THESIS

RECREATION CONFLICT AND MANAGEMENT OPTIONS IN THE VAIL PASS WINTER RECREATION AREA, COLORADO, USA

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ABSTRACT

RECREATION CONFLICT AND MANAGEMENT OPTIONS IN THE VAIL PASS WINTER RECREATION AREA, COLORADO, USA

This multi-part thesis focused on the underlying drivers of recreation conflict among winter recreationists in the Vail Pass Winter Recreation Area (VPWRA) in central Colorado. Data for the first manuscript were obtained from surveys collected in 2003 (n = 224, response rate = 93%) and again in 2014 (n = 242, response rate 89%) from randomly selected VPWRA non-motorized and motorized recreationists. A cluster analysis revealed significant changes in reported conflict over more than 10 years of recreation zoning at the VPWRA. Overall, the management system was effective at reducing, but not eliminating interpersonal conflict, while social values conflict increased over the period for non-motorized recreationists. Data for the second manuscript were collected from two sources: GPS units carried by recreationists in the VPWRA in 2010 and 2011 (n = 1,444,703, response rate = 90%), and survey data collected from non-motorized recreationists in the VPWRA in 2014 (n = 199, response rate 88% for on-site survey). A Geospatial analysis was performed to understand the extent of overlapping, or mixed non-motorized and motorized use occurring in the VPWRA. Then, a survey data analysis was conducted to test for differences in interpersonal conflict between non-motorized recreationists who traveled in mixed use areas, compared with those who did not travel in mixed use areas. Results suggest that interpersonal conflict is reported more often among non-motorized recreationists who traveled in areas of mixed use across five standard conflict variables. Themes from the analyses and management recommendations are discussed in the conclusion.

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DEDICATION

This is for all those who enjoy the myriad benefits of public land.

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CHAPTER 1 – INTRODUCTION

This two-part thesis focuses on conflict among winter recreationists in the Vail Pass Winter Recreation Area (VPWRA) in central Colorado. It is the culmination of data collected in collaboration with the US Forest Service, Rocky Mountain Research Station and White River National Forest, as well as the Department of Human Dimensions of Natural Resources at Colorado State University. Chapters 2 and 3 are independent manuscripts, but related in content objective: to provide parks and protected area (PPA) managers with better information on how winter recreationists use terrain in the VPWRA and what steps can be taken to reduce winter recreation conflict.

Recreation conflict has been the study of researchers since the early 1980s (Jacob & Schreyer, 1980). As recreation became increasingly popular following World War II and a rise in personal income in the United States, competition for natural resources and outdoor experiences led to conflict between recreationists (Cordell, 2008; Owens, 1985). In the decades since, researchers have built theory and gathered data on the principal underlying drivers of recreation conflict. Over time an important distinction has been made between interpersonal and social-values conflict (e.g., Graefe & Thapa, 2004). Interpersonal conflict (a.k.a., goal-interference) occurs when the physical presence or behavior of an individual or group interferes with the goals of another individual or group (Jacob & Schreyer, 1980). Social values conflict, on the other hand does not require physical interaction, but rather occurs between groups who may not share similar norms or values about an activity (Ruddell & Gramann, 1994; Vaske, Donnelly, Wittmann, & Laidlaw, 1995).

Managers of PPAs must decide how to manage recreation in such a way that resource damage and recreation conflict are limited while at the same time high-quality recreation experiences are provided. While PPA managers have implemented management structures to limit recreation conflict, research is lacking on the long-term effectiveness of these management structures.

This thesis examines the nature of winter backcountry recreation and then asks important questions on the effectiveness of the most common method for limiting recreation conflict, zoning, or the segregation of activities. The first manuscript (Chapter 2) uses survey data collected in the VPWRA in 2003 and again in 2014. These survey data provide a snapshot of the effectiveness of zoning management structure after more than 10 years of zoning enforcement and a more active management approach taken by VPWRA managers. The central hypothesis is that the implementation of zoning and active management by the US Forest Service at the VPWRA has decreased reported interpersonal and social values conflict among motorized and non-motorized recreationists.

The second manuscript (Chapter 3) builds on the first to further investigate the causes of lingering interpersonal conflict specifically among non-motorized recreationists. It uses a geospatial analysis of recreation in the VPWRA from Global Positioning System (GPS) points collected in 2010 and 2011 to characterize where recreation use is occurring and to calculate the extent to which motorized and non-motorized use is overlapping in the VPWRA. Then, it uses survey data (from the 2014 dataset used in the first manuscript) to understand if the areas of overlapping, or mixed, use is contributing to lingering conflict among non-motorized recreationists at the VPWRA. It hypothesizes that non-motorized recreationists who travel in

areas with no mixed use will report lower interpersonal and social values conflict, compared with those non-motorized recreationists traveling in areas of overlapping use.

The thesis is structured as followed: the first manuscript (Chapter 2) is presented with the associated abstract, tables and figures and cited references. Then, the second manuscript (Chapter 3) is presented similarly. Both manuscripts have their own introduction, methods, results, discussion and conclusion sections. Management implications and recommendations are provided for use both by VPWRA managers, as well as PPA managers elsewhere considering the utility of a zoned recreation management structure. Finally, the conclusion (Chapter 4) draws on important themes from both manuscripts, provides management recommendations, and highlights areas for future research on the topic of recreation conflict.

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CHAPTER 1 – WINTER RECREATIONIST CONFLICT AND MANAGEMENT APPROACHES AT VAIL PASS, COLORADO

Introduction

Conflict between recreationists is generally considered to fall into two main categories (Graefe & Thapa, 2004). First, interpersonal conflict (a.k.a., goal-interference) occurs when the physical presence or behavior of an individual or group interferes with the goals of another individual or group (Jacob & Schreyer, 1980). Interpersonal conflict can occur directly via a face-to-face encounter (e.g., between a backcountry skier and a snowmobiler on a shared route), or indirectly where evidence of one group's behavior is sufficient to cause conflict (e.g., a skier smells the exhaust of a snowmobiler). Different groups may share the same goal (e.g., experiencing untracked snow), but have different means of achieving that goal (e.g., skiing vs. snowmobiling), which can influence goal-interference conflict (Gibbons & Ruddell, 1995; Graefe & Thapa, 2004).

Second, social values conflict occurs between groups who may not share similar norms or values about an activity (Ruddell & Gramann, 1994; Vaske, Donnelly, Wittmann, & Laidlaw, 1995). Unlike interpersonal conflict, social values conflict is defined as conflict that can occur even when there is no direct contact between the groups (Carothers, Vaske, & Donnelly, 2001; Vaske, Needham, & Cline, 2007). For example, although encounters with llama packing trips may be rare, individuals may philosophically disagree about the appropriateness of using these animals in the backcountry (Blahna, Smith, & Anderson, 1995).

Evidence of interpersonal conflict has typically focused on motorized and non-motorized activities such as canoers and motorboaters (Adelman, Heberlein, & Bonnicksen, 1982).

Relevant winter recreation examples include interpersonal conflict between cross-country skiers and snowmobilers (Jackson & Wong, 1982; Knopp & Tyger, 1973; Vaske et al., 2007) or between backcountry skiers and helicopter-assisted skiers (Gibbons & Ruddell, 1995). Examples of social values conflict have tended to concentrate on activities where participants might have different worldviews (e.g., hunters vs. non-hunters, Vaske et al., 1995). These studies have demonstrated a need for empirically testing both interpersonal and social values conflict to improve managers' understanding of underlying drivers of conflict among recreationists.

Recreation managers care about conflict because it affects visitors' experiences. Similar to crowding, conflict can influence displacement, where visitors will no longer visit an area (Schneider, 2000). As the demand for recreation opportunities on public lands increases a need for solutions to conflict situations becomes more important.

Two related tools are commonly used to minimize conflict between recreationists (Schneider, 2000; Vaske et al., 2007). First, managers physically separate recreationists into zones, usually based on activity type, e.g., motorized or non-motorized zones. The primary aim of zoning is to limit interpersonal conflict. Second, to minimize social values conflict and to maintain zoning boundaries, managers often employ an "active management" approach. Active management is designed to provide recreationists with their desired experience. Active management often coincides with a fee system for using the area, as opposed to passive management where zoning is unlikely to be consistently enforced and education efforts minimal. Active management can take the form of (a) public education through signage along routes and along closures, (b) field personnel contacting recreationists about zoning designations and reasons for zoning, (c) enforcement of zoning boundaries, (d) management of parking areas, and (e) a collaborative planning approach for management changes (T. Kirkpatrick, personal

communication, March 15, 2015). Over time, an active management approach is thought to decrease social values conflict by demonstrating it is possible to have more than one recreation activity present on the same landscape. Providing access to high-quality terrain to both groups and then enforcing that provision is fundamental to active management and aligns with properly designed zoning.

While a need for measuring both interpersonal and social values conflict has been demonstrated (e.g., Carothers et al., 2001; Graefe & Thapa, 2004; Vaske et al., 2007), research is lacking on both the effectiveness of zoning to reduce interpersonal conflict as well as on the effectiveness of active management on reducing social values conflict. This article focused on a zoned, actively managed winter recreation area to understand the extent to which these management actions have reduced interpersonal and social value conflict. Data were collected in both 2003 and 2014 to examine conflict between motorized and non-motorized recreationists at the Vail Pass Winter Recreation Area (VPWRA) in the mountains of central Colorado.

Study Site

The VPWRA is a fee-operated area on the White River National Forest (WRNF) that requires each visitor is to pay an entrance fee. Revenue is used to operate trail grooming, the enforcement of activity zoning, public education, and parking lot management. The WRNF retains 95% of fee revenue collected at the VPWRA for management of the recreation area itself. The VPWRA sees approximately 35,000 visitors per winter season (USDA Forest Service, 2015). Visitors access the area from four primary portals, the most popular of which is located adjacent to Interstate 70 near the summit of Vail Pass on the east side of the VPWRA. This portal sees vast the majority of visitation. The other primary portals are located on the west side of the VPWRA and see much less use (USDA Forest Service, 2015).

The VPWRA was established by the WRNF as a result of a multi-year collaborative planning effort led by a volunteer task force of local partners and stakeholders formed in the early 1990s (USDA Forest Service, 2015). The establishment of the current boundaries of the VPWRA coincided with the WRNF Forest Plan Revision in 2002. The task force and WRNF mapped 55,000 acres around Vail Pass into three use areas: (a) multiple use area, open to both motorized and non-motorized users, (b) non-motorized use only, closed to motorized users, and (c) Hybrid-use area, open to motorized use only on established routes, closed to motorized use off established routes (see Figure 2.1). The hybrid zone is designed to allow snowmobilers to tow skiers and snowboarders to the top of terrain where the recreationists ski or snowboard down the slope to be met again by a snowmobiler. These recreationists access ski/snowboard terrain that is otherwise too far from an access portal to be reached in a single day.

In the late 1980s and early 1990s, hostile interactions between skiers and snowmobilers, resulted in verbal and some physical altercations (Hughes, 1997). Issues such as parking shortages, resource damage with shallow snowpacks, and poorly regulated outfitting and guiding, added to the need for equitable and clearly defined access to high-quality backcountry terrain (USDA Forest Service, 2015). The stakeholder task force recommended the use of a fee to help the WRNF pay for employees to provide active management and law enforcement at the VPWRA, in addition to trail grooming. The task force also agreed on zoning boundaries designed to give each recreationist activity access to favorable terrain, to minimize conflict between visitors and to improve the overall quality of the recreation experience.

Hypotheses

The 2003 data were collected in the first season after implementation of the current zoning map that came with the WRNF's 2002 Forest Plan Revision.

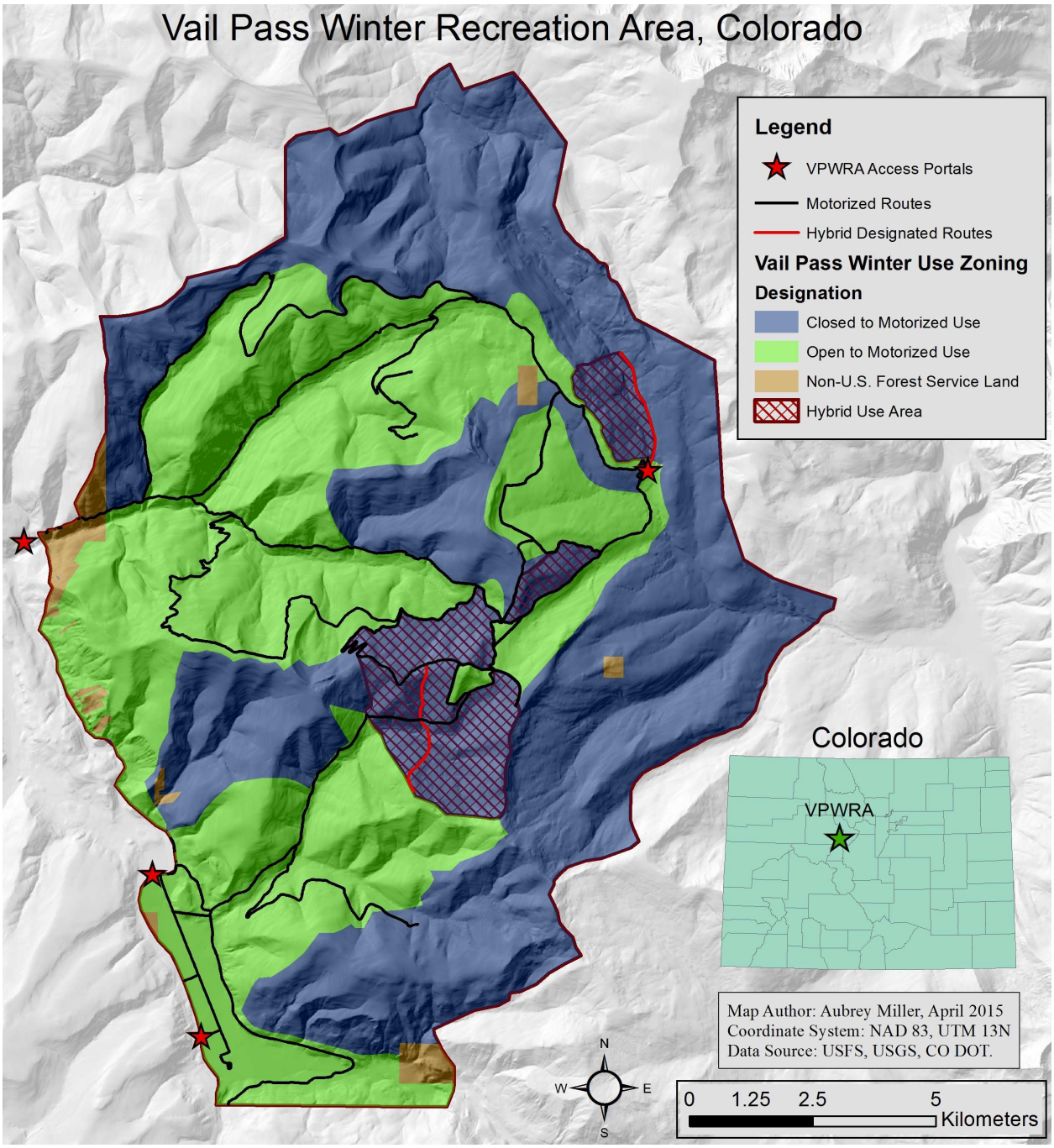

Figure 2.1 – Map of Vail Pass Winter Recreation Area and zoning designations

We examined the effectiveness of zoning and active management at the VPWRA on limiting interpersonal and social values conflict over more than a ten-year period of operations. The following hypotheses were advanced:

H_1: Non-motorized respondents will report a lower level of interpersonal conflict in 2014 compared with 2003.

H_2: Non-motorized respondents will report a lower level of social values conflict in 2014 compared with 2003.

H_3: Motorized respondents will report a lower level of interpersonal conflict in 2014 compared with 2003.

H_4: Motorized respondents will report no social values conflict 2014, consistent with 2003.

Method

Data were collected in the winter of 2003 and again in 2014. On-site surveys were distributed at the Vail Pass parking area to all recreationists after their recreation experience. Two versions of the survey were developed with the same questions, one for motorized recreationists and one for non-motorized recreationists. Motorized activities included snowmobiling, ski-biking (a track is attached to a motorcycle), utility terrain vehicle (UTV) operation (tracks are attached to UTV for snow travel), and snow-cat operation. Snowmobiling accounted for over 95% of the motorized respondents. Non-motorized activities include backcountry skiing and snowboarding, cross-country or nordic skiing, and snowshoeing.

If the respondent's primary activity that day was motorized, a motorized survey was given. Conversely, if the respondent's primary activity was non-motorized, a non-motorized survey was given to the respondent. If the recreationist was a snowmobile-assisted skier, a motorized survey was given, and a "hybrid" activity was noted on the survey.

For both 2003 and 2014, onsite surveys were distributed only on weekend days. The majority of the VPWRA visitation occurs on weekends. In 2014, an online version of the survey

was also created to capture visitation to the backcountry huts located in the VPWRA. Hut users were given the non-motorized version of the survey since motorized use is not allowed at the huts. Surveys from hut users were collected from weekdays in addition to weekends.

In 2003, completed surveys were collected from 104 non-motorized users and 120 motorized users. In 2014, completed surveys were collected from 199 non-motorized users and 43 motorized users. The combined sample size for both years was 466 (response rate across both years = 91%). A greater proportion of non-motorized surveys were collected in 2014 because of the high response rate from backcountry hut users in the VPWRA, which were entirely non-motorized (n = 180).

Variables Measured

The conflict variables in this article were identical to previous recreation conflict analyses (i.e., Carothers et al., 2001; Vaske et al., 1995, 2007). Respondents reacted to each of five experience indicators. Non-motorized users were asked how frequently they (a) saw motorized user traveling out of control, (b) saw motorized user being rude and discourteous, (c) saw motorized user pass too closely, (d) saw motorized user not yielding the right of way, and (e) saw motorized user disturb wildlife. The motorized users were asked to evaluate non-motorized users with the same set of questions (e.g., saw non-motorized user traveling out of control). The response categories for the questions were "never," "1-2 times," "3-5 times," and "almost always." Based on previous research (i.e., Carothers et al., 2001; Vaske et al., 1995, 2007), the responses were recoded into "not observed" (i.e., respondent reported it never happened) or "observed" (i.e., respondent reported it happened at least once).

Respondents were then asked if they believed each of these questions were a problem. The responses were initially coded on a four-point scale: "not a problem," "slight problem,"

"moderate problem," and "extreme problem." As with the above questions, the responses were recoded into either "no problem" or "problem."

Consistent with previous research (Carothers et al., 2001; Vaske et al., 1995, 2007), combining the frequency of occurrence (observed, not observed) variables with the corresponding perceived problem (no problem, problem) variables for each respondent produced conflict typologies with the three possible attributes: (a) no conflict, (b) interpersonal conflict, and (c) social values conflict (Figure 2.2). Individuals who observed or did not observe a given event, yet did not perceive it to be a problem were considered to have experienced no conflict (i.e., no interpersonal or social values conflict). Those who never saw a given event, but believed that a problem existed for the event were considered to be expressing a conflict in social values. Conversely, those who witnessed a particular event and believed that it had caused a problem were judged to be indicating interpersonal conflict.

		Perceived Problem	
		No	Yes
Observed	No	No Conflict	Social Values Conflict
	Yes	No Conflict	Interpersonal Conflict

Figure 2.2 – Conflict evaluation table. Adapted from Vaske et al., 1995

Results

Individual-level responses to each of the five "observed" and five "think problem" variables were compared between 2003 and 2014 (Table 2.1). Results showed variation with

each variable (e.g., "observed motorized user riding out of control" decreased 45% while "observed motorized user passing too closely" only decreased 9%). There were, however, consistent decreases for the observation of conflict variables in 2003 versus 2014 for both non-motorized and motorized users. Responses were less consistent with "think problem" variables for non-motorized respondents. For example, the variable "think motorized users riding out of control is a problem" decreased 11% from 2003 to 2014, but the variable "think motorized users disturb wildlife" increased 4% over the same period. For motorized respondents the "think problem" variables all saw decreases from 2003 to 2014.

Cluster analyses provided a multivariate perspective of conflict and allowed for comparison with previous research (e.g., Vaske et al., 2007) (Table 2.2). For each activity (non-motorized and motorized), cluster analyses were performed for 2, 3, and 4 group solutions. The 3-group solution provided the best fit for non-motorized respondents; the 2-group solution fit the data best for motorized respondents (e.g., only one individual was in the third motorized cluster). To confirm these solutions, the data were randomly sorted three times and cluster analyses were conducted after each sort. These analyses supported the two (motorized) and three (non-motorized) group solutions. The *k*-means cluster analyses revealed the same trend that Vaske et al. (2007)[1] found in their research on conflict among winter recreationists.

[1] Similar to Vaske et al. (2007), when the non-motorized data were stratified into "no conflict," "interpersonal conflict," "social values conflict," and "both interpersonal and social values conflict" the cluster analysis failed to reach convergence when testing for a two, three, four, or five cluster solution. Therefore, a *k*-means cluster analysis was performed on the data stratified into "no conflict," "interpersonal conflict," and "social values conflict" with a three-cluster solution.

Table 2.1 – Distribution of Respondents Observing Specific Events and Reporting Specific Problems

	Observed Measure			Problem Measure		
	Respondents (%)[1]		Change (%)	Respondents (%)[2]		Change (%)
	2003	2014		2003	2014	
Non-Motorized Evaluation of:						
Motorized users						
Riding out of control	50	5	-45	64	53	-11
Being rude or discourteous	38	21	-18	54	51	-2
Passing too closely	40	31	-9	55	58	2
Not yielding right of way	30	19	-10	48	51	3
Disturbing wildlife	19	16	-3	60	64	4
Motorized Evaluation of:						
Non-Motorized users						
Riding out of control	28	12	-16	20	7	-13
Being rude or discourteous	25	7	-17	26	14	-12
Passing too closely	27	10	-18	23	12	-11
Not yielding right of way	33	14	-19	31	10	-22
Disturbing wildlife	10	5	-5	14	10	-5

[1] Of total respondents, percentage reporting at least one observation of statement's behavior.
[2] Of total respondents, percentage reporting that he/she thinks statement is a problem.

Among non-motorized respondents, individuals in the first cluster reported no conflict across all five conflict variables (n = 102). Individuals in Cluster 2 (n = 91) consistently reported interpersonal conflict and individuals in Cluster 3 (n = 83) consistently reported social values conflict. For motorized respondents, 128 individuals consistently reported no conflict (Cluster 1) and 28 respondents reported interpersonal conflict (Cluster 2). Similar to Vaske et al. (2007), no motorized respondents reported social values conflict.

Table 2.2 – Cluster Analysis of Non-Motorized and Motorized Conflict Evaluations

	Final Cluster Centers		
	Cluster 1	Cluster 2	Cluster 3
Non-Motorized Evaluation of:	*n* = 102	*n* = 91	*n* = 83
Motorized users			
Riding out of control	No Conflict	Interpersonal	Social Values
Being rude or discourteous	No Conflict	Interpersonal	Social Values
Passing too closely	No Conflict	Interpersonal	Social Values
Not yielding right of way	No Conflict	Interpersonal	Social Values
Disturbing wildlife	No Conflict	Interpersonal	Social Values
Motorized Evaluation of:	*n* = 128	*n* = 28	
Non-Motorized users			
Riding out of control	No Conflict	Interpersonal	--
Being rude or discourteous	No Conflict	Interpersonal	--
Passing too closely	No Conflict	Interpersonal	--
Not yielding right of way	No Conflict	Interpersonal	--
Disturbing wildlife	No Conflict	Interpersonal	--

Table 2.3 shows the distribution of respondents after the cluster analyses for both non-motorized and motorized respondents. Combined 2003 and 2014 results for the non-motorized respondents indicate that 37% report no conflict, 33% report interpersonal conflict and 30% indicate social values conflict. Results for motorized respondents indicate that 82% report no conflict, 18% report interpersonal conflict and no respondents report social values conflict.

Table 2.3 – Distribution of Respondents in k-means Cluster Analyses

Type of Conflict	Non-Motorized Respondents (%)	Motorized Respondents (%)
No Conflict	37	82
Interpersonal Conflict	33	18
Social Values Conflict	30	0

Differences between reported conflict in 2003 and 2014 are examined in Table 2.4. Significant differences were observed between 2003 and 2014 for non-motorized respondents. The differences were not statistically significant for motorized individuals, but this is likely due to the smaller cluster analysis sample size in 2014 (n = 42), compared with 2003 (n = 114).

Table 2.4 – Overall Proportion of Perceived Conflict by Non-Motorized and Motorized Users

Type of Conflict	Non-Motorized Evaluations of Motorized Users (%)[1]		Motorized Evaluations of Non-Motorized Users (%)[2]	
	2003	2014	2003	2014
No Conflict	37	37	80	88
Interpersonal Conflict	43	28	20	12
Social Values Conflict	20	35	0	0

[1] Differences between 2003 and 2014: n = 276, χ^2 = 9.37, df = 2, Cramer's V = .183, p < .01

[2] Differences between 2003 and 2014: n = 156, χ^2 = 1.53, df = 1, Cramer's V = .096, p = .232

Non-motorized respondents reporting no conflict remained unchanged at 37% of respondents in 2003 and in 2014. Respondents reporting interpersonal conflict decreased by 15% over the period, from 43% of respondents in 2003 to 28% of respondents in 2014. Those respondents

reporting social values conflict increased 15% from 20% in 2003 to 35% in 2014. The results for motorized respondents showed an opposite temporal trend. Respondents reporting no conflict increased 8% (80% in 2003; 88% in 2014), while respondents reporting interpersonal conflict decreased 8% (20% in 2003; 12% in 2014). Motorized respondents reported zero social values conflict for both 2003 and 2014.

Discussion

With more than 10 years of enforcement of a zoning system at the VPWRA, interpersonal conflict among non-motorized respondents decreased significantly between 2003 and 2014, supporting Hypothesis 1. Conversely, despite more than a decade of active management at the VPWRA, social values conflict among non-motorized respondents actually *increased* significantly; Hypothesis 2 was not accepted. For motorized respondents, the results are less mixed. Consistent with Hypothesis 3, respondents did report less interpersonal conflict, and consistent with Hypothesis 4, social values conflict was not reported in either 2003 or in 2014.

These results are important for three main reasons. First, the asymmetrical pattern at the VPWRA between reported levels of conflict among non-motorized and motorized recreationists is consistent with previous studies, for example among skiers and snowmobilers (Jackson & Wong 1982; Knopp & Tyger, 1973; Vaske et al., 2007), backcountry helicopter-assisted skiers and other skiers (Gibbons & Ruddell, 1995) and between non-motorized and motorized watercraft (Shelby, 1980). Specifically, the pattern evident in Vaske et al. (2007), which included data from the VPWRA in 2003 showed how motorized recreationists consistently reported lower levels of interpersonal conflict and no social values conflict compared with non-motorized recreationists.

The disparity between reported interpersonal conflict for non-motorized and motorized recreationists may be partially explained by noise and exhaust from snowmobiles, which rank as important factors influencing reported conflict among non-motorized users (Lindberg, Fredman, & Heldt, 2009; Vittersø, Chipeniuk, Skår, & Vistad, 2004, Vaske et al., 2007). Since non-motorized recreationists by their nature do not create engine noise or exhaust these conflict variables cannot be examined for motorized respondents.

Second, the use of zoning as a way to reduce interpersonal conflict has been increasingly popular among recreation managers (e.g., Adams & McCool, 2010), and these results show that in the case of the VPWRA, the presence of interpersonal conflict among non-motorized recreationists did decrease over time. The VPWRA has been used as an example of effective zoning and decreased levels of conflict (Eisen, 2014). Compared with the hostile interactions between non-motorized and motorized recreationists reported in the early 1990s (Hughes, 1997), interactions between non-motorized and motorized recreationists are less contentious now. The decrease in interpersonal conflict, empirically examined in this article, verifies the management trend of the past 15 years to implement zoning as a way to limit interpersonal conflict. Despite the decrease in interpersonal conflict, it still persisted for nearly a third of non-motorized recreationists at the VPWRA in 2014. For managers interested in providing a high-quality winter recreation experience for both non-motorized and motorized activities, it is important to decipher what underlying factors may account for persistent interpersonal conflict among non-motorized recreationists.

Despite established zoning at the VPWRA, there are still areas of mixing of non-motorized and motorized activities near access portals, parking areas, and along some key travel corridors. This mixing could be influencing non-motorized respondents' overall reported levels

of interpersonal conflict. For example, prior to the winter of 2013/2014, non-motorized recreationists traveling to Shrine Pass were required to travel on a route closed to motorized users. The route is adjacent to, but several hundred meters from, a busy motorized route. Beginning in the winter of 2013/2014 managers at the VPWRA requested non-motorized recreationists begin to use the motorized route. In doing so, they created a new mixed-activity route that was not present during the 2003 season. Further analysis is required to identify changes to reported conflict when controlling for activity mixing. Also, depending on topography, physical separation of activities may not limit noise pollution from snowmobilers, which could inflate reported interpersonal conflict levels.

Third, the results from this analysis show that social values conflict increased significantly from 2003 to 2014 among non-motorized recreationists. According to this analysis, therefore, efforts to improve public education and active management at the VPWRA over the past decade have failed. Social values conflict is rooted in shared norms and values by non-motorized recreationists. This group may be expressing that the simple existence of motorized users is problematic for them. Education can help change this sentiment, but education programs addressing social values conflict (e.g., signage designed to show the benefits of zoning, or regulations limiting noise pollution of snowmobiles) need to be specifically targeted to commonly held norms and are unlikely to fully address underlying conflict on their own (Hidalgo & Harshaw, 2010). It is important to note the strong asymmetry of social values conflict between non-motorized and motorized recreationists at the VPWRA. More than a third of non-motorized respondents reported social values conflict with regard to the behavior of motorized users, but no motorized users reported social values conflict with non-motorized users. Active management efforts should focus specifically on norms held by non-motorized

recreationists. While education focused on non-motorized users is necessary, more research is needed on the effectiveness of other active management tools such as collaborative planning efforts and the best design and placement of signage and messaging on non-motorized recreationists.

Conclusion

The popularity and historical context of the VPWRA make it an ideal case study for the effectiveness of recreation zoning to limit interpersonal conflict and active management to limit social values conflict. Managers of other recreation areas with high levels of non-motorized and motorized recreation should consider zoning and active management, but this analysis suggests that further investigation is necessary to identify the extent to which these management tools will be successful. Effective zoning and active management have considerable operations costs and are more likely to require a fee, which may not be attractive to the public. In the VPWRA these tools reduced highly contentious conflict that persisted with a system of passive management and decreased interpersonal conflict, however with persistent social values conflict reported by non-motorized users, the implementation of zoning and active management should not be considered a panacea for recreationist conflict as a whole.

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CHAPTER 3 – THE EFFECTIVENESS OF ZONING TO REDUCE WINTER RECREATION CONFLICT

Introduction

Recreation in American parks and protected areas (PPAs) increased dramatically after World War II (Cordell 2008; Jensen and Guthrie 2006), and estimates indicate that overall participation will continue to climb in coming decades (Bowker et al. 2012). Recreation research since the 1960s has developed in two directions. First, a considerable body of research exists on recreation ecology, or the effects recreation has on the ecosystems in which it occurs (e.g., Hammit and Cole, 1998; Liddle, 1997; Monz, et al. 2010). The second direction has focused on describing patterns of recreation use and how those patterns may affect the availability or quality of recreational experiences (Manning, 2011).

Managers of PPAs are given a responsibility to sustainably manage resources for the use and enjoyment of current and future generations. An increasing demand for abundant and high-quality recreation opportunities in PPAs can create conflict between recreationists competing for their desired recreation experience. PPA managers rely on two common strategies for limiting conflict between recreationists. First, they limit the amount of interaction between groups by zoning recreation into areas open to a particular recreation activity while closed to another. Zoning is designed to separate activities and reduce interpersonal conflict. Interpersonal conflict occurs when the physical presence or behavior of an individual or group interferes with the goals of another individual or group (Graefe and Thapa 2004; Jacob and Schreyer 1980). Research shows interpersonal conflict often occurs between non-motorized and motorized recreation groups, for example between canoers and motorboaters (Adelman et al. 1982), between cross-

country skiers and snowmobilers (Jackson and Wong 1982; Knopp and Tyger 1973; Vaske et al. 2007), and between backcountry skiers and helicopter-assisted skiers (Gibbons and Ruddell 1995).

Second, PPA managers use an active management approach to visitor education and enforcement of zoning boundaries. A primary aim of active management is to limit social values conflict (Miller and Vaske 2015; Vaske et al. 2007). Social values conflict occurs between groups who may not share similar norms or values about an activity (Ruddell and Gramann 1994; Vaske et al. 1995). Social values conflict can occur between recreationists even with no direct contact between the groups (Carothers et al. 2001; Vaske et al. 2007). One group of recreationists may philosophically disagree about allowing another recreationist activity (e.g., Blahna et al. 1995; Vaske et al. 1995), so long-term education efforts are used to target the commonly held norms a group may have. For example, a Colorado Parks and Wildlife education program focused on the benefits of a regulation (C.R.S. 25-12-110) that limits off-highway vehicle noise pollution. Snowmobile noise pollution is often reported as a source of animosity from non-motorized recreationists towards motorized recreationists (Lindberg et al. 2009; Vittersø et al. 2004). The education program on the noise regulation is therefore designed to minimize social values conflict by demonstrating that snowmobiles are quieter now compared with in the past. Active management often coincides with a fee for recreation use in the PPA. Fee revenue is used in supporting an active management approach with field-going employees educating visitors on zoning boundaries and enforcing regulations.

While interpersonal and social values conflicts exist with distinct underlying drivers, they are closely related. Managers of PPAs have looked to zoning and active management to more fully address conflict between recreation groups (Miller and Vaske 2015; Schneider 2000; Vaske

et al. 2007). There is limited empirical research measuring the effectiveness of zoning and active management. Miller and Vaske (2015) used survey analysis to measure the changes in reported interpersonal and social values conflict over a more than 10-year period at the Vail Pass Winter Recreation Area (VPWRA) in central Colorado. The results showed interpersonal conflict decreased over the period for both non-motorized and motorized recreationists. Both groups, however, continue to report interpersonal conflict even with an established zoning system. Despite an established active management approach at the VPWRA, social values conflict among non-motorized recreationists *increased* over the period. One important finding was that despite a system of zoning at the VPRWA, there are areas with both non-motorized and motorized recreationists present. These mixed-use areas, it was hypothesized, may have been responsible for the lingering interpersonal and social values conflict.

The Miller and Vaske (2015) article built on previous research at the VPWRA to better understand the extent to which areas of mixed-use recreation influences reported levels of conflict reported by non-motorized recreationists. In this article we used two distinct methodologies to more clearly describe the nature of winter recreation at the VPWRA and identify factors responsible for persistent conflict among non-motorized recreationists. First, we performed a Geographic Information System (GIS) analysis of recreation Global Positioning System (GPS) data collected over two winter seasons at the VPWRA. The GIS analysis provides a more complete objective characterization of how recreationists move through a winter dispersed recreation landscape. Second, we used a survey to test whether there are reported differences among non-motorized recreationists who traveled in areas of mixed use, compared with those who did not travel in mixed-use areas.

Hypotheses

Based on previous winter recreationist conflict research and observations of recreationists at the VPWRA, the following three hypotheses were advanced:

H_1: Despite a zoning management plan, due to the presence of established travel routes, a disproportionate amount of recreation at the VPWRA will occur in mixed-use areas, compared with areas of no mixed-use.

H_2: Among non-motorized respondents, those traveling in mixed-use areas within the VPWRA will report a higher level of interpersonal conflict compared with those recreationists who did not travel in mixed-use areas.

H_3: Among non-motorized respondents, those traveling in mixed-use areas within the VPWRA will report a higher level of social values conflict compared with those recreationists who did not travel in mixed-use areas.

Methods

Study Site

The VPWRA encompasses 50,014 acres of sub-alpine and alpine terrain ranging from 2,652 to 3,869 meters and is managed by the White River National Forest (WRNF). The area is located immediately south of Vail Mountain Resort, west of the Eagles Nest Wilderness Area, and north of the Copper Mountain ski resort (Figure 3.1). Both Vail Mountain Resort and Cooper Mountain ski area hold special-use permits from the WRNF for ski operations on public land. Interstate 70 crosses through the eastern portion of the VPWRA, which is a one and a half hour drive to the Denver Metro Area and other Colorado Front Range communities. US Highway 24 forms the western boundary of the VPWRA connecting the mountain communities of Leadville and Minturn.

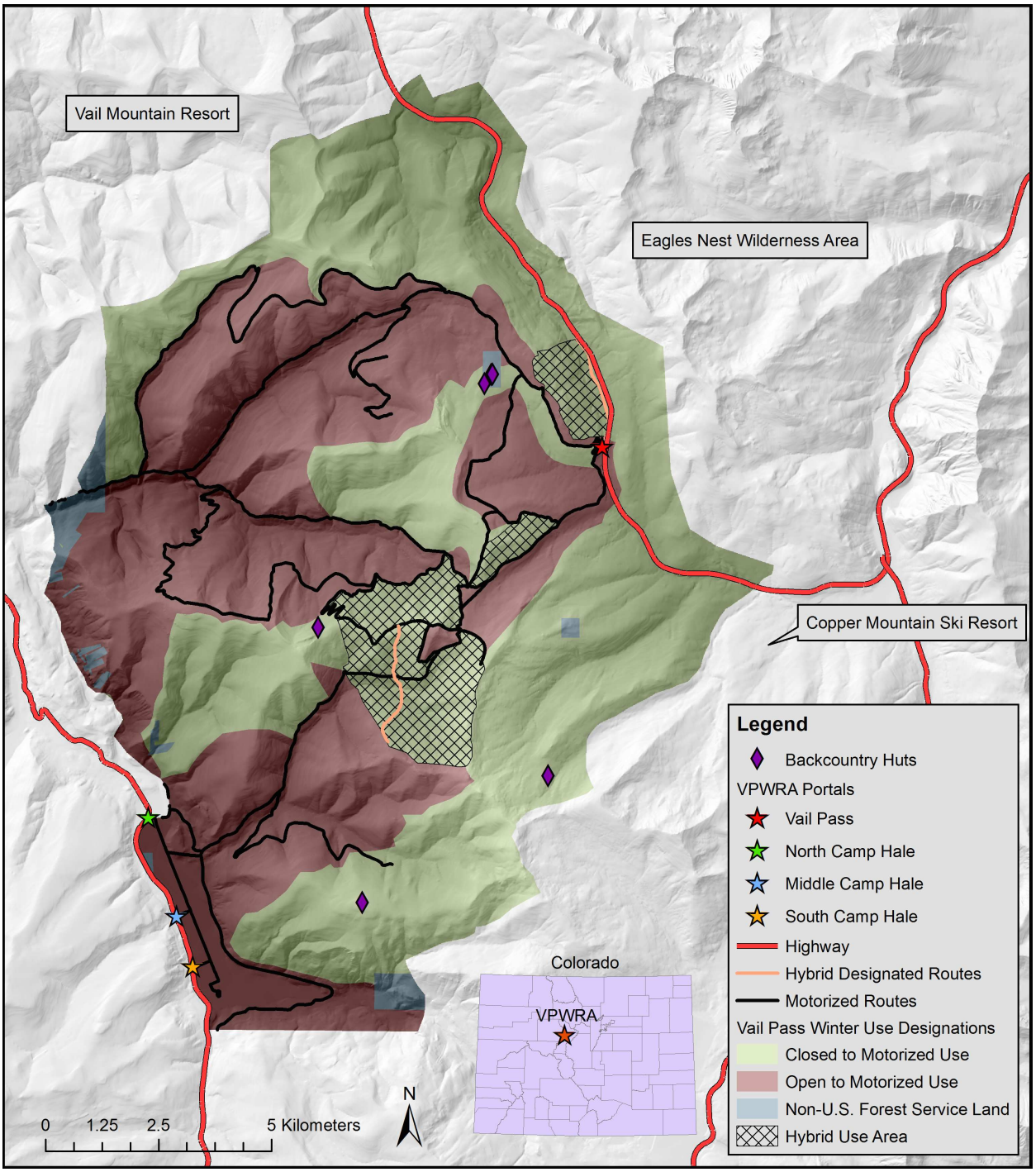

Figure 3.1 – The Vail Pass Winter Recreation Area (VPWRA) and recreation zoning designations and established groomed routes. See Miller and Vaske (2015) for history of recreation zoning at the VPWRA. The six backcountry huts (diamonds) and four primary access portals (stars) are also shown

Visitors to the VPWRA are required to pay an entrance fee (currently $6 per person per day), of which 95% is given to the WRNF to be used for trail grooming and full-time paid rangers who provide active management in the form of parking lot management, enforcement of regulations, and public education. The VPWRA sees approximately 35,000 visitors per winter season (USDA Forest Service 2015). The majority of visitors access the VPWRA from four primary portals, the busiest adjacent to Interstate 70, and three along the west side of the VPWRA (Figure 3.1).

The current zoning boundaries at the VPWRA reflect more than 20 years of collaboration between the WRNF and local stakeholders to provide access to high quality non-motorized and motorized backcountry terrain (Miller and Vaske 2015; USDA Forest Service 2015). Approximately 47% of the winter recreation area is closed to motorized use (Table 3.1), while 45% is open to motorized use. There are 3,307 acres (7%) of terrain designated for hybrid use. These areas allow motorized use along designated routes to provide access to skiers and snowboarders.

Table 3.1 – Recreation zoning designations at the VPWRA

Zoning Designation	Acres	Of Total VPWRA (%)
Closed to Motorized	23,512	47
Open to Motorized	22,290	45
Open to Motorized for Hybrid Access Only	3,307	7
Non-U.S. Forest Service Land	905	2
Total	50,014	

Backcountry hut users account for approximately 11,000 users annually (USDA Forest Service 2015). There are six backcountry huts located within the VPWRA, which are either

operated privately with special-use permits from the WRNF on public lands, or located on private inholdings (Figure 3.1). Hut users are predominately non-motorized recreationists, as motorized use is not permitted at most huts. The majority of recreationists access the huts from the main VPWRA portals, however, some visitors travel directly between huts, including from huts located outside the VPWRA. Additionally, some visitors to Janet's cabin in the southern extent of the VPWRA access the hut from Copper Mountain ski resort.

Data Collection

Two datasets were used in the analysis. First, a geospatial dataset was used to examine the overlapping use of non-motorized and motorized recreationists in the VPWRA. The GPS point dataset allows for a more reliable analysis of recreation patterns at higher spatial resolutions than traditional methods such as electronic trail counters or exit interviews with visitors, which do not provide an objective or complete picture of how recreationists move through a landscape (Cole and Daniel 2003; Hallo et al. 2005). Use of GPS units to study recreation is increasing (e.g. D'Antonio et al. 2010; Hallo et al. 2012; Lai et al. 2007; Rupf et al. 2011; Shoval and Isaacson 2006) as units become smaller and less expensive (Wing et al. 2005).

The second dataset comes from a survey that was administered to both non-motorized and motorized recreationists to analyze recreation conflict at the VPWRA. Data from the non-motorized group were the focus of this analysis since they reported higher levels of interpersonal conflict than the motorized group (motorized users also reported no social values conflict) in Miller and Vaske (2015).

Geospatial data

Data were collected from the VPWRA during the winter of 2010 and the winter of 2011. Recreationists were asked to carry a small GPS unit (Qstarz, model BT-Q1300), which stored a

GPS point every five seconds throughout their visit to the VPWRA. In addition to logging the geographic coordinates, the GPS unit also captured the speed, altitude, and turn-angle of each point but had no user-interface or real-time remote tracking. Researchers walked through the parking lot and asked a visitor from every fourth vehicle to carry the unit (response rate = 90%). One unit was carried per group. The number of people in the group, the mode of travel, the portal from which the unit was distributed, and the unit identification number were recorded. As an incentive for the visitor to carry the GPS unit, he/she could voluntarily provide an email address to which the GPS track was sent as a *Google Earth* file for viewing on a personal computer. Recreationists dropped the GPS units into a collection bin at the end of their visit to the VPWRA at which point the researchers collected the units, connected them to a computer and downloaded the data.

Data were categorized by the mode of travel for the individual or group carrying the unit, which included: (1) snowmobile, including ski bikes where a track is attached to a motorcycle, (2) hybrid, where a snowmobile or snowcat is used to access remote ski/snowboard terrain, (3) backcountry ski/snowboard, and (4) snowshoe/cross-country ski, generally travel routes through less-steep terrain. A data file was saved for each track, which contained all GPS points associated with the route taken by the recreationist. In some cases, GPS units were used for multiple days by recreationists staying at backcountry huts. In these cases, a separate track was saved for each day the unit was used.

Survey data

Survey data were collected in the winter of 2014. On-site surveys were distributed at the Vail Pass parking area to all recreationists after their recreation experience. Two versions of the survey were developed with the same questions, one for motorized recreationists and one for

non-motorized recreationists. The focus of this analysis was on the responses from non-motorized recreationists. Non-motorized activities include backcountry skiing and snowboarding, cross-country or nordic skiing, and snowshoeing. Hybrid users were categorized as motorized respondents and were not included in this analysis.

On-site surveys were distributed on weekend days. The majority of the VPWRA visitation occurs on weekends. An online version of the survey was also created to capture visitation to the backcountry huts located in the VPWRA. Some hut users do not access the VPWRA though the primary portals, entering instead from Copper Mountain or on a route from other backcountry huts outside of the VPWRA. The online version of the survey was necessary to reach these respondents. Hut users were provided the non-motorized version of the survey because motorized use is not allowed at huts where survey respondents were staying. Surveys from hut users were collected from weekdays in addition to weekends. Completed surveys were collected from a total of 199 non-motorized respondents (response rate = 88% for on-site), including 180 responses from hut users.

Variables Measured

Geospatial data

The geospatial variable of interest for this analysis was the spatial distribution of recreation use across the VPWRA. Specifically, this analysis focused on the extent to which non-motorized and motorized recreationists' terrain selection overlapped spatially.

Survey data

The conflict variables we analyzed were identical to previous recreation conflict analyses (i.e., Carothers et al. 2001; Miller and Vaske 2015; Vaske et al. 1995, 2007). Respondents reacted to each of five experience indicators. Respondents were asked how frequently they (1)

saw motorized user traveling out of control, (2) saw motorized user being rude and discourteous, (3) saw motorized user pass too closely, (4) saw motorized user not yielding the right of way, and (5) saw motorized user disturb wildlife. The response categories for the questions were "never," "1-2 times," "3-5 times," and "almost always." Based on previous research (Carothers et al. 2001; Miller and Vaske 2015; Vaske et al. 1995, 2007), the responses were recoded into "not observed" (i.e., respondent reported it never happened) or "observed" (i.e., respondent reported it happened at least once).

Respondents were then asked if he or she believed each of these questions was a problem. The responses were initially coded on a four-point scale: "not a problem," "slight problem," "moderate problem," and "extreme problem." As with the above questions, the responses were recoded into either "no problem" or "problem."

Consistent with previous research (Carothers et al. 2001; Miller and Vaske 2015; Vaske et al. 1995, 2007), combining the frequency of occurrence (observed, not observed) variables with the corresponding perceived problem (no problem, problem) variables for each respondent produced conflict typologies with the three possible attributes: (1) no conflict, (2) interpersonal conflict, and (3) social values conflict. Individuals who observed or did not observe a given event, yet did not perceive it to be a problem were considered to have experienced no conflict (i.e., no interpersonal or social values conflict). Those who never saw a given event, but believed that a problem existed for the event were considered to be expressing a conflict in social values. Conversely, those who witnessed a particular event and believed that it had caused a problem were judged to be indicating interpersonal conflict.

Data Analysis

Geospatial analysis

The geospatial data used in the analysis include 903 GPS tracks comprising 1,444,703 GPS points from 2010 and 2011 (Table 3.2; Figure 3.2).

Table 3.2 – Recreation GPS data collected by mode and year

Year	Mode	Tracks	Points
2010	Snowmobile	131	223,943
	Hybrid	127	316,761
	Ski/Board	73	171,270
	Snowshoe/XC-ski	16	41,686
	2010 Total	347	753,660
2011	Snowmobile	191	211,832
	Hybrid	169	233,035
	Ski/Board	176	221,669
	Snowshoe/XC-ski	20	24,507
	2011 Total	556	691,043
	Overall Total	903	1,444,703

The dataset was analyzed using ArcGIS 10.2. Points were categorized as non-motorized or motorized by the respondent's mode of travel. Ski/board and snowshoe/XC-ski were categorized as non-motorized. The hybrid points falling within 20m of an established route, along with snowmobile points were categorized as motorized.

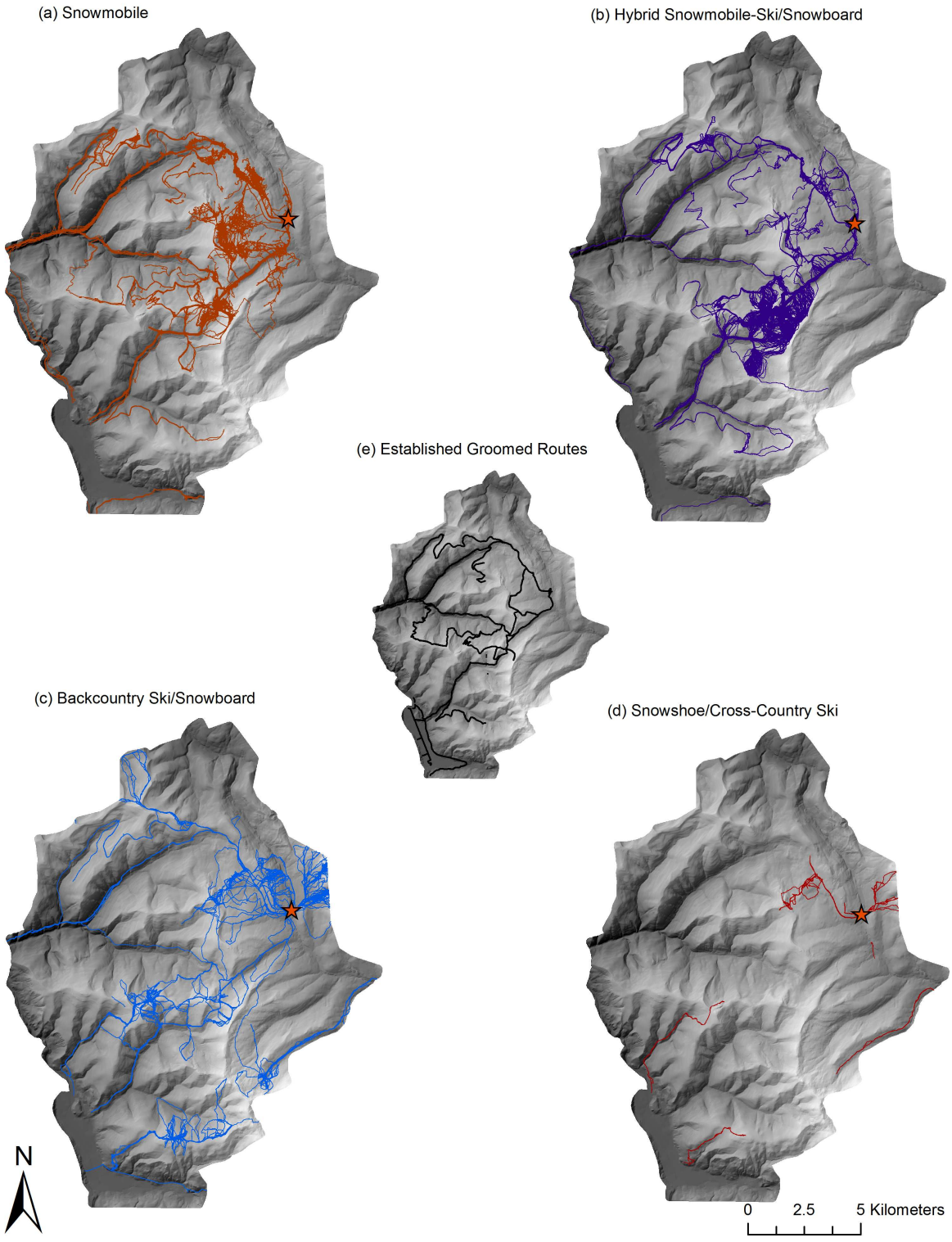

Figure 3.2 - Recreation GPS tracks by mode of travel, including (a) snowmobile, *n* = 322; (b) hybrid snowmobile and ski/snowboard, *n* = 296; (c) backcountry ski/snowboard, *n* = 249; and (d) snowshoe/cross-country ski, *n* = 36. The network of groomed routes is also depicted (e). The star represents the location of the primary portal adjacent to Interstate 70 at Vail Pass

The hybrid points greater than 20 m from an established route were not included in the analysis because they could not be accurately categorized as non-motorized or motorized. Once the GPS points were categorized, a raster analysis was performed converting the points into a new 10 m resolution output raster layer for non-motorized points and a second layer for motorized points that contained the number of points located within each 10 m^2 cell. Each raster layer was then reclassified into six categories based on the number of points contained within each cell.

Very low use (10 points or fewer), Low use (11-25 points), Moderate use (26-100 points), High use (101-250 points), Very high use (251-500 points), and Extreme use (greater than 500 points). Raster algebra was then used to identify the cells that contained both non-motorized and motorized recreation, at a resolution of $10m^2$. The final output raster contains all possible density combinations of overlapping non-motorized and motorized use (Table 3.3). Lastly, the final mixed-use layer was intersected with the original non-motorized and motorized GPS points to determine the proportion of recreation use occurring inside the mixed-use area, compared with the recreation occurring outside the area.

Survey analysis

Areas of mixed use were identified from the GIS analysis. Respondents were categorized as either having traveled in a mixed-use area or not, based on the locations they selected as one visited during their trip (locations identified in Figure 3.3 below). Locations were based on popular points of interest within the VPRWA. For example, if a respondent selected only Corral Creek/Uneva Peak as the location he/she traveled to during the trip, the survey was categorized as no mixed-use because motorized travel is not permitted along any possible travel route to reach this location.

Table 3.3 – Final mixed-use raster layer showing combinations of intensity of non-motorized and motorized recreation use

Level of Non-Motorized Use	Level of Motorized Use	Cell Count	Acres	Total of Mixed-Use Area (%)
Very Low	Very Low	6310	155.92	44.63
Very Low	Low	2505	61.90	17.72
Very Low	Moderate	3072	75.91	21.73
Very Low	High	735	18.16	5.20
Very Low	Very High	92	2.27	0.65
Very Low	Extreme	44	1.09	0.31
Low	Very Low	320	7.91	2.26
Low	Low	205	5.07	1.45
Low	Moderate	352	8.70	2.49
Low	High	218	5.39	1.54
Low	Very High	12	0.30	0.08
Low	Extreme	3	0.07	0.02
Moderate	Very Low	119	2.94	0.84
Moderate	Low	43	1.06	0.30
Moderate	Moderate	37	0.91	0.26
Moderate	High	34	0.84	0.24
Moderate	Very High	5	0.12	0.04
Moderate	Extreme	7	0.17	0.05
High	Very Low	7	0.17	0.05
High	Low	5	0.12	0.04
High	Moderate	3	0.07	0.02
High	High	2	0.05	0.01
High	Very High	3	0.07	0.02
High	Extreme	0	0	0
Very High	Very Low	1	0.02	0.01
Very High	Low	2	0.05	0.01
Very High	Moderate	1	0.02	0.01
Very High	High	0	0	0
Very High	Very High	0	0	0
Very High	Extreme	1	0.02	0.01
Extreme	Very Low	0	0	0
Extreme	Low	0	0	0
Extreme	Moderate	0	0	0
Extreme	High	0	0	0
Extreme	Very High	0	0	0
Extreme	Extreme	0	0	0

However, if the respondent selected a location that would require travel through a mixed-use area, the survey was categorized as mixed-use. Of the eight possible locations a respondent could have visited and checked on the survey, two (Uneva Peak/Corral Creek and Janet's Cabin/Stafford Creek) were locations with limited overlapping non-motorized and motorized use, which was in the vicinity of the parking area. The other six locations required travel through mixed-use areas.

A chi-square test was then performed on the data testing for differences in each of the five conflict variables between those respondents who traveled in mixed-use areas and those who did not.[1] Depending on the conflict variable measured, there were roughly four times more respondents who traveled in mixed-use areas compared with those who did not.

Results

Geospatial analysis

The GIS analysis provided an objective measure of where recreation occurs within the VPWRA and novel characteristics of recreation patterns. The distribution of recreation in the VPWRA varied by mode of travel (Figure 3.2). A total of 1,234,118 GPS points were used in the analysis. There were 210,585 points not included in the analysis because they were Hybrid recreation points greater than 20 m from an established route.

[1] Similar to Miller and Vaske (2015) and Vaske et al. (2007), a *k*-means cluster analysis was performed on the non-motorized dataset. Unlike in those analyses, however, no convergence was reached with a 2, 3, or 4 cluster solution and therefore, the cluster analysis was not included in this analysis. The relatively small sample-size of the non mixed-use respondents could be responsible for the lack of convergence.

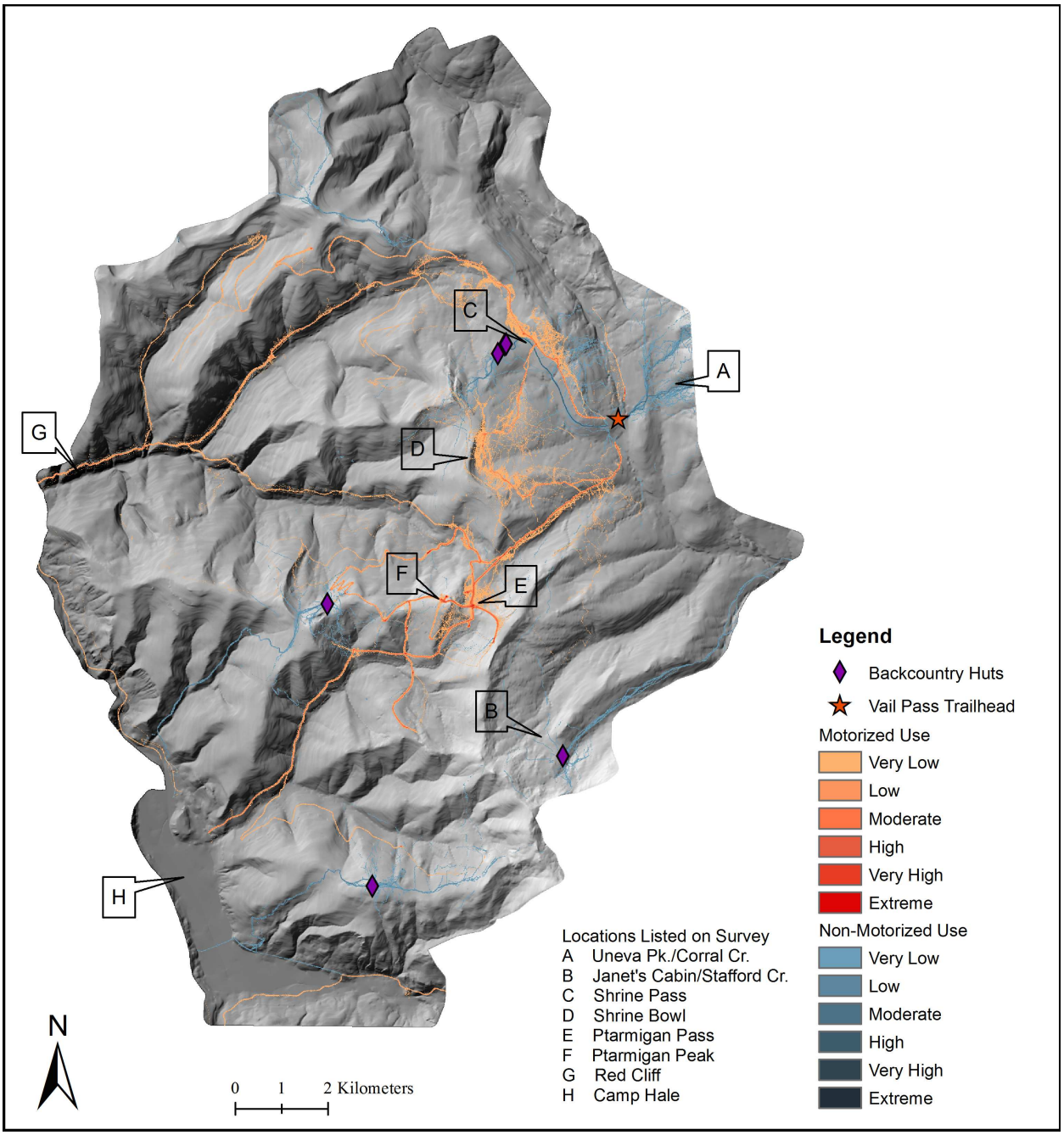

Figure 3.3 – Spatial distribution and density of GPS points collected from non-motorized and motorized recreation with the locations listed on survey given to recreationists

Non-motorized and motorized points analyzed (Table 3.4) revealed that the average motorized track was significantly longer (45.8 km for motorized compared with 9.1 km for non-motorized), and the mean speed was faster for motorized, compared with non-motorized recreationists (23.6

km/hr versus 3.4 km/hr, respectively). Non-motorized recreationists, however spent more time in the VPWRA with a mean of two hours and 14 minutes of time spent on recreation, compared with one hour 44 minutes for motorized recreation. The mean elevation of GPS points analyzed was similar for both groups (3,349 m for non-motorized points and 3,360 m for motorized points). Finally, non-motorized recreationists traveled in larger groups, on average, with a mean group size of 4.9 compared with 3.8 for motorized recreationists.

The geospatial analysis revealed differences in the extent of dispersion of recreation use. Non-motorized recreation was more dispersed than motorized recreation (mean of 287, median of 174 points per 10 m^2 cell with a dispersion index of 0.12, compared with a mean of 307, median of 213 points per cell with a dispersion index of 0.09 for motorized recreation) (Table 3.4). Dispersion was calculated between 0 and 1, where 0 is no dispersion with all points overlapping inside a single 10 m^2 cell and 1 is full dispersion with no more than one point per cell. Both groups showed little dispersion, which suggests that the much of the recreation occurred in a small land area. Figure 3.3 shows the spatial distribution of both non-motorized and motorized recreation in the VPWRA, as well as the density of use.

The areas of highest density—in other words, the areas with the greatest number of GPS points per cell—were located near or on established routes and points of interest. The network of established groomed routes (approximately 105 km) received predominately motorized use, but non-motorized recreation did occur. Backcountry skiers, snowboarders, cross-country skiers and snowshoers used established routes, which required less physical exertion compared with travel off established routes. The non-motorized routes were closed to motorized use. Figure 3.4 shows the distribution of overlapping non-motorized and motorized recreation with insets of two popular points of interest, Shrine Pass and Ptarmigan Pass.

Table 3.4 – Summary of GPS points used in analysis and results of raster analysis

	Non-Motorized	Motorized
GPS Summary Statistics		
Total Points	459,132	774,986
Total Tracks	285	618
Mean Points per Track	1,611	1,254
Mean Time per Track (h:min)	2:14	1:44
Total Track Length (km)	2,589	28,272
Mean Track Length (km)	9.1	45.8
Mean Speed (km/h)	3.4	23.6
Mean Altitude (m)	3,349	3,360
Mean Group Size	4.9	3.8
GPS Raster Analysis		
Cells with ≥ 1 GPS Point	54,659	68,021
Mean Points per Cell	287	307
Median Points per Cell	174	213
Dispersion Index[a]	0.12	0.09

[a] Calculated between 0 and 1, where 0 is no dispersion with all points overlapping inside a single $10m^2$ cell and 1 is full dispersion with no more than one point per cell.

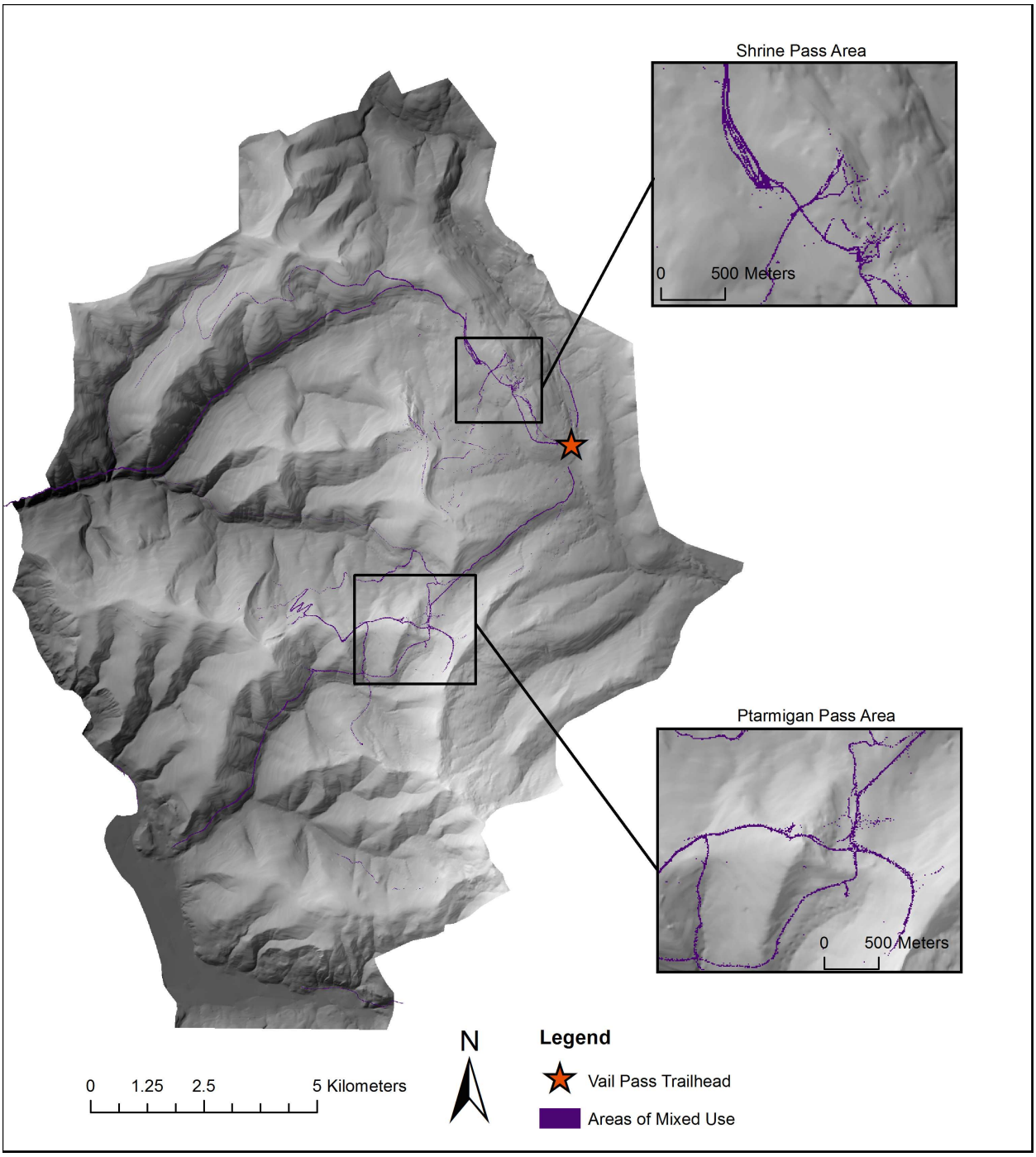

Figure 3.4 – Spatial distribution of mixed-use areas in the VPWRA at 10 m resolution. Cells containing both non-motorized and motorized GPS points amounted to 349.4 acres, or 0.7% of the total land area of the VPWRA and are most abundant around points of interest such as Shrine Pass and Ptarmigan Pass

Table 3.5 shows the size of the land area that recreation GPS points were collected from in the VPWRA with non-motorized, motorized and mixed-use recreation. The acreage was calculated by summing the number of 10 m^2 cells that contained at least one GPS point. Using this metric, non-motorized recreation occurred on only 2.7% of the entire 50,014 acres of the VPWRA. Motorized recreation occurred on 3.5% of the land area, and only 349.4 acres, or 0.7% of VPWRA contained both non-motorized and motorized recreation. Despite the small area of mixed-use recreation, these cells contained nearly 15% of non-motorized and 49% of motorized recreation (Table 3.5), supporting Hypothesis 1.

Table 3.5 – The area within the VPWRA with observed recreation use and the number of GPS points intersecting the area of mixed non-motorized and motorized use

	Acres	Points	Of Total (%)
Area of Observed Recreation [a]			
Non-Motorized Only	1350.7		2.7 [b]
Motorized Only	1761.5		3.5 [b]
Mixed Non-Motorized and Motorized Use	349.4		0.7 [b]
Points Intersecting Area of Mixed-Use			
Non-Motorized Points		67,984	14.8 [c]
Motorized Points		380,593	49.1 [c]

[a] Area calculated by summing all 10m^2 cells containing at least 1 GPS point
[b] The percent of land area of the total land area of the VPWRA (50,014 acres)
[c] The percent of total points that are located inside the mixed-use area

Survey analysis

The survey results highlighted differences in reported levels of interpersonal and social values conflict among non-motorized recreationists at the VPWRA (Table 3.6). Respondents who traveled in mixed-use areas reported higher interpersonal conflict for each conflict variable, compared with respondents who traveled in areas with no mixed-use, supporting Hypothesis 2.

Table 3.6 – Differences in recreation conflict in mixed-use areas among non-motorized respondents

Variable	Type of Conflict	Mixed-Use Area Visitors		χ^2 [a]	*p*	Cramer's *V*
		No (%)	Yes (%)			
Riding out of control		*n* = 32	*n* = 137	3.715	.156	.125
	No Conflict	41	49			
	Interpersonal	0	4			
	Social Values	59	46			
Being rude or discourteous		*n* = 31	*n* = 135	11.588	.003	.261
	No Conflict	42	51			
	Interpersonal	6	25			
	Social Values	52	24			
Passing too closely		*n* = 30	*n* = 138	9.166	.010	.231
	No Conflict	43	43			
	Interpersonal	13	36			
	Social Values	43	21			
Not yielding right of way		*n* = 31	*n* = 132	7.822	.020	.210
	No Conflict	48	51			
	Interpersonal	7	24			
	Social Values	45	25			
Disturbing wildlife		*n* = 34	*n* = 135	1.137	.566	.080
	No Conflict	35	36			
	Interpersonal	12	19			
	Social Values	53	45			

[a] Likelihood ratio

Respondents who traveled in mixed-use areas, however, reported lower social values conflict compared with respondents who traveled in areas with no mixed-use, not supporting Hypothesis 3.

For example, for the conflict variable "motorized recreationist being rude or discourteous" of the respondents who traveled in mixed-use areas 25% reported interpersonal conflict, compared with 6% for respondents who did not travel in mixed-use areas. Contrarily,

24% of mixed-use respondents reported social values conflict, compared with 52% of respondents who did not travel in mixed-use areas ($n = 166$, $\chi^2 = 11.59$, $p = .003$, Cramer's $V = .261$). Levels of interpersonal conflict were lower for respondents in areas with no mixed-use, however with four of the five conflict variables, some level of interpersonal conflict lingers (between 6% and 12% of respondents reporting it).

Discussion

The geospatial analysis revealed two important characteristics of winter recreation at the VPWRA. First, recreation use was not particularly dispersed with most use occurring on established travel routes. The consequence of low dispersion is that recreationists are more likely to encounter other recreationists during a typical recreation experience, increasing the opportunity for interpersonal conflict. Furthermore, despite separating non-motorized and motorized recreationists, there are areas where zones are small enough that non-motorized recreationists are likely to still hear and perhaps see motorized recreationists. For example, Figure 3.5 shows the area around Vail Pass, the primary portal adjacent to Interstate 70, where the density of use around established travel routes and the close proximity of parallel corridors are evident. Parallel corridors are designed to separate non-motorized and motorized use while still providing both access to points of interest, such as Shrine Pass (see Figure 3.3 for reference). However, if the corridors are too close together, they may not provide enough segregation to effectively limit interpersonal conflict. It is likely that parallel corridors were more effective at limiting interpersonal conflict than multiple-use routes with encounters likely between non-motorized and motorized recreationists.

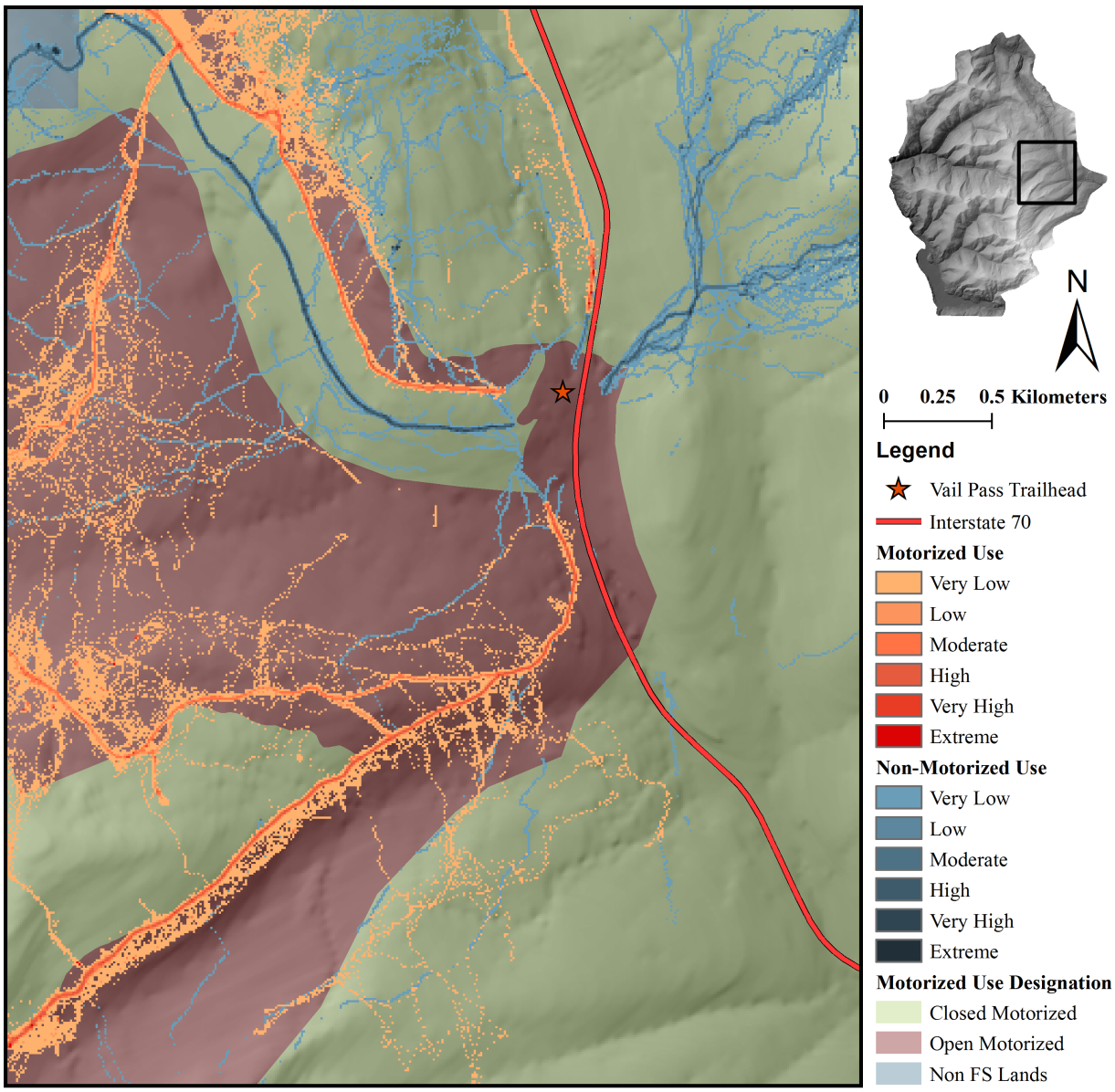

Figure 3.5 – Density of GPS points per cell ranging from very low to extreme for both non-motorized and motorized recreation near the Vail Pass portal, the primary access point to the VPWRA. Zoning designations are also depicted

Figure 3.6 depicts the locations of mixed-use around Vail Pass highlighting the frequent activity mixing along established travel corridors. Some non-motorized recreationists used established groomed motorized routes in Wilder Gulch to the south and Shrine Pass Road to the west of Vail Pass. The areas of mixed-use accounted for a large proportion of the total recreation

use, given that 99.3% of VPWRA had no mixed-use. This large proportion of recreation occurring in a small land area increases the possibility for encounters between non-motorized and motorized recreation and therefore increases the potential for interpersonal conflict.

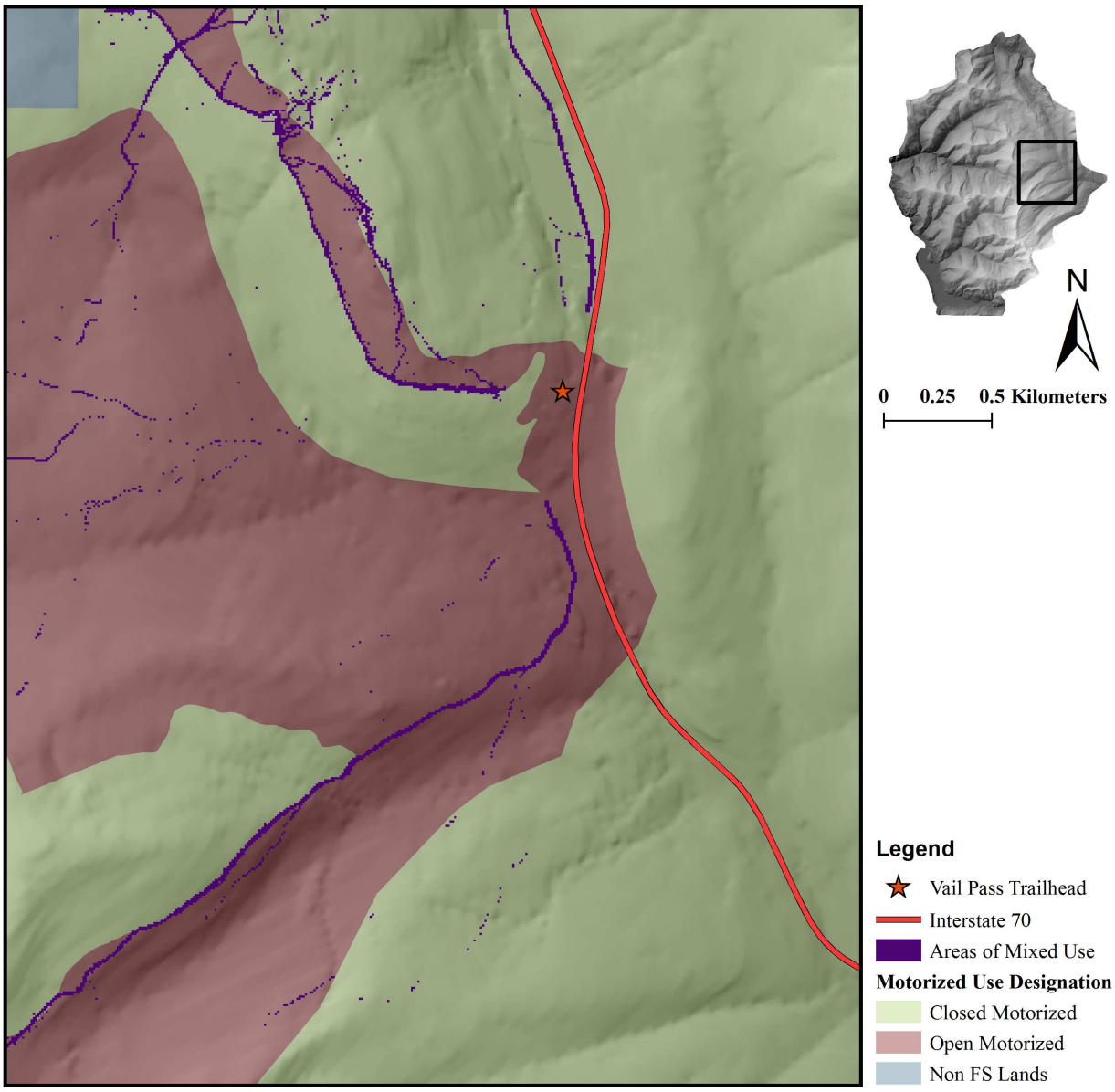

Figure 3.6 – Cells with both non-motorized and motorized recreation, most of which are located along established groomed travel routes and are less abundant as distance away from established routes increases

At the same time, the high density of use should encourage PPA managers to focus their active management efforts in mixed-use areas and along busy established groomed routes where recreation is most likely to occur and where messaging and public contacts are likely to reach the greatest number of visitors.

The survey analysis revealed lower interpersonal conflict among those non-motorized recreationists who traveled through terrain without mixed-use. However, a small amount lingers with these non-motorized respondents. One possible explanation is the effect of access portals, and specifically parking areas, which are mixed-use, small in geographic size, and have high numbers of recreationists at peak times. A backcountry skier's itinerary may be in an area closed to motorized use, but the time spent getting from a parking spot to entering the backcountry may be enough to see, hear and smell snowmobiles and may therefore create interpersonal conflict.

Survey respondents also reported higher levels social values conflict when traveling in areas of no mixed-use. One possible explanation for this could be that these recreationists chose to travel in area without motorized use precisely to avoid contact with motorized users. They may hold negative attitudes towards the use of snowmobiles and avoid being in mixed-use areas when feasible. Managers of PPAs should consider how they might be able to reach these recreationists who are generally traveling in areas of low (mixed and non-mixed) use and who may require messaging targeted to the negative attitudes towards motorized use.

Providing recreation opportunities to both non-motorized and motorized groups with less mixed-use is likely to further erode persistent interpersonal conflict among non-motorized recreationists. Two management suggestions are evident from the analysis. First, PPA managers should consider the feasibility of providing separate non-motorized and motorized access portals. At the Vail Pass portal, non-motorized and motorized users park in separate lots, however,

access to established routes and the backcountry at large, require travel in mixed-use areas. An established non-motorized route exists from the Vail Pass portal to the popular Shrine Pass. In 2014, rangers at the VPWRA allowed non-motorized use on the groomed motorized route to Shrine Pass, reversing previous management decisions. This analysis suggests separation of use in cases such as Shrine Pass will limit interpersonal conflict. If PPA managers could provide more direct access from parking areas to zoned terrain for both recreation groups, reducing the time a recreationist spends in a mixed-use area, the more likely zoning will be effective at limiting interpersonal conflict.

Second, PPA managers should consider how education campaigns could more effectively reach those non-motorized recreationists reporting social values conflict. Separation is not sufficient to address underlying attitudes and norms around snowmobile use in backcountry terrain. Targeted messaging around modern advances in snowmobile noise and pollution control may be one way to address the attitudes and norms. More research is needed on what kind of education and messaging is most effective at reaching these recreationists. Additionally, the collaborative process fostered by stakeholders and the USFS should be held as an example of a way zoning can provide equitable access to both non-motorized and motorized terrain. Without this model, the experiences of both groups would suffer significantly.

Conclusions

Managers of PPAs must decide how best to design and implement recreation zoning based on historical use patterns for the area, topographic features and considerations (such as access portals and parallel corridors), equitable access to favorable terrain for each group, and practical managerial considerations (e.g. maintenance of signs along zoning boundaries). This is no easy task. This analysis has shown that zoning does decrease interpersonal conflict among

non-motorized recreationists, however, despite zoning, recreationists at the VPWRA are likely to still share terrain, which enables persistent interpersonal conflict.

For other PPA managers facing recreation conflict, important consideration should be given to designing a zoning system that limits spatial overlap between non-motorized and motorized recreationists, including around access portals. The VPWRA zoning and active management model for a busy winter recreation area is effective at reducing interpersonal conflict, however, zoning adjustments are needed to extinguish conflict. The model is less effective at limiting social values conflict among non-motorized recreationists. Active management should be adjusted to target the attitudes and norms of non-motorized recreationists, especially those traveling in low-use areas with no motorized use.

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CHAPTER 4 – CONCLUSION

The underlying drivers of winter recreation conflict are complicated. However, the two manuscripts presented in this thesis helped to answer important fundamental questions about both the nature of winter recreation conflict and what steps can be taken to reduce it. The first manuscript showed that despite more than 10 years of a zoned recreation system in place in the Vail Pass Winter Recreation Area, conflict persisted. Specifically, while interpersonal conflict decreased between 2003 and 2014 among both non-motorized and motorized recreationists, more than a quarter of non-motorized recreationists still reported interpersonal conflict. And at the same time, social values conflict actually increased over the time period among non-motorized recreationists. This suggests that the zoning system may be working in some ways, but is failing in others. It also suggests that the active management approach taken in conjunction with zoning is not be working to limit social values conflict.

The second manuscript dug deeper into the effectiveness of zoning to reduce interpersonal conflict among non-motorized recreationists by analyzing how recreationists use terrain in the VPWRA and how terrain selection may be responsible, in part, for the persistent reports of interpersonal conflict. A GIS analysis revealed that despite a recreation zoning system, there was a disproportionate amount of recreation use occurring in a small area of overlapping non-motorized and motorized use. Of the 50,014 acres comprising the VPWRA, only 0.7% contained both non-motorized and motorized recreation during the sampling years. Within this small land area, 14.8% of non-motorized recreation use occurred and 49.1% of motorized recreation use occurred. The recreation use, in other words, was not especially dispersed but was rather densely focused around established groomed routes and points of interest. The implication

of recreation use at the VPWRA, then, is that non-motorized and motorized recreationists have a good probability to encounter one another despite zoned use.

The second manuscript also showed that non-motorized recreationists who travel in the areas of mixed use are reporting higher levels of interpersonal conflict, compared with those traveling in areas with no mixed use. This suggests that the areas of mixed use may be responsible for some of the persistent interpersonal conflict reported by non-motorized recreationists. At the same time, those non-motorized recreationists who traveled in areas of no mixed use reported higher levels of social values conflict. This may be a self-selecting group of skiers and snowshoers who chose to travel in areas of no mixed use specifically to avoid motorized recreationists, or it could suggest that the individuals traveling in mixed use areas may find the motorized recreationists less aggravating than their pre-trip expectations and therefore reported lower social values conflict, compared with those traveling in areas of no mixed use.

Themes

Three themes emerge from the analyses performed in this thesis. First, results further support asymmetrical reporting of conflict by non-motorized and motorized recreationists. Motorized recreationists reported lower levels of interpersonal compared with non-motorized recreationists. At the same time, social values conflict was nonexistent with motorized recreationists, but was commonly reported by non-motorized recreationists. This asymmetry suggests what while skiers may be very bothered by the presence of snowmobilers, snowmobilers do not mind the presence of skiers. These analyses further support this established finding.

Second, the spatial distribution of winter recreation is highly focused around established groomed routes and points of interest. “Dispersed recreation,” as backcountry skiing and

snowmobiling is categorized by PPA managers, is in this case not exceptionally dispersed. Rather, the presence of groomed routes accounts for a significant portion of total recreation use. As will be discussed below, this presents management opportunities and challenges. While some may perceive recreation use occurring across the entire VPWRA landscape, it is in fact occurring on a very small portion of the landscape (non-motorized use occurred on 2.7% of the total recreation area and motorized use occurred on 3.5%). This "footprint" of recreation use at the VPWRA does not account for evidence of the presence of recreation from, for example, sound from snowmobiles and compacted snow left by ski or snowmobile tracks, but it does suggest that recreation use is perhaps not as dispersed as is commonly believed. Terrain features may dictate the accessibility and desirability of whole areas to recreationists. Large swathes of terrain, in other words may be inaccessible or have poor snow quality, which keeps use in these areas very low. It is also possible that the extent and placement of groomed routes may directly dictate the level of dispersion. Groomed routes offer less strenuous and more efficient routes into backcountry huts and more desirable backcountry terrain.

The third theme, despite decreasing interpersonal conflict, is the increase in social values conflict among non-motorized recreationists. From the results of these analyses, it would appear that the active management approach taken by the managers of the VPWRA has been unsuccessful. The last 10 years have seen a dramatic rise in popularity for hybrid motorized and non-motorized recreation at the VPWRA. These skiers and snowboarders appear unbothered by motorized recreation, however, traditional non-motorized recreationists have at the same time reported increased social values conflict based on the norms and values that motorized use should not be allowed in the VPWRA. The increase in reported social values conflict also comes after implementation of sound limits for snowmobiles by the State of Colorado (a common

reason cited for the dislike of snowmobiles by skiers). Education efforts, such as signage and skier interactions with backcountry rangers, targeted at anti-snowmobile norms and values held by some skiers have not worked.

Management recommendations

The results from the two manuscripts have generated four simple management recommendations for popular backcountry winter recreation areas. The first two are specific to the VPWRA, and the last two are more broadly applicable for PPA managers. First, zoning is only useful if use is effectively zoned. Shared groomed routes, especially close to busy areas like access portals or points of interest, provide ample opportunity for direct interaction between non-motorized and motorized recreationists and will be a potential source of continued interpersonal conflict. Depending on terrain limitations, PPA mangers should create parallel corridors rather than shared routes between, for example an access portal and a point of interest. In the VPWRA, parallel corridors were in use between the Vail Pass trailhead and Shrine Pass, but in the winter of 2013/2014 non-motorized use was permitted on the groomed Shrine Pass Road. The close proximity to Vail Pass and the fact that it is one of two groomed routes motorized users can take to access areas further west in the VPWRA means that Shrine Pass Road is very busy. A busy route only increases the probability of non-motorized recreationists reporting interpersonal conflict. Moving non-motorized recreation back to a parallel corridor would help reduce interaction and thus interpersonal conflict.

Similarly, establishing an additional non-motorized route from Vail Pass towards Ptarmigan Pass to the west would decrease interactions in the Wilder Gulch corridor (See Figures 3.5 and 3.6 in Chapter 3 for an overview of the area). The establishment of a non-motorized route would incentivize non-motorized recreationists to avoid the groomed road and

with regular use it would be an efficient route for those recreationists heading to both Ptarmigan Pass further west as well as Janet's Cabin to the south. While parallel corridors do not preclude interpersonal conflict among non-motorized recreationists because sound and visible impacts may still be present, they do provide a low-cost tool for reducing interpersonal conflict.

The second recommendation is to establish and emphasize an education campaign focused on the negative norms and values held by non-motorized recreationists about the use of snowmobiles at the VPWRA. On weekend days, rangers greet all recreationists at the Vail Pass trailhead to collect fees and to provide a map of the VPWRA. This would be a great opportunity to also provide an information pamphlet to recreationists. This simple pamphlet should include information on the history of the VPWRA and efforts to provide high quality recreation opportunities to both groups. It could include information such as how the area has equal access for both groups, the identification of area where no interaction with snowmobiles will occur (east of Vail Pass), and suggestions for routes that can be taken that will decrease the interactions likely to occur. It should also provide information on management steps that have been taken to limit noise pollution. If non-motorized recreationists have a positive experience, where their expectations of the kind of experience they are looking for have been met, then over time their norms and values will become more favorable towards motorized recreation.

The third management recommendation for PPA managers more broadly is to carefully consider the location and size of access portals to popular recreation areas. If possible, separating access portals into non-motorized and motorized will limit interactions at the beginning of trips. First impressions are important. If a skier parks and is immediately exposed to the sound, sight and smell of snowmobiles, it is likely the first impression will influence any subsequent encounters with motorized recreationists over the course of their trip. If parking areas can be

separated with established routes accessing the backcountry from each portal, recreationists will not face immediate interaction with the other group and the possibility of a negative experience, decreasing the likelihood of interpersonal and social values conflict. For those areas where overlapping use is unavoidable, signage should clearly and concisely communicate that it is an area of mixed use and encounters between non-motorized and motorized recreationists are likely. Asking skiers to stay to the right on a groomed road, and snowmobiles to proceed slowly and look for skiers, will help ease the potential for encounters to lead to conflict.

Finally, the last management recommendation of PPA managers is to avoid implementing a zoned recreation management plan without an active management approach. Passive management in this case is the establishment of boundaries and regulations without dedicated education and enforcement. Active management requires rangers on the ground to make public contacts. Zoning is a strong statement to the public; equal access to high-quality terrain demonstrates communication between non-motorized and motorized interests, and when done successfully, demonstrates that it is possible for both groups to attain the experience they seek without conflict. However, if zoning boundaries are not enforced and the reasons behind zoning are not conveyed to recreationists, the legitimacy of efforts will be questioned and the utility of zoning more broadly will erode. Managers of PPAs should carefully consider the budgetary and logistical requirements of a robust active management approach before implementing a zoning system. Day-use fees may not be popular among visitors to PPAs, but avoiding fees should not be a reason for implementing zoning without an active management plan.

Future research needs

More research is needed in two areas to get a more complete picture of winter recreation conflict. First, researchers should investigate what education efforts are most successful at

targeting the norms and values of non-motorized recreationists who report social values conflict. Are there certain values or norms that are more likely to change with a strong education campaign? Are there other ones unlikely to change? Also, how can lessons learned from other fields help address the norms and values important in the case of social values conflict?

Second, more research is needed on the ways terrain characteristics can naturally segregate non-motorized and motorized recreationists. A geospatial analysis performed when zoning boundaries are being considered could help illuminate the location of natural pinch points where interactions are most likely to occur. It could also show opportunities for parallel corridors or separate corridors for established routes. More research is needed on the characteristics of desirable terrain for both groups, which, once identified, could be used in a geospatial terrain analysis. Data on the specific locations where recreationist report negative encounters could also be used to help shape the zoning boundaries of popular winter recreation areas. And, finally, this research could be extended beyond the winter backcountry settings to summer backcountry settings or to other recreation groups, such as mountain bikers, off-highway vehicle riders and others.

Final thoughts

This thesis is the culmination of interest in improving winter recreation management. The existence of recreation conflict is not new, but we have tools to reduce it that were not available in the past, namely better data on the spatial distribution of recreation use, established conflict variables that can be tested to measure success, and relevant examples of successful and failed efforts in reducing recreation conflict in PPAs. The thesis helps pull all these tools together to paint a more complete picture of what works and what does not work. Major gains have been

made at reducing recreation conflict over the past 25 years. More work is needed, and steps can be taken immediately.