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Knowledge, Norms and Preferences for Tamarisk Management in the Green and Colorado River Corridors of the Colorado Plateau

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KNOWLEDGE, NORMS AND PREFERENCES FOR TAMARISK MANAGEMENT

IN THE GREEN AND COLORADO RIVER CORRIDORS OF THE

COLORADO PLATEAU

by

E. Clay Allred

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Recreation Resource Management

Approved:

Dr. Robyn L. Ceurvorst Major Professor	Dr. Mark W. Brunson Committee Member
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UTAH STATE UNIVERSITY
Logan, Utah

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ABSTRACT

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by

E. Clay Allred, Master of Science

Utah State University, 2012

Major Professor: Dr. Robyn Ceurvorst
Department: Environment and Society

Extensive research exists regarding invasive alien plant species including impacts to native ecosystems and efficacy of control methods on public lands and river corridors. Many studies have identified the need for more research regarding the social implications of invasive alien species management. More specifically, additional research is needed regarding the impacts of invasive alien plant management on the Colorado Plateau to river-based recreation experiences. It is important for public land management agencies like the National Park Service to understand recreation-based stakeholders' knowledge, norms, and preferences toward managing prevalent alien plants like tamarisk.

For this study, 330 river users were questioned about their knowledge of tamarisk and preferences for tamarisk management on the Green and Colorado River corridors of the Colorado Plateau. Results show that a majority of river users want tamarisk to be removed. The tamarisk control methods investigated in this thesis were also evaluated by respondents as acceptable. The methods evaluated to be the most acceptable were the cut-stump method and the use of tamarisk leaf beetle, while prescribed fire and the use of a machine to mulch tamarisk were found to be less acceptable. The use of chainsaws to perform the cut-stump method was found to be acceptable in both the Green and Colorado River corridors. This thesis concludes with a summary of findings and implications for land managers and future research.

(90 pages)

PUBLIC ABSTRACT

Knowledge, Norms and Preferences for Tamarisk Management in the Green and Colorado River Corridors of the Colorado Plateau

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This research was created collaboratively between the National Park Service and Utah State University as an explorative study addressing social implications of tamarisk management. It has created a stronger partnership between the university and the National Park Service in Moab, Utah. Through this research, Utah State University was able to find valuable social science data to aid public land managers in the planning and management of tamarisk control on the Colorado Plateau. Utah State funded a research assistant for one year to perform this research, totaling approximately $16,000.

This study focused on finding river user knowledge, preferences, and norms for tamarisk control methods on the Colorado Plateau, including chainsaw noise in backcountry and proposed wilderness areas. The findings and implications of this thesis are valuable to the academic community and public land managers. Utah State University Moab, in partnership with the National Park Service, has supported travel to multiple locations to present this research. It has been presented, and received well, at the 2011 National Association of Recreation Resource Planners Conference, 2012 Conference of Research on the Colorado Plateau, and the 2012 Tamarisk Symposium. Researchers plan to publish this thesis at Utah State University and both chapters two and three in separate journals.

ACKNOWLEDGMENTS

With humility and deep gratitude, I would like to thank my committee. I am very grateful to Dr. Robyn Ceurvorst. Dr. Ceurvorst, my major professor, accepted me as a transfer student so that we would be able to perform this research. She was insightful, encouraging, and helpful from the time we discussed thesis ideas to the time a final draft was complete. She and the Utah State University Moab Education Center went out of their way to give me the tools I needed to succeed in the writing process, as well as funding to travel for conferences. Dr. Ceurvorst also obtained funding for me as a research assistant, which supported my family during this process. I thank Dr. Ceurvorst for allowing me to become a M.S. student and her research assistant.

Dr. Mark Brunson, the head of the Department of Environment and Society, has also been gracious in accepting me as a student and encouraging me throughout the writing process. Dr. Brunson's background allowed him to give key insights into normative theory and the importance of human dimensions in natural resource management. These insights helped shape the goal of our research and develop the purpose of this thesis.

Dr. Mark E. Miller, chief of resource stewardship and science for the National Park Service in Moab, Utah, was willing become a committee member, in addition to his demanding professional duties. I am very grateful that Dr. Miller was willing to give his time and talents to help me perform this research and write this thesis. As an ecologist, Dr. Miller gave valuable insight into riverine ecology and invasive alien plant management. In addition to giving his scientific expertise, Dr. Miller was able to help outline research questions that would be most useful to public land managers.

Finally, I would like to thank my family for their constant support throughout this process, especially my wife, Leslie. The research and writing process have demanded much of my time for several months. I am very grateful that my family has not only been willing to sacrifice time they might have spent with me, but have also been supportive of my studentship, lifting my spirit when I struggled. Thank you all very much.

E. Clay Allred

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CHAPTER 1

INTRODUCTION

Invasive alien plant species are a serious and continuing threat to environments worldwide. One prevalent invasive plant genus found in riparian areas throughout the Colorado Plateau is tamarisk, or salt cedar (*Tamarix* spp.). Introduced to the United States in the 1800s as an ornamental, today tamarisk has the second highest normalized cover and is the third most prevalent woody riparian plant in the western United States (Friedman et al., 2005; Stromberg, Chew, Nagler, & Glenn, 2009). With life-history traits that allow it to endure higher soil salinity, heat, and excessive drought, tamarisk has the ability to outcompete native cottonwoods and willows (Di Tomaso, 1998).

Federal land management agencies, such as the National Park Service (NPS), are mandated in Executive Order (EO) 13112 to control invasive alien species to the best of their ability (Williams, 2005). Due to its prevalence in the western United States, tamarisk is of particular concern to federal agencies. The NPS Organic Act states that protected resources will be preserved or restored, to the best of its ability, for the enjoyment of present and future generations (USDOI, 2006). For NPS managers, such as those in Canyonlands National Park, this implies preserving and restoring environments with concern for visitor experience both today and in the future.

The majority of research regarding tamarisk addresses changes in ecosystems, effective control methods, and native plant restoration. Little research, however, has examined the social implications of tamarisk management. This thesis addresses the need for further understanding of the social implications involved with tamarisk control by finding river user knowledge, norms, and preferences for tamarisk and tamarisk control methods. Due to the remote backcountry and proposed wilderness areas included in this research, special attention was given to the alteration of the natural soundscape. With a foundation of ecological research and the addition of social implications, public land managers may make more informed decisions regarding the implementation of tamarisk control methods.

Purpose and Organization

The primary objective of this thesis is to find river user knowledge, norms, and preferences for tamarisk control methods to provide federal land managers with a better understanding of the social implications of these actions. This thesis contains two separate standalone articles that address this objective using data from 330 onsite surveys of river users on the Colorado Plateau.

The first article in this thesis (chapter two) is exploratory in nature and describes river users' knowledge of tamarisk, desire for removal, and norms for tamarisk control methods. This article addresses three questions. First, what is river users' self-assessed overall knowledge of tamarisk? Second, do river users want tamarisk to be removed? Third, what are river user norms for tamarisk control methods?

The second article in this thesis (chapter three) builds upon the first article by investigating river user norms for the noise of a chainsaw being used to remove tamarisk. This article asks three questions. First, of river users who would like tamarisk removed, would they prefer it removed by chainsaws or handsaws? Second, what are river user norms for chainsaw use in different riverine areas? Third, is there a difference in river user norms for chainsaw noise on the Green and Colorado rivers? This article is followed by a brief integrative summary and discussion of implications of the two main articles presented in this thesis (chapter 4).

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CHAPTER 2

RIVER USER KNOWLEDGE, NORMS AND PREFERENCES FOR TAMARISK CONTROL METHODS ON THE COLORADO PLATEAU

Introduction

Research has heavily examined the impacts of invasive alien plant species on public lands and waterways (D'Antonio & Meyerson, 2002). Much of this research has dealt with the change in ecosystems, effective control methods, and native plant restoration. However, more research is needed regarding the social implications of invasive alien plant management. Additional research regarding topics like park visitors' preference for invasive alien plant management will reduce the potential for conflict among managers and visitors, while increasing the likelihood of achieving socially acceptable outcomes. This paper will address the need for more research regarding the social implications of invasive alien plant management by finding river user knowledge, norms and preferences for tamarisk and tamarisk management.

Tamarisk or salt cedar (*Tamarix* spp.) is a prevalent invasive alien plant genus on the waterways of the Colorado Plateau. To survive dry desert climates, tamarisk grows close to water sources, including thick groves along the Colorado and Green River corridors. The impacts of tamarisk on river users' experiences may include alteration of viewscapes, aesthetic quality, and opportunities for viewing wildlife (Belote, Makarick, Kearsley, & Lauver, 2010). Tamarisk may also limit safe access to shore and highly valued wilderness recreation areas. The environmental and social impacts of tamarisk may be critical to public land management agencies like national parks and other protected areas. One example can be found in the National Park Service (NPS) Organic Act, which mandates managers to preserve or restore natural resources, to the best of its ability, for the enjoyment of present and future generations (USDOI, 2006).

In addition to environmental concerns, research has identified the need for more understanding of the social implications of tamarisk management in order to preserve the quality of visitor experience (Hultine et al., 2010). The environmental and social impacts of tamarisk present land managers with an opportunity for exotic plant control and riparian restoration. Executive Order (EO) 13112 mandates federal agencies, where practical and permitted by law, to take actions including: preventing the introduction of invasive species, detecting and responding rapidly to and controlling populations of such species in a cost-effective and environmentally sound manner, and providing for restoration of native species and habitat conditions in ecosystems that have been invaded (Williams, 2005).

Some methods used to control tamarisk have included manual removal (pulling trees and cut-stump methods), mechanical (mulching trees), chemical control (foliar herbicide application), biological control (the release of the tamarisk leaf beetle, *Diorhabda elongate*), and prescribed fire (Belote, Makarick, Kearsley, & Lauver, 2010; Harms & Hiebert, 2006). While there are diverse methods used to control tamarisk, management decisions may be based upon variables including the type of site and visitor expectations for experiences at that site. Research has addressed perceptions of tamarisk management regarding aesthetic quality, however more research is needed regarding the social dimensions and implications of tamarisk and other exotic plant management on public lands (Hultine et al., 2010). This paper addresses river user knowledge of tamarisk, acceptability of tamarisk control methods, desire for tamarisk removal, and preferences for additional education and interpretation regarding tamarisk management.

Conceptual Background

Invasive Alien Species and Tamarisk Control Methods

The introduction and spread of invasive alien species (IAS) is one of the major threats to environments worldwide because of their ability to alter habitat structure and reduce native species diversity (Belote et al., 2010; Daab & Flint, 2010). Riparian ecosystems are vulnerable to IAS because they provide many opportunities for new species to become established through natural and anthropogenic disturbances (Brown & Peet, 2003; Tabacchi, Planty-Tabacchi, Roques, & Nadal, 2005). Anthropogenic impacts to rivers can include altered flow regimes, historical land use, and the purposeful introduction of IAS. Anthropogenic impacts can alter ecosystems competitive hierarchies and favor species with different life-history traits (Tickner, Angold, Gurnell, & Owen, 2001).

One plant genus on the Colorado Plateau that may have benefited from the alteration of riverine environments is tamarisk or salt cedar (*Tamarix* spp.). Tamarisk was first introduced in the United States as an ornamental plant in the 1800s. Shortly thereafter, tamarisk was introduced on western rivers to provide ecosystem services such as erosion control (Stromberg, Chew, Nagler, & Glenn, 2009). Today tamarisk has the second highest normalized cover and is the third most prevalent woody riparian plant in the western United States (Friedman et al., 2005). With life-history traits that allow it to endure higher soil salinity, heat, and excessive drought, tamarisk has the ability to outcompete native cottonwoods and willows (Di Tomaso, 1998).

Efforts to control tamarisk include using methods such as: manual removal (pulling trees and cut-stump methods), mechanical (mulching trees), chemical control (foliar herbicide application), biological control (the release of the tamarisk leaf beetle (*Diorhabda elongate*)), and prescribed fire (Belote et al., 2010; Harms & Hiebert, 2006). The tamarisk control methods addressed in this study are mechanical removal, the cut-stump method, prescribed fire, and the release of the tamarisk leaf beetle. Foliar application of herbicide to tamarisk stands is a potentially effective method but was not used in the study area. This paper focused on finding the norms (e.g., acceptability) of tamarisk control methods used in the study area.

Normative Research

When addressing human dimensions of natural resource management research, norms provide descriptive and evaluative information necessary for managers to identify goals and set standards (Manning, Lime, Freimund, & Pitt, 1996; Shelby, Vaske, & Donnelly, 1996). Past recreation research has defined norms as standards that individuals use for evaluating actions, or conditions caused by actions, as good or bad, better or worse (Shelby et al., 1996; Whittaker & Shelby, 2002). Norms are held by individuals as personal norms, and the aggregate of personal norms are social norms. Norms help land managers by describing acceptable conditions or actions (Shelby et al., 1996). By describing acceptable conditions for indicators with norms, managers may better understand where to set standards (Manning, 2011).

The river user norms addressed in this research may be of most importance to the NPS because of their duty to protect visitor experience. The study area for this research, much of it in Canyonlands National Park, included stretches of remote backcountry and proposed wilderness. In these areas management decisions are based upon more than solely which control methods are most effective. As proposed wilderness, special consideration must be given to the tranquility, solitude and natural condition that river users may desire when visiting these areas. Normative research aids management decisions when coupled with ecological research. This data completes a three dimensional view of public land management (Figure 2.1).

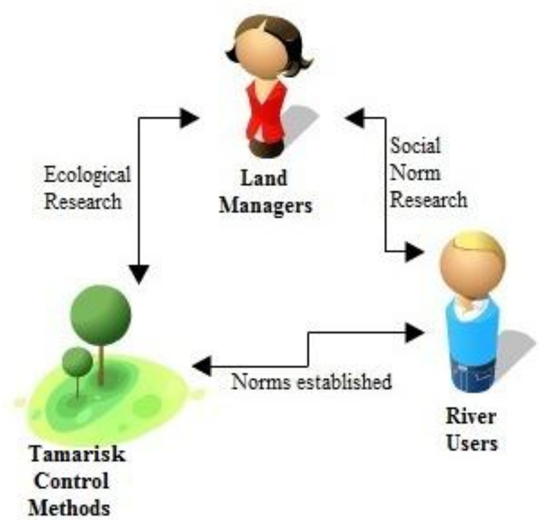

Figure 2.1 Flow model for tamarisk control methods (adapted from Manning, 2011).

Management Frameworks

Normative research may help managers set standards that are used in management-by-objective/indicator-based planning and management frameworks. These frameworks may include ecological, social, and managerial dimensions into decision-making about management strategies. Management frameworks commonly implemented for this purpose include Limits of Acceptable Change (LAC) (Stankey, 1988), Visitor Impact Management (VIM) (Kuss, Graefe, & Vaske, 1990), Visitor Experience and Resource Protection (VERP) (Manning, 2001), and the Recreation Opportunity Spectrum (ROS) (Manning, 2011). Little research exists regarding norms for tamarisk management that may be used in indicator-based planning and management frameworks. This research will address the norms and preferences of river users to aid in public land planning and management.

Potential for Conflict Index$_2$

The potential for conflict among river users for different tamarisk control methods can be found by using the Potential for Conflict Index (PCI) (Manfredo, Vaske, & Teel, 2003). Now in its second generation, PCI_2 requires no statistical training to interpret results and aids in the comprehension of normative data among nontechnical audiences (Vaske, Beaman, Barreto, & Shelby, 2010). PCI_2 results can be displayed graphically using bubbles that indicate the form, dispersion and central tendency of a variable (Vaske et al., 2010). In a PCI_2 graph, the size of a bubble indicates the potential for conflict, while the position of a bubble shows the mean evaluated acceptability.

The potential for conflict among respondents is given a value from 0 “minimum potential conflict” to 1 “maximum potential conflict.” If responses are equally divided in two, with either half on extreme of a scale for an evaluative question, the result would be

PCI = 1 “maximum potential for conflict.” The minimum potential for conflict (PCI = 0) is achieved when all responses for a question are at one point on an evaluation scale.

Research Questions

When public land managers address social implications in natural resource management, such as norms for tamarisk control methods, they may set appropriate standards, using management frameworks, and manage in socially acceptable ways. This research addressed the knowledge, preferences, and norms for tamarisk and tamarisk control methods on the Colorado Plateau to facilitate managers use of indicator-based planning and management frameworks. Three questions guided this research: (1) What are river users’ self-assessed knowledge levels of tamarisk? (2) Do river users want tamarisk to be removed? (3) How acceptable are different tamarisk control methods?

Methods

Data Collection

The river user population for this study average approximately 2,000 annually, and this study collected 330 completed questionnaires to fall within a 95% confidence level (Salant & Dillman, 1994). This sample size assumes a 50/50 split among respondents, half may support management actions and half may be in opposition to management actions. With this conservative value, researchers were able to generalize to the population of river users at a 95% confidence level with a 5% margin of error (Salant & Dillman, 1994).

This research focused on river users within approximately 159.33 river kilometers in Canyonlands National Park and surrounding areas, including stretches on the Green and Colorado Rivers. The Green River kilometers begin at Mineral Bottom Boat Ramp (point A in Figure 2.2) (38°31’31.14”N, 109°39’32.35”W) and end at Spanish Bottom (point B) on the Colorado River (38°09’24.37”N, 109°55’59.27”W), totaling 83.69 river kilometers. The Colorado River kilometers begin at the Intrepid Potash Boat Ramp (point C) (38°30’20.97”N, 109°39’32.35”W) and end at Spanish Bottom, accruing 80.47 river kilometers.

As shown in Figure 2.2, both river stretches began outside of Canyonlands National Park, the Green River in Bureau of Land Management (BLM) land and the Colorado River on both private and BLM lands. Both stretches conclude at Spanish Bottom, which is also the end of the flat-water in Canyonlands National Park and immediately before the first rapid of Cataract Canyon. The most common trip participated in by respondents was a canoe trip starting at Mineral Bottom, arriving at Spanish Bottom a few days later. From Spanish Bottom river users take a jet boat ride up the Colorado River to the Intrepid Potash boat ramp, which made data collection feasible at the end of visitors’ trips. Respondents completed questionnaires at either Intrepid Potash Boat Ramp or on a bus ride from the boat ramp to Moab, Utah.

Data Analysis

River users’ overall self-assessed knowledge of tamarisk was found with a single item measurement of their knowledge level on a scale ranging from 0 “no knowledge” to 3 “expert knowledge.” User norms for the acceptability of tamarisk control methods, in campsites and in-between campsites, were found through their evaluative responses.

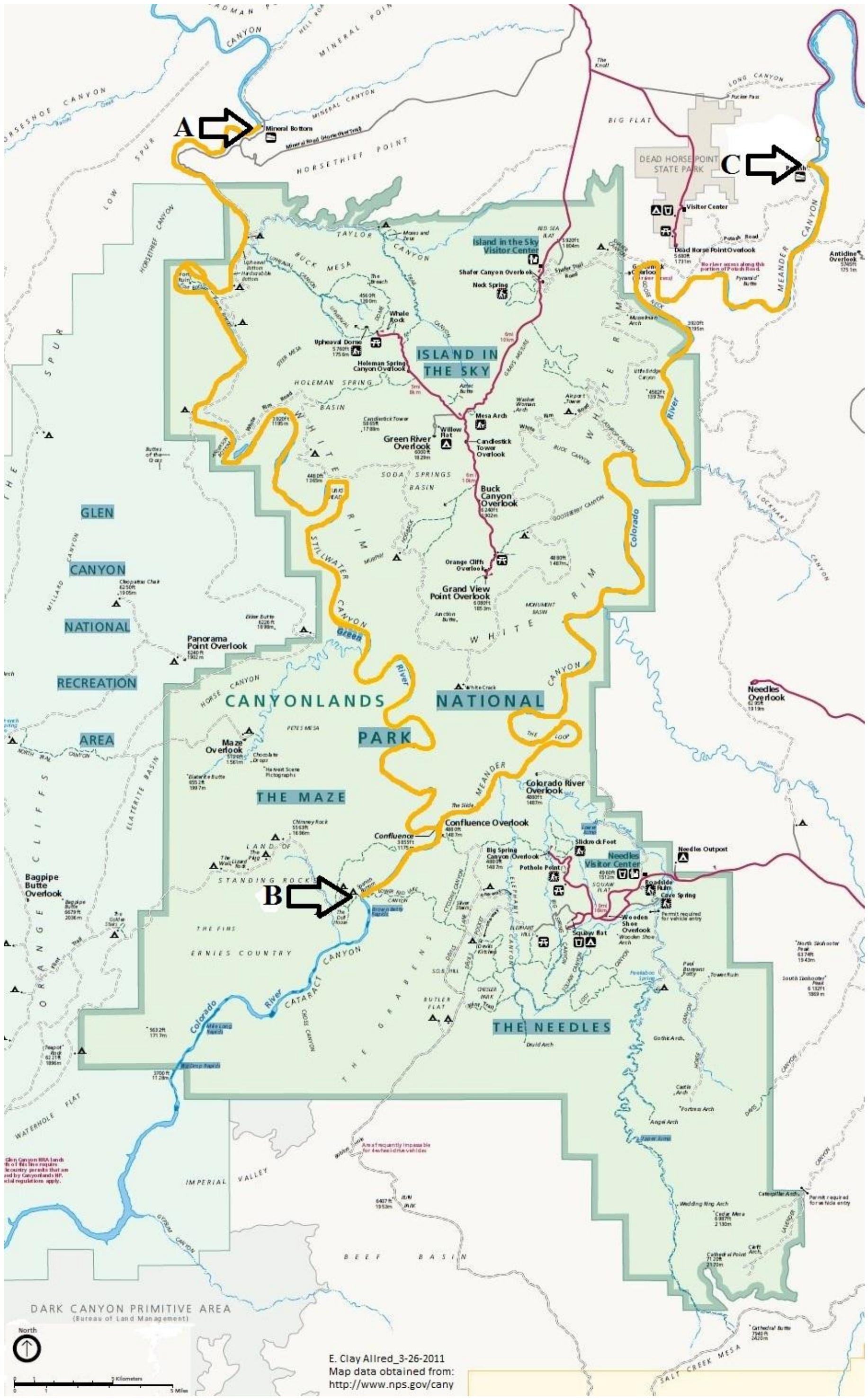

Figure 2.2 Study area of 159.33 river kilometers shown in orange. As indicated on the map: (A) Mineral Bottom (B) Spanish Bottom and (C) Potash boat ramp.

Questions regarding the acceptability of control methods were evaluated on a scale of acceptability ranging from -2 “very unacceptable” to +2 “very acceptable,” with 0 “neither” as a neutral point.

Photos showing mechanical control, burnt tamarisk, the cut stump treatment, and tamarisk defoliated by the tamarisk leaf beetle were included on the questionnaire, as shown in Figure 2.3. Similar research has shown that visuals allow respondents to comprehend conditions better than a written description (Brunson & Shelby, 1992; Ceurvorst, 2011; Manning & Freimund, 2004; Manning et al., 1996; Moyle & Croy, 2007; Shelby, & Harris, 1985). A close-ended question was asked concerning whether or not respondents wanted tamarisk to be removed. In addition, respondents were asked to state the reason they did or did not want tamarisk to be removed. Finally, these open-ended answers were later categorized for statistical analysis.

Data analysis was facilitated using SPSS 19 and Microsoft Excel, 2010. This software is widely used in social science and allows researchers to use descriptive statistics to analyze evaluative responses. Researchers coded and entered all responses into SPSS in order to find descriptive statistics. Those statistical values were then used in PCI_2 equations to discover the potential for conflict. After finding norms (mean responses) for methods and the potential for conflict, Microsoft Excel was used to create PCI_2 graphs. The data collected in this research describes two important types of normative information (1) mean acceptability of tamarisk control methods, and (2) user agreement, or the potential for conflict.

Mechanical (mulch)

Burning

Cut-stump

Tamarisk Leaf Beetle

Figure 2.3 Tamarisk control methods addressed in this research.

The results of PCI_2 represent the average distance between responses compared to the maximum potential distance between responses on a given scale (Vaske et al., 2010):

$$\mathrm{PCI}_2 = \left[\sum \left(n_k n_h d_{k,h}\right)\right] / \delta \qquad \text{for } k = 1 \text{ to } i \text{ and } h = 1 \text{ to } i;$$

where n_k is the number or responses at each value in the scale, n_h being the number of responses at other scale values, $d_{k,h}$ the distances between responses, and δ is the maximum distance between extreme values multiplied by the number of times this distance occurs (Sharp, Larson, & Green, 2011; Vaske et al., 2010). The results found using PCI_2 will inform readers of the potential for conflict when using any of the control methods addressed in this study. These results will also be graphed, allowing the reader to easily interpret the data.

With the PCI_2 results, a statistical significance of the difference (*d*) between PCI_2 values can be calculated using the following formula (Vaske et al., 2010):

$$d = |(\mathrm{PCI_a} - \mathrm{PCI_b})| \, / \, \sqrt{[(\mathrm{PCI_{aSD}})^2 + (\mathrm{PCI_b})^2]}$$

This formula compares the PCI_2 values and the simulated PCI_2 distributions between two groups (e.g., different control methods). If the *d* statistic is greater than 1.96 using this formula, the PCI_2 values of the compared groups are considered to be significant at the $\alpha = 0.05$ significance level (Vaske et al., 2010). This equation will be used to compare the difference between PCI_2 values for tamarisk control methods and determine if there is a statistically significant difference between these values.

Results

River Users' Self-assessed Knowledge of Tamarisk

When river users assessed their knowledge of tamarisk on a scale from 0 "no knowledge" to 3 "expert knowledge" the proportion of respondents evaluating their overall knowledge of tamarisk as some knowledge totaled 57%, with 23% of respondents claiming no knowledge, as shown in figure 2.4. These two knowledge evaluations make up 80% of the sample surveyed. The respondents that assessed their knowledge as advanced totaled 17%, while 3% of respondents assessed their knowledge as expert. Overall, the majority of river users had a low level (e.g., some) knowledge of tamarisk.

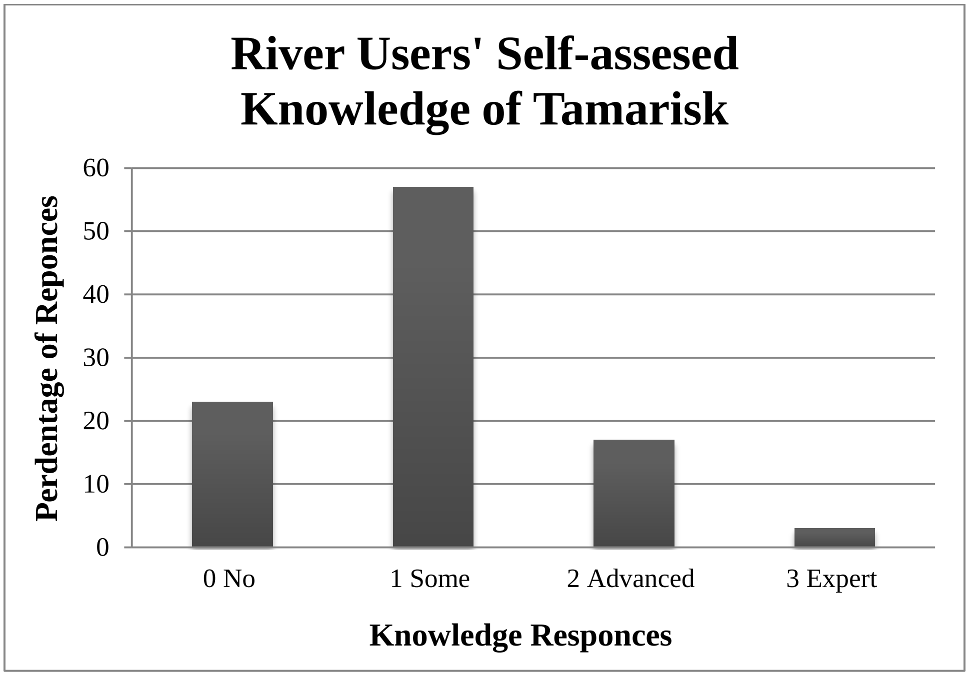

Figure 2.4 River users' self-assessed knowledge of tamarisk.

When respondents were questioned whether they would like tamarisk to be removed, 88% answered affirmatively (Figure 2.5). Sixty-two percent of all respondents stated that they wanted tamarisk removed because it is an invasive alien plant, or because they want to see native plants succeed (Table 2.1). Nine percent of respondents indicated they wanted tamarisk removed because of both ecological and social reasons (e.g., access to shore for recreation or safety). Only 6% of respondents gave reasons they would not like tamarisk removed. The opposition to tamarisk removal included sentiments like wanting to leave nature alone, thinking the task was too large, and belief that tamarisk was not a problem.

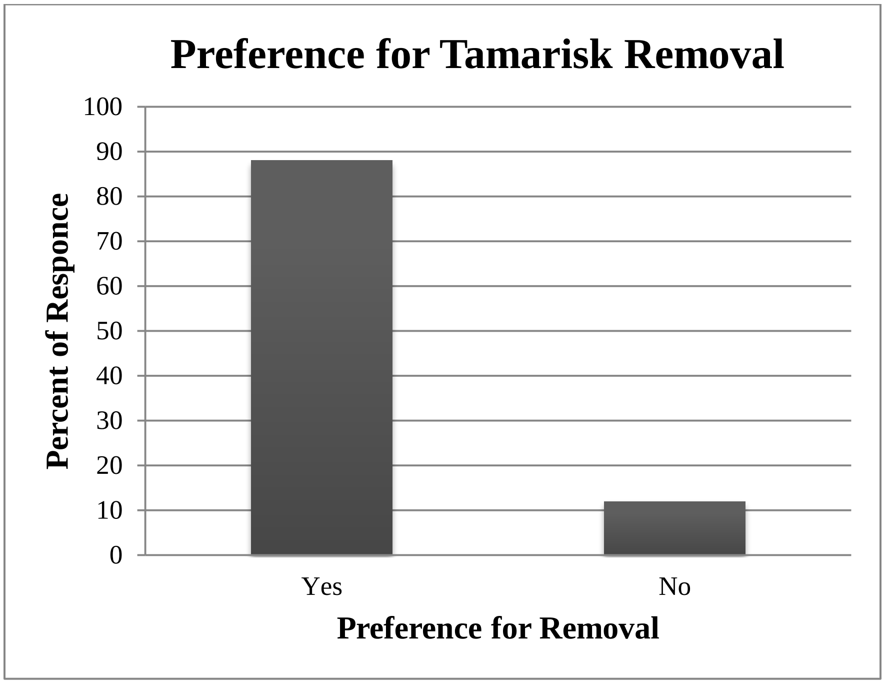

Figure 2.5 Respondents preference for tamarisk removal.

Norms for Control Methods

The mean evaluations for the majority of tamarisk control methods investigated in this research were found to be acceptable by river users. Norms for tamarisk control methods were found using a scale of acceptability from -2 “very unacceptable” to +2 “very acceptable”, with 0 “neither” as a neutral point. The cut-stump method had norms, or mean acceptability evaluations, of 0.97 and 0.93, between camps and in camps respectively. The norms for use of the tamarisk leaf beetle were 0.95 between camps and 0.86 in camps. Burning had a lower average evaluation, with norms of 0.62 between camps and 0.41 in camps. Given the data found, researchers could not find mechanical removal as acceptable nor unacceptable, at 0.04 between camps and 0.05 in camps (shown in Table 2.3).

Mechanical removal, or the mulching of tamarisk, was also the only method not evaluated by a majority of respondents as acceptable (Table 2.2). Managers should exercise caution when implementing tamarisk control methods with lower norms that reflect lower acceptability evaluations. In this research, a relationship was observed between the potential for conflict and acceptability in this study, with the potential for conflict increasing as the acceptability for tamarisk control methods decreased.

Table 2.1 Reasons for River Users' Preference of Tamarisk Removal

Preference for Tamarisk Removal and Reason		Percent of Respondents
Yes		
	Because it is invasive	41.3
	For native species and biodiversity	20.8
	Uses too much water	4.9
	For native ecosystems and access to recreation sites	9.1
	Access to camps and other recreation sites	12.5
	To improve the viewscape	1.1
	Reduces quality of recreation experience (e.g., harbors mosquitoes, smells bad)	2.3
No		
	To protect the ecosystem (e.g., erosion control, leave nature alone)	2.3
	Too difficult and costly to remove	2.7
	User liked tamarisk or it does not bother them	3.0

Table 2.2 Percentages of User Evaluations for Tamarisk Control Methods

	Percent of Response				
Methods in areas respective to camps	-2 Very Unacceptable	-1 Unacceptable	0 Neither	+1 Acceptable	+2 Very Acceptable
Burn Between	6.6	16.3	11.3	40.3	25.6
Burn In	7.3	22.7	13.6	34.4	22.1
Cut-stump Between	2.5	8.5	11.0	45.0	33.0
Cut-stump In	3.2	9.2	12.0	43.0	32.6
Beetle Between	6.0	8.9	10.2	33.7	41.3
Beetle In	6.7	10.6	11.9	31.4	39.4
Mechanical Between	14.7	27.6	16.3	23.8	17.6
Mechanical In	13.5	28.0	16.7	23.6	18.2

Table 2.3 Descriptive Statistics for Norms of Tamarisk Control Methods

Tamarisk Control Action	Mean[1]	PCI_2[2]	Skewness	Kurtosis	Standard Deviation
Burn Between Camps	0.62	0.40	-0.69	-0.58	1.21
Burn in Camps	0.41	0.45	-0.37	-1.06	1.26
Cut-stump Between Camps	0.97	0.23	-1.06	0.71	1.00
Cut-stump in Camps	0.93	0.25	-1.01	0.47	1.05
Beetle Between Camps	0.95	0.33	-1.10	0.27	1.19
Beetle in Camps	0.86	0.36	-0.94	-0.17	1.24
Mechanical Between Camps	0.02	0.49	0.04	-1.26	1.36
Mechanical in Camps	0.05	0.48	0.03	-1.25	1.34

[1] Mean being the sum of the individual values for each respondent divided by the number of cases: Evaluated on a scale ranging from -2 "very unacceptable" to +2 "very acceptable", with 0 "neither" as a neutral point.
[2] The potential for conflict (PCI_2) is measured on a scale ranging from 0 "minimum potential conflict", to 1 "maximum potential conflict."

Table 2.4 Paired-samples *t*-test of Acceptability for Control Methods in and Between Campsites (n=330)

	Mean Acceptability of Control Action by Location			
Independent Variable	Between Camps	In and Adjacent to Camps	*t*-value	*p*-value
Burn	0.61	0.41	4.07	.001
Cut-stump	0.97	0.91	1.81	.072
Beetle	0.96	0.87	4.57	.001
Mechanical removal	0.05	0.10	1.58	.116

A comparative analysis of users' preference for control methods being used in campsites, and in and between campsites, was performed using a paired-samples *t*-test (Table 2.4). This comparison shows visitors' difference in norms for individual methods in different settings. Table 2.4 displays the tamarisk control methods and their respective *t* and *p*-values. These values describe the probability that the differences found between methods in camps and between camps were not just random chance.

The *p*-values for burning and using the tamarisk leaf beetle are so low that there is little chance that these values are random. The values for cut-stump and mechanical removal are much higher. These values have about a 7% and 12% chance of being collected randomly, making them less reliable when comparing norms for methods used in and between camps. While the cut-stump method is close to $p = .05$, which would be acceptable in this research, the *p*-value for mechanical removal is much higher. This is most likely due to the high variability in response for the mechanical method, making the *p*-value and the potential for conflict higher, as well as making researchers unable to find the use of this method acceptable or unacceptable. According to the data found in this study, the norm for the mechanical method did not differ from zero.

Potential for Conflict Index (PCI_2)

PCI_2 values are measured on a range from 0 “minimum potential conflict” to 1 “maximum potential conflict”. The potential for conflict among respondents ranged from PCI_2 value of 0.41 for mechanical removal and 0.20 for the cut-stump method (Table 2.1). With burning having a PCI_2 value of 0.36 and beetle with 0.31, all of the PCI2 values were relatively low but indicate there is conflict among respondents. A relationship between the potential for conflict and acceptability was observed, with the potential for conflict increasing as acceptability decreased.

The PCI_2 graph (Figure 2.6) shows PCI_2 magnitude, dispersion and central tendency of users’ norms for tamarisk control methods on the Green and Colorado rivers of Canyonlands National Park. The PCI_2 graph contains bubbles representing both in campsite and in between campsite treatments for all four control methods. The size of the bubble represents the potential for conflict regarding the acceptability of tamarisk control methods, the larger the bubble, the greater potential for conflict. The central tendency of the bubble depicts the mean acceptability of the given method (Vaske et al., 2010).

The differences between norms for tamarisk control methods were found using the PCI_2 difference (d) equation. This equation compares the PCI_2 values of variables to determine if there is a statistically significant difference between the chosen variables. If the result of this equation is $d > 1.96$, the difference between the compared values is statistically significant at $a = 0.05$. The d values comparing the difference of all control methods are shown in Table 2.5, however, readers should exercise caution when referencing this table. The application of this formula in multivariable analysis is still being researched due to a high experiment-wise error rate.

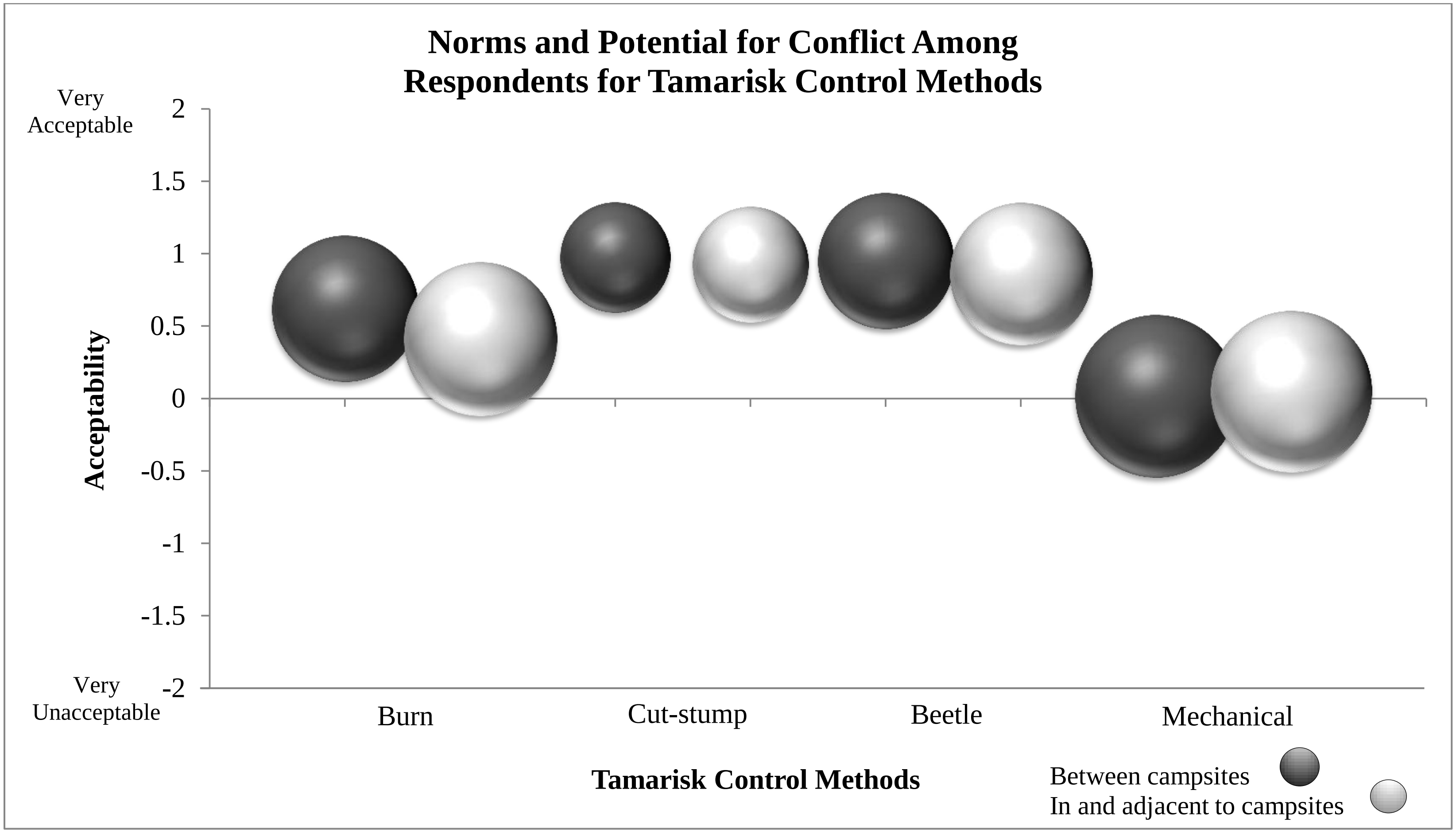

Figure 2.6 Norms and potential for conflict among tamarisk control methods. In this PCI_2 graph the size of the bubble represents the potential for conflict regarding the acceptability of tamarisk control methods, the larger the bubble, the greater potential for conflict. The central tendency of the bubble depicts the mean acceptability of the given method (Vaske et al., 2010)

Table 2.5 PCI_2 *d* Values Showing Difference Between PCI_2 Values for Tamarisk Control Methods

	Tamarisk Control Methods							
Areas Respective to Camps	Burn Between	Burn In	Cut-stump Between	Cut-stump In	Beetle Between	Beetle In	Mechanical Between	Mechanical In
Burn Between	0.00	1.04	3.81	3.36	1.45	0.83	1.99	1.79
Burn In	1.04	0.00	5.19	4.73	2.47	1.81	1.06	0.86
Cut-stump Between	3.81	5.19	0.00	0.50	2.00	2.60	6.12	5.80
Cut-stump In	3.36	4.73	0.50	0.00	1.57	2.18	5.68	5.36
Beetle Between	1.45	2.47	2.00	1.57	0.00	0.56	3.31	3.10
Beetle In	0.83	1.81	2.60	2.18	0.56	0.00	2.65	2.46
Mechanical Between	1.99	1.06	6.12	5.68	3.31	2.65	0.00	0.13
Mechanical In	1.79	0.86	5.80	5.36	3.10	2.46	0.13	0.00

PCI_2 *d* values with $d > 1.96$ represent a difference between methods' PCI_2 values (Vaske et al., 2010).

Finally, this research addressed river user desire for additional education and interpretation regarding tamarisk and tamarisk management in the questionnaire (Appendix A). Eighty-four percent of respondents reported that they would like to see more educational or interpretative information regarding tamarisk. This offers public land managers an excellent way to inform the public about management actions. Offering additional education may help public land managers by raising the social acceptability of tamarisk control methods.

Discussion and Conclusion

This article examined river users' overall knowledge of tamarisk, preference for removal, norms for control methods, and finally, preference for additional education or interpretation. The average overall self-assessed knowledge of tamarisk among respondents was low. The majority of respondents indicated that they would like tamarisk removed. Normative results also found the majority of tamarisk control methods to be acceptable by respondents. Finally, the majority river users indicated that they would like more education and interpretation about tamarisk and tamarisk management.

These findings have implications for public land managers. First, a majority of respondents (80%) evaluated their overall knowledge of tamarisk as "no knowledge" or "some knowledge." Eighty-four percent of respondents indicated that they would like additional education or interpretation regarding tamarisk. River users' interest in receiving additional education should be addressed by public land managers, as outlined in EO 13112 (Williams, 2005). In addition to mandating the control of invasive alien species, EO 13112 requires federal land management agencies to educate the public, where possible and practical. Examples of this education may include interpretive talks by rangers, increased or improved signage, and informative brochures included in river permit information.

Second, the norms for all tamarisk control methods were examined. Burning, use of the tamarisk leaf beetle, and the cut-stump method had a mean acceptability above zero; however, with the data in these findings, researchers found mechanical removal as neither acceptable nor unacceptable. The cut-stump method and use of the tamarisk leaf beetle had the highest acceptability and least potential for conflict, while the potential for conflict was greater, and the acceptability lower for the burning method. The potential for conflict was highest for the mechanical method.

These findings have potentially positive implications for land management agencies that may use the tamarisk leaf beetle and cut-stump methods. When implementing tamarisk control methods with acceptable norms, managers may increase the acceptability of management actions. Managers should exercise caution if using burning and mechanical removal as there was a relationship observed in this study between acceptability and the potential for conflict among respondents, with the potential for conflict being higher for methods with lower acceptability.

Third, the results found may help managers understand norms for river users, but do not address any other stakeholders. The findings in this paper are exploratory in nature and limited in scope. Public land managers may want to address other stakeholders including: different recreation-based user groups, private landowners in river corridors, communities found near rivers, and grazing permit holders. By broadening the scope of this research, land managers may be more sensitive to the wants of all stakeholders. In addition to the scope of this study being limited to river users, tamarisk is the only plant genus addressed. These findings do not address any other species or control methods on the Colorado Plateau.

These findings also have implications for future research. First, in addition to addressing other stakeholders and species, future research may be performed regarding other social aspects of tamarisk management. Viewscape alterations may be important to consider when thinking about tamarisk control because of the dominant role tamarisk plays in riparian ecosystems. Removing this prevalent invasive will change the viewscape and future research might address the social acceptability for any alterations to viewscape. Like this article, researchers might use photographs showing conditions to help respondents assess the acceptability of conditions created by tamarisk control.

Second, more in-depth inquiries could be made regarding the reason responses are given. For instance, while addressing norms for control methods, evaluation questions may be coupled with a field for an open-ended response, allowing respondents to explain the reason for their evaluation. In addition, respondents could be asked to evaluate their knowledge of key aspects of tamarisk and tamarisk management to establish their overall knowledge, as opposed to their overall knowledge being self-assessed.

Third, research regarding tamarisk control might include cluster analysis for different user segments, sites, or social physiological variables. Future analysis of normative data using PCI_2 may also be improved by developing a method to find statistical significance in multivariable analysis. Currently the statistical significance of the difference between two variables can be calculated using the distance (*d*) formula (Vaske et al., 2010), however, when applied to multivariable analysis the experiment-wise error rate becomes high. While the Bonferroni Correction may be applied to the difference formula in this situation, a PCI_2 difference test formulated to find statistical significance for differences between PCI_2 results with three or more findings may be developed to facilitate multi-variable analysis without additional correction.

Finally, future research is needed on issues that compliment tamarisk management in river corridors on the Colorado Plateau. With the control and removal of tamarisk, opportunities are given for invasions of other alien species. Future research may address the social implications of restoration actions that result from tamarisk control. In addition to restoration actions, researchers may focus on other alien species that are often associated with populations of tamarisk, such as Russian knapweed (*Rhaponticum repens,* previously called *Centaurea repens*).

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CHAPTER 3

RIVER USER NORMS FOR CHAINSAW NOISE CREATED WHILE REMOVING TAMARISK

Introduction

Managing parks and similar protected areas with the objective to preserve natural soundscapes is becoming an important aspect of public land management (Ambrose & Burson, 2004; Dumyahn & Pijanowski, 2011). With various human-caused noises from aircraft, vehicles on roads, maintenance, and park visitors, natural soundscapes are increasingly scarce resources (Park, Lawson, Kaliski, Newman, & Gibson, 2009). Visitors in places like national parks want to experience natural quiet, without the addition of human-caused noise. Past research shows that 91% of visitors are drawn to national parks to enjoy natural soundscapes, and the longer a visitor is subject to human caused noise, the more it takes away from their experience (Ambrose & Burson, 2004; Marin, Newman, Manning, Vaske, & Stack, 2011).

With a desire to improve visitor enjoyment, the National Park Service (NPS) will preserve and restore natural soundscapes to the greatest extent possible (USDOI, 2006). The NPS Natural Sounds Program Office oversees this objective so that visitors may have the opportunity to enjoy tranquility, solitude and the sounds of nature (Jensen & Thompson, 2004). This mission must however have leniency for visitor use and management actions. One management action where human-caused noise may be produced is during the control of invasive alien species (IAS). These actions are required by Executive Order (EO) 13112, which mandates federal land management agencies, where practical and permitted by law, to take actions including: preventing the introduction of invasive species, detecting and responding rapidly to, and controlling populations of such species in a cost-effective and environmentally sound manner (Williams, 2005).

The spread of tamarisk (*Tamarix* spp.), or salt cedar, an invasive alien plant genus, presents federal land managers with a need for invasive alien plant control. Tamarisk has the second highest normalized cover and is the third most prevalent woody plant in riparian ecosystems in the western United States (Friedman et al., 2005). Tamarisk has significant environmental impacts and may encumber river user's recreation experience by growing densely along riverbanks (Belote, Makarick, Kearsley, & Lauver, 2010).

While the presence of tamarisk may affect river users' experience, the removal of tamarisk may certainly do the same. Tamarisk control methods are often noisy, and the most frequently used method in difficult to reach areas may be the cut-stump method where a chainsaw is used to cut trees. This method is used frequently because chainsaws are both portable and effective; however, the noise created by a chainsaw alters the natural soundscape. This paper will address river user acceptability for noise created by chainsaw use in proposed wilderness areas and other remote public lands along two river corridors on the Colorado Plateau.

Conceptual Background

Normative Research

Past studies have addressed the relationship between human-caused noise and park visitor experience; however, research is needed to examine the influence of noise created by IAS control on visitor experiences (Park et al., 2009). This research addressed the knowledge gap by examining river users' norms for chainsaw noise. Norms have been defined as standards that individuals use for evaluating behaviors or conditions caused by behaviors, as good or bad, better or worse (Shelby, Vaske, & Donnelly, 1996; Whittaker & Shelby, 2002). When addressing social implications in natural resource management, social norms provide descriptive and evaluative information necessary for managers to identify goals and set standards. The structural norm approach, for example, has described the acceptable range of conditions in various recreation settings, for different activities, attributes, situational variables, and management actions (Shelby et al., 1996).

One application of normative research is to compare norms in different settings (Shelby et al., 1996). This application has been used to compare indicators, such as visitor encounters on frontcountry and backcountry trails and boat encounters on whitewater river trips. These studies have helped managers determine standards for indicators like social carrying capacity (Manning, Lime, Freimund, & Pitt, 1996; Shelby et al., 1996). Comparing norms for different settings in this research may be helpful to land managers as river user norms for chainsaw noise may vary greatly in different river settings.

Like norms for carrying capacity, norms for chainsaw noise will allow managers to understand the threshold for acceptable change in conditions, by which they may set standards (Manning, 2011). The addition of normative data to land management planning allows managers to understand what visitors evaluate as acceptable impacts to natural soundscapes (Miller, 2008). With these data, a three-dimensional view regarding effects of management actions on the natural soundscape may be developed. Figure 3.1 displays how managers recognize river user norms for chainsaw noise that results from tamarisk removal as well as taking action to control tamarisk.

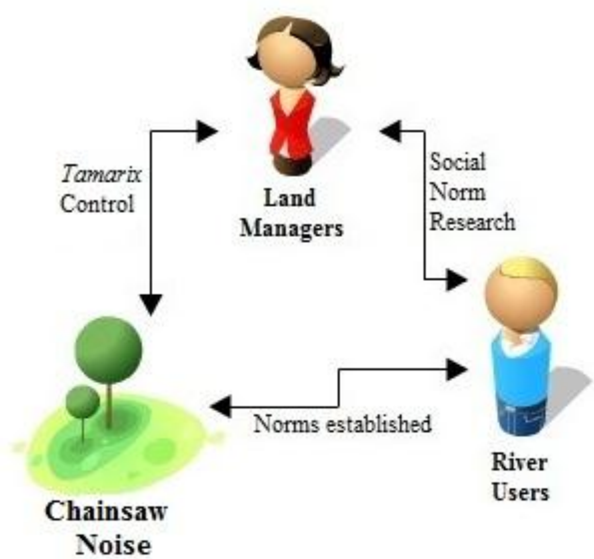

Figure 3.1 Three-dimensional view of soundscape interaction between river users and managers (adapted from Manning, 2011).

Norms in Planning and Management Frameworks

Some management frameworks used to define the extent of resource protection and type of visitor experience to be provided include Limits of Acceptable Change (LAC) (Stankey, 1988), Visitor Impact Management (VIM) (Kuss, Graefe & Vaske, 1990), Visitor Experience and Resource Protection (VERP) (Manning, 2001), and the Recreation Opportunity Spectrum (ROS) (Manning, 2011). Frameworks like VERP can be vitally important to the National Park Service because of the park service two-fold mission to preserve or improve the condition of natural resources, while making parks accessible for the enjoyment of present and future generations (USDOI, 2006).

Human-caused noise (e.g., chainsaw noise) is a manageable, measureable variable (e.g., indicator) in park soundscape research, planning and management (Manning et al, 2006). Management-by-objective/indicator-based planning and management frameworks are increasingly regulating indicators like noise. These frameworks may incorporate ecological, social, and managerial dimensions into decision-making about management strategies. This study will provide managers with norms for chainsaw noise on the Green and Colorado River corridors that may be used in indicator-based management frameworks.

Potential for Conflict Index$_2$

There exists a potential for conflict among river users regarding chainsaw noise on the Green and Colorado rivers. Potential conflict between stakeholders, such as river users, can be quantified and described using the Potential for Conflict Index (PCI) (Manfredo, Vaske, & Teel, 2003). Now in the second generation, PCI$_2$ requires no statistical training to interpret results and aids in the comprehension of normative data among nontechnical audiences (Vaske, Beaman, Barreto, & Shelby, 2010). PCI_2 results can be displayed graphically using bubbles that indicate the form, dispersion and central tendency of a variable (Vaske et al., 2010). In a PCI_2 graph the size of a bubble indicates the potential for conflict, the greater the size, the greater potential for conflict. The central tendency of a bubble shows the mean evaluated acceptability.

The potential for conflict among respondents is given a value from 0 “minimum potential conflict” to 1 “maximum potential conflict.” If responses are equally divided in two, with either half on the extreme ends of a scale for an evaluative question, the result would be PCI = 1 “maximum potential for conflict.” The minimum potential for conflict, zero, is achieved when all responses for a question are at one point on the evaluation scale.

Research Questions

When public land managers address social implications in natural resource management, such as chainsaw noise created in tamarisk control, they may set standards using management frameworks and manage in socially acceptable ways. This research addressed river user norms for chainsaw noise created in tamarisk control to facilitate managers’ use of indicator-based planning and management frameworks. This research was guided by the hypothesis that chainsaw noise would be unacceptable to river users. Findings are based on three questions: (1) If river users would like tamarisk to be removed, would they prefer it to be removed by chainsaws or handsaws? (2) What are river users’ norms for chainsaw use in different riverine areas? (3) Is there a difference in river users’ social norms for chainsaw noise on the Green and Colorado Rivers?

Methods

Data Collection

With a user population of approximately 2,000 annually, this study collected 330 completed questionnaires to fall within the 95% confidence level, with +/- 5% margin of error (Salant & Dillman, 1994). The research area addressed in this paper includes approximately 159.33 river kilometers in Canyonlands National Park and surrounding areas, including stretches on the Green and Colorado rivers. The Green River kilometers begin at Mineral Bottom boat ramp (point A in Figure 3.2) (38°31’31.14”N, 109°39’32.35”W) and end at Spanish Bottom (point B) on the Colorado River (38°09’24.37”N, 109°55’59.27”W), totaling 83.69 river kilometers. The Colorado River kilometers begin at the Intrepid Potash boat ramp (point C) (38°30’20.97”N, 109°39’32.35”W) and end at Spanish Bottom accruing 80.47 river kilometers.

While the majority of the study area resides within Canyonlands National Park, the both river stretches begin outside the park, the Green River in Bureau of Land Management (BLM) land and the Colorado River on both private and BLM lands. Both stretches conclude at Spanish Bottom, which is also the end of the flat-water sections of river in Canyonlands National Park, immediately before the first rapid of Cataract Canyon. The most common trip participated in by respondents was a canoe trip starting at the Mineral Bottom Boat Ramp, arriving at Spanish Bottom a few days later. From Spanish Bottom river users took a jet boat ride up the Colorado River to the Intrepid Potash Boat Ramp, which made data collection feasible at the end of their trip. Respondents completed questionnaires at the Potash Boat Ramp or on a bus ride from the boat ramp to Moab, Utah.

Data Analysis

For this research, the independent variable was the noise of a chainsaw being used to remove tamarisk in river corridors and the dependent variable was river users' acceptability of chainsaw noise. Users' norms for chainsaw noise were found by asking how acceptable the noise of a chainsaw running for tamarisk removal was on both rivers. These close-ended questions were answered on a scale of acceptability ranging from +2 "very acceptable" to -2 "very unacceptable," with 0 "neither" as a neutral choice. The questionnaire also included close-ended questions asking if users wanted tamarisk removed, and if they preferred handsaws or chainsaws. One open-ended question asked why respondents did or did not want tamarisk removed. Answers from this question were categorized in order to be quantified for statistical analysis.

Data analysis was facilitated using SPSS 19 and Microsoft Excel, 2010. This software is widely used in social science because it allows researchers to use desceriptive statistics to analyze normative responses. The data collected in this research describes two important types of normative information using $PCI_{2,}$ (1) river user agreement (the potential for conflict), and (2) mean acceptability of chainsaw noise used for tamarisk removal on both rivers.

Potential for Conflict Index$_2$

The results of PCI_2 represent the average distance between responses compared to the maximum potential distance between responses on a given scale (Vaske et al., 2010):

$$\mathrm{PCI}_2 = \left[\sum \left(n_k n_h d_{k,h}\right)\right] / \delta \qquad \text{for } k = 1 \text{ to } i \text{ and } h = 1 \text{ to } i;$$

where n_k is the number of responses at each value in the scale,

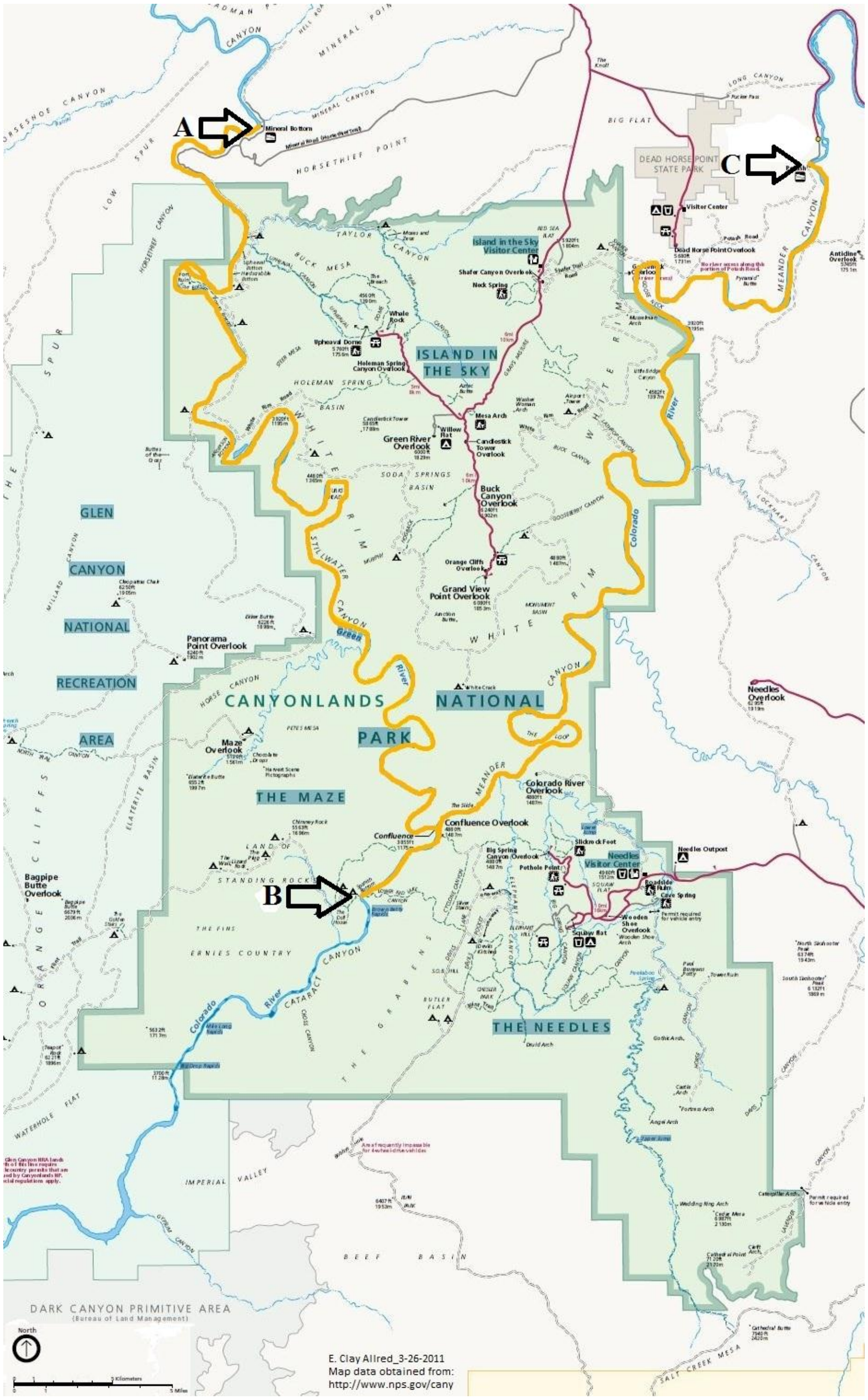

Figure 3.2 Study area of 159.33 river kilometers shown in orange. (A) Mineral Bottom (B) Spanish Bottom (C) Potash boat ramp.

n_h being the number of responses at other scale values, $d_{k,h}$ the distances between responses, and δ is the maximum distance between extreme values multiplied by the number of times this distance occurs (Sharp, Larson, & Green, 2011; Vaske et al., 2010).

With the PCI_2 results, a statistical significance of the difference (*d*) between two PCI_2 values can be calculated using the following formula (Vaske et al., 2010):

$$d = |(\mathrm{PCI_a} - \mathrm{PCI_b})| \; / \; \sqrt{[(\mathrm{PCI_{aSD}})^2 + (\mathrm{PCI_b})^2]}$$

This formula compares the PCI_2 values and the simulated PCI_2 distributions between two groups (e.g., noise on the Colorado and Green rivers). If the *d* statistic is greater than 1.96 using this formula, the PCI_2 values of the compared groups are considered to be significantly different at the $\alpha = 0.05$ significance level (Vaske et al., 2010). PCI_2 equations were used to compare (1) the PCI_2 values for chainsaw noise between the Green and Colorado River corridors and (2) determine if there is a statistically significant difference between these values.

Results

Preferences for Saw Use and Norms for Chainsaw Noise

Sixty-two percent of respondents indicated that they would prefer the use of chainsaws over handsaws for tamarisk removal. While the use of a chainsaw would alter the soundscape and potentialy infringe upon visitor experience, river users in this sample evaluated the use of chainsaws to be acceptable on both the Green and Colorado Rivers. The noise of a chainsaw being evaluated as acceptable in the recommended wilderness of Canyonlands National Park may conflict with past soundscape research. Researchers believe this difference in findings may be due to the motivation for tamairsk removal, with 88% of respondents wanting tamarisk to be removed.

On the scale of acceptability for chainsaw noise from -2 “very unacceptable” to +2 “very acceptable,” the average evaluation of acceptability (e.g., norm) on the Colorado River was 0.49. Chainsaw noise on the Green River was found to be slightly less acceptable with a norm of 0.33, as seen in Table 3.1. Table 3.2 shows the percent of response among river users for chainsaw noise using the scale of acceptability. These values indicate a majority of repondents in our sample found chainsaw noise created while removing tamarisk to be acceptable. While these evaluations indicate that chainsaw noise would be acceptable to most river users, the norms were low for chainsaw noise, between 0 “neither” and 1 “acceptable.”

Table 3.1 Descriptive statistics for norms of chainsaw noise on the Green and Colorado rivers.

	Mean[1]	PCI_2[2]	Standard Deviation	Skewness	Kurtosis
Colorado River	0.49	0.26	1.07	-0.68	-0.31
Green River	0.33	0.31	1.16	-0.49	-0.78

[1] Mean being the sum of the individual values for each respondent divided by the number of cases: Evaluated on a scale ranging from -2 “very unacceptable” to +2 “very acceptable” with 0 “neither” as a neutral point.
[2] The potential for conflict “PCI_2” is measured on a scale ranging from 0 “minimum potential conflict” to 1 “maximum potential conflict”.

Table 3.2 Evaluations for chainsaw noise on the Green and Colorado rivers.

	Percent of Response				
Chainsaw Noise Location	-2 Very Unacceptable	-1 Unacceptable	0 Neither	+1 Acceptable	+2 Very Acceptable
Green River	7.8	20.1	16.0	43.6	12.5
Colorado River	5.3	15.8	16.8	48.8	13.4

Norms for Noise on the Green and Colorado Rivers

Figure 3.3 shows differences between the normative evaluations for chainsaw noise on Green and Colorado rivers using PCI_2. While chainsaw noise produced removing tamarisk on the Colorado River was found to be more acceptable than hand-sawing, there was also less potential for conflict with a PCI_2 of 0.25. The Green River had less agreement (e.g., higher potential for conflict) with a PCI_2 of 0.31, indicated by a larger bubble in the PCI_2 graph. The bubble for chainsaw noise on the Green River is also lower in relationship to the verticle axis, showing that it was evaluated to be less acceptable than chainsaw noise on the Colorado River.

The PCI_2 difference test was used to calculate the statistical significance (d) between PCI_2 values for noise on the Green and Colorado River. The value for d found with this formula was 1.78. This value was below the required $d > 1.96$ for statistical significance at $a < 0.05$. Although the norms for chainsaw noise on the rivers were different, the PCI_2 values were not statistically significant between the different settings. This value was calculated using a difference test created for Microsoft Excel (Vaske et al., 2010).

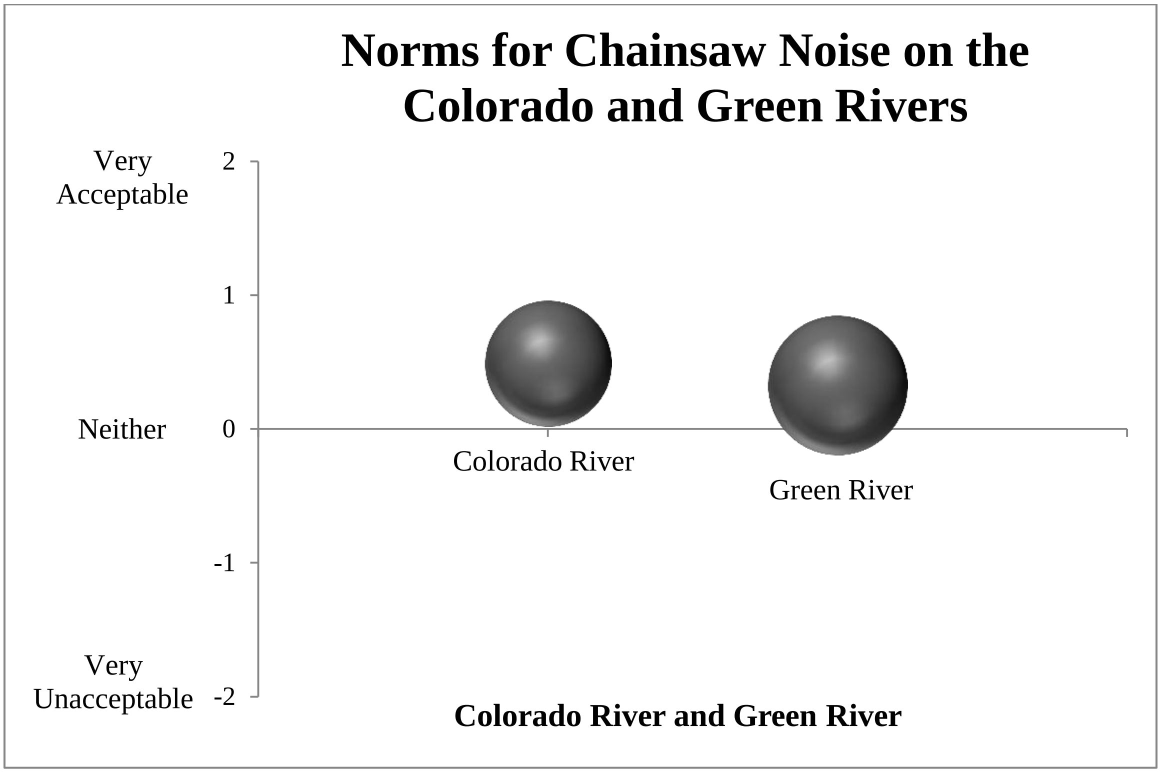

Figure 3.3 PCI_2 graph showing chainsaw noise acceptability and potential for conflict on the Green and Colorado rivers.

Discussion and Conclusion

This article examined both river user preference for type of saw used, and norms for chainsaw noise in different settings. Results show the majority of respondents prefer the use of chainsaws over handsaws for tamarisk removal. Chainsaw noise was evaluated by the river user sample to be acceptable on both the Green and Colorado River. There was a difference between the potential for conflict among respondents for chainsaw noise on the rivers, however, using the PCI_2 difference test, these values were found to be statistically insignificant.

These findings have implications for public land managers. First, results show river users' preference for chainsaws rather than handsaws. This normative data may be valuable for land managers when used in indicator-based planning and management frameworks on the Colorado Plateau. With the knowledge that river users prefer the use of chainsaws, land managers may have more confidence when implementing the use of chainsaws in tamarisk control.

Second, the river users in the 330-respondent sample found chainsaw noise created while removing tamarisk to be acceptable. The norm for chainsaw noise on the Green River was 0.33, and the Colorado River 0.49, on a scale of acceptability ranging from +2 “very acceptable” to -2 “very unacceptable,” with 0 “neither” as a neutral choice. Although not highly acceptable (e.g., very acceptable), the norms for chainsaw noise addressed were acceptable. Managers should exercise caution when implementing chainsaw use as the acceptability for chainsaw noise was low.

Third, the potential for conflict was found for chainsaw noise created while removing tamarisk on the Green and Colorado River. The potential for conflict among respondents is given a value from 0 “minimum potential conflict” to 1 “maximum potential conflict” (Vaske et al., 2010). On this scale, the PCI_2 value for noise was 0.26 on the Colorado, and 0.31 on the Green. When testing the difference between these values using the PCI_2 difference test, the difference was not found to be statistically significant. This means that the potential for conflict among respondents regarding chainsaw noise created while removing tamarisk is the same on either river.

This study also has implications for future research. First, these findings may be the foundation for future tamarisk research that may include user motivations for normative responses. For instance, the preference for chainsaw use in tamarisk removal was established, but the reasons that respondents were inclined to have chainsaws used are still unknown. One variable for future research could be the timing of chainsaw use for tamarisk removal. This could be performed with the hypothesis that chainsaw noise may be even more acceptable when there are fewer river users.

Second, other aspects of soundscape ecology may be addressed in future research. The natural soundscape is important to visitors and should be protected for visitor experience. Future research may help established standards based on a noise level indicator, such as a decibel level or time exposed to the noise (Ambrose & Burson, 2004; Marin et al., 2011). Research should further address aspects of chainsaw noise including acceptable levels of noise and visitor distance from work site. With noise level as an indicator (e.g., decibel), land managers would be able to set standards to maintain acceptable noise levels at tamarisk control sites.

Finally, a noise level indicator may also be established for restoration activities. Restoration activities at tamarisk control sites often include the use of motorized equipment to auger, or drill, into the ground. This equipment accelerates the process of planting native species but may create noise similar to a chainsaw. Future research may help establish restoration noise standards based on an indicator, such as a decibel.

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CHAPTER 4

CONCLUSION

The two preceding chapters advanced the field of recreation resource management by examining: (a) river user overall self-assessed knowledge of tamarisk, (b) preference for tamarisk removal, (c) norms for tamarisk control methods, (d) preference for additional education or interpretation regarding tamarisk, (e) preference for type of saw used in tamarisk control, and (f) river user norms for the noise of a chainsaw being used to remove tamarisk in different riverine settings. This chapter briefly summarizes major findings in this thesis and addresses the implications for managers and future research.

Summary of Findings

Little research exists regarding the social implications of tamarisk control. The second chapter in this thesis examined three questions to address this knowledge gap. First, what are river users' self-assessed overall knowledge of tamarisk? Second, do river users want tamarisk to be removed? Third, what are river user norms for tamarisk control methods?

Results showed a majority of respondents (80%) evaluated their overall knowledge of tamarisk as "no knowledge" or "some knowledge," on a scale from 0 "no knowledge" to 3 "expert knowledge." While self-assessed knowledge was low, the desire to remove tamarisk was high, including 87.8% of respondents. Tamarisk control methods were evaluated using the evaluative dimension of acceptability ranging from -2 "very unacceptable" to +2 "very acceptable" with 0 "neither" as a neutral point. The most acceptable norm was cut-stump with a mean score of 0.95, while the norm for use of the tamarisk leaf beetle was 0.91. Burning in and in-between camps was less acceptable at 0.52, and mechanical removal was neither acceptable nor unacceptable at 0.04. Norms for beetle, burning and cut-stump methods fall between the neutral point and acceptable, meaning they were acceptable but not highly acceptable. This implies managers should exercise caution using these tamarisk control methods. Given the data in these findings, the norm for the mechanical method is no different than zero, and was neither found to be acceptable nor unacceptable.

The third chapter expanded on these results by investigating river users' norms for the noise of a chainsaw being used to remove tamarisk. Norms were addressed for the Green and Colorado River corridors separately, to compare the acceptability of this noise in different settings. This article asked three questions. First, of river users who would like tamarisk to be removed, would they prefer removed by chainsaws or handsaws? Second, what are river user norms for chainsaw noise in different riverine areas? Third, is there a difference in river user norms for chainsaw noise on the Green and Colorado rivers?

Results indicate that river users find the noise of a chainsaw being used to remove tamarisk as acceptable in both the Green and Colorado River corridors. According to a range of acceptability for chainsaw noise from -2 "very unacceptable" to +2 "very acceptable," the norm for chainsaw noise on the Colorado River was 0.49. Chainsaw noise on the Green River was slightly less acceptable with a norm of 0.33. While chainsaw noise was more acceptable on the Colorado River, the difference between the rivers' PCI_2 values was statistically insignificant. This means the potential for conflict among respondents resulting from chainsaw noise did not differ significantly between these two river settings.

Implications for Public Land Managers

This thesis improved the understanding of social implications resulting from tamarisk control methods by finding river user knowledge, norms, and preferences for aspects of tamarisk management. While other studies have addresses attitudes toward exotic plant management (Tidwell, 2005), little research has addressed the impacts to recreation experiences resulting from tamarisk control methods. Results in this study will potentially be useful for public land managers when managers are able to make decisions not solely based on management capacity (e.g., cost, time, etc.). These findings may also be utilized when setting standards in management-by-objective/indicator-based planning and management frameworks (Shelby, Vaske, & Donnelly, 1996).

First, consider the knowledge of river users about tamarisk and tamarisk management. A majority of respondents (57%) evaluated their overall knowledge of tamarisk as “some knowledge.” Eighty-four percent of respondents indicated that they would like additional education or interpretation regarding tamarisk. River user interest in receiving additional education should be addressed by public land managers, as outlined in EO 13112 (Williams, 2005). In addition to mandating the control of invasive alien species, EO 13112 requires federal land management agencies to educate the public, where possible. Examples of this education may include interpretive talks by rangers, increased or improved signage, and informative brochures included in river permit information.

Second, the majority of norms for tamarisk control method were acceptable, with mechanical being neither acceptable nor unacceptable. The cut-stump method and use of the tamarisk leaf beetle were the most acceptable, while burning was less acceptable. These findings have potentially positive implications for land management agencies that may implement tamarisk control. When implementing acceptable control methods, managers may reduce the potential conflict, however, the methods researched in this study were not highly acceptable and managers should exercise caution when implementing them. For instance, managers may want to implement the cut-stump method, but not on a trail being used by visitors or in a campsite visitors occupy. The potential for conflict should also be considered before implementation. This research observed a relationship between the acceptability evaluations and the potential for conflict, with the potential for conflict being higher for methods with lower acceptability.

Third, the findings in this paper are exploratory in nature and limited in scope. These results may help managers understand norms for river users, but do not address any other stakeholders. Public land managers may want to address other stakeholders including: different recreation-based user groups, private landowners in river corridors, communities found near rivers, and grazing permit holders. By broadening the scope of this research, land managers may understand the norms of additional stakeholders. In addition to the scope of this study being limited to river users, tamarisk is the only plant genus addressed. Future research may address many other invasive alien plant species and control methods on the Colorado Plateau.

Fourth, this thesis addressed river user preference for chainsaws rather than handsaws. Sixty-two percent of respondents indicated that they would prefer the use of chainsaws to handsaws for tamarisk removal. This finding may conflict with past soundscape research, however, these researchers believe that this finding is an outcome of river users' desire for tamarisk removal. While mechanized tool may not be acceptable in wilderness settings normally, river users have recommended the use of chainsaws specifically for tamarisk removal. This normative data may be valuable for land managers when used in indicator-based planning and management frameworks. With the knowledge that river users prefer the use of chainsaws, land managers may have more confidence when implementing the use of chainsaws in tamarisk control.

Fifth, respondents found the noise of a chainsaw used to remove tamarisk as acceptable. The norm for chainsaw noise on the Green River was 0.33, and the Colorado River 0.49, on a scale of acceptability ranging from +2 "very acceptable" to -2 "very unacceptable," with 0 "neither" as a neutral choice. This indicates that norms for chainsaw noise created while removing tamarisk to be acceptable but not very acceptable. The reasons for normative responses were not found in this study, however, these results show the noise of a chainsaw being used to remove tamarisk as acceptable for use.

Implications for Future Research

Findings in this thesis also highlight issues warranting future research. First, more in-depth inquiries could be made regarding the reason responses are given. Chapter 2, for example, found river users' self-evaluated overall knowledge of tamarisk. This may be improved by asking respondents to evaluate their knowledge of key aspects of tamarisk and tamarisk management. More in-depth inquires for normative responses could also be made. For instance, while addressing norms for control methods, evaluation questions may be coupled with an open-ended response, allowing respondents to explain the reason for their evaluation.

Second, future research may broaden the scope of this study. Researchers may address other stakeholders including: different recreation-based user groups, private landowners in river corridors, communities found near rivers, and grazing permit holders. By broadening the scope of this normative research, land managers may be more sensitive to all stakeholders. In addition to the scope of this study being limited to river users, tamarisk is the only plant genus addressed. These findings do not address many other species and control methods on the Colorado Plateau that may become variables in future research.

Third, in addition to addressing other stakeholders and species, future research may be performed regarding other social aspects of tamarisk management. Viewscape alterations may be important to consider when thinking about tamarisk control because of the dominant role tamarisk plays in riparian ecosystems. Removing this prevalent invasive will change the viewscape and future research might address the social acceptability for alterations to viewscapes. Like this article, researchers might use photographs showing conditions to help respondents assess the acceptability of conditions created by tamarisk control.

Fourth, future research is needed on issues that compliment tamarisk management. With the control and removal of tamarisk, opportunities are given for the invasion of other alien species. Future research may address the social implications of restoration actions that result from tamarisk control. In addition to restoration actions, researcher may focus on other alien species that are often associated with populations of tamarisk, such as Russian knapweed (*Rhaponticum repens*, previously known as *Centaurea repens*).

Fifth, other aspects of soundscape ecology may be addressed. The natural soundscape is important to visitors and should be protected for visitor experience. Future research may address aspects of chainsaw noise including acceptable levels of noise and visitor distance from work site. With noise level as an indicator (e.g., decibel), land managers would be able to set standards to maintain acceptable noise levels at tamarisk control sites. In addition, a noise level indicator may also be established for restoration activities. Restoration activities at tamarisk control sites often include the use of motorized equipment to auger, or drill, into the ground. This equipment accelerates the process of planting native species, but may create noise similar to a chainsaw. Future research may help established standards based on a noise level indicator, such as a decibel, or time exposed to the noise (Ambrose & Burson, 2004; Marin, Newman, Manning, Vaske, & Stack, 2011).

Finally, research regarding tamarisk control might include cluster analysis for different user segments, sites, or social physiological variables. Future analysis of normative data using PCI_2 may also be improved by developing a method to find statistical significance in multivariable analysis. In chapters two and three of this thesis PCI_2 was used to compare normative responses among river users (Vaske, Beaman, Barreto, & Shelby, 2010). Currently these statistical models are believed to be the most robust in comparing the potential for conflict among normative responses; however, there are inherent limitations when using PCI_2.

For instance, the PCI_2 difference (*d*) formula only allows a researcher to compare the difference between two values. This formula was useful when comparing the Green and Colorado River corridors in chapter 3, but was limiting when comparing the tamarisk control methods in chapter 2, due to the experiment-wise error rate. While current researchers mat apply the Bonferroni Correction to the difference formula in this situation, a PCI_2 difference test formulated to find statistical significance for differences between PCI_2 results with three or more findings may be developed to facilitate multi-variable analysis without additional correction.

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APPENDICES

Appendix A

Questionnaire

Tamarisk (Salt Cedar) Control Methods

Utah State University is conducting this survey to gather input on tamarisk control methods in the Green and Colorado River corridors. Your input helps the NPS and other land management agencies make informed decisions regarding tamarisk (salt cedar) control methods. ***Please answer <u>all</u> questions.***

1. Please check ***all*** of the activities in which you participated on this trip. **(check ALL THAT APPLY)**

☐ ***A.*** Rafting ☐ ***E.*** Canoeing ☐ ***G.*** Jet boating ☐ ***H.*** Pack rafting

☐ ***B.*** Photography ☐ ***D.*** Kayaking ☐ ***F.*** Hiking ☐ ***C.*** Fishing

2. From the activities in Question 1, write the letter of the ***<u>ONE</u> main activity*** in which you participated in on this trip ________.

Burning	Cut-stump	Tamarisk Leaf	Mechanical
			

3. How would you rate your overall **knowledge of tamarisk (salt cedar)**?
(check ONE) ☐ No Knowledge ☐ Some Knowledge ☐ Advanced Knowledge ☐ Expert Knowledge

4. ***<u>Based on your current knowledge of tamarisk</u>***, how acceptable would it be for managers to take ***<u>EACH</u>*** of the following actions?

	Very Unacceptable	Unacceptable	Neither	Acceptable	Very Acceptable
Burning along riverbanks between campsites	1	2	3	4	5
Burning in and adjacent to campsites	1	2	3	4	5
Cut-stump along riverbanks between campsites	1	2	3	4	5
Cut-stump in and adjacent to campsites	1	2	3	4	5
Tamarisk leaf beetle along riverbanks between campsites	1	2	3	4	5
Tamarisk leaf beetle in and adjacent to campsites	1	2	3	4	5
Mechanical removal (back hoe) along riverbanks	1	2	3	4	5
Mechanical removal in and adjacent to campsites	1	2	3	4	5

Continues on next page

5. Would you like tamarisk to be removed?

☐ Yes ☐ No **Why?** ☐

6. If you answered **YES**, where would you like it removed?

(check ONE) ☐ Campsites ☐ Along riverbanks between campsites ☐ Both

7. If tamarisk were being sawed down, which would you rather have on the river? **(Please consider the effects on the natural soundscape and the number of people conducting the work.)**

(check ONE) ☐ 2 chainsaws ☐ 20 handsaws

8. The noise of a chainsaw running to remove tamarisk on the Colorado River is:

(check ONE) ☐ Very Acceptable ☐ Acceptable ☐ Neither ☐ Unacceptable ☐ Very Unacceptable

9. The noise of a chainsaw running to remove tamarisk on the Green River is:

(check ONE) ☐ Very Acceptable ☐ Acceptable ☐ Neither ☐ Unacceptable ☐ Very Unacceptable

10. Should there be more educational or interpretive information about tamarisk management on the Green and Colorado rivers?

(check ONE) ☐ No ☐ Yes ☐ Unsure

You are: ☐ Male ☐ Female

What is your age? _________ years old

Where do you live? State / Province ________________ Country __________________

You are a: **(check ONE)**

☐ Private river user
☐ Client of a guiding service
☐ River guide or outfitter
☐ Ranger or technician

Appendix B

Poster presented at the National Association of

Recreation Resource Planners (NARRP) Conference, 2011

River User Norms for Tamarisk (Salt Cedar) Control Methods

Clay Allred M.S. Candidate, Recreation Resource Management, Utah State University
Robyn L. Ceurvorst Ph.D., Utah State University Moab
Mark E. Miller Ph.D., National Park Service Ecologist, Southeast Utah Group

Control Methods

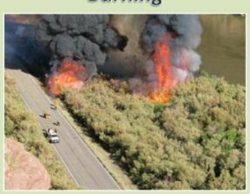
Biological Control

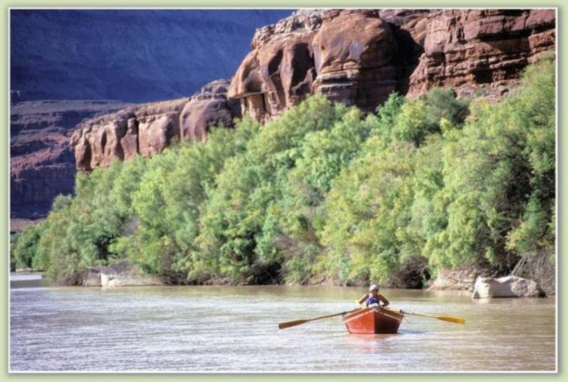
Tamarisk Leaf Beetle

Cut-stump Method:
Cutting and applying herbicide

Manual Removal

Burning





Norms: Standards that individuals use for evaluating behaviors, activities, environments, or management proposals as good or bad, better or worse.

Importance of Norms

With normative research land managers will know the acceptability of tamarisk control methods in high value recreation and wilderness areas.

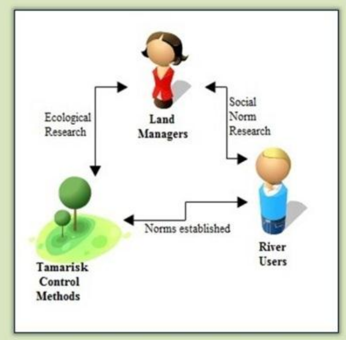
River users norms for indicators will then help managers set standards for tamarisk management actions.

Purpose of Norms in Tamarisk Management

1. Norms help identify goals.
2. Norms help define salient characteristics of high quality settings.
3. Norms give information about acceptable impact levels.
4. Norms help differentiate minimal conditions from optimal conditions.
5. Norms help identify important impacts about which people feel more strongly.
6. Normative information indicates the degree of consensus among different groups.

Research Questions:

1. What is the acceptability of these various control methods on tamarisk?
2. Is this acceptability influenced by users wilderness expectations?



Utah State University MOAB EDUCATION CENTER

Appendix C

2012 Tamarisk Symposium Presentation

KNOWLEDGE, NORMS AND PREFERENCES TOWARD TAMARISK MANAGEMENT IN THE GREEN AND COLORADO RIVER CORRIDORS OF THE COLORADO PLATEAU

Utah State University College of Natural Resources

Allred, C., Ceurvorst, R., Brunson, M., Miller, M.

Introduction and Purpose

The introduction and prevalence of tamarisk on rivers

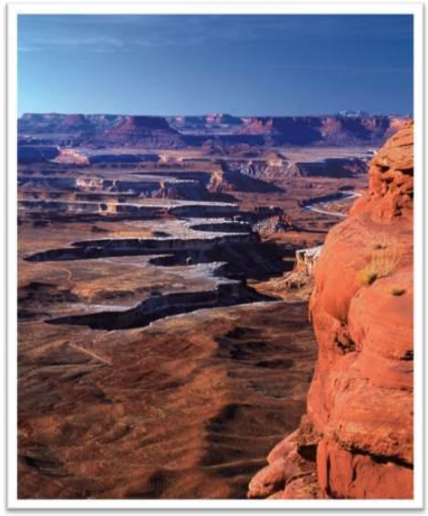
control actions

River user experience may be altered by tamarisk management practices

- Two articles:
  - Knowledge, norms and preferences for tamarisk management.
  - Norms for chainsaw noise in different river settings.

Conceptual Background

- Background areas
  - Invasive Alien Species
  - Management Frameworks
  - Norms in Natural Resource Management
  - Potential for Conflict Index$_2$
  - Natural Soundscapes

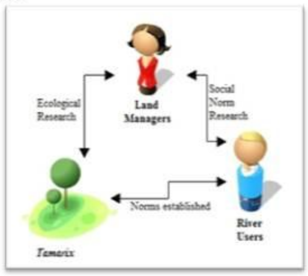


Invasive Alien Species

- Today tamarisk has the second highest normalized cover and is the third most prevalent woody riparian plant in the western United States (Friedman et al., 2005).
- Executive Order (EO) 13112 mandates federal agencies to prevent the spread of and control populations of invasive species.

Management Frameworks

- These frameworks help managers set standards based on measurable, manageable indicators.
- Example: The National Park Service Visitor Experience and Resource Protection (VERP) Framework.
  - Managers select and monitor indicators that reflect desired conditions.



Social Norms

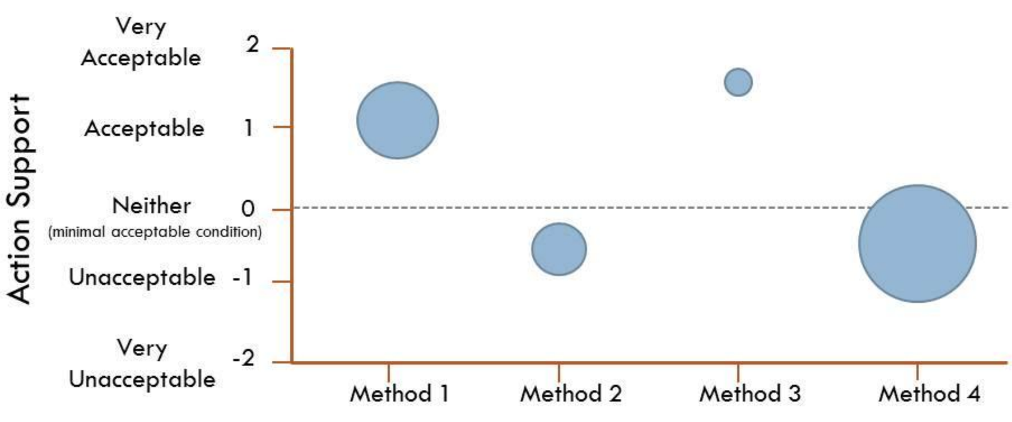
- Norms are standards that individuals use for evaluating actions, or conditions caused by actions, as good or bad, better or worse (Shelby, Vaske, & Donnelly, 1996).
- By describing acceptable conditions for indicators with norms, managers may better understand where to set standards (Manning, 2011).

Potential for Conflict $Index_2$

- Potential conflict between stakeholders, such as river users, can be quantified using the Potential for Conflict $Index_2$ (PCI_2).
- PCI_2 requires no statistical training to interpret results - aids in the comprehension of normative data among nontechnical audiences.
- The potential for conflict among respondents is given a value from 0 "minimum potential conflict" to 1 "maximum potential conflict."

Potential for Conflict $Index_2$

- The Potential for Conflict $Index_2$ (PCI_2) gives researchers a way to display normative results (Vaske, Beaman, Barreto, & Shelby, 2010).



x-axis: indicator measured (e.g., type of control method)
y-axis: evaluation (e.g., acceptance)

Natural Soundscape

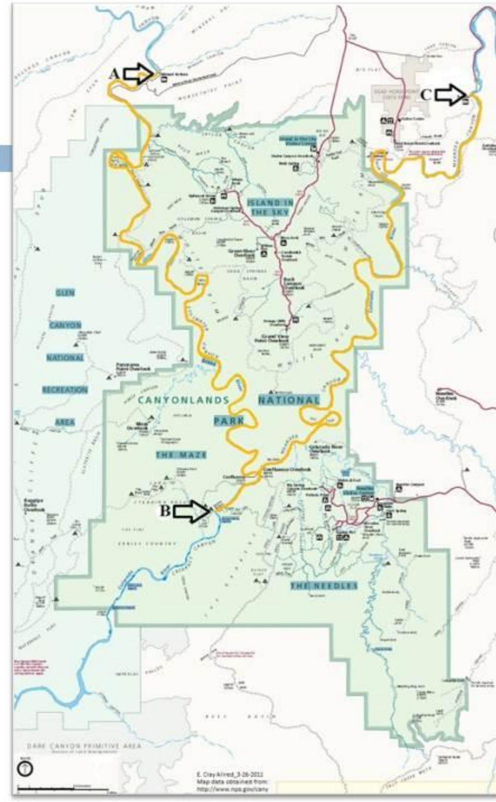
- The natural sounds that occur in an environment without the addition of human-caused noise.
- Important aspect of wilderness where visitors want solitude, tranquility and natural quiet.
- Tamarisk management and human caused noise.

Research Questions

- What is river user self-assessed overall knowledge of tamarisk?
- Would river users like tamarisk removed?
- What are river user norms for control methods?
- Would river users prefer the use chainsaws or handsaws to remove tamarisk?
- What are river user norms for chainsaw noise on the Colorado and Green rivers, and do they differ?
- Would river users like more education and interpretation regarding tamarisk management?

Methods

- Study area of 159.33 river kilometers shown in orange.
- As indicated on the map:
  - (A) Mineral Bottom
  - (B) Spanish Bottom
  - (C) Potash boat ramp
- Sampling and data collection.
  - River recreation season April to October 2011
  - n = 330 questionnaires (95% CI)



Questionnaire

- Knowledge evaluation
- Norms for methods in and adjacent to campsites
- If and why users do or do not want tamarisk removed
- Norms for chainsaw noise on Green and Colorado River
- Preference for education and interpretation


Mechanical (mulch)


Burning


Cut-stump

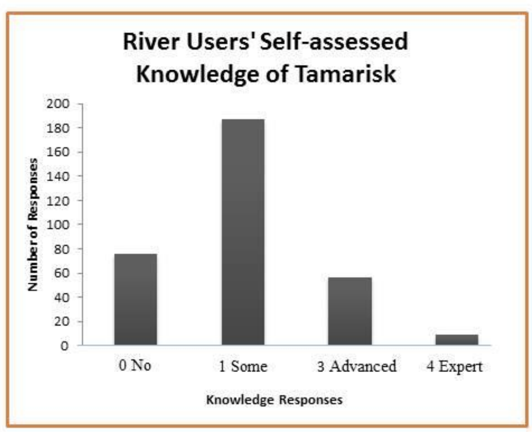

Tamarisk Leaf Beetle

Analysis

- SPSS 19 – Statistics for social science
- Excel 2010 – Graphs using PCI_2 data
- Potential for Conflict Index$_2$ (Vaske et al., 2010)
  - PCI_2 values (between 0 and 1)
    - $\mathrm{PCI}_2 = \left[\sum\left(n_k n_h d_{k,h}\right)\right]/\delta$
  - Distance formula
    - $d = |(\mathrm{PCI_a} - \mathrm{PCI_b})| \,/\, \sqrt{[(\mathrm{PCI_{aSD}})^2 + (\mathrm{PCI_b})^2]}$
  - Http://warnercnr.colostate.edu/~jerryv/PCI2/index.htm

Results

- Self-assessed knowledge
  - No knowledge – 23%
  - Some knowledge – 57%
  - Advanced knowledge – 17%
  - Expert knowledge – 3%
  - Most users = some knowledge

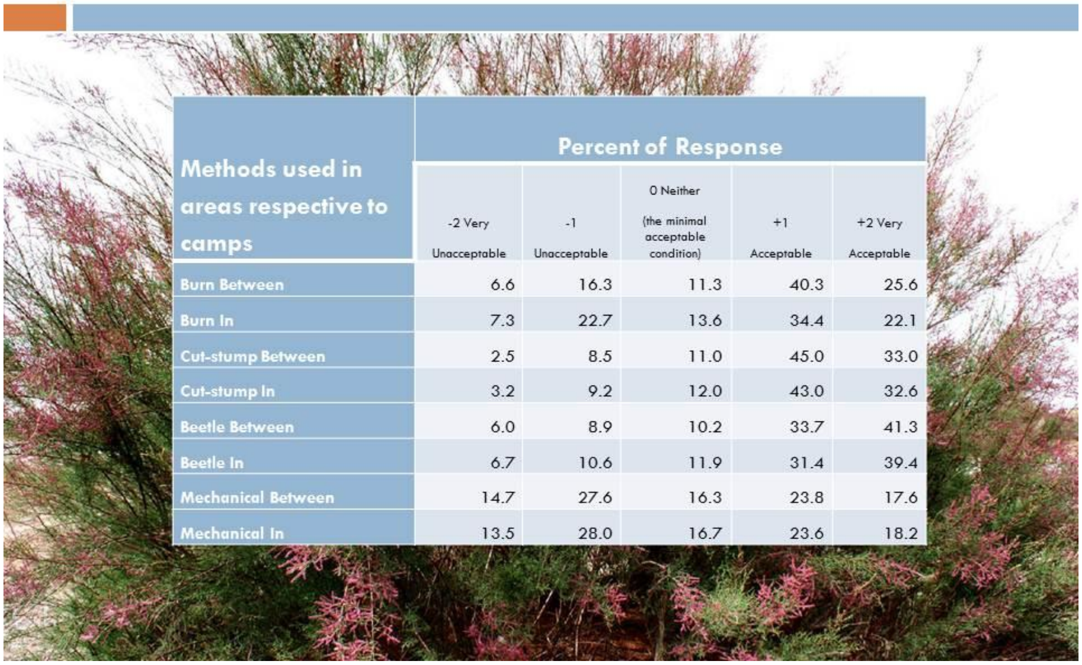


Tamarisk Removal Preference – Why?

88% of sampled river users support tamarisk removal

	Preference for Tamarisk Removal and Reason	Percent of Respondents
Yes	- Because it is invasive	41.3
	- For native species and biodiversity	20.8
	- Uses too much water	4.9
	- For native ecosystems and access to recreation sites	9.1
	- Access to camps and other recreation sites	12.5
	- To improve the viewscape	1.1
	- Reduces quality of recreation experience (e.g. harbors mosquitoes, smells bad)	2.3
No	- To protect the ecosystem (e.g. erosion control, leave nature alone)	2.3
	- Too difficult and costly to remove	2.7
	- User liked tamarisk or it doesn't bother them	3.0

Evaluative Makeup of Norms



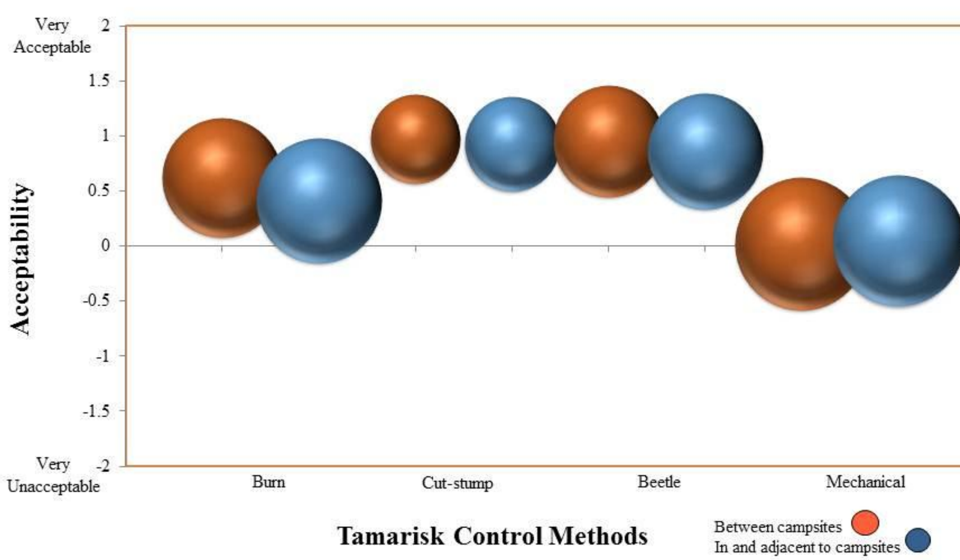
Methods used in areas respective to camps	Percent of Response				
	-2 Very Unacceptable	-1 Unacceptable	0 Neither (the minimal acceptable condition)	+1 Acceptable	+2 Very Acceptable
Burn Between	6.6	16.3	11.3	40.3	25.6
Burn In	7.3	22.7	13.6	34.4	22.1
Cut-stump Between	2.5	8.5	11.0	45.0	33.0
Cut-stump In	3.2	9.2	12.0	43.0	32.6
Beetle Between	6.0	8.9	10.2	33.7	41.3
Beetle In	6.7	10.6	11.9	31.4	39.4
Mechanical Between	14.7	27.6	16.3	23.8	17.6
Mechanical In	13.5	28.0	16.7	23.6	18.2

Norms for Control Methods

Tamarisk Control Action	Mean[1]	PCI_2[2]	Skewness	Kurtosis	Standard Deviation
Burn Between Camps	0.62	0.40	-0.69	-0.58	1.21
Burn in Camps	0.41	0.45	-0.37	-1.06	1.26
Cut-stump Between Camps	0.97	0.23	-1.06	0.71	1.00
Cut-stump in Camps	0.93	0.25	-1.01	0.47	1.05
Beetle Between Camps	0.95	0.33	-1.10	0.27	1.19
Beetle in Camps	0.86	0.36	-0.94	-0.17	1.24
Mechanical Between Camps	0.02	0.49	0.04	-1.26	1.36
Mechanical in Camps	0.05	0.48	0.03	-1.25	1.34

1. Mean being the sum of the individual values divided by the number of cases: Evaluated on a scale ranging from -2 "very unacceptable" to +2 "very acceptable", with 0 "neither" as a neutral point.
2. The potential for conflict (PCI_2) is measured on a scale ranging from 0 "minimum potential conflict", to 1 "maximum potential conflict".

Norms and Potential for Conflict Among Respondents for Tamarisk Control Methods



Evaluative Makeup of Norms

	Percent of Response				
	-2 Very Unacceptable	-1 Unacceptable	0 Neither	+1 Acceptable	+2 Very Acceptable
Chainsaw Noise on Green River	7.8	20.1	16.0	43.6	12.5
Chainsaw Noise on Colorado River	5.3	15.8	16.8	48.8	13.4

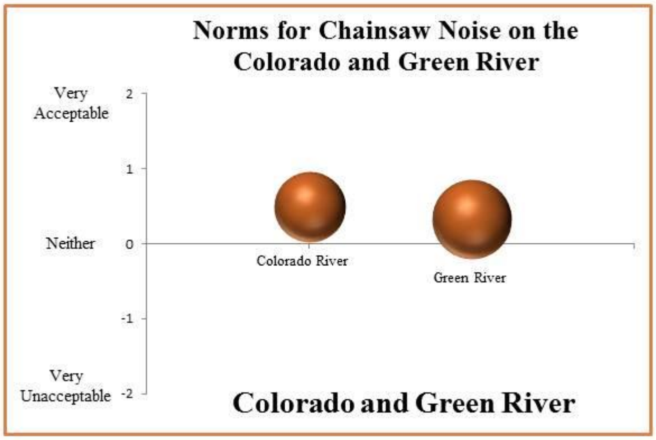
Saw Preference & Norms for Chainsaw Noise

- 62% of respondents prefer the use of a chainsaw.

	Mean[1]	PCI_2[2]	Standard Deviation	Variance	Skewness	Kurtosis
Colorado River	0.49	0.26	1.07	1.15	-0.68	-0.31
Green River	0.33	0.31	1.16	1.35	-0.49	-0.78

1. Mean being the sum of the individual values divided by the number of cases: Evaluated on a scale ranging from -2 "very unacceptable" to +2 "very acceptable", with 0 "neither" as a neutral point.
2. The potential for conflict (PCI_2) is measured on a scale ranging from 0 "minimum potential conflict", to 1 "maximum potential conflict".

Norms and PCI_2 for Chainsaw Noise



- The norms for chainsaw noise on the rivers differed slightly. Their PCI_2 values differed but the difference was not statistically significant.

Education & Interpretation

- 84% of respondents reported that they would like to see more educational or interpretative information regarding tamarisk management.
- Offering additional education may help public land managers by raising the social acceptability of tamarisk control methods.

Implications for Managers

- Control method norms were **acceptable.**
- Chainsaw preference and norms.
- Low knowledge; 84% indicated that they would like additional education or interpretation regarding tamarisk.
  - Interpretive talks by rangers
  - Increased or improved signage
  - Informative brochures included in river permit information.

Implications for Future Research

- Why?
- Viewscape: monoview
- Soundscape
- Broaden scope:
  - Stakeholders
  - Species and methods
- Other social topics:
  - Norms for restoration
  - Norms for plant succession
- PCI2 – Multivariable analysis improvement

Questions?

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