Examining Differences between OHV Riders: A Spatial Approach to Understanding Tolerance

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Abstract: The purpose of this study was to examine perceived differences related to goal interference and tolerance for lifestyle diversity between all terrain vehicle riders, off-highway motorcycle riders, and four-wheel drive operators, and to identify where conflict related to tolerance was most likely to occur. Data was collected using a combination of on-site interviews and mail back questionnaires. Results of this study indicate that perceived differences related to tolerance are present and a spatial understanding of where tolerance is more likely to occur can help managers provide more sustainable riding opportunities on public lands in a way that meets the user's needs and better conserves natural resources.

Keywords: Off-Highway Vehicles, GIS, Tolerance, Goal Interference

Introduction

Off-highway vehicle recreation has existed on public lands for decades. In the early 1950's and 1960's off-highway motorcycle riding was occurring on backcountry roads (Havlick, 2002). In the early 1970's the first ATV was introduced by Honda and was found recreating on public lands shortly there after. During these early years, OHV recreation on public lands was minimal, and most managers were able to operate under a closed unless open policy for regulating OHV use (Executive Order 11644, 1972; Executive Order 11989, 1977). However, in the mid-1990's both OHV sales and OHV recreation on public lands dramatically increased. From 1995-2003, new retail sales of all-terrain vehicles (ATVs) and off-highway motorcycles (OHMs) more then tripled, rising from approximately 386,000 to over 1.1 million (Havlick, 2002). Four-wheel drive recreation (FWD) has also had a steady increase in participation, with specific interests in rock crawling and sand sports (Campbell, 2006). In response to this increase in OHV recreation, the Travel Management Rule (2005) was passed mandating the management of OHV recreation on Forest Service lands in a manner that provided for quality riding experiences, ensured visitor safety, and protected natural resources.

In a rapid push to build OHV trails that helped managers meet these Travel Management Rule objectives, much of the focus on OHV research has been on desired experiences of OHV rider groups, with little attempt to examine if these groups perceive themselves as different from each other. The purpose of this study was to examine perceived differences related to goal interference and tolerance for lifestyle diversity between all-terrain riders, off-highway vehicle riders, and four-wheel drive (FWD) operators, and to identify areas where conflict related to tolerance was most likely to occur. Specifically, the objectives of this study were to (1) examine the level of out-group conflict and degree of tolerance between all-terrain vehicle, off-highway motorcycle, and four-wheel drive operators, (2) examine where conflict related to tolerance is most likely to occur based on shared resource preferences, and (3) examine how the spatial knowledge of conflict related to tolerance could be used in making planning recommendations for creating sustainable riding opportunities. Although tolerance itself can not be directly linked to landscape resources, resources that are highly favored when engaged in a specific recreation activity can be identified. These preferred resources can be mapped for each activity group and then compared across activity groups allowing for the identification of where conflict is most likely to occur based on the assumption that riders will choose areas that are best suited to meet their recreation needs (Kliskey, 2000). The outcome of the process provides managers with a set of maps that can be incorporated into the recreation planning process and aid managers in deciding where to implement single and multiple use trail systems within areas that are preferred by specific rider groups.

Understanding and Managing Recreation Conflict

The study of recreation conflict has evolved over time, shifting from a descriptive nature of addressing incompatible activity groups to providing more meaningful explanations as to the causes of recreation conflict. The advance of Jacob and Schreyer's theoretical framework of goal interference has provided the clearest definition of conflict (Hammitt and Schneider, 2000), and has been the standard framework in examining conflict over the past three decades (Confer *et al.*, 2005). Conflict is defined as goal interference attributed to another's behavior, suggesting that in order for conflict to occur, either direct or indirect contact must be made. Direct contact refers to face-to-face contact or encounters with another individual. Indirect contact refers to seeing the presence of an individual in the form of vehicle tracks, litter, etc. One must then internalize this contact and evaluate its affect on the recreation experience, which is typically based on previous social or physical contact (Jacob and Schreyer, 1980).

Conflict resulting as goal interference can be addressed more directly by managers by way of posting and monitoring speed limits, meeting with user groups, posting signs, utilizing volunteers to help monitor and disseminate information, or provide a stronger presence of law enforcement (Moore, 1994). However, addressing behavioral issues may ignore other underlying causes of recreation conflict which must also be addressed if conflict management is to be effective (Manning, 1999). The model of goal interference further suggests four fundamental causes of conflict, one of which is tolerance for lifestyle diversity.

Tolerance for lifestyle diversity refers to the ability to accept or reject a lifestyle that is perceived as different from ones own (Jacob and Schreyer, 1980). Within the theory of goal interference Jacob and Schreyer (1980) state that the degree of tolerance held by an individual consists of two main components. First, individuals perceive themselves as part of a group, and those who are not within that group are different. Second, group differences are evaluated. In instances where these differences are evaluated negatively, there may be an inability to share resources. Furthermore, Jacob and Schreyer (1980) hypothesize that when "group differences are evaluated as undesirable or a threat to ones recreation goals, conflict results when members of the two groups confront each other" (p. 377).

It has long been noted that conflict due to tolerance can not be eliminated. Rather, managers must seek to understand intolerance as it relates to providing recreation opportunities and try to minimize conflict occurrences (Jacob, 1977). More recent studies have also echoed this notion, suggesting that managers seek to separate activity groups who are intolerant of each other (Vaske *et al.*, 2000; Thapa and Graefe, 2003). Recreation management frameworks such as the Recreation Opportunity Spectrum (ROS) can aid managers in minimizing recreation conflict through the implementation of zoning strategies, and assist in promoting quality visitor experiences through offering diversity (Clark and Stankey, 1979; Daniels and Krannich, 1990).

Although the concept of zoning may work to help minimize motorized vs. non-motorized conflicts, it is not a universal remedy for resolving all recreation conflict issues (Daniels and Krannich, 1990). Often times, recreation conflict occurs within similar activity groups which may occur within the same zone (Todd and Graefe, 1989; Watson *et al.*, 1994; Vaske *et al.*, 2000). In such cases, zoning may be ineffective and other tactics must be implemented in order to help minimize conflict. Planning and trail design strategies such single and multiple use trail designs and varying trail difficulty can also be implemented to help disperse recreation visitors and help create quality recreation opportunities while reducing conflict (Moore, 1994). Although these tactics have been extensively discussed within the current body of literature, few have looked at conflict spatially in order to help identify how to best separate users that are sensitive to conflict in a manner that best utilized available resources.

Geographic Information Systems (GIS) is a tool that can help managers begin to evaluate potential recreation conflict within a spatial context. Representation of various recreation opportunities for various user groups within a single managed area allows for a range of potential opportunities to be compared and assessed simultaneously which may lead to the development of management solutions for otherwise contentious activities (Kilskey, 2000). This often involves the need to assess large amounts of information related to user preferences, user perceptions of conflict, and biological and physical constraints. GIS provides managers with the appropriate tools to evaluate this large amount of information as well as the ability to ask geographic questions about possible management actions (Falbo, Queen & Blinn, 1991). By doing so, managers can began to evaluate how potential actions could help enhance user experiences, minimize user conflicts, and preserve environmental integrity before any actual decisions are implemented on the ground. As a result, accuracy and long-term cost efficiency of managing an area are increased (Naber and Leung, 2006). Recent advances within GIS and recreation research has began to link visitor preferences (Kilskey, 2000) and values (Brown, 2005; Reed and Brown, 2003) to resource attributes, allowing managers to identify areas of potential conflict as well as potential use. Other studies have examined visitor use and travel patterns in order to identify areas of heavy use, and discuss management strategies to help reduce resource impacts and minimize potential user conflicts (Wing and Shelby, 1999).

Developing an understanding of visitor use levels, travel patterns, and preferences spatially can not only help identify areas in need of management focus to reduce conflict potential, but can also assist managers in understanding where to concentrate management efforts to help provide quality recreation opportunities. In the Netherlands, researchers recognized the social benefits of forests, and created a regional model that depicted visitor volume and visitor preference. The model itself can be useful in assessing how to plan for the volume of individual use within a given area, and to some extent assess the quality of an experience based on the visual attraction (de Vries and Goossen, 2002). In Yellowstone National Park, GIS was used to help create and map indicators and standards as it related to providing quality visitor experiences. Recognizing that quality trails lead to quality recreation opportunities, Xiang (1996) developed a method for trail alignment to evaluate the most suitable areas for trail construction based on ecological, biological, and economical constraints.

Managers are also often faced with the conflicting dual mission of preserving ecological integrity of an area while providing quality recreation opportunities within those areas. In order to help balance between resource use and resource preservation, GIS, global positioning systems (GPS), and remote sensing (RS) tools have been utilized to help plan and manage for sustainable opportunities. In Gwaii Haanas National Park, researchers built a GIS database incorporating ecological, archeological, and levels of visitor use data to establish baseline levels of visitor impacts. Data was evaluated independently and in conjunction within each other in order to evaluate areas sensitive to impacts and determine where management efforts should be focused (Gajda *et al.*, 2000). A similar study in conducted at Boston Harbor integrated resource information and visitor carrying capacity data in order to help monitor recreation impacts (Leung *et al.*, 2002). Data collected with GPS units in conjunction with GIS information has been used to evaluate campsite impacts and develop management strategies to help restore areas receiving unacceptable impacts. Remote Sensing techniques have also shown to be valuable in identifying and monitoring recreation impacts, specifically within coastal recreation areas (Ingle *et al.*, 2003).

Methods

Study Area

Ocala National Forest (ONF) is located in North Central Florida, and is within a day's drive of most Florida residents. Of the four National Forests within Florida, ONF receives the highest number of OHV visitors annually. Similar too many other National Forests within the U.S., OHV recreation went unmanaged, allowing cross country travel uncontained to a trail system until 1999. Recognizing the environmental and social impacts that were resulting from miss management, the forests Land and Resource Management Plan was revised to state that all OHV recreation must occur on existing user made trails within unrestricted areas (USDA Forest Service, 1999) until an actual trail system could be designed and constructed. Although this action was a step toward gaining control of OHV recreation within a currently unmanaged system, it still was insufficient in reducing environmental and social impacts throughout the forest. At the initiation of this research effort in 2005 managers were still in the trail designation and planning phase. As a result research efforts and analysis were all aimed to aid managers within this recreation planning process.

Ocala National Forest is composed of approximately 389,000 acres and is mostly known for its pine-scrub habitat, which composes over 50% of the forest (USDA Forest Service, 2005). The sand pine scrub is a fire dependent community, characterized by a closed canopy of sand pines (*Pinus clausa*) and a thick under-story of scrub live oak (*Quercus geminate*), myrtle oak (*Quercus myrtifolia*), chapman oak (*Quercus chapmanii*) and saw palmetto's (*Serenoa repens*) (FNAI, 1990). Due to the ecosystem's isolation, many endemic and endangered species live within the habitat including the Florida scrub-jay (*Aphelocoma coerulescens*), scrub buckwheat (*Eriogonum longifolium* var. *gnaphalifolium*), and Lewton's milkwort (*Polygala lewtonii*) (Wildlaw, 2006). Long leaf pine ecosystems, characterized by open over-story, widely spaces trees and a dense ground cover of wiregrass and forbs is also prevalent throughout the forest (FNAI, 1990). Small pockets of hardwood hammocks can be found

Collecting Social Data

Data collection was achieved through the implementation of on-site interviews and mail-back surveys. The on-site survey was meant to gather basic information on the respondent trip characteristics and provide them information about the overall study. At the end of the interview the researcher provided the participant with a nine-page mail back questionnaire which contained a postage paid envelope. Using Dillman's (2000) Tailored Method Approach, a follow-up postcard was mailed one week after the original mail-back was distributed. If the mail back was not returned after another two weeks, a new mail-back survey was sent to the participant. From September 30, 2006 – March 31, 2007 a total of 703 onsite interviews have been completed. Forty-three participants refused to take a mail back survey resulting in the distribution of 660 mail back questionnaires. Of the mail back surveys given out 295 were returned for a 44.7% response rate (ATV = 219, OHM = 37, 4x4 = 39).

Measuring goal interference and tolerance

Goal interference was measured through two multi-scale items indices. To be consistent with Jacob and Schreyer's definition of goal inference attributed to other's behavior, a list of seven potential problem behaviors were presented to the respondent in the form of a five-point Likert scale. The scale items were repeated for each rider group resulting in a total of three behavioral indices. Cronbach's alpha was used to evaluate the reliability of each of the scales, all scales were highly reliable (Table 1).

In addition, Jacob and Schreyer (1980) state that in order for conflict to occur, contact must be made and this contact must be interpreted and evaluated as having a negative affect on one's recreation experience. To address this affect on the recreation experience, two statements regarding the affect of seeing and encountering individuals were presented to respondents in the form of a five-point likert scale. Like the previous scale, statements were repeated for each rider group. A cronbach alpha revealed that these three indices were also highly reliable (Table 1).

Regarding tolerance, Jacob and Schreyer (1980) proposed that when group differences were evaluated as undesirable or a potential threat to recreation goals, then conflict is likely to occur. In order to be consistent with this statement as well as maintain the ability to compare tolerance results to previous studies, this study utilized a two item index measuring the extent of agreement to which the presence of other OHV activity groups were bothersome and undesirable. The statements used to compose the tolerance index were repeated for each user group resulting in a total of three tolerance indices. The final cronbach alpha for each indices indicated that the three scales were highly reliable (Table 1).

Table 1. Goal interference and tolerance index items and reliability

Index	Cronbach Alpha		
	ATV	**OHM**	**FWD**
Behavioral Index [a]	.95	.96	.95
People on X are destructive			
People on X ride unsafely			
People on X are discourteous			
People on X pass unsafely			
People on X cut others off			
People on X ride to fast			
People on X are out of control			
Affect on Experience Index [b]	.90	.92	.91
Seeing People on X			
Encountering People on X			
Tolerance Index [c]	.87	.86	.86
I find it undesirable to meet people on X			
People on X bother me			

Evaluating resource preferences

In order to define which areas of the forest riders found to be the most desirable for OHV recreation as well as to examine the potential inability to share the same resources, riders were presented with a list of 13 spatial descriptions of physical settings (8 vegetation, 2 soil, and 3 water) that were found within the study area. Respondents were asked to rate the extent to which they liked or disliked each of the physical settings when operating an OHV specifically within Ocala National Forest.

Analysis of Social Data

A series of t-tests were used to assess goal interference and perceived differences relating to tolerance for lifestyle diversity where the independent variable was the individuals activity group (ATV, OHM, or FWD), and the dependent variable was the index. To compensate for unequal sample sizes between rider groups, the Welch statistic was used to evaluate mean differences (Algina *et al.*, 1989; Turner and Thayer, 2001).

A principle component analysis (PCA) with varimax rotation was used to further examine the eight vegetation physical setting variables in order to see if there were any underlying dimensions for desired vegetation attributes, and to examine the potential of reducing the number of variables being mapped. Due to the small number of soil and water variables as well as the desire to incorporate different spatial layers within the GIS spatial analysis the other variables were left as is and mean scores for each attribute were obtained.

All data analysis was conducted using SPSS v 11.5.

Spatial Analysis

Once the social data was analyzed, a four-step spatial analysis process was carried out. First a data inventory was completed to help assess where OHV recreation could potentially take place within the study area. This entailed gathering all available spatial information on threatened and endangered species, sensitive habitats, cultural resources, and existing recreation opportunities. The final data inventory was developed into a single map through an overlay process, and utilized as an analysis mask later in the spatial analysis procedure.

Second, the 13 physical resource variables where grouped into 3 main categories; vegetation, soil, and water. Each of these three physical setting categories were paired with an appropriate GIS layer. Each attribute within each GIS layer was then reclassified into new attributes to reflect social data results. Lastly, these newly reclassified categories were assigned new values according to the mean of each rider group within each GIS layer.

Third, each GIS layer for each activity group was combined through an overlay process in order to create a recreation terrain preference map for each rider group (Kliskey, 2000). The analysis mask created in step one was also combined with the other three existing layers within this step so only areas that could actually be used to create OHV riding opportunities were considered in the final analysis. Once the four layers were combined, each activity group's recreation terrain preference map was collapsed into three ranges of high, medium, and low preference (Carr and Zwick, 2005) according to the maps standard deviation. Standard deviation reclassification usually results in fairly equal intervals, allowing for a fair comparison between layers (Carr and Zwick, 2007) The final recreation terrain preference maps were meant to model preference only, and were not necessarily representative of actual use. The individual models assume that riders will choose terrain with physical landscape resources that are best suited to meet their riding needs, and that the higher the preference for an area the more likely they are to want to ride within that area to achieve some desired goal(s) (Kliskey, 2000).

Fourth, the three recreation terrain preference models were combined in an overlay process creating a single potential conflict map that could represent all possible combinations of conflict between the three activity groups (Carr and Zwick, 2005). Conflict potential was noted to occur anytime at least two user groups shown to have significant different tolerance levels toward one and other and shared the highest preference for a given resource. When only one activity group had the highest preference for a resource the area was given lead preference to that activity group.

All GIS layers with the exception of one were initially in vector format, however all final spatial results were converted to raster, with a grid size of 50 meters during spatial analysis. All spatial analysis was conducted within ArchINFO 9.0.

Results

Socio-Demographics

Overall, participants tended to be white (95.3%), male (78.3%), and between the ages of 30-39 years old (34.6%). Individuals operating OHMs were more likely to be male (94.1%) compared to those operating FWD vehicles (64.9%). Individuals operating FWD vehicles were also more likely to be younger (32.4%) compared to other rider groups. All respondents were highly educated receiving at least some college education or beyond (52.9%), and received an annual household income of $90,000 or more. (Table 2).

Goal Interference

Those operating OHMs are more likely to view the behavior of those operating ATVs as a somewhat serious problem (mean = 2.12) compared to ATV rider perception of OHM behavior (mean = 1.76). However, the affect on both ATV riders and OHM riders experience was more likely to be increased when seeing and encountering an out-group member. Therefore, it could be concluded that conflict related to behavior between ATV and OHM riders is overall not practically significant since the behavior of ATVs does not have a negative affect on OHM riders enjoyment. Also, those operating ATVs were slightly more tolerant of those operating OHMs (mean = 1.61) than OHM riders were of ATV riders (mean = 1.96) (Table 3).

Those operating FWD vehicles are more likely to view the behavior of those operating ATVs (mean = 3.40) as a serious problem while those operating ATVs were more likely to view the behavior of FWD operators as a somewhat serious problem (mean = 1.83). In addition, those operating FWDs were more likely to experience decreased enjoyment as a result of seeing or encountering those on ATVS (mean = 3.64), however those operating ATVs were likely to experience increased enjoyment when seeing or encountering those operating FWDs (mean = 2.73). Likewise, those operating FWDs were more likely to show low-tolerance towards ATV operators (mean = 3.24) while ATV operators showed a higher tolerance towards FWD operators (mean = 1.67). As a result, conflict between ATV and FWD operators tends to by asymmetrical with FWD operators experiencing more conflict as a result of goal interference and inability to accept perceived differences of ATV riders (Table 4).

Table 2. Activity group socio-demographics

	ATV (%) (n = 218)	**OHM (%) (n=38)**	**FWD (%) (n=39)**	**TOTAL (%) (n = 295)**
Gender $X^2 = 8.951$ $p < .01$				
Male	78.2	94.1	64.9	78.3
Female	21.8	5.9	35.1	21.7
Age $X^2 = 26.844$ $p < .001$				
18 – 29 years old	14.9	17.1	32.4	17.5
30 – 39 years old	38.5	25.7	21.6	34.6
40 – 49 years old	32.7	45.7	16.2	32.1
50 – 59 years old	11.5	11.4	16.2	12.1
60 years or over	2.4	0.0	13.5	3.6
Income $X^2 = 25.877$ p = ns				
$10,000 - $19,999	1.0	3.0	6.3	1.9
$20,000 - $29,999	5.5	9.1	6.3	6.0
$30,000 - $39,999	7.0	3.0	15.6	7.5
$40,000 - $49,999	9.0	0.0	18.8	9.1
$50,000 - $59,999	10.0	3.0	6.3	8.7
$60,000 - $69,999	7.5	15.2	12.5	9.1
$70,000 - $79,999	12.5	15.2	6.3	12.1
$80,000 - $89,999	11.0	6.1	3.1	9.4
$90,000 or more	36.5	45.4	25.1	36.2
Education $X^2 = 7.708$ p = ns				
> Some high school	6.0	8.1	5.4	6.1
High school diploma	31.0	27.0	27.0	30.0
Some college	32.0	32.4	32.4	21.1
College graduate	20.7	24.3	24.3	21.7
Some graduate school	3.0	5.4	0.0	2.9
Graduate degree	7.4	2.7	10.8	7.2
Ethnicity $X^2 = 2.884$ p = ns				
White	94.2	97.1	100.0	95.3
Hispanic or Latino	3.9	2.9	0.0	3.3
African American	0.5	0.0	0.0	0.4
Asian American	1.0	1.0	0.0	0.7

Table 3. Out-group conflict and tolerance between ATVs and OHMs

Out-Group Conflict & Tolerance	Mean		W-Stat
	ATV	OHM	
Behavior Index	1.76	2.12	4.89*
Affect on Experience	2.55	2.62	0.18
Tolerance	1.61	1.96	5.07*

* p < .05

Table. 4. Out-group conflict and tolerance between ATVs and FWDs

Out-Group Conflict & Tolerance	Mean		W-Stat
	ATV	FWD	
Behavior Index	1.83	3.40	57.58**
Affect on Experience	2.73	3.64	52.23**
Tolerance	1.67	3.24	73.75**

** p < .01

Similar to out-group conflict between ATV and FWD operators, FWD operators are also more likely to view the behavior of OHM operators as a serious problem (mean = 3.25), and indicated that seeing or encountering those operating OHMs would decrease their enjoyment (mean = 3.56). Reversely, those operating OHMs were likely to view FWD behavior as a somewhat serious problem (mean = 1.96), and seeing or encountering FWD operators was likely to increase their enjoyment on the trails (2.82). Lastly, FWD operators showed less tolerance toward OHM operators (mean = 3.34) than OHM operators showed toward FWD operators (mean = 2.07). Therefore, it could be concluded that conflict between OHM and FWD vehicles is also asymmetrical with FWD operators experiencing more conflict as a result of goal interference and tolerance for life style diversity toward OHM operators (Table 5).

Table 5. Out-group conflict and tolerance between OHMs and FWDs

Out-Group Conflict & Tolerance	Mean		W-Stat
	OHM	FWD	
Behavior Index	1.96	3.25	28.54**
Affect on Experience	2.82	3.56	11.37**
Tolerance	2.07	3.34	26.61**

** p < .01

Preferences for Environmental Resources

The principle component analysis of the eight vegetation variables revealed two components explaining 68.8% of the variance, and each component was highly reliable (Table 6). The first component represented those who have a desire to ride in areas with dense vegetation, and the second component represented those who have a desire to ride in more open settings. Neither component showed a preference for any particular ecosystem type, rather the overall preference was focused on vegetation density.

Table 6. Principle component analysis results

Variable	Component 1	Component 2
Vegetation		
Dominated by pine trees and wire grass	.837	
Dominated by hardwoods and shrubs	.913	
Dominated by a mix of pine trees and hardwoods	.900	
Scrub	.418	
A mix of pine trees and open spaces		.860
A mix of hardwood trees and open spaces		.835
A mix of pine trees and hardwoods and open spaces		.796
Open with no presence of vegetation		.575
Percent of variance explained	*36.1%*	*32.7%*
Cronbach Alpha	*.82*	*.73*

Overall, all rider groups shared the same preferences for open habitats. Those who operated ATVs and OHMs shared similar preference for dense habitats, while those who operated FWD vehicles held a slightly lower preference (mean = 3.30) Those who operated FWD vehicles were also more likely to place a higher preference on sandy soils compared to other rider groups who place higher preferences on compact soils, particularly for those operating OHMs (mean = 4.59). The ability to see water at least some of the time was the most preferred scenic attribute for all three groups in comparison to the desire to not see water at all (Table 7).

Table 7 . OHV riders resource preferences

Variable	Mean Scores		
	ATV	**OHM**	**FWD**
Vegetation			
Open Habitats	3.63	3.79	3.64
Dense Habitats	3.70	3.62	3.30
Soils			
Compact Soils	4.00	4.59	3.11
Dry/Sandy Soils	3.34	2.89	3.62
Scenic Attributes			
Where water can not be seen	2.37	2.51	2.75
Where water can be seen some of the time	3.95	3.81	3.76
Where water can be seen all of the time	3.51	3.38	3.19

Areas where ATV riders have the highest preference for resources tend to occur around the western and eastern boundaries of the forest (Figure 1), and make up 6.57% of the total preferred area. These areas are mostly composed of compact soils, and tend to where water could be seen at least some of the time. Vegetation is more likely to be dense, being composed mostly of hardwoods and are within close proximity to wetlands. Areas of medium preference are found in close proximity to highly preferred areas and make up 36.75% of the study area. Lastly, areas of the lowest preference make up the majority of the study area (56.59%) and are located throughout the central portions of the forest where soils tend to be dry and sand and water is less likely to be visible. Vegetation is mixed between open and dense habitats, but is mostly composed of pine scrub habitat (Table 8).

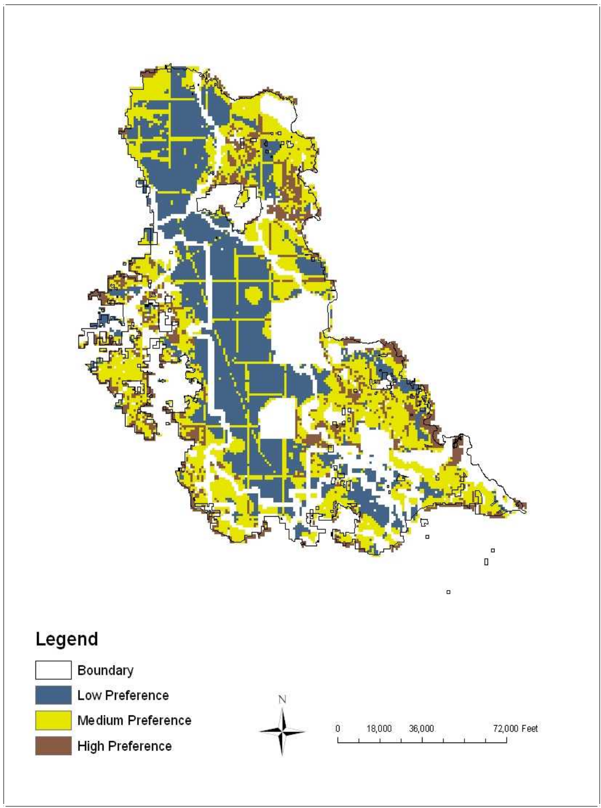

Figure 1. ATV recreation terrain preference map

Similar to ATV riders, OHM riders have the highest preference for resources that occur on the eastern border and some high preference areas on the western border composing 9.15% of the total area (Figure 2). Likewise, areas of medium preference occur in close proximity to high preference areas and account for 30.83% of the area. Low preference areas account for 60.01% of the total area, and are mostly located within the central region of the forest (Table 8).

Table 8. Composition of preferred areas for OHV riders

Rider Group	Composition of Preferred Areas (%)		
	High	Medium	Low
ATV	6.57	36.75	56.59
OHM	9.15	30.83	60.01
FWD	31.69	29.38	38.92

Four-wheel drive operators have more high preference areas in comparison to the other rider groups (31.69%), and can be found in the northeast, southeast, and southwestern areas of the forest (Table 8). These areas tend to occur in close proximity to water, on drier soils, and in dense vegetation. Medium preference areas are also more scattered about, but can be found mostly within the south central region of the forest. These areas are also more likely to be composed of drier soils and within more open habitats. The ability to see water is also more limited. Similar to the other rider groups, areas of low preference are mostly located within the central region of the forest (Figure 3).

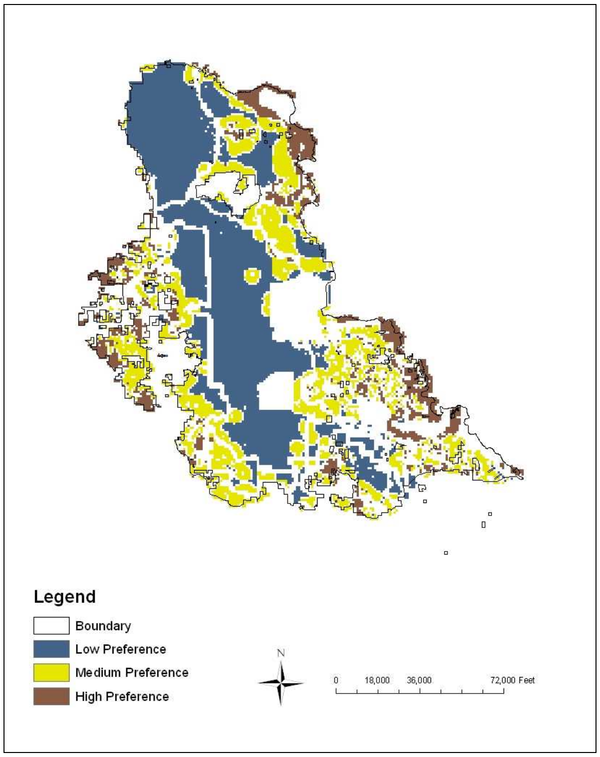

Figure 2. OHM Recreation Terrain Preference Map

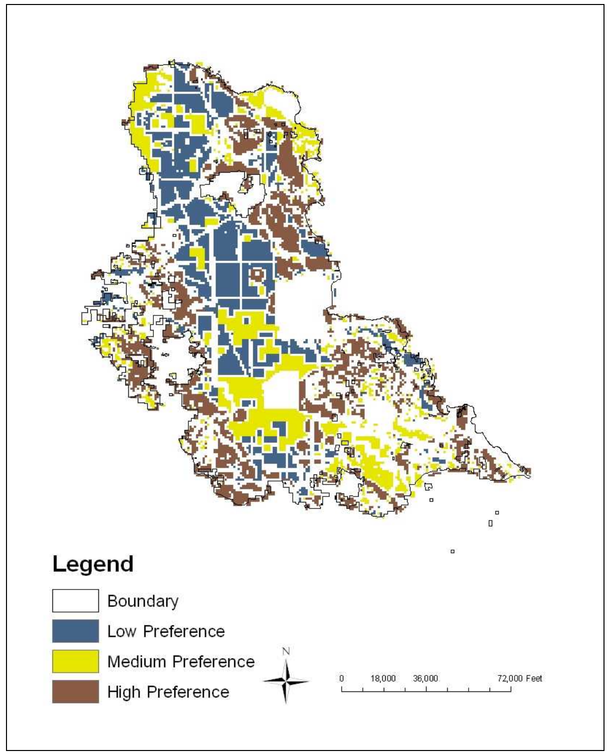

Figure 3. FWD Recreation Terrain Preference Map

Mapping Potential Conflict

Each of the resource variables were paired with an appropriate GIS layer. First, the vegetation variables were paired with a forest density layer. Within the forest density layer each cell contained a percentage value between 0-100%, representing the amount of tree canopy modeled within each cell. The Forest Service Southern Research Station, National Park Service and other state and federal agencies use the National Vegetation Classification System (NVCS) when conducting land cover/land class classifications. Under NVCS, areas containing 60% or more canopy cover are noted as areas dominated by vegetation. Areas containing 25%-60% canopy cover are defined as more open areas where crown canopy is not touching. Therefore, areas of dense forest were classified as having 60% closed canopy cover within each cell (Nature Conservancy, 1994; Federal Geographic Data Committee, 1997).

Soils were paired with a soils layer and were reclassified into compact and sandy soils according to soil drainage. Soil drainage is closely correlated with soil texture, allowing for the assessment of potential soil compaction. Soils with larger pore space, generally sandy soils, are well drained whereas soils containing smaller pore spaces, generally clay soils containing at least 20% clay or more, are much more compact (Whiting *et al.*, 2006). Soils that were classified as excessively well to moderately well drained were considered to be sandy soils. Soils that were classified as somewhat poorly drained to very poorly drained were classified as compact soils.

Lastly, a water surface layer was paired with the variable relating to the ability to see water. First, a view-shed analysis was performed to identify where water could be seen all of the time, and where water could not be seen at all. Assessing the ability to see water at least some of the time was a three step process. Initially, a straight line distance analysis from all surface water was conducted. Then, zonal statistics were conducted using the view-shed analysis as an input layer, and the straight line distance analysis as the value raster. Zonal statistics produce an output table that computes central tendency values for each defined zone within the specified layer based on values within the input layer (ESRI, 2002). Results indicated that the mean distance within areas that water could be seen at least some of the time was 3181.41 feet. Therefore it could be concluded that in areas 0-3,182 feet away from water, a rider would be more likely to see water then areas 3,183 feet or further away. As a result, areas within 3,182 feet were defined as areas where water could be seen some of the time, and all other distance were reclassified as areas where water could not be seen.

Since the results of potential conflict related to tolerance among the three rider groups revealed that individuals operating FWD vehicles were more likely to experience conflict as a result of low tolerance compared to those operating OHMs and ATVs, conflict was noted to occur when those operating FWD vehicles and at least one other rider group shared the highest preference for an area. An area was given preference to a rider group when they were the only group to have the highest preference for the area. Conflict as a result of low tolerance could potentially occur between FWD operators and other rider groups on approximately 39% of the forest (Figure 4), however the majority (36.94%) of that potential would occur in areas of low preference. Conflict between FWDs and ATVs are also likely to occur in just over 9% (9.47%) of the area, 4.07% of which both groups share high resource preferences (Table 9).

Table 9. Composition of potential conflict areas and lead preference areas

Potential Conflict	Pixel Count	Percentage of Area
All in potential conflict, all low preference	1374945	36.94
All in potential conflict, all medium preference	7858	0.21
All in potential conflict, all high preference	96191	2.58
Potential conflict between ATV and FWDs, medium preference	201150	5.40
Potential conflict between ATV and FWDs, high preference	151606	4.07
OHM riders have lead preference (medium preference)	56288	1.51
OHM riders have lead preference (high preference)	244625	6.56
FWD riders have lead preference (medium over low)	657753	17.67
FWD riders have lead preference (high over medium)	932015	25.03

Not all areas showed the potential for conflict to occur (Figure 5). For those who operated FWD vehicles, just over 25% (25.03%) of high preference areas showed less potential for conflict since these are areas that FWD operators preferred more then any other rider group. Similar to the FWD recreation terrain preference maps, these areas occur in the northeast, southeast, and southwestern portions of the area. Likewise, 17.67% of areas given medium preference by FWD operators are also less likely to experience conflict since these are areas of low preference for other rider groups (Table 0). Medium preference areas tend to mostly occur in the south central region of the forest, with a few scattered areas in the north central region.

In addition, OHM operators had some areas where conflict potential was less likely since this group help higher preferences for resources then other rider groups within these areas. These areas tended to be more spread out along the eastern and western borders of the forest accounting for 6.56% of the areas (Table 9), and tended to occur in the northeast, southeast, and west central portions of the forest. Area's where medium preference was given was most likely to exist within the southeastern portion of the forest, and accounted for 1.51% of the area.

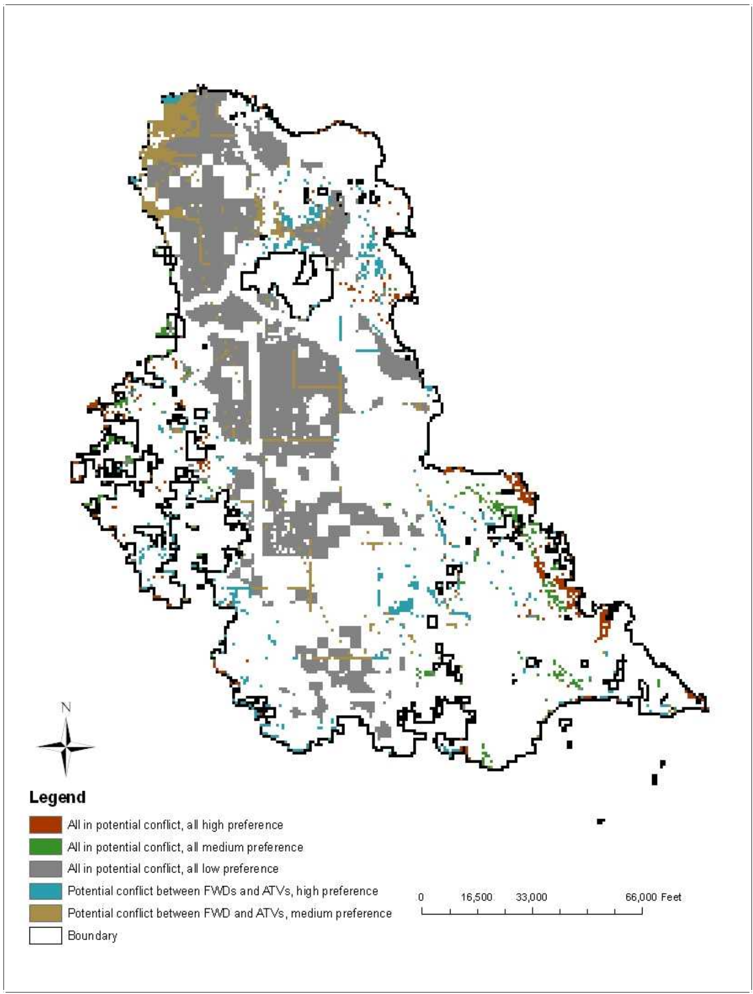

Figure 3-4. Potential conflict areas

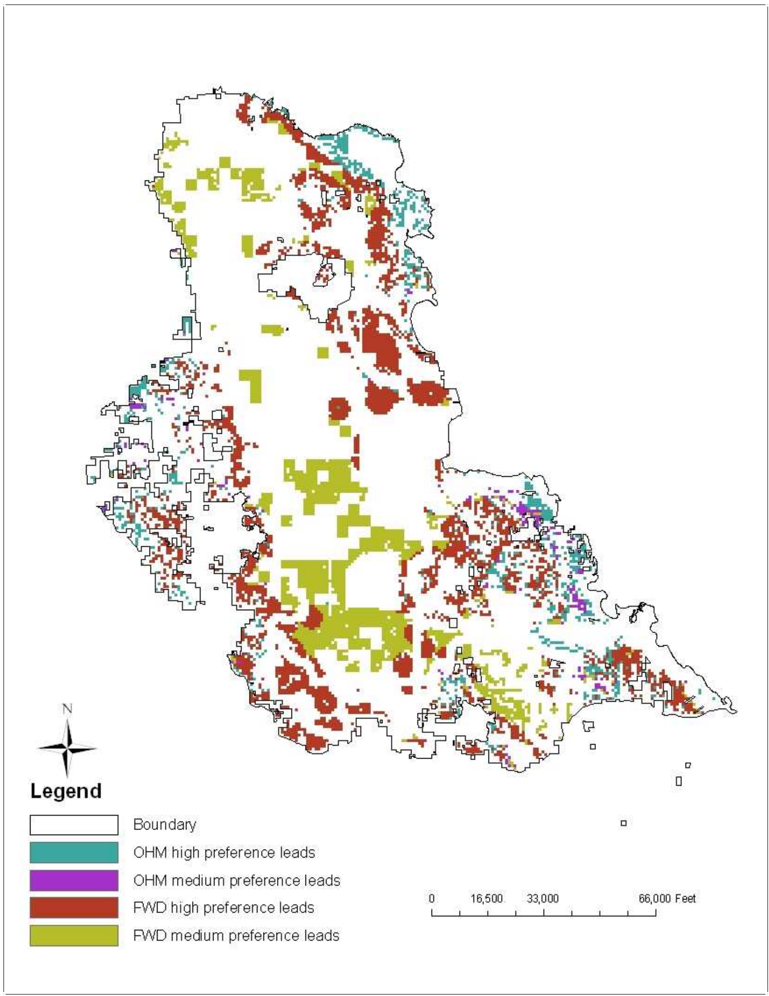

Figure 3-5. Areas of lead preference

Discussion & Management Recommendations

The social data collected allowed for the identification of potential conflict as a result of tolerance, and the spatial analysis provided further insight as to where this conflict related to tolerance is most likely to occur based on shared resource preferences. Survey results were reflective of similar conflict studies and further supports that conflict tends to be asymmetrical. As stated within the literature review, conflict resulting from goal interference is more easily managed since managers can take direct actions which will manipulate and affect riders behavior. Management actions may include but are not limited to posting and monitoring speed limits, holding user groups meetings, providing on-site education about proper trail etiquette, and increasing the presence of law enforcement.

Significant differences in the degree of tolerance occurred between all rider groups. As stated previously, the statistically significant differences between ATVs and OHMs hold little practical value for managers. A review of the mean scores indicates that those operating ATVs “strongly disagree” while those operating OHMs “disagree”. Therefore, it could be concluded that while some differences exist, overall tolerance levels between ATVs and OHMs are fairly high.

However, managers should continue to monitor for conflict between these rider groups in order to evaluate changing or evolving perceptions of conflict over time.

Four-wheel drive operators tolerance toward out-group members was significant and comparatively low to ATV and OHM rider groups, suggesting that those who operate four-wheel drive vehicles perceive themselves differently and find it undesirable to encounter those operating ATV and OHMs. The differences in tolerance levels between FWD operators and other rider groups may also result in an inability to share resources (Jacob and Schreyer, 1980). Implications and solutions for this are discussed further under management implications. According to the theory of goal interference, tolerance for lifestyle diversity is generally affected by an individuals view of technology and resource consumption as well as prejudice (Jacob and Schreyer, 1980). Previous research on OHV visitors and comments from members of the OHV community has shown that ATV and OHM riders typically desire trail riding opportunities (Wernex, 1994; Crimmins and NOHVCC, 2006) while FWD operators tend to desire more technical challenges for their vehicle (Kawaja, 2006; Neal, 1999). As a result the way in which the various groups of OHVs manipulate the environment may be viewed differently by those who operate FWD vehicles thereby contributing to different levels of tolerance toward other riding groups. Prejudice and stereotypical views can be influenced by ethnicity, gender, age, and social class (Jacob and Schreyer, 1980). A review of socio-demographics between rider groups shows that individuals operating FWD vehicles tended to be younger and were a more even mix of males and females compared to other rider groups suggesting that the differences in tolerance may be a function of age and/or gender.

Management Recommendations

For this study, analysis focused on planning efforts. This has several benefits and implications for managers. By understanding and acknowledging that OHV rider groups, particularly those operating FWD vehicles, perceive themselves as different from one and other, managers can plan accordingly to help minimize conflict that may later result in unsafe trail conditions due to unacceptable behavior (Dolesh, 2004). As mentioned earlier, many studies that have taken a more direct approach at examining conflict related to tolerance, and have found tolerance to exist between activity groups have suggested spatial separation. This recommendation is also suggested here; however, not all riders will have the desire to be separated from other rider groups. Although conflict exists, conflict itself is never rampant (Thapa and Graefe, 2004). Rather, it tends to affect a small percentage of the population and the majority of visitors are generally satisfied (Manning, 1999). Therefore, a greater majority of users may be managed within a multiple use setting, and it is suggested that managers also provide for single use trails in order to provide opportunities for those who are more likely to experience conflict. The results from the spatial analysis can aid managers in the decision making process of how to best achieve the single and multiple use separation between activity groups while still providing opportunities within areas riders may find desirable.

Looking at the potential conflict map (Figure 4), areas noted as “potential conflict” may be better suited for multiple use areas since these are areas that all riders groups prefer. Areas that had “lead preference” for a specific rider group 9Figure 5) may be best suited for single use areas. Given that the recreation terrain preference models assumed that riders would chose areas that best suit his or her needs, then opportunities could be planned in areas of high preference. However, the majority of areas that were all in potential conflict were areas of low preferences and found within the central region of the forest while areas of higher preference were around the forest boundaries. In addition, areas of high preference for both ATV and OHM riders also tended to occur around the forest outer boundaries. This proximity to residential and/or commercial areas may pose an additional challenge to managers seeking to maximize opportunities within preferred settings that also help minimize conflict, indicating that what may be desired is not always possible. Both visitors and managers must be flexible and willing to compromise if quality opportunities are to be created within the resources available (Moore, 1994).

Also, OHV recreation is a dispersed activity requiring large areas for trail riding opportunities. Creating trails within appropriate riding areas that consider riders physical setting preferences and allows for dispersed use will help minimize conflict as a result of less social contact. Dispersing use may also result in more sustainable trails in the long run, allowing for continued quality recreation opportunities (Crimmins and NOHVCC, 2006). It is often thought that dispersing use over large areas will create larger and more frequent resource impacts (both ecological and biological). However, dispersing use so that riders are more spread out along a trail system will have neither a positive or negative affect on the environment assuming that the number of places through which the trail traverses is the same as if use were concentrated (Hammitt and Cole, 1998). Results from the spatial analysis can help define specific areas in which a diverse trail system could be created. Referring back to the potential conflict map and considering the need to provide diversity, areas containing the greatest, continuous mix of opportunities would be the most suitable areas to disperse use over a large area.

Lastly, managers can provide education in order promote tolerance between rider groups. Often, visitors are more similar than they perceive themselves to be, and it has been suggested that promoting an understanding of other activity groups motivations, attire, and techniques specific to the activity may help raise tolerance toward out-groups (Ranthum, 1995). Education may also help promote an awareness of responsible and sustainable behavior by all recreation activity groups, thereby reducing the overall impact to the resource (Manning, 1999). Using a combination of spatial separation and education can help create opportunities for those who are more sensitive to experiencing conflict while providing information to users who may help build tolerance between rider groups over time.

Conclusions

This study adds to the existing body of knowledge in several ways. First, it examines perceived differences related to tolerance within the OHV visitor community, a group not yet previously studied within this context. Results indicate that not all OHV riders perceive themselves the same, and managers should take that into consideration when creating riding opportunities. If these differences are ignored, negative consequences that affect visitor safety, visitor experiences, and resource protection may occur (Moore, 1994). This study also took a new approach at examining the spatial context of conflict related to tolerance in order to help identify where conflict was most likely to occur. The spatial identification of conflict can help managers identify where to concentrate management efforts to minimize recreation conflict as well as help plan for new recreation opportunities that consider rider group preferences as well as rider group differences. Although this study took a planning approach, the methods could be adapted to assess conflict potential related to tolerance on existing trail systems. Specifically, this study used a management mask so that only areas suitable for riding were evaluated. For an existing trail system, a trails layer would be used instead of a mask, thereby containing all evaluations to the trail system.

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