed DEMs using the RADIATE command in MAP II. [2]

The Monte Carlo approach used here adds several of these visibility maps together. The resulting probabilistic visibility map indicates the number of times each cell was seen from the viewpoint. To facilitate interpretation, the boundary between the foreground (0 to 1/2 mile) and middle ground (1/2 to 3 1/2 miles) is indicated. The distances used are appropriate for the Northeastern region where the site is located (Felleman 1982).

Results

The total seen area of the control visibility map in figure 1 is 3480 cells. Only one of the fifty Monte Carlo simulations had a greater seen area: trial 23 is 9.1 percent larger at 3861 cells. The size of the seen area of the other 49 trials ranges between 2889 and 3295 cells with a mean of 3114 cells. Therefore, the Monte Carlo approach indicates that the control visibility map in figure 1 may over-estimate seen area by five to fifteen percent.

2/ The command used was "Radiate <<VIEWPOINT>> To 7620 At 2 Over <<RANDOM ELEVATIONS>>' where the 3X3 cell area surrounding the view point in RANDOM ELEVATIONS was reset to its unperterbed control elevations.

The probabilistic visibility map produced from all fifty Monte Carlo trials is shown in figure 3. While approximately 43.8 percent of the control map is never visible, this percentage is reduced to 33.3 in the probabilistic visibility map. The results are even more dramatic for the always seen areas which drop from 56.2 to 17.3 percent. In other words, approximately half of the total map in figure 3 is in a "gray" zone of less than certain visibility or invisiblity.

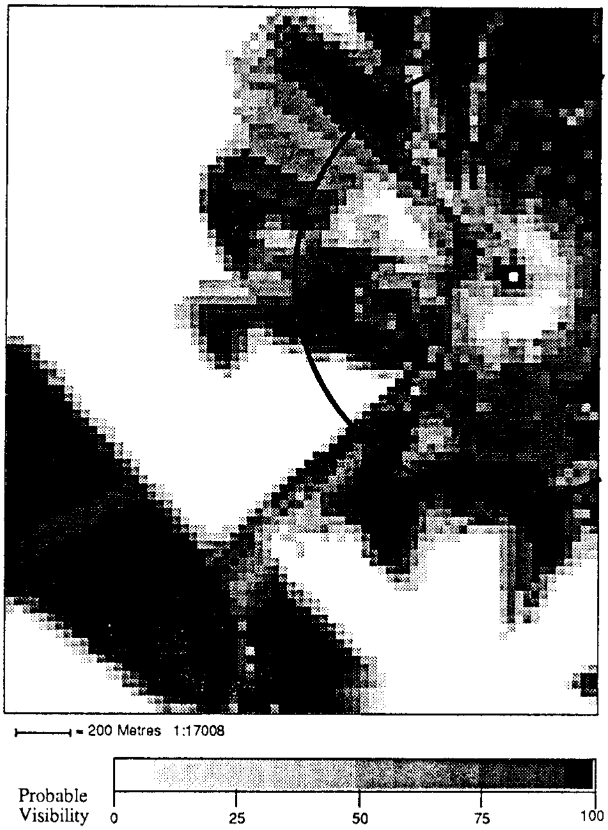

Figure 3. This visibility map shows the probability of a point being seen from the view point based on a summation of fifty Monte Carlo simulations. The boundary between the foreground and middle ground is indicated by the arc.

Even when the Monte Carlo trials are grouped into five bundles of 10, there is significant variation among the different probability profiles of the resulting visibility maps, as shown in figure 4. There is very high agreement about the number of cells with no probability of being seen. For instance, these include areas on the backside of the larger hills, particularly those in the middle ground. There is also considerable agree-ment about the number of cells that are always seen. For instance, these include slopes on the opposite side of the valley.

Looking back at the probabilistic visibility map in figure 3, there is clearly a very high proportion of "gray" area within the near as compared to the middle distance. This pattern is made more apparent in figure 5, which provides separate probabilistic visibility profiles for the foreground and middle ground. The overall U-shaped pattern is evident for both distance zones, though the foreground has an overall greater probability of being seen. In particular, the proportion of the foreground that is never seen is substantially less than the area that is always seen.

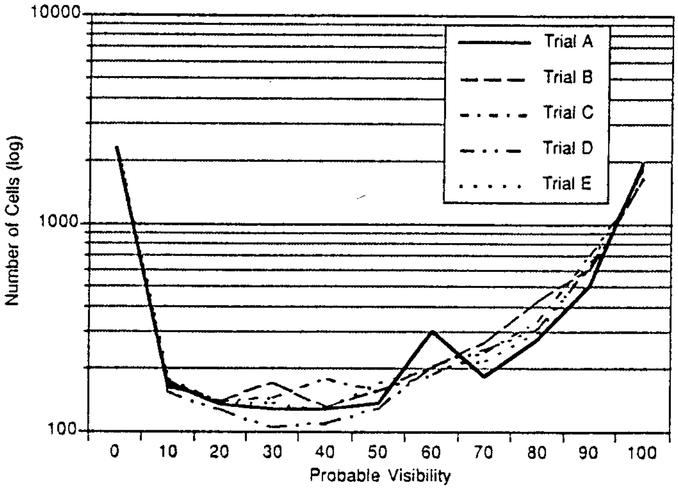

Figure 4. The fifty Monte Carlo visibility maps were grouped in batches of ten to form probabilistic visibility maps. The number of cells in each level of probabilistic visibility is plotted above.

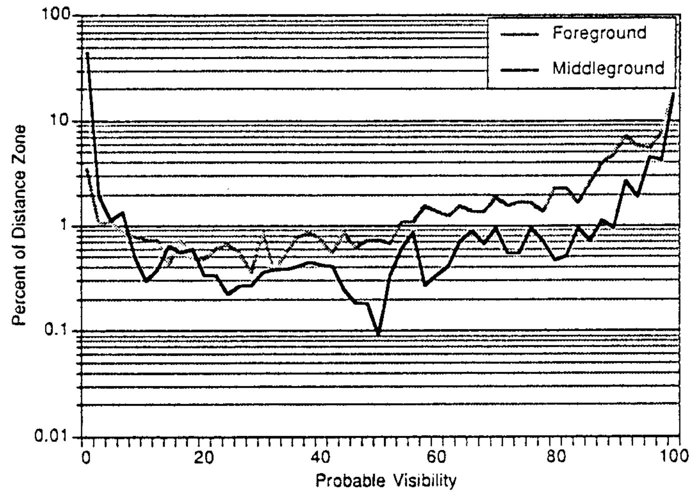

Figure 5. Separate probabilistic visibility profiles for the foreground and middle ground.

A comparison is made among the percent area seen in the control visibility map and the mean probabilistic visibility from the 10-run and 50-run probabilistic visibility maps. In order to make the comparisons using independent data sets, it was necessary to create a sixth set of ten randomly perturbed elevations. The t – tests in tables 1 and 2 are calculated by comparing the probabilistic visibility of corresponding cells for the whole map. The results in table 1 indicate that the means obtained for the control and 10-run visibility maps are significantly different in each of the six trials. However, the means in table 2 for the 10-run and 50-run maps do not give significantly different results. The implication for this view point and topography is that the fuzziness added by the 10-run probabilistic visibility maps is a significant addition to the information contained in the control visiblity map. However, the 50-run simulations do not seem to add significantly to the information contained in the 10-run probabilistic visibility maps.

Table 1. Comparison of mean percent seen areas for the control visibility Map and 10-run probabilistic visibility maps

	$\bar{x}$ % Seen Area			
Trial	Control	10-runs	*t*	*p*
A	56.2	50.5	6.7	.000
B	56.2	50.0	7.4	.000
C	56.2	49.8	7.6	.000
D	56.2	50.6	6.6	.000
E	56.2	50.2	7.1	.000
F	56.2	50.1	7.2	.000

Note : Independent sample *t* -tests with 6191 data points in each sample.

Table 2. Comparison of mean percent seen areas for 10-run and 50-run probabilistic visibility maps

	$\bar{x}$ % Seen Area			
Trial	10-runs	50-runs	*t*	*p*
A	50.5	50.2	.38	.702
B	50.0	50.4	-.53	.596
C	49.8	50.4	-.80	.426
D	50.6	50.2	.55	.583
E	50.2	50.3	-.20	.843
F	50.1	50.4	-.28	.776

Note : Independent sample *t* -tests with 6191 data points in each sample.

Summary and Conclusions

The importance of considering accuracy and precision in decision-making has been discussed. It is shown that decision-makers demand answers that are both highly accurate and precise, conditions that are frequently lacking in the real world. Fuzzy statements and less than optimal decisions are commonly employed as a strategy to protect decision-makers from making politically disastrous decisions. It is argued that support staff have the responsibility to present study results in ways that accurately reflect their relative certainty. Such presentations would assist decision-makers in arriving at optimal decisions.

An approach for representing the error associated with the map products of GIS models that use data with estimated variance is presented. The approach uses Monte Carlo simulation techniques to randomly perturb the original database within its estimated level of error. Visibility mapping, an analysis frequently conducted by landscape architects, is selected as the GIS modeling technique to demonstrate this approach.

While only one viewpoint in one terrain is considered, the results may still offer some tentative guidance. They indicate that a 10-run Monte Carlo simulation creates a probabilistic visibility map that contains more information than the traditional seen/not seen map. There does not seem to be a statistically significant difference between a 10-run and 50-run Monte Carlo simulation. However, in particularly sensitive situations, it might be advised to conduct more than 10-runs in the foreground, since it appears that areas nearer to the viewpoint are more sensitive to random errors.

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AUTHOR INDEX

AUTHOR	PAGES
Batcheller, Gordon R.	134
Beaman, Jay	111
Bernier, James R.	81
Bevins, Malcolm I.	91, 203
Briceland, Richard H.	3
Bristow, Robert S.	225
Brown, Cindy M.	118
Brown, Tommy L.	134, 149, 153
Brunson, Mark	169
Buerger, Robert	156
Burr, Steven W.	15
Cheng, Hsiang Tai	98
Connelly, Nancy	153
Cottrell, Stuart P.	45
Danchuk, Greg	173
Dawson, Chad P.	153, 156
Deblinger, Robert D.	61
Dennis, Donald F.	116
DiStefano, James J.	134
Donnelly, Maureen P.	61, 72, 129
Dustin, Daniel L.	6
Dwyer, John F.	20
Echelberger, Herbert E.	94
Ewert, Alan	51
Felleman, John P.	230
Fesenmaier, Daniel	177
Fletcher, James E.	122
Frick, George E.	139
Gitelson, Richard J.	15
Glass, Ronald J.	134
Gobster, Paul H.	20, 209, 215
Graefe, Alan R.	45, 55
Gratzer, Miklos	156
Halstead, John M.	118
Hopping, Russ	61
Johnson, Stephen	228
Kacprzynski, Fred	83
Klar, Lawrence	228
Lindsay, Bruce E.	118, 139
Lindsay, John J.	66
Loomis, David K.	160
Lord, Bruce E.	102
Luloff, Albert E.	118
Lusk, Anne	10
Malone, Daniel T.	66
Manalo, Alberto B.	139
McCreedy, Christine Cornell	177
Moore, Roger	55
More, Thomas A.	94, 134
O'Leary, Joseph T.	177, 182
O'Malley, Georgia L.	182
Palmer, James F.	230
Rechisky, Allison	106
Reiling, Stephen D.	98
Ross, Malcolm, Jr.	70
Schaeffer, Kelly	86
Schroeder, Herbert W.	25
Shelby, Bo	169
Siemer, William F.	134, 149
Solan, David S.	187
Stanley, Dick	111
Steele, R. J.	122
Stevens, Thomas H.	142
Strauss, Charles H.	102
Sugerman, Deborah	31
Swett, Gail	228
Thomson, Ed	173
Trott, Cheryl	98
Vander Stoep, Gail A.	36
Vaske, Jerry J.	61, 72, 129
Warnick, Rodney B.	160, 190, 228
Williamson, Brad	106
Young, Anderson B.	51
Zwick, Rodney R.	72, 197, 203

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