

# Mapping Tradeoffs in Values at Risk at the Interface Between Wilderness and Non-wilderness Lands<sup>1</sup>

Alan Watson<sup>2</sup>, Roian Matt<sup>3</sup>, Tim Waters<sup>4</sup>, Kari Gunderson<sup>5</sup>, Steve Carver<sup>3</sup>, Brett Davis<sup>2</sup>

## Abstract

On the Flathead Indian Reservation in Montana, U.S., the Mission Mountains Tribal Wilderness is bordered by a buffer zone. To successfully improve forest health within that buffer zone and restore fire in the wilderness, the managing agency and the public need to work together to find solutions to increasingly threatening fuel buildups. A combination of qualitative, culturally sensitive research and a web-based mapping exercise have been used to develop understanding of the tradeoffs Reservation residents describe in relation to potential buffer zone actions. The primary meanings Tribal members associate with the Buffer Zone are protection of the wilderness, wildlife and water quality, access and functional attachments, recreation and scenic values, and personal and cultural meanings. To build trust among both tribal and non-tribal residents, fire planners must understand how proposed actions interact with values at risk assigned by the local community and describe a prioritization process that addresses publicly perceived threats

*Key Words: buffer zone, cultural landscapes, fuel treatment, geographic information systems*

## Introduction

The urgency to restore fire across the landscape is growing annually, due to uncontrollable wildfires becoming more common across the western U.S., and climate change and encroachment of human settlement on fire-based ecosystems (Miller 2006). Years of active

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<sup>2</sup> Research Scientist and GIS Specialist, Aldo Leopold Wilderness Research Institute, USDA Forest Service, Rocky Mountain Research Station (e-mail: [awatson@fs.fed.us](mailto:awatson@fs.fed.us), [bhdavis@fs.fed.us](mailto:bhdavis@fs.fed.us))

<sup>3</sup> Community Outreach Coordinator, Forestry Department, Confederated Salish & Kootenai Tribes ([greeneyednativewoman@yahoo.com](mailto:greeneyednativewoman@yahoo.com))

<sup>4</sup> Consultant and Faculty, The University of Leeds ([waters\\_tim@hotmail.com](mailto:waters_tim@hotmail.com), [S.J.Carver@leeds.ac.uk](mailto:S.J.Carver@leeds.ac.uk))

<sup>5</sup> Assistant Professor, The University of Montana ([cnd2543@blackfoot.net](mailto:cnd2543@blackfoot.net))

fire suppression has led to the build up of hazardous fuel loads creating ideal conditions for destructive wildfires (Johnson et al. 2001). Currently, fire management is very focused on re-instating natural fire regimes through progressive fuel treatment and allowing fire, as nearly as possible, return to function in its natural ecological role (Miller 2006). Thinning and burning are being used to reduce fuel loads to near natural conditions, after which natural fire regimes can be allowed to operate. To instil trust and accomplish resource management objectives, a high degree of collaboration and participatory planning with the public is needed (Liljeblad and Borrie 2006). Among the key contributors to trust in fire and fuel management decisions is procedural justice (Liljeblad and Borrie 2006), or the perceived fairness, equity and legitimacy of decisions managers make. People want to be assured that managers understand the values they attach to forest lands and these values are at least considered in decision making.

Throughout the western U.S., rural communities and federal, state and local agencies are working cooperatively to initiate plans for reducing risks associated with the build-up of hazardous fuel on forest and grass lands. Critically important in accomplishing fuel treatment and fire management objectives is the interface between wilderness and non-wilderness lands (Gunderson 2006). In designated Wilderness, the use of wildland fire, including prescribed burns, can help restore the natural role of fire as well as create a buffer along the wilderness boundary to protect non-wilderness values associated with adjacent lands. This paper describes a participatory process and methodology that has been developed to help capture personal and community meanings (or values at risk) associated with a landscape for the planning and potential application of fuel treatment and fire management. The aims of the project are to:

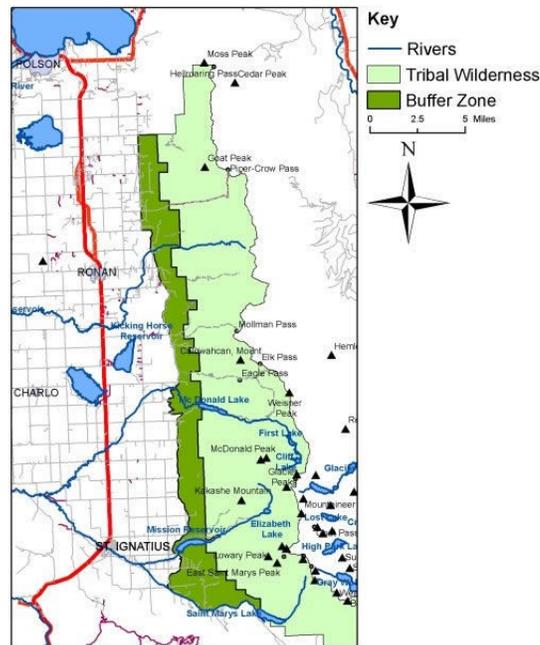
- Describe meanings residents place on the landscape within the Tribal Buffer Zone on the Flathead Indian Reservation with the ultimate goal of using this local knowledge to better understand tradeoffs in values at risk in forest fuel reduction strategies implemented by the Tribal Forestry Department; and
- Map these values for the Tribal Buffer Zone to understand the intensity and spatial distribution of individual and community meanings associated with this landscape of contested meanings.

## **Background**

On the Flathead Indian Reservation in Montana, an interface area exists between the Mission Mountains Tribal Wilderness and the non-wilderness valley floor. The area, formally protected as the Mission Mountains Tribal Buffer Zone, was established in 1987 in the foothills of the Mission Mountains with the intention of protecting the Wilderness from outside influences; primarily human civilization and development on the valley floor (Figure

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1). This interface area provides opportunities for multiple uses, including cultural uses, some home sites, recreation, and other consumptive and non-consumptive resource uses.



**Figure 1**-- The Mission Mountains Tribal Wilderness and Tribal Buffer Zone extend north to south along the eastern border of the Flathead Indian Reservation.

One of the primary concerns within the study area is the effect that fire suppression has had on the structure and general health of the forest within significant portions of the Buffer Zone. Large fires in 1910 contributed to intolerance and immediate suppression of most fires throughout the West in most of the 20<sup>th</sup> century (Aplet 2006). Both the Tribal Wilderness and the Buffer Zone exhibit heavy and hazardous accumulations of dead wood and down timber on the forest floor, a dense understory of brush and young trees, and closely spaced trees and closed forest canopy (CSKT 2005c). Such forests are increasingly regarded as “unhealthy” and highly susceptible to destructive wildfires, as well as to insects. In contrast, the traditional culture of local tribes included the use of fire as a tool to nurture and sustain the natural resources of the land. Tribal people used fire on a vast scale applying it to the land at different times of the year for various reasons. This included the thinning of dense brush in forested areas to keep them “clean” for wildlife and hunting, clearing of trails for travelling, and nurturing of food and medicinal plants for subsistence use. In the 19<sup>th</sup> Century, native use of fire began to be altered as European settlement expanded into the West, and by the early 20<sup>th</sup> Century, following these devastating fires of 1910, the traditional use of fire by tribal people was largely eliminated. Tribal resource managers now employ modern fire management

techniques, though with consideration of the cultural values ascribed to the land (CSKT 2005a).

The current focus of resource managers is on how to reduce potentially hazardous fuel loads in the Buffer Zone in order to address “emerging issues of public and firefighter safety, reduce the risk of large high intensity fires, and restore the forests to a more biologically balanced condition” (CSKT 2005b, p.1). However, past proposals to change the Buffer Zone classification from unavailable to available for timber harvest have failed due to lack of support among Tribal members. The current process therefore uses participatory methods adapted from a previous project in the adjacent Bitterroot National Forest (Gunderson and Watson 2007) and expanded to use web-based mapping methods developed in the UK (Carver et al. 2001; Evans and Waters 2007) to better capture how Tribal and non-tribal Reservation residents relate to the Buffer Zone and the threats they perceive to this relationship.

## **Participatory approaches to understanding values at risk**

One of the key problems in developing a better understanding of different responses to landscape level management actions, such as fuel treatments, is being able to confidently record and accurately spatially delineate the meanings stakeholders ascribe to the landscape. Previous methodology development work on understanding personal and community values at risk and mapping them as input to landscape-level fuels treatment (Gunderson 2006, Gunderson and Watson 2007) utilized semi-structured interviews, key informant interviews and focus groups to encourage people to talk about their local landscape, to differentiate between the meanings associated with places they commonly went and those they seldom or have never visited, explore the scale of these meanings through mapping exercises and discuss how these meanings interact with intentional fuel treatments. Maps were then digitized and imported into GIS for display during decision making on location of fuel treatment activities and techniques used.

Being able to actually map and discuss the different meanings people place on the landscape in this fashion has a number of advantages over less place-based techniques. These include the ability to link meanings to specific locations or landscape units, and perform advanced analyses on responses by looking at spatial relationships based on proximity, adjacency, containment, connectivity and visibility. “Hot spot” areas could be delineated through categorizing and displaying information such as number of people indicating a particular spot, the importance people gave to that indicated spot and the specificity of the area indicated.

Despite success in previous methodology testing, a number of shortcomings were identified in the mapped-based aspects of methodology developed. Of particular need for improvement was the need to increase the number of people engaging in this map-based activity. The cumbersome task of a researcher meeting with every person, or even focus group discussions, and leading them through a pencil and paper exercise while trying to either record or note things they say about these important areas was a very difficult task. An individual's relationship with a local landscape is essentially fuzzy and cannot be easily captured using traditional map-based features or entities such as points, lines and polygons. So, while scale is captured, it is not captured efficiently, and the intensity of meanings attached to places was not captured at all.

In order to address these issues, the current project adopts more fuzzy methods of capturing the landscape areas that people value or for which they hold a particular meaning. This is based on the application of a Java-based mapping Applet called "Tagger" that uses a spray-can tool to allow users to define areas on a base map in a manner that allows them to easily vary the density and shape of the sprayed area (Evans and Waters 2007). This tool captures fuzzy spatial concepts in defining relationships, as well as (un)certainity and importance in the relative meanings attached to these places. The system can be used both online over the internet and offline on a stand-alone laptop computer.

## Methodology

An expanded rapid appraisal technique (Beebe 1995) is used to direct three phases of data collection. Each phase is guided by a specific objective as follows. In Phase 1 key knowledgeable informant interviews were used to develop an understanding of the range and types of meanings attached to the Mission Mountains Tribal Buffer Zone and for contrast, also the Wilderness, by both Tribal members and non-tribal member residents on the Flathead Indian Reservation (Watson et al. in press). In Phase 2, participatory GIS methods were used to visually illustrate the intensity and spatial distribution of the meanings differentiated in Phase 1, and record perceived threats to these meanings, within only the Buffer Zone. In Phase 3 focus group interviews are being used to better understand the interaction between mapped landscape meanings from Phase 2, perceived threats, and potential fuel treatment options.

### ***Phase 1: key informant interviews***

Semi-structured interviews were conducted with Tribal members and non-tribal Reservation residents to solicit information on the range and types of meanings associated with this landscape (Wilderness and Buffer Zone). Following the work of Lewis and Sheppard (2005), key informants were selected to meet the following criteria: 1) knowledge, understanding and appreciation of traditional Tribal and non-tribal meanings associated with the landscape; 2) roles in the community that require a wide exposure to a range of Tribal and non-tribal

perspectives and perceptions of the landscape; and 3) ability to communicate with outsiders and ability to discuss relevant research issues in detail.

Twenty-two interviewees were asked to provide information about the meanings attached to the landscape in interviews scheduled and conducted at the convenience of the interviewee. These analyses and results are described in detail by Watson et al. (2007) and Watson et al. (in press).

### ***Phase 2: landscape mapping***

The actual methods used here to capture spatially fuzzy locations draw strongly on previous work on mapping place meanings (see Gunderson and Watson 2007) and on participatory GIS (see Carver et al. 2001 and Evans and Waters 2007). These methods are brought together in developing a fuzzy GIS-based tool for collecting qualitative, but spatially referenced, local knowledge and meanings from key informants and a broad public representing both Tribal and non-tribal residents. These are analyzed by creating composite maps of the fuzzy attribute-tagged maps generated by survey respondents and linking these to comments solicited during the mapping exercise and attached to the maps generated. The result of this phase of the project is a GIS dataset that provides a visual representation of the intensity and spatial distribution of meanings associated with the Buffer Zone, as well as comments on threats to these meanings.

All but one of the twenty-two interviewees from Phase 1 of the project were also engaged in Phase II, as well as obtaining additional input from other residents within the region via an online version of the system. Whereas it is believed possible to reach saturation in regard to the range and types of landscape meanings through 15-20 key informant interviews, research by Gunderson (2006) would suggest that greater numbers of Phase 2 respondents are required to capture the richness and variation in the spatial distribution of these meanings. Initially, thirty-four subjects participated in a test of the system to determine feasibility of this computer-based substitution for the paper and pencil method used previously. Some data were collected offline with a laptop computer. Some were done online via the web. All offline exercises were assisted by one of the research team, sometimes to make it easier for high priority participants (e.g., elders or previous participants) to engage and sometimes due to deficiency in computer skills or internet access. While the web-based exercise is open for a prolonged time to allow community participation and greater confidence in generalization, this paper illustrates results from only the initial thirty-four subjects.

Data were collected in a way that generated five map layers of themed meanings. These were driven by the Phase 1 findings and represent the meanings of the Buffer Zone for Tribal members: “protection of the wilderness,” “wildlife and water quality,” “recreation and scenic values,” “access and functional attachments,” and “personal and cultural” meanings. For demonstrative purposes, this paper focuses on 154 images developed by these 34 subjects across the five themed layers. For the overall map and categorization process, these 154

images are averaged and images produced using classes based on natural groupings inherent in the data with break points identified by picking the class breaks that group similar responses and maximize the differences between classes (Jenks 1967). For analysis purposes, the five individual meaning layer images are then presented, based on the same classification scheme used to develop the “overall mean” image. Additional analysis is possible and demonstrated by single layer analysis using the Jenks classifications generated from within the responses to a single meanings layer.

### ***Phase 3: focus group interviews***

The objectives of the third phase of the project are to present the GIS output outlined above and collaboratively discuss these with Tribal members and non-tribal residents in regard to the potential effects of different fuel treatment methods in the Buffer Zone. At the time of writing, this work is still ongoing. At least two focus group interviews will be conducted, facilitated by research team members. Phase 3 also serves the very positive purpose of informing the public that their views are valued and are being incorporated into the planning process thereby helping to break down one of the main barriers in accomplishing resource management objectives, maintaining trust.

### ***Development of the landscape mapping tool and user interface***

The main user interface is based around the “Tagger” fuzzy area definition software developed by Evans and Waters (2007) as a Java applet running within a standard web browser environment. This uses a spray can tool with which a user can define fuzzy areas of varying density on a map. Variations in intensity, or importance, can be easily made by spraying more or less over an area, making it correspondingly darker or lighter. Attribute information can be attached to the fuzzy area through the use of free-format text input boxes. The basic interface consists broadly of: a spray can tool that enables the user to spray fuzzy areas on a map; radio buttons to select small or large spray sizes; an Erase button to remove any spraying from the current map; a New Area button to save the current sprayings and allow the user to spray another area; a Paint All button that opens up a dialog window asking for a number from 0-100% to uniformly spray over the whole area; a Send Everything button that sends all the saved sprayings and attached attributes to the server; and text areas where the user is asked to answer “Why are areas important?”, and “What are the threats to these areas?”

Users progress through the application in a linear fashion as follows: 1) Welcome and outlining of the tasks and any technical requirements needed; 2) Background information about the project, fire and fuel treatments and the area of the Buffer Zone; 3) Introduction to the mapping system, explaining concepts such as “The longer you hold down the mouse button the darker it gets. The darker it gets means it has more importance” showing examples, and how users can use the mapping tool to indicate intensity; 4) Practice page, which helps people become familiar with the spray can mapping tool; 5) Questionnaire, with questions

about age, gender, residence, tribal membership, zip code, and whether they were doing the exercise individually, or in a group; 6) After the questionnaire, each person is asked to “Please show on the next map those areas that are most important to you...” for each of the five layers of meanings described in Phase I. An option is given to skip a map, if desired. 7) Maps were given (in random order, to help reduce bias) for each layer: a) Wildlife & Water Quality; b) Access and Functional Attachments; c) Protection of the Wilderness, d) Personal and Cultural Meanings; and e) Recreation and Scenic Values; 8) Besides indicating on each map where the most important areas were, they also answered the questions “Why are these areas important” and “What are the threats to these areas 9) After completing all the maps, a thank you page is shown together with further details about the project.

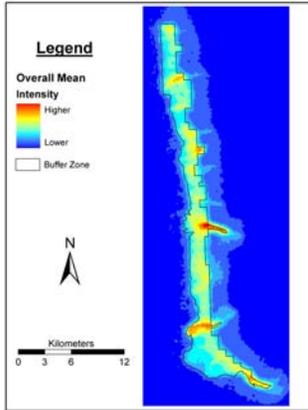
Each sprayed area entered by the user is processed by the Tagger software into a standard image format (gif and GeoTIFF) and compressed. The image and associated attribute information are stored and can be viewed either as an individual entity or combined into an aggregate “average” map based on all the users’ responses. The Tagger system also includes a query function, where researchers can click on the composite image of everyone’s responses and query this area for the text associated with that area, weighted by intensity. Additional administrative tools include the ability to examine, delete or edit individual maps and textual responses.

## Results

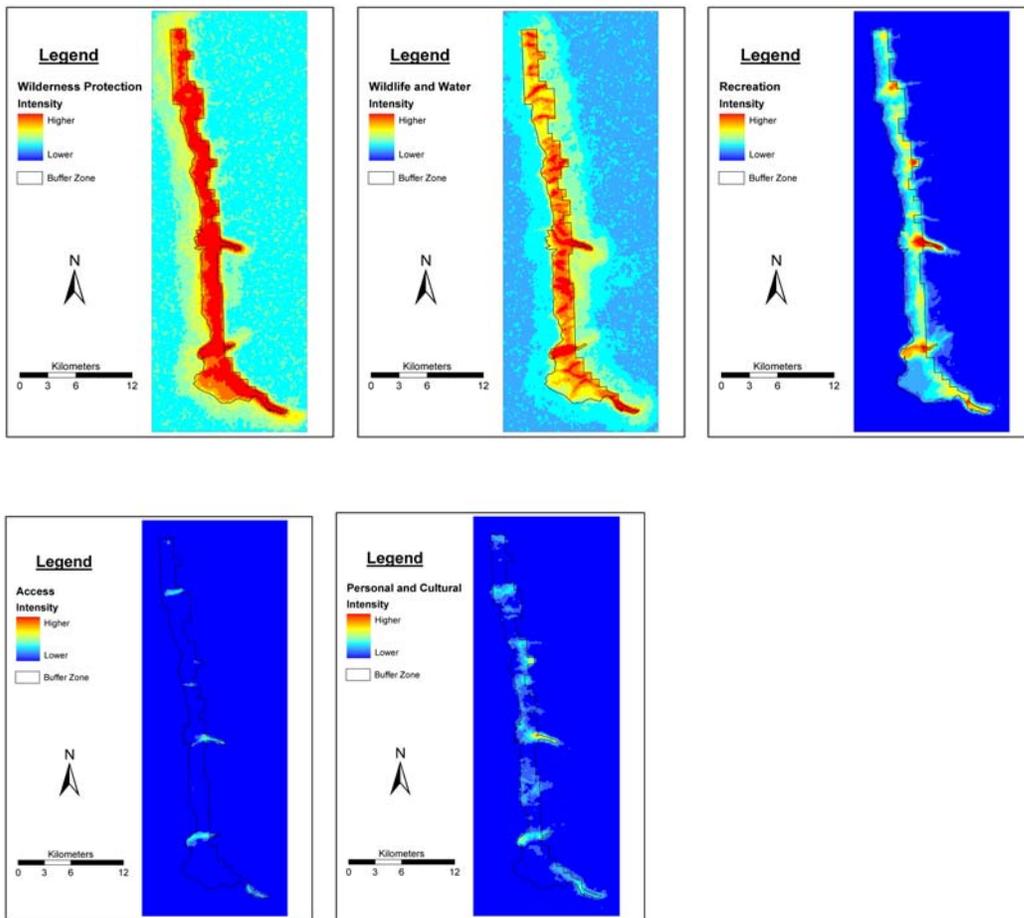
The results from the Phase 2 mapping exercise are shown in Figure 2 as an overall average across 154 user-created maps. These data are preliminary, representing the initial effort at obtaining public participation in this process. A mixture of online (web-based) and offline (laptop-based) participants were included and results monitored to assure quality of data capture. After this preliminary data collection with the thirty-four participants, the wider public was invited to participate in this process via the local media including announcements in the local, weekly newspaper and on the tribal government intranet web site appearing on every employee’s log-in page.

It can be seen from the averaged maps in Figure 3 that there are marked differences in the spatial pattern and intensity of meanings associated with the five themes. It should be noted that in order to aid comparison, the same classification and color scheme is used for all five theme maps and the overall average map.

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**Figure 2--** Composite map for overall averaged results (Jenks method,10 categories)



**Figure 3--** Results for all 5 layers of meanings attached to the Buffer Zone by Tribal and non-tribal residents (10 categories – Jenks method from Overall Average)

Of the five themes, protection of wilderness shows the greatest uniformity, perhaps as a result of the general view among respondents of the Buffer Zone as a policy zone with universal value throughout. A significant proportion of users used the “Paint All” button to apply a uniform spray density over the whole area for this theme to indicate value that is broad in scale (covering the whole Buffer Zone). The access theme exhibits the least extent of coverage of important places, likely due to the presence of privately owned land within the buffer zone and the limited number of access points to the wilderness. Hot spots within the recreation and scenic values layer reflect the location of access corridors and are possibly driven by frequency of visits to several popular sites within the Buffer Zone or Wilderness. It is clear that more remote and inaccessible areas are also highly valued and have meaning for several of the layers. The map for wildlife and water quality shows perhaps the greatest spatial variation of all the five themes with users identifying areas not in easily accessed or frequently used areas, but on their environmental credentials for wildlife and water protection.

Since “protecting the wilderness” is the broadest meaning assigned to the buffer zone among the subjects, for illustrative purposes, the results of threats reported by subjects is presented here. For thirty-four tribal and non-tribal residents, the perceived threats to this community meaning were basically in four categories: threat of wildfire, intense logging, roads and development, and off-highway vehicle use.

The threat of wildfire was prominently attributed to “80 plus years of fire restriction,” and fears they would potentially be “started by careless people.” “Uncontrolled fires now would be disastrous,” due to “fire exclusion for so long.” “Doing nothing” remains to be a threat to the function of the buffer zone to function as a protector of the wilderness. People realize the buffer zone is “over stocked” or “dense,” there is a “fuel buildup,” of concern, particularly the potential of “a stand replacing fire now.” The “hazard” associated with potential wildfire due to changes in vegetation and fire exclusion is a dominant theme for threats to this area’s ability to protect the wilderness.

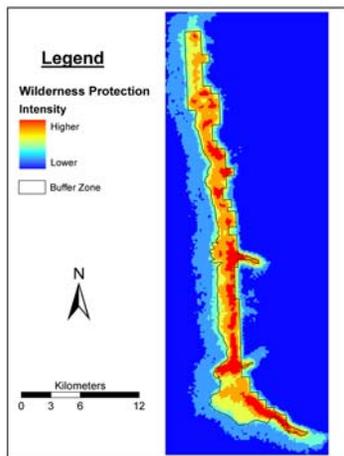
While potential for wildfire was broadly recognized by many subjects, logging is also commonly listed among threats, giving rise to the dilemma tribal resource managers face. The threats are most commonly described as “over use by modern machinery,” “intense logging,” “commerce,” “extreme logging,” “commercial logging,” and “large scale logging,” giving suggestion that people are concerned not just about logging, but the scale and intensity it might entail.

Not particularly related to the purpose of this paper, but also significant threats to the buffer zone are concerns residents have about perceived growth in road access, subdivision of property, and ATV and motorcycle use on and off roads. Some miscellaneous threats attached to specific areas in the buffer zone were cattle grazing, recreation over use, horses, litter, weeds, impacts to water quality, and insect outbreaks. While a larger proportion of subjects indicated this meaning was attached broadly to the buffer zone than for other, more specific

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meanings, many of these threats were attached to specific places in the buffer zone, providing some opportunity to base discussions about priorities for management actions.

An additional level of analysis is presented for the “protection of wilderness” layer. In this case (Figure 4) the Jenks method was used to map averages across all subjects (30) for this meanings layer. Within this data set, some highest priority areas emerge



**Figure 4--** Results for all “protection of wilderness” layer of meanings attached to the Buffer Zone by Tribal and non-tribal residents (6 categories – Jenks method)

## Conclusions

This paper describes a new planning support system aimed at collecting spatial and contextual information about public perceptions of landscapes to develop better understanding of place-based values. The three phase approach used here demonstrates a rigorous approach to participation and data collection in developing publicly acceptable management strategies and actions in the face of multiple, spatially variable and sometimes conflicting viewpoints. The process described involves a mix of both face-to-face and automated methods of data collection using key informant interviews to inform the development and application of automated methods of spatial and attribute data capture using map-based computer interfaces.

Mapping results assume prior success in capturing the richness of meanings attached to the complex buffer zone landscape. The combination of user-defined fuzzy areas and qualitative data collection methods has enabled a wide range of personal and community meanings to be spatially delimited across a broad area. Automated data collection and 24/7 availability of the online version of the system also means that the work can span a far greater audience than would be possible via traditional face-to-face or paper-based social survey methods, making detailed and disaggregated analyses possible with higher numbers of respondents. In addition, the

linkage of themed spray patterns and tagged attributes with user profiles makes detailed analysis of differences between different demographic and/or stakeholder groups possible. For example, in the final analysis, focus will likely be on Tribal member responses, though understanding of non-tribal responses is also of interest to land managers and the Tribal Council. The resulting dataset and possibilities for further analysis represents an extremely rich resource for policy development in regard to resource management that takes both public perceptions and the realities of the physical world into account.

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