Integrating social and natural resource information to improve planning for motorized recreation

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Recreation planning
Recreation conflict
Conflict resolution

A B S T R A C T

Throughout the United States and other countries, off-highway vehicle (OHV) recreation has become a dominant recreation use of the landscape. In response, social scientists worked to understand who off-highway vehicle (OHV) riders were, while natural resource scientists worked to document and mitigate natural resource impacts that were resulting from unmanaged OHV recreation. The purpose of this study was to examine both social and natural resource aspects of landscape planning as it relates to OHV management. Specifically, this study sought to expand the current knowledge base of who OHV riders were by examining the potential for conflict between all-terrain vehicle riders, off-highway motorcycle riders, and four-wheel drive operators. In addition, the potential for conflict between rider groups was examined spatially based on riders stated resource preferences. The outcome of this process provides managers with a set of maps that can be used within the planning process to help reduce potential conflict between riders, increase rider enjoyment, and meet conservation goals of an agency.

Introduction

Throughout the United States and other countries, off-highway vehicle (OHV) recreation has become a dominant recreation use of the landscape (Cordell, Betz, Green, & Owens, 2005; Havlick, 2002). In response to this growing demand, recreation and land managers have acknowledged an immediate need to better manage for OHV riding opportunities in a manner that ensures sustainable riding environments, ensures safe riding conditions, and ensures the creation of opportunities that may result in quality riding experiences (Bosworth, 2004). Most research has focused on identifying ways to manage OHV recreation in a manner that reduces environmental impacts (Buckley, 2004; Chavez & Knap, 2006; Havlick, 2002; Snyder, Whitmore, Schneider, & Becker, 2008), however, very little research has focused on ways to ensure the creation of quality riding opportunities. Understanding what will contribute to and detract from a quality riding experience will be a key element in improving the management of OHV recreation. One element of providing quality recreation experiences is to manage conflict inherent with many nature-based recreation activities, but particularly apparent in motorized recreation (Graefe & Thapa, 2004). Although recreation conflict between motorized and non-motorized recreation has been extensively examined, little research has focused on the potential for conflict between motorized recreation groups.

In addition to the lack of research focusing on conflict between motorized activity groups, little research has taken a spatial approach in understanding where conflict is most likely to occur. Understanding conflict potential within a spatial context can further assist both managers and the affected activity groups to look beyond perceived differences that result in conflict and bring focus to developing effective solutions that are aimed at providing desired recreation opportunities (Gimblett & Guisse, 1997). This spatial context is even more important when examining OHV recreation, which often occurs across large landscapes in diverse terrain.

The purpose of this study was to extend the theoretical application of goal interference by examining the potential for conflict due to low tolerance between OHV riders and examine where this potential conflict due to low tolerance (if low tolerance existed at all) was most likely to occur based on riders stated resource preferences. Specifically, the objectives of this study were to (1) examine the degree of tolerance between all-terrain vehicle (ATV), off-highway motorcycle (OHM), and four-wheel drive (FWD) operators, (2) examine riders preferred resources when operating an OHV, and (3) examine where conflict related to intolerance was most likely to occur based on shared resource preferences. Although tolerance itself cannot be directly linked to landscape attributes, resources that are highly favored when engaged in a specific recreation activity can be identified. These preferred

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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 developing a set of alternative solutions to reduce potential conflict, increase opportunities for rider enjoyment, and reduce environmental impacts.

Background

Following the recognition of the need to better manage for OHV riding opportunities, research was conducted that focused on gathering descriptive information on who OHV riders were and what their motivations were for engaging in OHV activities. These initial studies revealed that OHV riders were most likely to be male, between 30 and 40 years of age, and married with children living at home (Fisher, Blahna, & Bahr, 2001; Fly, Stephens, Askins, & Hodges, 2002; Parent, Alvalapati, Stein, & Hodges, 2007). In addition, initial research efforts found that riders were most likely to be motivated to enjoy nature and spend time with family and friends (Sanyal, 2007). Other information sources investigated and described the activity styles of OHV riders. Specifically, ATVs and OHM riders have been described as being focused on trail riding enjoyment (Wernex, 1994) while FWD recreation tends to be focused on challenging one’s vehicle and overcoming obstacles (Kawaja, 2006; Neal, 1999).

Although this research has been helpful in extending our current knowledge base in whom OHV riders are and what they desire from an OHV riding experience, little empirical research has investigated possible differences between ATV riders, OHM riders, and FWD operators. Understanding possible differences between these rider groups would further assist manager’s ability to create safe, quality riding opportunities by reducing the potential for recreation conflict which may hinder a recreation experience. Furthermore, understanding the potential for recreation conflict between OHV riders would assist managers in creating more environmental sustainable riding opportunities (Dolesh, 2004; Snyder et al., 2008).

The study of recreation conflict has also 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 & Schneider, 2000), and has been the standard framework in examining conflict over the past three decades (Graefe & Thapa, 2004). 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, or other impacts. 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 & Schreyer, 1980). 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 one’s own (Jacob & 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 one’s 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 cannot 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, which are intolerant of each other (Thapa & Graefe, 2003; Vaske, Carothers, Donnelly, & Baird, 2000). 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 & Stankey, 1979; Daniels & 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 & Krannich, 1990). Often, recreation conflict occurs within similar activity groups which may occur within the same zone (Todd & Graefe, 1989; Vaske et al., 2000; Watson, Niccolucci, & Williams, 1994). 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 as 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 who 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 (Kliskey, 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 found within the landscape. 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 begin 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 & Leung, 2006). Recent advances within GIS and recreation research have begun to link visitor preferences (Kliskey, 2000) and values (Brown, 2005; Reed & 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 & Shelby, 1998). More recently, GIS-based methods that incorporated ATV rider stated preferences for trail attributes within sustainable riding areas were also shown to be an effective planning tool (Snyder et al., 2008).
Materials and 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 three 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 a lack of OHV management, the ONF’s Land and Resource Management Plan was revised to state that all OHV recreation must occur on existing user made trails within unrestricted areas (U.S.D.A. 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 focused identifying if conflict was a possible key issue of concern, and if so, developing a method to examine possible management solutions.

Ocala National Forest is composed of approximately 157,422 hectares and is mostly known for its pine scrub habitat, which comprises over 50% of the forest (U.S.D.A. 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 understory of scrub live oak (Quercus geminata), myrtle oak (Quercus myrtifolia), chapman oak (Quercus chapmanii) and saw palmetto’s (Serenoa repens) (FNPI & FDNR, 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 spaced trees and a dense ground cover of wiregrass and forbs are also prevalent throughout the forest (FNPI & FDNR, 1990). Small pockets of hardwood hammocks can be found near the forest boundaries. In addition, ONF contains several smaller parcels of land located on the southeast of the forest’s larger boundary. Due to the small size of these parcels as well as their distance from the main forest, these parcels were not considered in this study (Fig. 1).

Collecting social data

Data were collected from OHV riders through the implementation of on-site interviews and mail-back surveys. With assistance from Ocala National Forest recreation managers, temporary designated access points were identified as good survey locations (i.e. temporary campgrounds and temporary designated parking areas). Using these locations as a starting point, a stratified random sampling procedure based on day of the week (weekend and weekday) and volume of use (low and high) was used to sample participants. Trained interviewers randomly selected individuals (at least 18 years of age) from each visitor group and asked them to
complete a short on-site interview. The on-site interview was meant to gather basic information on the respondent’s 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 that 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 to March 31, 2007 a total of 703 on-site interviews were 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 distributed 295 were returned for a 44.7% response rate (ATV = 219, OHM = 37, FWD = 39).

Evaluating tolerance for lifestyle diversity

Researchers have measured tolerance for lifestyle diversity with a variety of techniques within the literature. Based on Jacob and Schreyer’s proposition of tolerance, some studies have taken a more direct or norms approach and evaluated tolerance based on desirable and undesirable contact within and between activity groups (Thapa & Graefe, 2004; Vaske et al., 2000) or perceived compatibility between two activities (Ivy, Stewart, & Lue, 1992). Other studies have assessed tolerance with a social values approach, examining beliefs and attitudes between activity groups (Blahna, Smith, & Anderson, 1995; Carothers, Vaske, & Donnelly, 2001; Watson, Williams, & Daigle, 1991). Also, the internal reliability of some of the scales used to measure tolerance has been inconsistent. In measuring tolerance levels between those operating canoes and those operating motorboats, the reliability for each activity group’s tolerance index varied and overall was at lower then usually acceptable values (Ivy et al., 1992). When assessing the degree of tolerance between skiers and snowboarders Vaske et al. (2000) was more successful and achieving acceptable levels of internal validity and reliability then previous tolerance studies which focused on the same activity groups (Thapa & Graefe, 1999).

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 within this study to previous studies, this study utilized a two item index measuring the extent of agreement between 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’s alpha for each index indicated all three were reliable (ATV α = .87; OHM α = .86; FWD α = .80). (Table 1). The authors acknowledge that ATV riders compose the majority of mail-back respondents, however, ATV riders generally make up the majority of OHV riding population within the study area.

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 (please refer to Tables 4 and 5 for attribute descriptions). These spatial descriptions were developed from conversations with local area managers about potential riding habitat characteristics that existed within the study area as well as examinations of a GIS land use landcover shapefile of the study area. Respondents were asked to rate the extent to which they liked or disliked each of the described physical settings when operating an OHV specifically within Ocala National Forest.

Analysis of social data

A series of Welch t-tests were used to assess perceived differences relating to tolerance for lifestyle diversity where the independent variable was the individual’s activity group (ATV, OHM, or FWD), and the dependent variable was the tolerance index. The individual’s activity group was based on the participant’s primary activity of the day. To compensate for unequal sample sizes between rider groups, the Welch t-test statistic was used to evaluate mean differences (Algina, Olejnik, & O’canto, 1989; Turner & 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. All social data analysis was conducted using SPSS v 11.5.

Spatial analysis

Once the social data were analyzed, a four-step spatial analysis process was carried out. First, a desktop analysis 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 (i.e. wetlands), cultural resources, existing recreation opportunities (i.e. facilities and trails), and roads. Federal and state guidelines were consulted in creating buffers for each attribute (FDOT, 2005; U.S.D.A., 1999, 2005). The final desktop analysis was developed into a single map through an overlay process, and utilized as an analysis mask later in the spatial analysis procedure.
Second, the physical resource variables were grouped into 3 main categories: vegetation, soil, and water. Each of these three physical setting categories were then paired with a corresponding GIS layer. Each attribute within each GIS layer was then reclassified into attributes that matched the groupings of each environmental characteristic presented to respondents. Specifics on how each layer was reclassified are provided within the results section. 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 (vegetation, soil, and water) 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 & 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 & 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 due to low tolerance between the three activity groups (Carr & Zwick, 2005). Conflict potential was noted to occur anytime when at least two user groups were shown to have significant different tolerance levels toward one another 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 m during spatial analysis. All spatial analysis was conducted within ArcGIS 9.0.

Results

Socio-demographics

Results mirror previous OHV studies showing that respondents tended to be white, educated (beyond high school), and earn an annual household income of $60,000 or more (Cordell et al., 2005; Fly et al., 2002; Parent et al., 2007). Overall, respondents tended to be white (95.3%), male (78.3%), and between the ages of 30 and 39 years old (34.6%). Individuals operating OHMs were more likely to be male (94.1%) compared to those operating FWD vehicles (64.9%) ($X^2 = 8.951, p < .01$). Individuals operating FWD vehicles were also significantly more likely to be younger (32.4%) compared to other rider groups ($X^2 = 26.844, p < .01$). All respondents were educated receiving at least some college education or beyond (52.9%), with no significant differences existed between riding groups ($X^2 = 7.708, p = ns$). Household annual income was variable ranging mostly between $60,000 or more annually (67.1%), with the largest percentage of respondents reporting an annual household income of $100,000 or more annually (31.0%) followed by $60,000–$79,999 (21.8%). No significant differences were found between rider groups and reported annual household income ($X^2 = 11.47, p = ns$) (Table 2).

Tolerance for lifestyle diversity

Riders operating FWD vehicles were the least tolerant of both ATV and OHM riders. Specifically, individuals operating FWD vehicles were significantly less tolerant of ATV riders (mean $= 3.24$) than ATV riders were of FWD operators (mean $= 1.66$). Four-wheel drive operators were also significantly less tolerant of those operating OHMs (mean $= 3.34$) compared to OHM operators tolerance toward FWD operators (mean $= 2.08$). Lastly, there were statistically significant differences between ATV and OHM tolerance levels toward each other. However, a review of the rider groups mean scores reveal that both rider groups disagree with the index statements. Therefore, it can be concluded that although significant differences exist between ATV and OHM rider groups, the differences hold little practical meaning for managers, and more focus should be placed on the intolerance of FWD operators toward ATV and OHM rider groups (Table 3).

<table>
<thead>
<tr>
<th>Gender</th>
<th>ATV (%)</th>
<th>OHM (%)</th>
<th>FWD (%)</th>
<th>TOTAL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>78.2</td>
<td>94.1</td>
<td>64.9</td>
<td>78.3</td>
</tr>
<tr>
<td>Female</td>
<td>21.8</td>
<td>5.9</td>
<td>35.1</td>
<td>21.7</td>
</tr>
</tbody>
</table>

$X^2 = 8.551; p < .01$ df $= 2$

<table>
<thead>
<tr>
<th>Age</th>
<th>ATV (%)</th>
<th>OHM (%)</th>
<th>FWD (%)</th>
<th>TOTAL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18–29 years old</td>
<td>14.9</td>
<td>17.1</td>
<td>32.4</td>
<td>17.5</td>
</tr>
<tr>
<td>30–39 years old</td>
<td>38.5</td>
<td>25.7</td>
<td>21.6</td>
<td>34.6</td>
</tr>
<tr>
<td>40–49 years old</td>
<td>32.7</td>
<td>45.7</td>
<td>16.2</td>
<td>32.1</td>
</tr>
<tr>
<td>50–59 years old</td>
<td>11.5</td>
<td>11.4</td>
<td>16.2</td>
<td>12.1</td>
</tr>
<tr>
<td>60 years or over</td>
<td>2.4</td>
<td>0.0</td>
<td>13.5</td>
<td>3.6</td>
</tr>
</tbody>
</table>

$X^2 = 26.844; p < .001$ df $= 8$

<table>
<thead>
<tr>
<th>Income</th>
<th>ATV (%)</th>
<th>OHM (%)</th>
<th>FWD (%)</th>
<th>TOTAL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$19,999 or less</td>
<td>1.0</td>
<td>3.7</td>
<td>3.0</td>
<td>1.6</td>
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<tr>
<td>$20,000–$39,999</td>
<td>14.1</td>
<td>7.4</td>
<td>21.2</td>
<td>14.3</td>
</tr>
<tr>
<td>$40,000–$59,999</td>
<td>17.7</td>
<td>3.7</td>
<td>24.2</td>
<td>17.1</td>
</tr>
<tr>
<td>$60,000–$79,999</td>
<td>21.4</td>
<td>33.3</td>
<td>15.2</td>
<td>21.8</td>
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<tr>
<td>$80,000–$99,999</td>
<td>15.1</td>
<td>11.1</td>
<td>12.1</td>
<td>14.3</td>
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<tr>
<td>$100,000 or more</td>
<td>30.7</td>
<td>40.7</td>
<td>24.2</td>
<td>31.0</td>
</tr>
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</table>

$X^2 = 11.47; p = ns$ df $= 10$

<table>
<thead>
<tr>
<th>Education</th>
<th>ATV (%)</th>
<th>OHM (%)</th>
<th>FWD (%)</th>
<th>TOTAL (%)</th>
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<tbody>
<tr>
<td>Some high school</td>
<td>6.0</td>
<td>8.1</td>
<td>5.4</td>
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<tr>
<td>High school diploma</td>
<td>31.0</td>
<td>27.0</td>
<td>27.0</td>
<td>30.0</td>
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<tr>
<td>Some college</td>
<td>32.0</td>
<td>32.4</td>
<td>32.4</td>
<td>31.1</td>
</tr>
<tr>
<td>College graduate</td>
<td>20.7</td>
<td>24.3</td>
<td>24.3</td>
<td>21.7</td>
</tr>
<tr>
<td>Some graduate school</td>
<td>3.0</td>
<td>5.4</td>
<td>0.0</td>
<td>2.9</td>
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<tr>
<td>Graduate degree</td>
<td>7.4</td>
<td>2.7</td>
<td>10.8</td>
<td>7.2</td>
</tr>
</tbody>
</table>

$X^2 = 7.708; p = ns$ df $= 10$

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>ATV (%)</th>
<th>OHM (%)</th>
<th>FWD (%)</th>
<th>TOTAL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>94.2</td>
<td>97.1</td>
<td>100.0</td>
<td>95.3</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>3.9</td>
<td>2.9</td>
<td>0.0</td>
<td>3.3</td>
</tr>
<tr>
<td>African American</td>
<td>0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Asian American</td>
<td>1.0</td>
<td>1.0</td>
<td>0.0</td>
<td>0.7</td>
</tr>
</tbody>
</table>

$X^2 = 2.08 3.34 26.61*$ ns df $= 6$

Tolerance measures$^a$

Activity style Welch stat

<table>
<thead>
<tr>
<th></th>
<th>ATV</th>
<th>OHM</th>
<th>FWD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between ATV and OHM</td>
<td>1.62</td>
<td>1.96</td>
<td>–</td>
</tr>
<tr>
<td>Between ATV and FWD</td>
<td>1.66</td>
<td>3.24</td>
<td>3.34</td>
</tr>
<tr>
<td>Between OHM and FWD</td>
<td>–</td>
<td>2.08</td>
<td>26.61*</td>
</tr>
</tbody>
</table>

$^a$1 = strongly disagree; 3 = neutral; 5 = strongly agree.
Density layer was reclassified into compact and sandy soils according to soil drainage. 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 (Whiting, Card, & Wilson, 2006).

The end result of a viewshed analysis which incorporated a digital elevation model (50 m) as an input layer and a water surface (i.e. lakes, ponds, rivers) as the observer points was used to assess where water could and could not be seen within the forest. The model did not incorporate the effect of the density or height of the trees within the area. To assess areas where water “could be seen at least some of the time” a straight line distance analysis from all surface water was conducted and zonal statistics were consulted to obtain the average distance within the forest where water could always be seen. Areas falling equal to or less than this average distance were classified as areas where a rider would be more likely to see water at least some of the time. Areas greater than the average distance were classified as areas where riders were less likely to see water some of the time.

Areas where ATV riders have the highest preference for resources tended to occur around the western and eastern boundaries of the forest (Fig. 2), and made up 6.57% of the study area. These areas were mostly composed of compact soils, and tended to be 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 in close proximity to wetlands. Areas of medium preference were found in close proximity to highly preferred areas and made up 36.75% of the study area. Lastly, areas of the lowest preference made 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, sandy, and water is less likely to be visible. Vegetation within the low preference areas is mixed between open and dense habitats, but is mostly composed of pine scrub habitat (Table 6).

Similar to ATV riders, OHM riders had the highest preference for resources that occurred on the eastern border and some high preference areas on the western border composing 9.15% of the total area (Fig. 3). Likewise, areas of medium preference occur in close proximity to high preference areas and accounted for 30.83% of the area. Low preference areas accounted for 60.01% of the total area, and are mostly located within the central region of the forest (Table 6).

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 6). These areas tend to occur in close proximity to water, on drier soils, and in dense vegetation. Medium preference areas were also more scattered about, but could be found mostly within the south central region of the forest. These areas were 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 (Fig. 4).

Mapping potential conflict

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

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**Table 4** Principle component analysis results.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Component 1</th>
<th>Component 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominated by pine trees and wiregrass</td>
<td>.837</td>
<td></td>
</tr>
<tr>
<td>Dominated by hardwoods and shrubs</td>
<td>.913</td>
<td></td>
</tr>
<tr>
<td>Dominated by a mix of pine trees and hardwoods</td>
<td>.900</td>
<td></td>
</tr>
<tr>
<td>Scrub</td>
<td>.418</td>
<td></td>
</tr>
<tr>
<td>A mix of pine trees and open spaces</td>
<td>.860</td>
<td></td>
</tr>
<tr>
<td>A mix of hardwood trees and open spaces</td>
<td>.835</td>
<td></td>
</tr>
<tr>
<td>A mix of pine trees and hardwoods and open spaces</td>
<td>.796</td>
<td></td>
</tr>
<tr>
<td>Open with no presence of vegetation</td>
<td>.575</td>
<td></td>
</tr>
<tr>
<td>Percent of variance explained</td>
<td>36.1%</td>
<td>32.7%</td>
</tr>
<tr>
<td>Cronbach Alpha</td>
<td>.82</td>
<td>.73</td>
</tr>
</tbody>
</table>

**Table 5** OHV rider’s resource preferences.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean scores</th>
<th>ATV</th>
<th>OHM</th>
<th>FWD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open habitats</td>
<td></td>
<td>3.63</td>
<td>3.79</td>
<td>3.64</td>
</tr>
<tr>
<td>Dense habitats</td>
<td></td>
<td>3.70</td>
<td>3.62</td>
<td>3.30</td>
</tr>
<tr>
<td>Soils</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compact soils</td>
<td></td>
<td>4.00</td>
<td>4.59</td>
<td>3.11</td>
</tr>
<tr>
<td>Dry/sandy soils</td>
<td></td>
<td>3.34</td>
<td>2.89</td>
<td>3.62</td>
</tr>
<tr>
<td>Scenic attributes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Where water cannot be seen</td>
<td></td>
<td>2.37</td>
<td>2.51</td>
<td>2.75</td>
</tr>
<tr>
<td>Where water can be seen some of the time</td>
<td>3.95</td>
<td>3.81</td>
<td>3.76</td>
<td></td>
</tr>
<tr>
<td>Where water can be seen all of the time</td>
<td>3.51</td>
<td>3.38</td>
<td>3.19</td>
<td></td>
</tr>
</tbody>
</table>

* 1 – strongly dislike; 3 – neutral; 5 – strongly like.
area was given lead 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 (Fig. 5); however, a large portion (36.94%) of that potential would occur in areas of shared low preference. Conflict between FWDs and ATVs was likely to occur in just over 9% (9.47%) of the area, 4.07% of which both groups share high resource preferences (Table 7).

Not all areas showed the potential for conflict to occur (Fig. 6). For those who operated FWD vehicles, just over 25% (25.03%) of high preference areas showed lower levels of potential conflict since these are areas that FWD operators preferred more than any other rider group. Similar to the FWD recreation terrain preference maps, these areas occur in the northeast, southeast, and south-western 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 7). 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 held higher preferences for resources than 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 area (Table 7), and tended to occur in the northeast, southeast, and west central portions of the forest (Fig. 6). Areas where medium preference was given were most likely to exist within the southeastern portion of the forest, and accounted for 1.51% of the area.

There were no areas where ATV riders has lead preference.

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**Table 6**
Composition of preferred areas for OHV riders.

<table>
<thead>
<tr>
<th>Rider group</th>
<th>Composition of preferred areas (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
</tr>
<tr>
<td>ATV</td>
<td>6.57</td>
</tr>
<tr>
<td>OHM</td>
<td>9.15</td>
</tr>
<tr>
<td>FWD</td>
<td>31.69</td>
</tr>
</tbody>
</table>

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**Legend**

- Lowest Preference
- Medium Preference
- Highest Preference
- Restricted
- County Boundaries

**Fig. 2.** ATV recreation terrain preference model.
Discussion & management recommendations

The social data collected allowed for the identification of potential conflict as a result of low tolerance, and the spatial analysis provided further insight that conflict related to low tolerance is most likely to occur based on OHV rider’s shared resource preferences. Survey results were reflective of similar conflict studies and further supports that conflict tends to be asymmetrical. 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” with items stating they are not tolerant of OHMs while those operating OHMs only “disagree” with similar statements referring to ATV operators. 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 lower toward ATV and OHM rider groups, suggesting that those who operate four-wheel drive vehicles are more likely to perceive themselves differently and more likely to 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 & Schreyer, 1980). Implications and solutions for this are discussed further under management recommendations.

According to the Theory of Goal Interference, tolerance for lifestyle diversity is generally affected by an individual’s view of technology and resource consumption as well as prejudice (Jacob & 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 (Crimmins & NOHVCC, 2006; Wernex, 1994) 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. This could then contribute to different levels of tolerance toward other riding groups. Prejudice and stereotypical views can be influenced by ethnicity, gender, age, and social class (Jacob & 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, specifically investigating the potential for conflict between rider groups as a possible key issue of concern. By understanding and acknowledging that OHV rider groups, particularly those operating FWD vehicles, perceive themselves as different from one another, managers can incorporate this knowledge into the planning process in order 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 to examining conflict related to tolerance, have found tolerance to exist between activity groups, and have suggested these activities should be spatially separated. This recommendation is also suggested here; however, not all riders will have the desire to be separated from other rider groups. Although the potential for conflict exists, conflict itself is never rampant (Graefe & Thapa, 2004). Rather, it tends to affect a small percentage of the population and the majority of visitors are generally satisfied (Manning, 1999). Therefore, it may be possible that a greater majority of users can be managed within a multiple use setting, while still providing some single use trail opportunities for those who are more likely to experience conflict. The results from the spatial analysis can aid managers in developing alternative management and trail development solutions of how to best
achieve the single and multiple use separation between activity groups while still providing opportunities within areas riders may find desirable.

For example, looking at the potential conflict map, areas noted as “potential conflict” may be better suited for multiple use areas since these areas that all rider groups prefer. Areas that had “lead preference” for a specific rider group may be best suited for single use areas. Given that the recreation terrain preference models assumed that riders would chose areas that best suited their 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 & 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 effect on the environment assuming that the number of places through which the trail traverses is the same as if use were concentrated (Hammitt & 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 to promote tolerance between rider groups. Often, visitors are more similar than they perceive themselves to be, and it has been suggested that

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**Fig. 6.** Areas of lead preference for rider groups.
promoting an understanding of other activity groups’ motivations, attitude, and techniques specific to the activity may help raise tolerance toward out-groups (Ramthun, 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). Authors acknowledge that the majority of participants within this study were ATV riders. Although this was reflective of the use and balance of OHV visitors within the study area, future research should examine conflict and tolerance within and between ATV, OHM, and FWD user groups of equal size to determine if similar conclusions are derived.

This study also took a new approach to examining the spatial context of conflict related to tolerance in order to help identify where conflict took place and was most likely to occur. The spatial identification of conflict may be used as a possible tool to assist managers in identifying where to concentrate management efforts as it relates to minimizing recreation conflict. Also, the spatial identification of conflict and terrain preference maps may also be used to assist managers in creating alternative solutions when planning for new recreation opportunities that consider rider group preferences as well as rider group differences. Although this study took a planning approach in the Ocala National Forest, the methods could be adapted to assess conflict potential related to tolerance on existing trail systems in a variety of areas. 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.

Acknowledgements

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