

# Human Relationships to Fire Prone Ecosystems: Mapping Values at Risk on Contested Landscapes

Kari Gunderson, Steve Carver, and Brett H. Davis

**Abstract**—A key problem 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. To more accurately understand these relationships with the Bitterroot National Forest, Montana, U.S.A., local residents were asked to identify specific places, why they valued them, and how fuel treatments affected these values. Resulting maps displayed variation in the spatial scale and differences in terms used to describe attachments to places they have visited and those they have not. This paper and pencil exercise failed to adequately capture intensity of meanings. To address this issue, a computer-based mapping exercise was used with residents on the Flathead Indian Reservation, Montana, U.S.A., to capture the intensity and spatial distribution of meanings associated with proposed fuel reduction projects on this landscape. This paper will present two different mapping approaches and discuss challenges in mapping meanings.

## Introduction

To successfully improve forest health and restore fire in fire prone ecosystems, natural resource management agencies, tribal governments, and the public need to work together to find solutions to increasingly threatening fuel buildups. Land managers need to understand how proposed actions impact values at risk assigned by local residents and describe a prioritization process that addresses publicly perceived threats to build trust and acceptance among local

residents in fire prone communities. Community meanings (or values at risk) could include loss of homes, changes in vegetation or scenery, wildlife and water quality, cultural meanings or recreational uses. One of the key problems in developing a better understanding of different responses to resource management proposals, such as the fuel treatments dealt with here, is being able to faithfully record and accurately spatially delineate the meanings that stakeholders ascribe to the landscape in question. This needs to be done in a consistent and repeatable manner if cross-comparisons are to be made between different stakeholder groups and/or different areas. This paper will present two different mapping approaches used to ascertain the meanings people attach to geographic areas. Both of these approaches were developed in an attempt to provide public input into proposed landscape-level fuel treatments. The mapping approaches provide important tools for land managers with implications for improved decision-making and trust building on contested landscapes. This work picks up on some criticism leveled at GIS for being too technocratic and divorced from community level realities of life on the ground (e.g., Pickles and others 1995; Craig and others 2002) by applying spatial data models that approximate more closely the way that people perceive and understand the landscapes in which they live and work.

## Background

### The Bitterroot Front

The Bitterroot National Forest (BNF) is located in Montana, U.S.A. The Bitterroot Front, approximately 400,000 acres, features an east to west continuum, beginning with developed private lands in the valley floor, transitioning to the wildland/urban interface, then to roaded U.S. National Forest lands, then upslope to roadless non-wilderness areas, and finally reaching the Selway-Bitterroot Wilderness to the west. Since 2000, wildfires have burned large tracts of public and private land on the Bitterroot Front; the effects of these fires were perceived negatively, resulting in significant portions of the public who do not fully trust the fire and fuels decisions that managers make (Watson 2001; Liljeblad and Borrie 2006). In response to these concerns, a study was conducted to more accurately understand the personal and community meanings and values attached to important places on the Bitterroot Front by local residents and determine how BNF actions interact with those values in fire management decisions. Figure 1 shows a map of the Bitterroot Front.

Kari Gunderson is an Assistant Professor, College of Forestry and Conservation, The University of Montana, 12 Campus Drive, Missoula, MT 59812 U.S.A. E-mail: kari.gunderson@umontana.edu.

Steve Carver is a Director of the Wildland Research Institute at the School of Geography, University of Leeds, UK. E-mail: S.J.Carver@leeds.ac.uk.

Brett H. Davis is a GIS Specialist at the USDA Forest Service Rocky Mountain Research Station, Aldo Leopold Wilderness Research Institute. E-mail: bhdavis@fs.fed.us

Watson, Alan; Murrieta-Saldivar, Joaquin; McBride, Brooke, comps. 2011. Science and stewardship to protect and sustain wilderness values: Ninth World Wilderness Congress symposium; November 6-13, 2009; Meridá, Yucatán, Mexico. Proceedings RMRS-P-64. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 225 p.

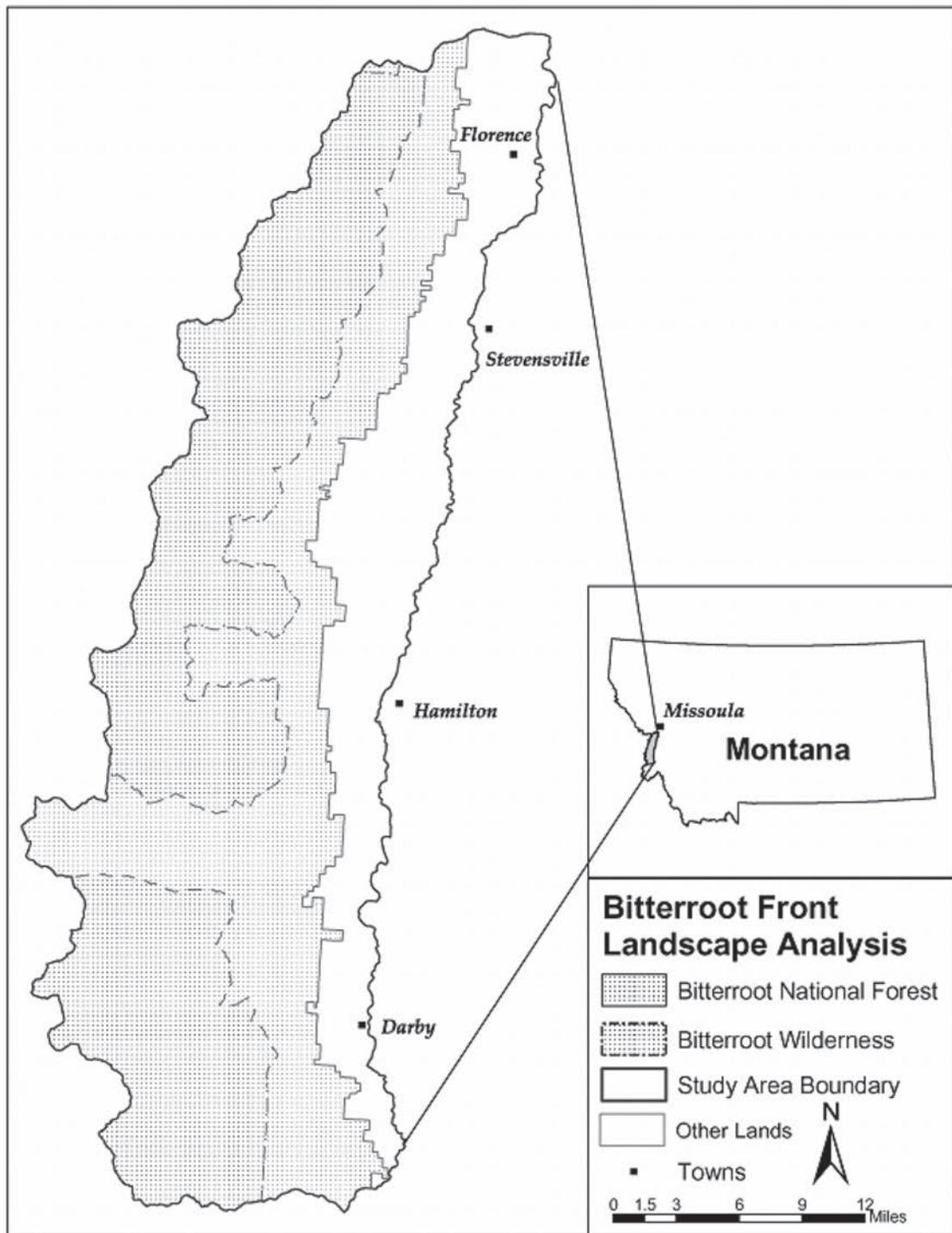


Figure 1—Bitterroot front.

### The Mission Mountains Tribal Wilderness Buffer Zone

On the Flathead Indian Reservation in Montana, the Mission Mountains Tribal Wilderness (92,000 acres) is bordered on the east, across the Mission Mountain divide, by the U.S. Forest Service Wilderness (Flathead National Forest, Mission Mountains Wilderness—74,000 acres) and on the west between the Wilderness and the Reservation community, with about 22,000 acres of land in a unique protected status. When originally established, it was listed as not available for commercial timber harvest. The “Buffer Zone,” originally designated to protect the Wilderness from human activities

extends along the wilderness boundary and contains some homes and a few roads, therefore, remaining a working landscape within the community. Both the Wilderness and the Buffer Zone are broadly considered protected cultural, as well as natural, landscapes. Thus, major decisions about management of these areas are subject to review by the Tribal Cultural Committee, the Tribal Council, and the Tribal member public. To successfully improve forest health within that Buffer Zone and increase opportunities to restore fire in the Wilderness, the Tribal Forestry Department and the public needed to work together to find solutions to increasingly threatening fuel buildups. Figure 2 shows a map of the Mission Mountains Tribal Wilderness and the Buffer Zone.

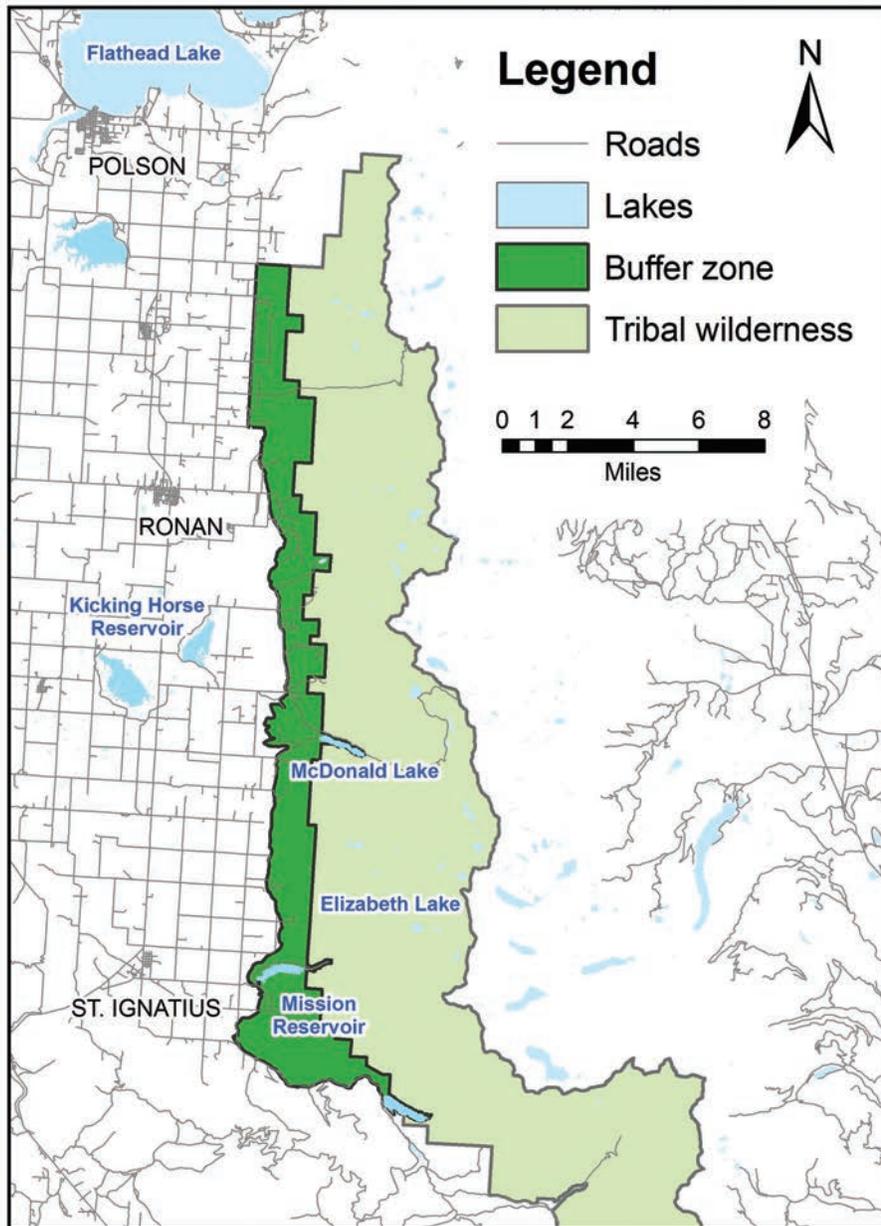


Figure 2—Mission Mountains Tribal Wilderness and Buffer Zone, Montana.

## Participatory Approaches to Understanding Values at Risk

A key challenge to develop a better understanding of different responses to landscape level management actions, such as fuel treatments, is to confidently record and accurately represent, in a spatial manner, the meanings stakeholders assign to the landscape. If cross-comparisons are to be made between different stakeholder groups and/or different areas, this needs to be done in a consistent and repeatable manner. An individual's relationship with the local landscape is spatially fuzzy and cannot be easily captured using traditional map-based features or entities such as points, lines and polygons. Where these places begin and end is difficult to express in definitive terms and, therefore, is not easily captured and incorporated within the strictures of Cartesian-based GIS data models. Inevitably, when given a map and a pencil and asked to define areas that have value or meaning, respondents will adopt a variety of approaches ranging in scale and detail from broad sweeping circles that indicate an approximate area to small, crisply outlined regions that attempt to follow the landscape as closely as possible.

Being able to actually map and compare different meanings people place on the landscape has a number of advantages over more general place-based approaches, such as offering a list of potential meanings to the study participants and asking study participant to rank how important each value is (Rokeach 1973; Brown and Reed 2000; Cordell and Stokes 2000; Haas and others 1986). The advantages of mapping and comparing different meanings include the ability to link meanings to specific locations or landscape units, and to perform advanced analyses on responses by looking at spatial relationships based on proximity, adjacency, containment, connectivity and visibility. "Hot spot" areas have been delineated in past studies through categorizing information such as the number of people indicating a particular spot is important, the type of feeling or value people associated with a geographic area, and the specificity of the area indicated. Of particular need for improvement with this type of methodology was the ability to increase the number of people engaging in this map-based activity while retaining good scale representation and capturing the intensity of the meanings and identifying perceived threats to those meanings. An individual's relationship with a local landscape is not spatially exact and cannot be easily captured using traditional map-based features. So, while scale has sometimes been estimated, it has not been captured efficiently, and the intensity of meanings attached to places has not previously been captured at all. The two mapping projects highlighted in this paper offer an expanded approach to mapping meanings, with greater accuracy at capturing intensity of these meanings.

## Methods

Work on mapping landscape values and meanings relative to landscape level fuel treatments on the Bitterroot Front was carried out in cooperation with the Bitterroot National Forest. Researchers on this project conducted a baseline assessment of individual and community meanings attached to the Bitterroot Front using a rapid appraisal methodology (Gunderson 2006; Gunderson and Watson 2007). Semi-

structured interviews, key informant interviews of community leaders, and focus group interviews were conducted with local residents to talk about their local landscape, to differentiate between the meanings associated with places they commonly went to and those they have seldom or never visited, and to discuss how these meanings interact with alternative fuel treatments. As part of these interviews, respondents were asked to spatially define these areas and the meanings attached to them by drawing on paper base maps. These were then digitized and imported into GIS for analysis and integration into the decision-making process alongside existing ecological modeling efforts used to evaluate alternative fuel treatments on the Bitterroot landscape. This research project allowed managers to better understand the relationship between the social and ecological data being used to develop fuel treatment plans on the Bitterroot Front.

Some challenges were identified in the map-based aspects of these methods used in the Bitterroot Front project. These include the varying degrees of detail used by respondents when circling areas on a paper map and the labor-intensive nature of the digitizing process (Carver and others 2009). People usually talk about places they know, use, or have visited either by name or in more vague terms such as 'the head of valley beyond the lake' or 'the woods out the back of my acreage' (Evans and Waters 2007). Where these places begin and end is difficult to express in definitive terms and, therefore, is not easily captured and incorporated. Inevitably, when given a map and colored marking pens and asked to define areas that have value or meaning, respondents will adopt a variety of approaches ranging in scale and detail from broad sweeping circles that indicate an approximate area to small, clearly outlined regions that attempt to follow the landscape as closely as possible.

In order to address the challenges described in the Bitterroot Front project, the Tribal Buffer Zone project adopted more fuzzy methods of capturing the landscape areas that people value or for which they hold a particular meaning. This was based around the application of a Java-based mapping applet called "Tagger" that used a spray-can tool, similar to that found in most desk top image processing/ manipulation packages, to allow users to define areas over a base map in a manner that allows them to easily vary the intensity of meanings, extent, and shape of the sprayed area. This is used to capture information about fuzzy spatial concepts such as vagueness and approximation in defining spatial pattern and extent, as well as (un)certainly and importance in the relative values and meanings attached to these. The system was used both online over the Internet and offline on a stand-alone laptop by tribal and non-tribal members of the Flathead Indian Reservation. Internet-based GIS have been used to solicit public opinion about a growing range of spatial decision problems (Carver and others 2002). Figure 3 provides spray pattern examples.

A combination of qualitative, culturally sensitive research and a web-based mapping exercise employing fuzzy mapping methods was used to develop understanding of the meanings Tribal members attach to the Buffer Zone, articulate trust issues, and describe perceived threats to these meanings. An important element in developing this understanding was describing contrasting meanings associated with both the Wilderness and the Buffer Zone by both Tribal and non-Tribal residents. Results guided focus group discussions with

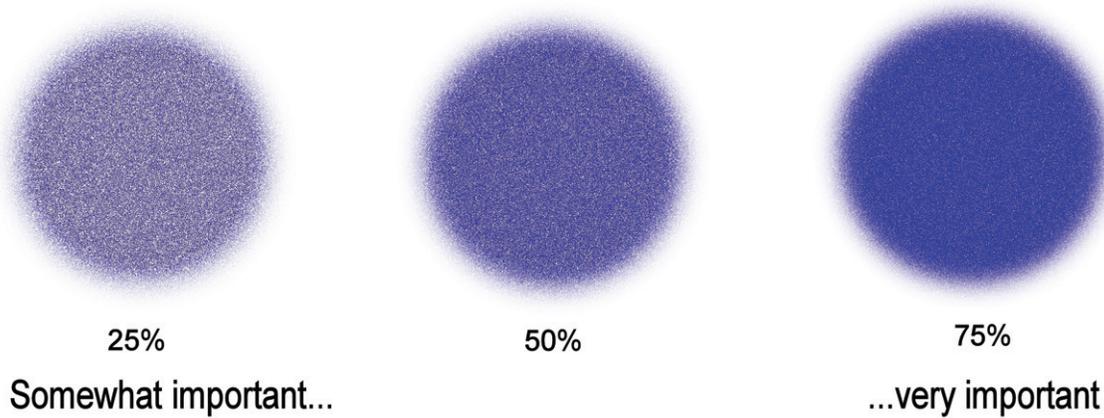


Figure 3—Spray pattern examples.

forest managers, Tribal members, and the Tribal Council about proposed fuel treatments.

The actual methods used to capture spatially fuzzy regions and their assigned attributes draw strongly on previous work on mapping place meanings and on participatory GIS (Carver and others 2009). These methods were brought together in developing a fuzzy GIS-based tool for collecting qualitative, but spatially referenced, local knowledge and meanings from a range of recognized community leaders, or key informants, and local people. Place meanings were analyzed by creating composite maps of the fuzzy attribute-tagged maps generated by survey respondents and linking these to more in-depth transcripts from interviews with recognized community leaders. Data were collected in a way that generated five map layers of themed meanings. These were driven by the key informant interviews and collected to represent the meanings of the Buffer Zone for themed topics covering ‘wilderness protection,’ ‘wildlife and water values,’ ‘recreation,’ ‘access,’ and ‘personal and cultural meanings.’ Participatory GIS methods were used to display the range, types, intensity and spatial distribution of the meanings associated with the Buffer Zone.

## Results

The results from the Tribal Buffer Zone mapping exercise could be displayed in five themed topics plus a composite of all meanings for all users. These data represent an 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 presentation, data capture, and to plan more complex analyses that make the distinction between Tribal and non-Tribal groups as well as standard geo-demographic differences of age and gender. After preliminary data collection with community leaders, 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 website appearing on every employee’s start-up login page. The resulting composite maps

displayed differences in spatial patterns and intensity of meanings associated with the five themes. Hot spots represented areas of higher levels of importance and specificity of areas indicated by participants. The composite maps were presented to the Tribal Council by members of the Tribal Forestry Program, resulting in a decision to approve a pilot fuels reduction project in the Tribal Buffer Zone.

## Conclusions

The two projects highlighted in this paper have demonstrated that these mapping approaches are well suited to developing a better understanding of peoples’ relationships with the land, and are particularly useful for contrasting meanings attached to different classifications of land. They indicate participants’ beliefs about what is worth protection, what it should be protected from, and how it is viewed by people from different cultures and/or stakeholder groupings.

We learned that the paper and pencil exercise used on the Bitterroot Front failed to adequately capture intensity of meanings. Computer-based mapping used on the Flathead Indian Reservation increased the number of people involved; retained good scale representation; captured intensity of meanings; and possessed an ability to better visualize where meanings fit into the landscape, as well as understand perceived threats to these meanings. There are pros and cons for each method described in this paper. The Bitterroot Front project was easier to implement but suffers from variability and a non-fuzzy nature, whereas the Buffer Zone Project is more involved and requires high-level programming skills to implement, but produces better and more easily manipulated results. On a technical level, the Tagger software used in the Tribal Buffer Zone project could be developed to work with commonly used web mapping interfaces such as *Google Earth*. This would make the tool more readily available to a larger audience and make it easier to incorporate into a wider range of applications.

Many indicator-based planning systems are successful at providing focus on the higher-order values at risk in the relationships people have with a particular landscape.

In this manner, if interested parties can agree on which of these values (or meanings) are most important to protect and to what degree they are willing to have them impacted in order to realize some of the other desirable benefits, a system of managing and monitoring tradeoffs can often be realized.

The positive experiences and results from the work described here would indicate that the approach adopted will find wider application across a range of spatial problems requiring an element of public participation involving vague or spatially fuzzy concepts (Carver and others 2009). The Bitterroot Front and Buffer Zone mapping projects provide promising participatory approaches for land managers and stakeholders with implications for improved decision-making and trust building on contested landscapes.

## References

- Brown, G.; Reed, P. 2000. Validation of a forest values typology for use in National Forest planning. *Forest Science*. 46(2):240-247.
- Carver, S.; Evans, A.; Fritz, S. 2002. Wilderness attribute mapping in the United Kingdom. *International Journal of Wilderness*. 8 (1): 24-29.
- Carver, S.; Watson, A.; Waters, T.; Matt, R.; Gunderson, K.; Davis, B. 2009. Developing computer-based participatory approaches to mapping landscape values for landscape and resource management. In: Geertman, Stan; Stillwell, John Charles Harold, eds. *Planning support systems best practice and new methods*. Series: *GeoJournal Library*. 95: 431-448.
- Cordell, K.; Stokes, J. 2000. Future roles: The social value of wilderness: a Forest Service perspective. *International Journal of Wilderness*. 6(2): 23-24.
- Craig, W.J.; Harris, T.M.; Weiner, D. 2002. *Community participation and geographic information systems*. CRC Press, Boca Raton, FL.
- Evans, A.J.; Waters, T. 2007. Mapping vernacular geography: Web-based GIS tools for capturing "fuzzy" or "vague" entities. *International Journal of Technology, Policy and Management*. 7(2): 134-150.
- Gunderson, K. 2006. Understanding place meanings for wilderness: personal and community values at risk. *International Journal of Wilderness*. 12(1): 27-31.
- Gunderson, K.; Watson, A. 2007. Understanding place meanings on the Bitterroot National Forest, Montana. *Society and Natural Resources*. 20: 705-721.
- Haas, G.E.; Hermann, E.; Walsh, R. 1986. Wilderness values. *Natural Areas Journal*. 6(2): 37-43.
- Liljeblad, A.; Borrie, W.T. 2006. Trust in wildland fire and fuel management decisions. *International Journal of Wilderness*. 2(1): 39-43.
- Pickles, J., ed. 1995. *Ground truth: the social implications of Geographic Information Systems*. London: The Guildford Press.
- Rokeach, M. 1973. *The Nature of Human Values*. New York: Free Press.
- Watson, A.E. 2001. Bitterroot National Forest. Community telephone survey open-ended questions analysis. Unpublished report to the Bitterroot National Forest. March 2001. Available from Bitterroot National Forest and the Aldo Leopold Wilderness Research Institute, Missoula, MT.