River Corridor Social Value Mapping:
Using the GIS Application *SolVES* for Idaho's
Middle Fork of the Salmon River

By Nathan Lee Moody

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Approved:

Pam Foti., Ph.D., Chair
Marieke Taney, M.S.
Martha Lee, Ph.D.
Darius J. Semmens (USGS), Ph.D.

ABSTRACT

RIVER CORRIDOR SOCIAL VALUE MAPPING:
USING THE GIS APPLICATION *SolVES* FOR IDAHO'S
MIDDLE FORK OF THE SALMON RIVER

NATHAN LEE MOODY

Rivers in America serve as valuable corridors for ecosystem services. The Wild and Scenic Rivers act of 1968 has set aside pristine and primitive riverine systems for preservation and the enjoyment of the American populous. The character of being remote, wild, and generally unchanged by man embodies the qualities that are valuable to the users of the river. This research assesses and quantifies twelve perceived non-market landscape social values (Aesthetic, Biological Diversity, Cultural, Economic, Future, Historic, Intrinsic, Learning, Life Sustaining, Recreation, Spiritual, and Therapeutic) of river corridor users. These values are connected to 'value points' and attributed to their relative locations along the Middle Fork of the Salmon River (MFSR). The MFSR is a heavily managed wilderness river in Idaho used primarily by recreational river users and commercial adventure based tourism. This study inventories and quantifies the values of some of these users. The result is the production of river corridor maps depicting zones of intensity for the quantified landscape values. This value inventory and mapping was conducted through survey administration methods developed for use in the GIS software "Social Values for Ecosystem Services" (*SolVES*). *SolVES* models spatial relations of held non-market values as they are conceivably connected to landscapes. By focusing on the MFSR as a river corridor landscape, this research acts as a pilot example of applying this form of social value quantification and mapping to a smaller landscape scale and specific use region. The value map models and statistical outputs of *SolVES* are in relation to portions of 91 completed surveys from three river user subgroups (Commercial River Guides, Commercial River Guests,

and Private Floaters). A greater representation of the guiding community is shown through higher returns of usable spatial data tied to social values. These maps represent 424 survey points of value along the river corridor from all surveys. Correlation tests were conducted to find interface between zones of value intensity (ex. high aesthetic value) and areas of land management concern (human impacted campsites). Varying levels of correlation were found to exist between certain landscape values and higher campsite impact showing that certain values were higher in areas of high human impact and some values were much lower in areas related to impact. The models of social value mapping in the MFSR corridor produced through *SolVES* all had a very high goodness of fit for value representation tied to the landscape. This study shows that modeling held social values of river users can correlate to potential river management concerns and help offer insight into how users perceive and value the landscape based on those concerns.
Keywords: *ecosystem services, social value mapping, public participation GIS, wilderness management, wild and scenic rivers*

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Chapter 1: Introduction

1.1 Background

1.1.1 Human Impact Monitoring in Wilderness

Spatially understanding anthropogenic connections and impacts within wild landscapes can be beneficial for land management decision making. Discovering and discerning where and how humans impact the landscapes around them in connection with other natural processes and ecosystems can provide insight into how human impacts can be managed to deter negative outcomes.

In September of 1964, the Wilderness Act was passed in the United States. This act explicitly defined goals and requirements to protect areas of the landscape “so as to preserve [their] natural conditions” (Wilderness Act. 1964). In these designated wilderness areas the protection against impacts to the ecosystems of more primitive settings focuses on providing conditions usable and desirable by humans. Protection for these ‘natural conditions’ raises concerns associated with the protection of public wilderness lands in the United States from overuse and degradation while simultaneously allowing for public use. To mitigate these issues the management process must include the assessment of environmental health, ecological impact from humans, and the ability of the landscape to provide ‘wilderness’ services that benefit the stakeholders of the landscape.

Monitoring and assessing the conditions of wilderness land use by humans includes the use of many diverse and distinct geographic areas and terrain, along with equally as many techniques for monitoring. Past research has focused on the localized impacts of specific trails and campsites (Cole. D. 1989). It has been acknowledged that the use of wild areas will include humans camping and impacting the areas around such campsites that can lead to conditions possibly detracting from the described conditions being protected for (Frissell, S. S. 1978). By monitoring the state and quality of campsites a "condition class method of monitoring campsites was developed" (Glidden, N. 2005) to take into account the quantitative factors associated with landscape and campsite impacts.

Currently, land management agencies in America apply these methods of assessing and monitoring the conditions of campsites along rivers deemed to possess wild and scenic characteristics under the Wild and Scenic Rivers Act of 1968 (Cole. D., 1989; Cole, D., Manning, R., & Lime, D. 2005; Cole, D. N., Foti, P., & Brown, M.. 2008). As of January 2015, there are a total of 12,708.8 miles of protected wild and scenic waterways in the United States. These miles of river are protected national resources due to the "outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values" (Wild & Scenic Rivers Act, 1968) that are embodied and inherent in these free flowing rivers. Management of large scale wild areas requires constant monitoring of conditions to ensure compliance with the objectives explicit within the binding legislation that created the wild areas. In comparison to the majority of waterways in the United States, great importance is placed on the protection of the wild and scenic river qualities with the intent to preserve them for generations to come in a state as unaffected by human travel as possible. Wild river management in America seeks a balance between the legally prescriptive need to provide access to some of the nation's protected areas, while controlling the impacts incurred within the corridors of these same rivers by those who value and use those resources.

1.1.2 Mapping Social Values of Ecosystem Services

In recent decades, research and methods have been developed to account for and quantify the beneficial goods and services provided to mankind by nature (MA, 2005). To quantify intangible and non-market ecosystem values of wild areas numerous modeling and survey methods have been developed (Brown, G. 2005, Brown, G. et al. 2011, de Groot, R.S., et al. 2002, Kumar, M., Kumar, P. 2008, Sherrouse, B. C., et al, 2011). Certain methods and tools created for the quantification and valuation of these services focus on the non-monetary and non-market value services provided by landscapes. These values account for the perceived and potentially non-tangible returns provided by a landscape and are generally characterized as cultural ecosystem services. Wilderness areas, along with wild and scenic rivers are managed landscapes that legally cannot be used for extractive resource purposes but can provide for these cultural ecosystem services. The distinction of lands set aside for aesthetic and non-invasive enjoyment provides a prescribed area that can be used both in recreational contexts and as study areas to monitor biological and ecosystem processes outside of the influence of humans. Because of the non-tangible and intrinsic nature of the services provided by wilderness landscapes, methods for monitoring cultural ecosystem services must be focused on quantifying the perceived social values for the landscape.

The identification and quantification of these socially held values presents the opportunity to better integrate and form connections between the landscape and the stakeholders of wild areas. Identifying distinct values that are not related to an economic service flow that are in connection to the landscape can present insight into how stakeholders perceive and use wildland resources. Recent applications and research has been focused on the ability to use geographic information system (GIS) applications to spatially relate those landscape values to explicit locations (Sherrouse, B. C., *et al*. 2011). The research conducted by Sherrouse *et al* honed in on research needs to "develop a geographic information system (GIS)… designed to calculate and map the relative social values of ecosystem services as perceived by diverse groups of stakeholders" (Sherrouse, B. C. *et al*. 2011). The application, "Social Values for Ecosystem Services" (*SolVES*) connects survey data with geospatial data to produce maps identifying areas of high social value concentration within the prescribed study area. The development of the *SolVES* application "serve[s] as a model for future development of more advanced tools that will be useful to decision makers, stakeholders and researchers" (Sherrouse, B. C. 2011). By exploring how social value mapping can apply to a wider range of social groups in a geographically or regionally defined landscape such as a recreationally utilized river corridor. To create a more usable tool there needs to be specificity choosing the environmental, as well as anthropogenic landscape conditions used in *SolVES*. This research utilizes a homogenous user group of a wilderness river corridor, namely river floaters of the Middle Fork of the Salmon River in Idaho. By focusing on a set linear location and a certain subgroup of user ship for that area, *SolVES* can be used to develop tools to help build insight into specific user group values within the river corridor.

1.1.3 Research Questions

The research questions addressed in this study are:

1. How can the methods of non-market value quantification and mapping be applied to wilderness river management, specifically the Middle Fork of the Salmon River (MFSR) in Idaho for use in socio-cultural and ecological prioritization of management action to preserve wilderness character as defined by the Wilderness Act?
2. Is the GIS application *SolVES* a viable, streamlined tool to produce GIS products that lead to useful wilderness river management applications based on ecosystem service flow along river corridors?

1.1.4 Applications

This thesis builds off of previous frameworks of assessing and quantifying non-market landscape values and utilizes spatial analysis and GIS methods for spatially relating these perceived landscape values to defined, small scale locations within a wilderness study region. This research strives to refine a model of assessment and data collection for a more specialized wildland management region with distinct management variables compared to previous research, which has focused on assessment of larger landscapes and mixed use public lands. These previous studies evaluated a wide range of public stakeholders and there connection and valuation of the landscape in relation to National Forests in Colorado (Clement-Potter, J. M. 2006). A more defined focus on specific users who value a river corridor can provide unique inference to specific user types (recreational rafting, hiking, horse packing) and the values that account for these preferences. Ultimately analysis of use type, intensity and level of value can be related to current ecological conditions which may or may not be affected by these values and subsequent use types. By exploring problems associated with certain types of stakeholder/user activity in connection with the perceived values present within the river environment managers can incorporate balance for resource protection and use through understanding these relationships.

To test the workability of monitoring users perceived landscape value on a smaller scale the Middle Fork of the Salmon River (MFSR) was chosen for its relatively high user capacity as a recreational river corridor. The MFSR as a river corridor is currently managed as a wilderness area and has defined recreational and non-extractive human uses. By understanding user values, focus can be applied to areas of ecological concern based on potential overlap of use practices, stakeholder values and intended purpose of management which could include protection of historical cultural sites and riparian ecological health. The corridor landscape provides ecosystem services that rely on the protection and preservation of the wilderness character, as well as the ability for humans to interact with that character while not negatively affecting the qualities of the landscape that are desired through the distinction as a wilderness river.

Although the MFSR corridor has seen human presence for millennia including the seasonal inhabitation by the Takudika (Mountain Shoshone) and more recently by miners, ranchers, and recreationalists the current goal is to manage for the “preservation of the values for which the wilderness and wild and scenic river were designated to protect” (Central Idaho Wilderness Act. 1980). This management designation and direction have preserved the character of the river corridor so that it is relatively pristine. In section 8 of the Central Idaho Wilderness Act (CIWA) it is also stated that is the duty of representatives of the act;

> Central Idaho Wilderness Act. SEC. 8.
> (1) To carry out the cultural resource management program required by paragraph (1) of this section, the Secretary shall, as part of the comprehensive management plan required under subsection 5(a) of this Act, develop a cultural resources management plan for the wilderness and the river. Such plan shall—
> (A) encourage scientific research into man's past use of the River of No Return Wilderness and the Salmon River corridor;
> (B) provide an outline for the protection of significant cultural resources, including protection from vandalism and looting ns well ns destruction from natural deterioration;
> (C) be based on adequate inventory data, supplemented by test excavation data where appropriate;
> (D) include a public interpretation program; and
> (E) comply with all Federal and State historic and cultural preservation statutes, regulations, guidelines, and standards.

Based on the direction of management to include monitoring and inventory of cultural resources it is important to understand how these resources affect those who use the resource currently. These values for cultural or other potential qualities in the wilderness river landscape can be assessed using public participation geographic information systems (GIS) to spatially understand where these values resources are and how they are valued by users. Utilizing survey research methods created and developed through studies of ecosystem service appreciation and landscape valuation (Sherrouse. B.C. 2011) user preference and attitude can be monitored. Survey results allow researchers to obtain perceived social values for the landscape from stakeholders by incorporating mapping components within the surveys, which provides the information needed to generate maps of stakeholder values. By surveying visitors and users of the MFSR researchers can ascertain which non-market social values are ascribed to the river corridor. More importantly, these values can be connected to spatially explicit locations. These values can then be mapped and analyzed in relation to areas of managerial concern, ecologically and socially, within the river corridor.

Mapping human value concentrations embedded within the human/physical landscape has been referred to as 'Hotspot' mapping in previous landscape value research (Brown, G. 2007., Sherrouse, B. C. 2011.). The reasoning for such applications of connecting people with place has been described as "an operational bridge… needed to connect special place locations (geography of place) with their underlying perceptual rational (psychology of place) for ecological planning and resource management purposes" (Brown, G. 2007). The operational bridge that Brown spoke of can be created through mapping those actual places embodying regions of greater social value. The distinction and useful nuance of mapping these places within heavily used wilderness river corridors is that certain uses are prescribed and many uses are not allowed based on management criteria. Because of this, there is a streamlined and semi-predicted amount of physical locations, limited to the actual topography and the region of management. Brown (2007) also asserts that by mapping the social values attributed to the landscape this will provide opportunities to:

1. Identify areas of agreement in landscape value.
2. Identify areas of disagreement (potential conflict).
3. Overlay landscape values with objective landscape features.
4. Develop a system for ranking potential land use activities for consistency with landscape values.

To create meaningful maps of user values within the river corridor that can analyzed for potential management application there has to be spatial relevance to landscape metric data such as popular campsites, trail networks, and cultural/historically degraded areas along with defined user groups. The results of this analysis will have map outputs that can be used to compare known areas of concern for managers with areas of high landscape value intensity. This approach can be used to inform management planning prioritizing areas of strong high value intensity for restoration or impact mitigation attention. Ultimately, the methods used in this thesis will help develop potential answers to the questions of how to account for high volumes of human traffic within a valuable wild landscape resource while giving land managers the tools to isolate areas of ecological concern, cultural sensitivity, and overuse.

Chapter 2: Literature Review

2.1 Ecosystem Services Valuation

Ecosystem services can be summarized as "the benefits people obtain from ecosystems" (MA, 2005). To account for the connection between ecosystems and the services beneficiaries obtain from them, methods have been developed to economically value these services monetarily (Boyd, J. *et al*. 2007) as well as quantify non-monetary values present within the landscape (Brown, G. 2013). A collection of definitions have emerged over the past two decades to address the nature of 'ecosystem services,' and in recent research, methods have been developed to quantify these values and in some cases spatially map the non-market valuation flowing from ecosystem services. From this, the question arises; "How can the relationship between landscape and ecosystem characteristics and their associated functions and services be quantified?" (De Groot, R. S. *et al*. 2010). This question of how to effectively create a metric and measurable return for use in decision making has been a concern for land managers, politicians, and conservation/preservationists arguably since humankind began to utilize the earth's resources.

The discussion of ecosystem service valuation covers a range of concerns and implications within the current framework of landscape use revolving around the problems of quantifying the flow of those services. In a previous study of ecosystem service flow, the analogy of floodwater flowing through a river valley has been used as a comparison to monitoring the supply, demand, and flow of the services issuing from the flood of ecosystem services, as the flood moves across the landscape it carries the services with it (Bagstad, K. J., Johnson, G. W., Voigt, B., & Villa, F. 2013). The paper goes on to elucidate five key components that consistently and quantitatively account for the flood of services that issue from the landscape.

1. *Beneficiaries* of the services provided by ecosystems.

2. *Carriers* of the services to the beneficiaries.

3. Whether contact with the carrier is beneficial or detrimental to humans.

4. Whether the carrier is *rival* or *non-rival*, and *biophysically limited* or *unlimited*.

5. The "flow type used in routing the carrier from ecosystems to people or for some services routing people to ecosystems" (Bagstad, K. J., et al. 2013). The MFSR acts as a service carrier that accommodates people within the ecosystem services.

As a literal interpretation of the river analogy, these elements can be applied to the assessment of ecosystem service flow within an actual river corridor. In the case of the MFSR, the wilderness character of the landscape is protected under federal law to allow for "outstanding opportunities for solitude or a primitive and unconfined type of recreation" (Wilderness Act. 1964). This legal declaration puts into the public court a defensible condition of ecosystem service carrying capacity. For non-market attributes such as 'solitude' and 'primitive… recreation' the types of beneficiaries can be defined as those users of the river corridor landscape for the intended purpose of recreational use as well as experiencing wilderness character which provides the primitive conditions. In the case of the MFSR, the corridor itself is intrinsically the carrier of the non-market ecosystem services present within the wilderness landscape. A river, if used for human recreational or other non-market values, is itself a *provisioning benefit*, or one that provides services and delivers them to humans. Humans travel to scenic and protected rivers such as the Grand Canyon of the Colorado, the Middle Fork of the Salmon River, or the Rouge River, to enjoy the benefits provided therein. By modeling the service flow that a wilderness river provides, a quantifiable analysis of service output can be calculated based on a surveyed percentage of the user base of the river resource. Further analysis of the provisioning ecosystem service flow of wilderness river corridors can be summarized by exploring the relationships between the source region, the sinks (areas that absorb or degrade the service carrier), and the use region (Bagstad, K. J., et al. 2013).

This thesis focuses on modeling distribution of use locations for cultural ecosystem services within a confined geographical region. This is an important geographical awareness because river users travel in the same direction (the direction of the rivers downward travel) and utilize homogeneous spatial locations. The classification of the services provided by a wilderness river can be likened to the ‘flow’ of human use throughout its corridor. This idea of flow for ecosystem services can provide a landscape scale appreciation for the carriers present within a wilderness environment as well as the specific ways in which they are used/appreciated.

To discuss mapping social values across landscapes, it is important to first discuss the spatial perceptions of landscapes. Based on the wilderness concerns of this study, emphasis will be put on the assessment of attitude and mapping of attributes associated with wilderness and more pointedly with the MFSR corridor which is located within the Frank Church River of No Return Wilderness. This study approaches the idea of spatial value mapping with attention on the concepts of linking human value to the landscape through understanding user perception of the landscape. A spatial perceptual mapping methodology created by Andrew Kliskey titled

"Wilderness Perception Mapping" (WPM) used in a study across New Zealand addressed the "identification of geographical variation in wilderness perceptions [which] involves translating a relatively abstract concept into more concrete spatial terms" (Kliskey, A. D. 1994). These abstract concepts of wilderness perception were classified into four distinct indicators of a purism scale to define the general properties of wilderness. These indicators are; artifactualism (which refers to the physical properties that have influenced human development), remoteness, naturalness, and solitude. These indicators are important because they represent the baseline for wilderness quality as it relates to users of the resource. In further studies that have addressed mapping human perceptions of the uses of wilderness these overarching qualities have been taken into account.

To address the range of values held for wild lands and the ecosystem services associated with wilderness landscapes, survey methodologies and geospatial tools have been developed to accurately and transparently represent the values mentioned above in mapping applications. The practice of incorporating geospatial information into thematic maps is a key component of geographic information sciences (GIS). Using GIS to analyze spatial and temporal qualities of environmental data, as well as social data related to landscape scale questions provides opportunities to make connections between human use and ecosystem response. It is important to note that;

"Quantifying, mapping, and valuing ecosystem services does offer the public and private sector alike a promising way to communicate resource management tradeoffs, particularly for development or extractive resource use that could degrade ecosystem services. However, depending on the decision context, ecosystem service analysis may be more or less useful, which will in part be contingent upon what additional new insights an ecosystem services approach offers relative to the "business as usual" approach to conducting environmental impact assessments" (Bagstad, K.J. et al. 2013).

This "business as usual" mindset of impact assessment protocol along river corridors is documented and structured and is seen in the research of David Cole with the assessment of the MFSR in regard to using "Rapid Inventory Assessment techniques", and more precise monitoring techniques used to assess impact to terrestrial wilderness (Cole, D. N. 2014). The monitored and itemized impact datum from the MFSR can be correlated to geospatially mapped regions of social value. A GIS application that is used in conjunction with the program ArcGIS to explicitly relate social values to the landscape is "Social Values for Ecosystem Services" (*SolVES*). This application was developed with the United States Geologic Survey (USGS) and is used to map social value metrics gathered from survey data based on public attitude and preference in relation to national parks (Sherrouse, B.C., et. al., 2011.). This type of metrics based tool used to gauge value and perceived quality and effect on ecological areas due to mixed use is a management tool can be used for understanding human/ecosystem use resilience. To acknowledge the nuances of effects derived and perceived in wilderness settings, surveys based on public attitude toward use can provide insight into overall perceptions of how current management is administered. In an article about sustainability in natural tourism, the importance of protecting and sustaining certain aspects of the natural state ranked first in a poll taken in Montana consisting of 108 members of the tourism industry. In this study four qualities are connected to preserving the resources present in wilderness are: natural and cultural heritage, community stability, quality of life and unique natural environment (McCool S. F., et al. 2001). Taking into account wilderness visitors perceptions and how the standards of quality reflect the resource, a value system emerges both in a market sense and non-market schema reflecting the benefits of the ecosystem services.

River management for the MFSR has relied on inventory and monitoring frameworks for evaluation of human impacts and assessment of the conditions of wilderness protection. Specifically, Wilderness Rivers support recreational “use [that] varies greatly in space, time, nature, and intensity” (Manning, R. E. 1979). Due to this dynamic reality of use and impact, values of space can shift accordingly as reflections of the state of condition. Social value mapping has emerged as a means of quantifying the ways in which humans place importance on certain landscapes and specific locations in wild lands.

2.2 Wilderness and Wild Rivers as Social Resources

American Wilderness as defined by the 1964 Wilderness Act, is a place “where man himself is a visitor, who does not remain.” As such, federal wilderness management relies on maintaining the existence and protection of public lands and areas that are considered ‘wild’ as a primitive resource while allowing human passage through them. The wilderness resources of the United States provide recreational and tourism benefits that to be utilized predicate human passage through areas that are considered primitive leading to sometimes adverse human impact. So to effectively manage the wild lands resource for the enjoyment of the public while maintaining the qualities of wilderness, it is the struggle of managing agencies to find a balance between “providing recreational uses, yet resource protection” (Hammitt, W.E. 1987).

Wilderness areas intrinsically possess four qualities as laid out by the 1964 Wilderness act and described in “Keeping It Wild: an Interagency Strategy to Monitor Trends in Wilderness Character across the National Wilderness Preservation System”(Carver et al. 2013), they are: natural, untrammeled, undeveloped and [have] the ability to provide solitude or primitive and unconfined recreation. Under these guidelines, a state of separation between human influence and the conditions for human enjoyment are reliant on the ideals of protecting wilderness preservation and also human use in primitive areas. It is a truism that if human interactions occur within a wilderness area, “no matter how small, [they] will produce an impact of some type” (Hammitt, W.E. 1987). It is also the case that the management of these areas falls to an interagency collaboration in which environmental impact studies, human and recreational impact assessments and human interaction surveys are conducted to appraise the most effective methods for the management and preservation of the wild land resource. These studies culminate in operating plans for commercial recreation, guidance for private recreationalists and other users, and the composition of Environmental Impact Statements (EIS) that allow for future management while keeping intact the nature of the wilderness area itself.

2.3 Recreational Impacts

In addition to the 109,511,038 acres of protected wilderness included in the National Wilderness Preservation System (The Beginnings of the National Wilderness Preservation System, retrieved Dec. 10th 2014) there are as of January 2015, 12,708.8 miles of Wild and

Scenic river in the United States of America (National Wild and Scenic Rivers System. 2015). The rivers included in the Wild and Scenic (W&S) system range in their usable nature from highly used, wild reaches of chiefly undeveloped river corridors (ex. MFSR) flowing through wild and semi-wild public land to riparian systems relatively untouched by mankind existing outside of civilization (ex. Big Jacks Creek, ID). These varying conditions of wild and scenic quality require strategies from land management agencies to account for, and address human involvement/impacts and degradation to the naturalness qualities inherent therein. This emphasis is derived from the accepted norms of defined wilderness values. This has led to monitoring research within backcountry settings focused on human campsite impacts, water quality, riparian ecological degradation, etc (Cole, D.N. *et al*. 2008). More recently attention has been given to quantifying the valuation of numerous ecosystem services within regions (Bagstad, K. J., *et al*. 2013, Kumar, M., Kumar, P. 2007, Millennial Ecosystem Assessment, 2001). From these assessments, spatial mapping tools of impacted areas connected to perceived non-market value of ecosystem services (naturalness, the availability of solitude, and unconfined recreation) has emerged to measure the attributes and qualities that are integral to the wilderness resource on a humanistic level.

As part of the long list of recreational management concerns within wilderness areas and wild and scenic river corridors, primitive camping claims high priority due to the de facto reality that human occupation causes impact. In areas of remote wilderness where direct control is limited, the impacts of camping are much greater. This is in part because the types of recreation in remote wilderness areas differ greatly (Cole, D. N. *et al*. 2004). This relation between human presence and ‘natural’ conditions have led to a rise in recreational impact monitoring, specifically in areas where high concentration of human activity can be studied, namely distinct campsites along river corridors in wilderness areas.

In wilderness areas that are heavily used for recreation, management plans have been put in place to preserve what can be called the wilderness character (Carver et al. 2013). This character or set of characteristics could be defined as the reason why the pristine environment is important as a cultural resource in the first place. Along with understanding what the characteristics of a wilderness resource are, it is important to map out the specific conditions of the resource. In a mapping study of Death Valley (DEVA), GIS geo-data was collected and categorized based on the four qualities listed above in *Wilderness and Wild Rivers as Social Resources* section to ascertain conditions of the wilderness inputs and their deviation from what is considered pristine wilderness to judge the overall character of the wilderness as a resource (Carver et al. 2013). This quantitative data collection within a wilderness can add insight to how campsites within wilderness areas can also be measured for spatial impacts as well as severity of impact. This data is coded to rank them in a hierarchical structure as to assess whether the areas need rehabilitation or limited use to regain the wilderness character (Cole, D. N., & Monz, C. A. 2004).

Numerous studies have been conducted to assess the damage and impact on high use campsites to attain data sets on how those human interactions impact and affect the wilderness resource in regard to physical degradation. Studies have been conducted in relation to nearness to water, overall camp impact size and general markers of impact among wilderness areas (Cole, D.

N. 1989). Measurements have also been taken to indicate where spatial relevance to impact site location, size and the spread of damage occurs in relation to certain geographic features including rivers (Monz, C. A. *et al*. 2004). It is also known that the compacting of soils on non-hard surface campsites occurs rapidly and may occur within a year of human use. This is directly in relation to the healing time for vegetation and soils to return to a naturalized state which can take between 8 and 13 years (Hammitt, W.E. 1987). This time frame does not allow for certain wilderness recreation areas and their campsites to recover year to year to regain the pristine and 'natural' quality and wilderness characteristics originally intended to be preserved.

By acknowledging the nature of campsite and wilderness fragility and by using techniques from the campsite monitoring mentioned above, monitoring plans have emerged in backcountry areas of very high use, namely on wild and scenic rivers where there is a large amount of tourism, i.e. the MFSR. Studies along designated wild and scenic rivers in the U.S. have created data sets showing how visitor impacts on backcountry campsites can be decreased by dispersing the density of visitors in more remote locations (Cole, D. et. al. 2008). It should be noted that the phenomena of channelization in wild and scenic river corridors relating to human dispersal limits the areas that dispersal can happen. Along the Middle Fork of the Salmon River, 104 designated campsites for river recreational use puts a defined limit on where humans can populate the corridor. These camps are assessed every five years to determine the amount of human impacts incurred. These impacts are monitored using the Frissell Campsite Condition Class System (Appendix C). For campsites qualified as class 4 or 5 direct intervention from river managers is applied to address issues of degradation. Management strategies that address campsite impacts focus on the Limits of Acceptable Change (LAC) for the defined character of the river corridor, as well as the capacity of the site to accommodate the amount of seasonal human use present within the corridor.

In addition to the studies that address the many physical stresses that are put on the wilderness, qualitative research has explored the relationship between human experiences and the subsequent perception in the wilderness as defining characteristics of the resource. It is noted that historically, resource managers have striven to protect the wilderness resource in regard to human capacities (Roggenbuck. 1993). Areas of public land within America that are designated wilderness are managed not only for mixed human use, but also for conditions that define and relate to a pristine environment “untrammeled by man” (Wilderness Act. 1964). When the wilderness is experienced, and also affected by people who have no distinct mindset of what to expect on their first foray into an area prescribed as ‘wild’ they develop upon first encounter conditions that they then evaluate as acceptable. These encounters are seen as the 'norm' and become the standard of quality for those experiencing the conditions for the first time (Laven, D.N., et al. 2005).

It is also the case however, that those who live and work in areas where ‘wild’ land is commonplace and may or may not be surrounded by the tangible presence of it experience connection with the concept of social-ecological systems (SES). These systems include the ecosystem services that are derived from non-market and non-tangible outcomes of wilderness environs such as the river corridor of the MFSR. Where there is close relationships between human systems and the biophysical conditions of the natural world there is a correlation of benefit and values (Alessa, L., et al. 2008). Perceptions change regarding wildland values. This is based on the ways that these areas are valued, whether those values are recreational, cultural or economic, distinctions between the ways landscapes are valued are connected to the perceptions of those who utilize the landscape. This difference in perception creates a dichotomy in the range of how the otherwise non-market values of the resource are accounted for.

2.4 Spatial Analysis and Future River Management

By using quantifiable methods of evaluation for discovering how the use of wildland resources for recreational purposes reflect public perception analysis can be done to account for these values and perceptions in light of management concern. The methods of accounting for social values perceived in landscapes has been researched in parts of Colorado, United States as well as applications in Australia (Clement, J.M., Cheng, A.S. 2006., Van Riper, C.J., et al, 2012.) The Clement research in Colorado focused on 12 landscape values that were applied to the assessment of public perceptions within the Pike and San Isabel National Forests within Colorado. This assessment lead to the numerical attribution of hypothetical dollar amounts to each of the 12 values and linked them to specific locations within the Pike, San Isabel National Forests (Sherrouse, B.C., *et al*. 2011). This study provided a measurable connection to be made between the ecosystem services provisioned from public lands to the stakeholders of the resource. Ultimately the study provided survey data to be applied to the GIS application *SolVES* for the creation of hotspot value maps depicting regions where public land stakeholder applied weighted value correlated with public uses. This study demonstrated “one alternative of how a GIS application can be developed and applied to unite concepts and methods from ecosystem services assessment and social value mapping" (Sherrouse, B.C., et al. 2011). The results of the research using *SolVES* to generate maps "that illustrate the distribution of quantitative, non-monetary value" intend to "serve as a model for the future development of more advanced tools that will be useful to decision makers, stakeholders, and researchers (Sherrouse, B.C., et al. 2011).

It is also noted that "the values perceived by ecosystem stakeholders are inadequately captured by conventional utilitarian valuation methods, which neglect the value of the psychological well-being derived from an individual's relationship with nature" (Kumar, M., Kumar, P. 2008). Mapping stakeholder values into more specialized regions such as wilderness areas, or river corridors used primarily for recreation may account for the attitudes and perceptions of those who value the "relationship with nature." Mapping these non-market values attached to a landscape may point out instances or use that are in line with or disjointed from management ideals for pristine wild areas or river corridors that are protected for defined use. Those who have created a standard of quality based on pristine conditions will travel further away to recreate (Roggenbuck, J.W., et al. 1993). Exploration of how users of protected wild lands value the landscape in connection with the idea of the individual's role and appreciation of the landscape could provide insight into how the landscape can be managed to accommodate use as well as protect the quality of the protected biophysical character of wilderness.

Taking into account how human impacts affect the ecological processes within a protected region in relation to potential user value points to the need for assessing how and where values are connected and if those overlap with areas of potential ecological concern. The connection of these values to areas of human density on wild and scenic rivers may provide a visual representation of how and where users of wilderness river corridors congregate and create areas of potential management concern. The spatial regions of human/ecological connection in a river corridor such as the MFSR can be considered a control on human use and impact connect to locations of value because “any place with the characteristics of a campsite is a campsite” (Cole, D.N. 2013) Due to the understanding that human use focuses on certain locations within the river corridor, areas of concern have been monitored and inventoried creating a list of campsites along the MFSR with corresponding impact ratings. By measuring not only the 'impacts' humans have imposed on a river ecosystem such as the MFSR but also the perceptions and value connections with them through tools such as *SolVES* an understanding of management connection between social values along rivers and the impacts relating to specific spatial locations. By mapping and analyzing connections within a wilderness river corridor for what Gregory Aplet describes as both “freedom and naturalness” (Aplet, G. 2000) management plans can be implemented. Overall, this dichotomy rests on the more fundamental connection of humans with the ecosystem, our descriptions of impact rests on the existence of human interaction with the protected wild.

By acknowledging that human impacts in a wilderness setting affect the standards of quality for both use and the protection of the wild land resource, measurable progress in preservation relies on studying impacts along with how users of the resource value it. Methods of accounting for and connecting impacts and values both ecological and behavioral in a quantified way may be used in management plans to address issues of protecting naturalness while preserving the values of use. To use tools such as "spatial catalysts combined with site-selection tools, probability theory combined with site-selection tools, spatial simulation models and spatial simulation models combined with site-selection tools" (Leroux, S. J., & Rayfield, B. 2014) can provide methods to monitor and assess data to adapt management plans to accommodate future human travel and ecological resilience.

The lasting conditions of wild and scenic rivers in America hold value in the resources present in their corridors based on user's connections to the landscape scale qualities and values such as biological diversity, cultural sites and ideals of pristine intrinsic value. By assessing current user values attached to wild and scenic river resources to spatially connect them to explicit sites within the corridor, maps can visually represent overlap zones of the importance of place for those who utilize the resource and the areas that need protection for wilderness and primitive riverine character. By connecting these value metrics with areas of severe overall impact to wild and scenic conditions, management plans can be made to account for and adapt site management to promote ecosystem health. By defining these areas of overlap and connection between the social and ecological, balance can be found in the way we manage landscapes to provide for a lasting wilderness environment based on analysis of relational qualities between social value hotspots and their nearness to areas of managerial concern.

Chapter 3: Methods

This chapter defines the study region used to map social values in a river corridor and the methods used to collect the social value data related to the geographic locations based on previous landscape value mapping methods (Alessa, L. 2007., Brown, G. 2007., Sherrouse, B. *et al*. 2011). The survey used for this study, *Visitor Values and Preferences Relating to the Wild and Scenic Middle Fork of the Salmon River, Idaho* (Appendix A) is similar to surveys used in previous studies so that common data retrieval methods are in place. The data retrieval for spatial analysis based on the parameters needed for the *SolVES* geodatabase are outlined to define important differences for this studies data requirements compared to previous studies. The model flow of how social values are quantified and spatially located along the river corridor with use-attribute distinction is detailed for the application of *SolVES* along with the specifications of regional and corridor specific mapping requirements. Lastly, the statistical relevance of using nearest neighbor zonal statistics will be discussed to explain the significance of value intensities in regard to campsite conditions and locations as defined by Frissell/Cole impact monitoring studies along the Middle Fork of the Salmon River (MFSR).

3.1 Study Area

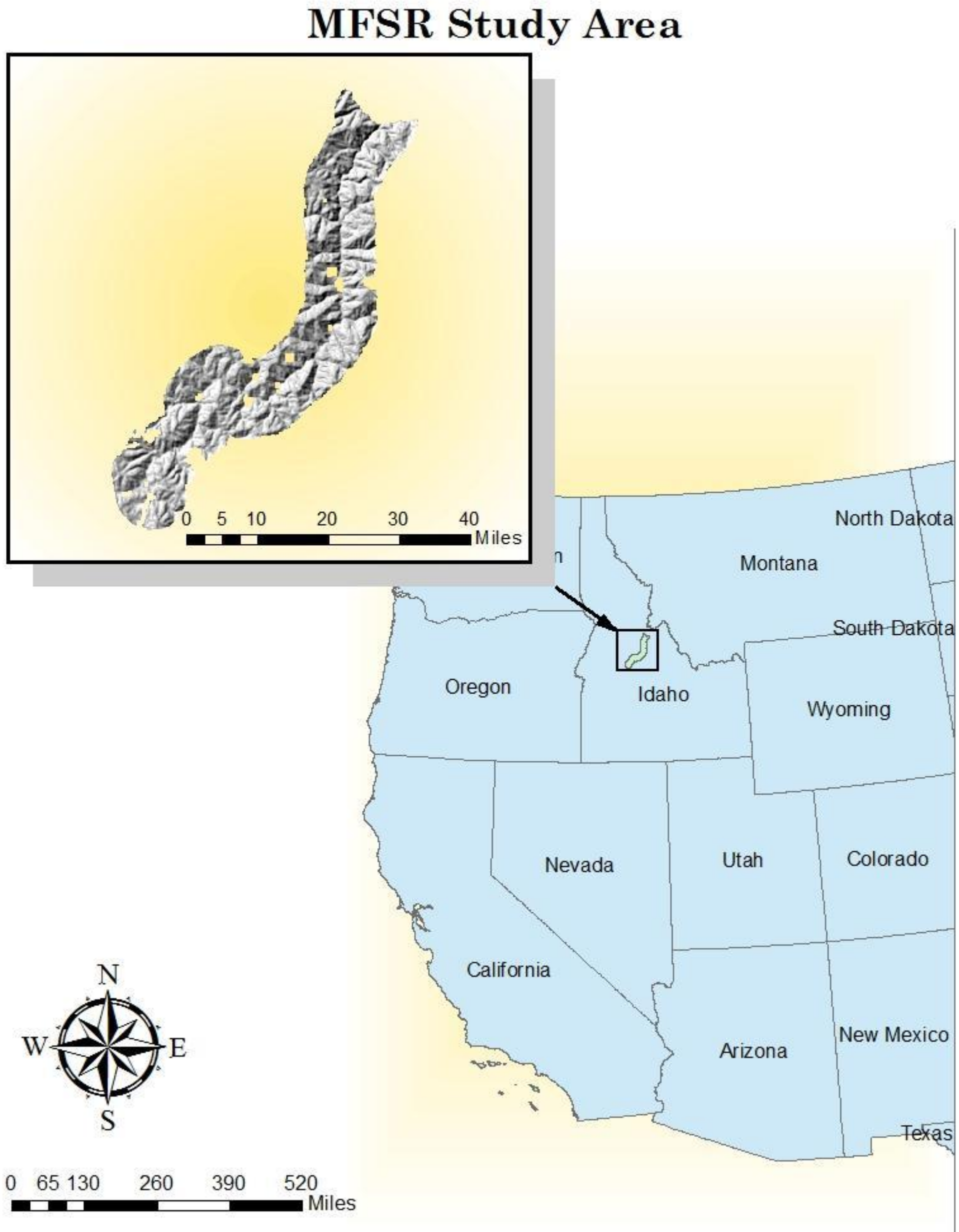

Figure 3.1: Map of MFSR Study Area in Central Idaho. The inset of the study region depicts a hillshade raster data image of the MFSR.

The area of focus for this research is the region of land and water encompassed within a 5 mile buffer of the primary waterway of the MFSR. The location of this waterway is located entirely within Central Idaho and lies within the designated Frank Church River of No Return Wilderness (FCRNRW). Survey results and related spatial value allocations are connected to the localized areas of human use (approximately within a five mile buffer) along the bounded waterline of the river itself. For the purpose of the research, the designated wild and scenic portion of the MFSR was analyzed. This section is roughly 104 miles in length and the measurement in terms of river mileage starts at the designated human multi-use and water craft put-it of Boundary Creek. See above map Figure 3.1 for exact location. Boundary Creek is the common put-in for recreational, commercial users, as well as being the primary location that the United States Forest Service's (USFS) patrol launches from. This study analyzes data relating to the river corridor below Boundary Creek flowing to the popular take-out location Cache Bar. Cache Bar is located at mile 104, which is 104 miles from Boundary Creek.

Although situated within a road less wilderness area, the 104 miles of the wild and scenic MFSR is heavily used seasonally. The heavy use season is May 28th through Sept 3rd (2015) and constitutes the lottery control portion of the year regulated by the USFS. The total usage for the river including Commercial Guides, Commercial Guests, and Private Boaters was 11,284 in 2015. The data gathered for this study comes from users of the MFSR and their land and river use preferences in relation to the entire 104 miles of the MFSR river corridor. Survey inputs are in connection to any possible sites along the MFSR. This includes campsites, trail networks, rapids, cultural sites or any other landmark or feature that can be spatially located along or in the river. For this study, definite titles for specific sites or any commonly acknowledged landmarks, waterways or features utilized the river guidebook, *The Middle Fork of the Salmon: a Comprehensive Guide; 3rd edition* written by Matt Leidecker, as the primary reference resource for the naming of specific study sites along the 104 mile reach of the MFSR.

The connection of river users with the entire 104 mile length of the MFSR is the region of interest (ROI) for this study. Survey data collection however was limited to the non-wilderness road accessed Cache Bar recreational take-out. Cache Bar is located on the Main Salmon River ~3 miles below the confluence of the MFSR and the Main stem of the Salmon River. This site was chosen for being the most popular of three official road accessed terminus points for recreational river trips down the MFSR. It accommodates the highest volume of wilderness visitors leaving the river during the lottery control season; May 28th through September 3rd. This site accommodates the largest number of visitors leaving the MFSR.

The landscape in which the Middle Fork flows through presents a diverse and dynamic shift in ecosystems and geologic character as the river flows north through its entire 104 mile reach. The riverine system supports a large population of the protected Westslope Cutthroat Trout, bull trout as well as endangered anadromous Chinook salmon and steelhead. The surrounding landscape is home to large ungulates including elk and mule deer as well as large predators such as black bear and Canadian grey wolves. The interface of these natural systems with high human recreational use for approximately 5-6 months provides a backdrop for a resource unconfined wilderness experience.

3.2 Data Collection

3.2.1 Survey Methods

The data needed to successfully create spatial location raster images of social values for ecosystem services using the application *SolVES* requires specific spatial and text data attributable to landscape users. The formatting requirements for this data are defined in the geodatabase design section of “Social Values for Ecosystem Services, Version 3.0 (SolVES 3.0)-Documentation and User Manual” (USGS. 2015). The required data to enter into the geodatabase was collected directly from users and stakeholders of the MFSR. The collection of this data was accomplished by gathering participant responses to physically and electronically distributed versions of the survey identified in Appendix A. This process was conducted over select dates in July, August, and September of 2015 based on addressing river corridor users exiting the river corridor during the period of highest seasonal use.

The survey used for this study is composed of a cover letter, and three distinct questionnaire sections. The cover letter is designed to inform the survey participant of the research intent and potential applications of the data retrieved in regard to further river monitoring and management research. The three questionnaire sections are crafted in a manner similar to surveys administered by previous landscape social value and preference studies (Brown, G. 2004, Allesa, L., et al. 2008, Sherrouse, B. C., et al. 2011). The use of surveys in previous studies focused on integration of public knowledge about the landscape where random mail-based surveys were sent out to gather information regarding the participant’s use of the landscape (Brown, G. 2007) In the case of this study the survey study targets particular users of the MFSR resource.

The three sections of questions are (1) demographic questions (including use type), (2) quantifying value point distribution to various landscape values for each participant using the landscape value typology of 12 distinct values; Aesthetic, Biological Diversity, Cultural, Economic, Future, Historic, Intrinsic, Learning, Life Sustaining, Recreational, Spiritual, Therapeutic, and (3) locating areas within the MFSR corridor that correspond to the values quantified in section (2).

The first section of the survey following the cover letter consists of ten questions assessing variable of the survey participant such as age, income, and familiarity with the MFSR resource. The tenth question asks whether or not the river user agrees or disagrees with a fee increase for use of the MFSR. This question is included to provide the USFS with direct river user preference and is not utilized in the social value mapping study.

Section two of the survey asks respondents to distribute 100 hypothetical value points, across the 12 landscape values equally. The intent was for participants to distribute the points across the value types so that the total points allotted summed to 100. Choices for point distribution varied. Points could be distributed to only one value, appointed to any mixture of the values, or distributed evenly across all twelve. This method of point value distribution was chosen as a non-defined point system as opposed to using the hypothetical monetary points used in previous *SolVES* application studies (Sherrouse, B.C., et al. 2011). By not having a type of monetary influence on point distribution, value points could focus on a simulated percent amount of value given to each landscape value.

The hypothetical point distribution of this study differs from previous studies in that it removes the monetary valuation component. In comparison, the survey administered by Clement (2006) asks stakeholders and residents surrounding the Pike and San Isabel National Forest in Colorado to distribute $100 imaginary dollars among the values. Although the idea of affixing a monetary value to the non-market qualities of the landscape can be used as an economic valuation of what normally cannot be given monetary weight and value, it may lead to the influence of paying for services instead of inherently valuing the landscape. To avoid the possibility of guiding participants into feeling as if the exercise was a way to say how much they would 'pay' for the landscape values, this research was structured for participants to view choosing these values as attributing a portion of a 'whole' value or part of 100 value points. These points, being attributed the potential allotment of 100, act as markers for effectively 100 percent of social value given by the participant. After each value has points allotted, section (3) of the survey asks the participants to name or describe explicit locations along the MFSR that embody the landscape values and the point value distribution of one or many of the values listed in the previous section. By linking these values and their points to specific locations, map can be made of where densities of social value occur within the river corridor.

For section three the survey participants are asked to spatially identify areas along the MFSR that embody the values listed above. It also asks that the specific value attached to it be named. This exercise was completed by having survey participants name unique locations by writing the name(s) or physical descriptions of very specific landmarks within the MFSR river corridor. This method was chosen over marking dots on laminated land cover maps of the MF due to confusion over specific locations along the river and some survey respondents unaware of locations of certain places. Mail back surveys in previous studies relied on respondents putting marking dots on physical maps to represent spatial locations of importance (Clement-Potter, J. M. 2006). This method was also not used because the MFSR utilizes standardized names of designated campsites, cultural sites, and detailed trails. Thus, due to the ambiguity caused by map interpretation on-site for survey respondents and email distribution the explicit naming method was chosen.

The explicit naming of the sites was a result of the uniform knowledge and denotation of site names defined by river guidebooks representing the MF. These guidebooks include literature distributed by the USFS as well as private publications. In particular, Matt Liedecker's *Middle Fork of the Salmon River: A Comprehensive Guide* was used based on the ground truthing accuracy of accepted site names, mileage along the river corridor, and GPS coordinates integrated into site locations achieved through the authors diligent research of the area. This guidebook was also used based on wide readership and use of the guide by all three survey sub-groups; commercial guides, commercial guests, and private rafters.

In the research conducted by Sherrouse (2011), the "SolVES output was analyzed for a series of survey subgroups and social value types," those groups were "defined by user-selected parameters". In contrast, the survey subgroups for this study were defined by the users associating with a certain type of 'recreation' user ship of the MFSR. This distinction in survey groups and subgroups was constructed to address the types of users of the river resource. For this research, 'Recreational' users were targeted based on their relatively homogeneous time frame as well as recreational methods of use for the spatial location (rafting/floating along the length of the MFSR). Due to a uniform activity base for each of the user subgroups, landscape scale social values that would be connected to the river corridor can be broken into analysis of the three groups. Each participant's survey response is coded as being from one of three subgroups; 'Private Users' (1), 'Commercial Guests' (2), and 'Guides' (3). In the survey, a (4) subgroup was available, 'Government Employee,' however no responses were returned from this group. The groups are defined as: private recreational users of the MFSR who travel to float, hike or camp along the MFSR, commercial guests visiting the MFSR with a licensed commercial outfitter, and professional guides working on the MFSR for licensed outfitters. Appendix B presents the USFS year-end review showing the number of users and their subgroups (private and commercial usage) for the total usage of the MFSR during the 2015 control, and out of control seasons.

In contrast to the Clements (2006) study of the Pike and San Isabel National Forests in Colorado where a large number of surveys were distributed to a random population surrounding the study area through a mail out survey which included a mapping portion. The survey distribution for this study focuses on direct contact with users as they exited the river corridor. This method provides an observational sampling representation as opposed to a random sampling of the total sample population. The sample population for the MFSR study was chosen based on the relatively limited number of human uses and stakeholder designations in the river corridor within the high use period. An example of this is that 'Recreational' users within the wilderness

MFSR river corridor compose the greatest number of people using the MFSR outside of a small population of private land in-holdings and federal employees managing the landscape. This study focuses on populations that do not reside in the study area year round. As a user base, recreational users do not necessarily live in near proximity of the MFSR. This is due to topographical ruggedness and wilderness designation that generally includes substantial distance from population centers making the study of perceived value a range between high familiarity (Commercial Guides), and those less familiar (Commercial Guests, Private Boaters). The MFSR is also popular with recreational users because of its renowned as a premier whitewater and recreation recreational river corridor which draws a higher sample population. Users of the MFSR may travel great distances to visit the resource. The number of people who visit this region annually is controlled by the allotment of recreation use permits through the USFS. In total the 2015 river floating season as documented by the USFS included 11,284 distinct river users (USFS. 2015) as referenced in Appendix B.

3.3 Survey Distribution

Survey material was administered via a physical method or an electronic method to the three distinct user types, Commercial Guides, Commercial Guests, and Private Boaters using the MFSR. The first distribution method consisted of on-site paper surveys given out at Cache Bar. Cache Bar is the primary take-out location for the majority of Middle Fork rafting trips. For every participant handed a survey, a brief explanation of research goals was given by the researcher explaining the intended social value mapping project. Participants were asked to fill out the survey on-site. Only five Commercial Guides out of all subgroups were able to fill out the survey on site out of thirty one physically returned surveys. For those who could not fill out surveys on-site, an alternative method of physical distribution and return was used which is described below.

Due to heightened activity and time restraints at the takeout area, pre-packaged physical surveys were given to commercial guides, commercial guests (with the permission of distribution from the respective outfitters), and private rafting groups in pre-addressed envelopes for streamlined return. For guides, this was done so that guides coming off of a commercial MFSR trip could fill out the response on the 43 mile drive out to North Fork, Idaho where the responses could then be mailed back directly using a US Postal Service mailbox outside of the North Fork post-office. Commercial guests were given pre-stamped envelopes as well, and were asked to fill out the survey on their bus ride to North Fork, Idaho and to then mail or return the sealed responses to the researcher.

The second, non-physical method of distribution was accomplished by obtaining the e-mail addresses for prospective survey participants. A researcher on-site obtained this e-mail list by requesting emails from MFSR users after they were finished de-rigging from their trip. The explanation of research goals was given in the same manner as addressing those who preferred a physical survey. The collected email addresses were used to send the electronic (and identical) version of the *Visitor Values and Preferences Relating to the Wild and Scenic Middle Fork of the Salmon River, Idaho* (Appendix A). The e-mailed survey was administered a week after the e-mail addresses were received by responses being automatically sent to the survey site and into the survey response database. This was done to ensure continuity of communication between researcher and participant.

The dates of survey administration were within the normal lottery control season for the MFSR (May 28th-September 3rd). The exception for this distribution was the administration of surveys to private MFSR users who utilized the MFSR between September 18th and the 23rd. For these dates 44 surveys were sent to participants on October 15th, 2015 as a large group survey distribution.

3.4 *SolVES* and Geospatial Data

To successfully utilize the application Social Values for Ecosystem Services (*SolVES*) for spatial analysis, tables representing the point allocation data for each landscape value type and the locations of value allocation along the river must be gathered and integrated into a SolVES.gdb. The collected survey response data are collated and the geodatabase tables are then filled in according to the geodatabase requirements of *SolVES* 3.0. These tables correspond with the unique responses of all the survey participants. In conjunction with preference and quantified attitude data, the unique identifiers for each survey and the values allocated to specific points are linked to digitized point feature classes. These points are required for *SolVES.* The researcher must use ArcGIS to create a point tied to each location specified in the survey. These points represent the specific locations along with identifiers for every value submitted in section (2) and (3) of the survey in connection to landscape qualities of the MFSR.

An example of this is the survey response of *Spiritual Value* being connected to the singular spatial location of Veil Falls. For every survey point defined by the respondents to a point is mapped and ultimately connected to the value points for that respondent. With the Veil Falls point, a point feature class was created and a single point was placed on the location of the waterfall named Veil Falls. All points were found and placed by the researcher using a satellite imagery base map provided by ArcGIS. All points in the MFSR study were placed using NAD 83 UTM Zone 11n projection. This information is then structured into the source file geodatabase to have a separate survey point feature class for each location and the connected numerical value. Figure 3.2 shows the model flow of the input geospatial data into the geodatabase to be analyzed. The symbology of the following diagram depicts how each input relates to the others and works together. The symbol (1-M) represents a one input to many input relationship between the feature classes and table data.

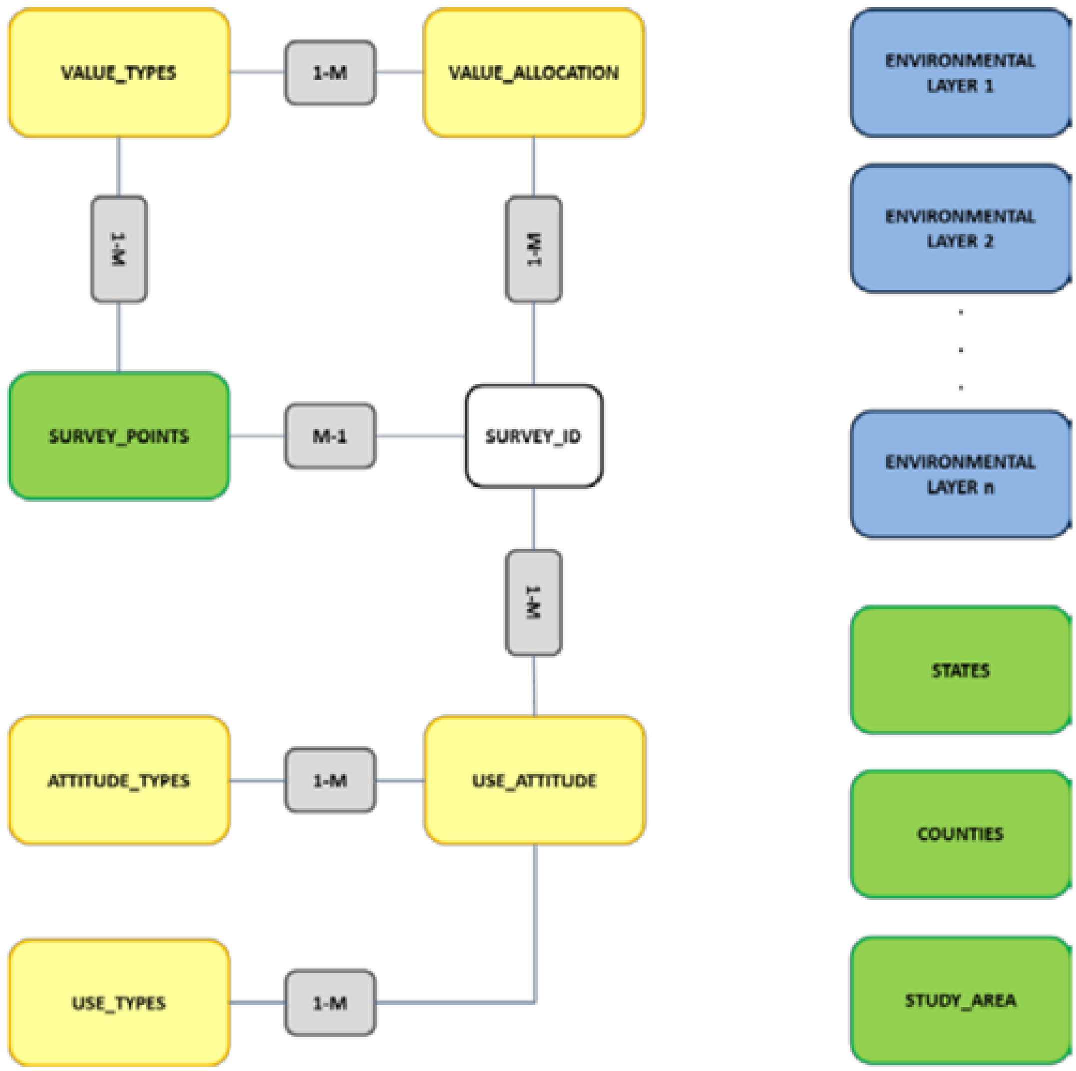

Figure 3.2: Model of Input Data Flow for SolVES.gdb. (USGS. 2015)

Along with the required social value data obtained through survey responses, environmental layers of the study area are also needed to perform analysis. These layers are landscape scale environmental qualities defined by the research needs. These layers are partially defined by the requirements of the program itself for spatial analysis while others are reference based for regionally specific zonal statistics and the measured 'distance to' the survey value points. To obtain these layers, pertinent environmental qualities relating to the resource were examined. The layers used were namely features of the landscape that could potentially affect perceived value. For the MFSR analysis, environmental layers consist of the following raster layers; Slope (which was calculated from the MFSR digital elevation model (DEM) using the Slope tool in ArcGIS), Elevation (created from a mosaic of four DEM rasters of the MFSR area then masking to the five mile buffer range of the study area), Hillshade (created with the Hillshade tool based off of the MFSR DEM), Distance to River (created using a polygon layer of the Middle Fork of the Salmon River itself to find the distance to the river feature), Distance to River Trail (similar to the distance to river layer, this found the distance to the prominent river trail based on a polyline layer), and Distance to Rapids (distance to rapids that were digitized as separate polygon layers). All environmental layers were clipped/masked to the extent of the study area to define their boundaries which is required for *SolVES* to run analysis. To actually determine the distance from each feature in the 'Distance to' layers, the geoprocessing tool *Euclidean Distance* was used to find the distance away from each polygon or line feature that represents geographical features relevant to users and stakeholders of the river corridor.

Regional reference data was also included. The reference feature classes for analysis located in the United States include polygon layers for the states and counties of any particular state and region. Although these are not specific to the research or survey points, these layers are used in the final output to provide geographic reference. Although five environmental layers were used for this study, "any number of raster datasets" (USGS. 2015) can define the landscape metrics to be spatially computed against the survey points.

Table 3.1: *Environmental Layers Used for MFSR SolVES analysis and their purpose*

Evironmental Variable Abbreviation	Name of Environmental Layer
DTRAPIDS	Distance to Rapids
DTRIVER	Distance to River
DTRTRAIL	Distance to River Trail
MF_DEM1	Elevation
MFSR_HILLSHADE	Hill Shade
MFSR_SLOPE	Slope

Description
(DTRAPIDS) The measured meter distance to rapids within the river corridor
(DTRIVER) The measured meter distance to the Middle Fork of the Salmon River
(DTRTRAIL) The measured meter distance to the river trail that follows ~78 miles of the Middle Fork
(MF_DEM1) Elevation of the River Corridor measured in meters
(MFSR_HILLSHADE) A model layer depicting hill shade based on azimuth and altitude of the sun
(MFSR_SLOPE) The measure of degrees of slope along the Middle Fork

In addition to the environmental layer criteria, an overall Survey Point layer is created to represent all spatial locations along the river and the values attached to them. This layer is entered into the *SolVES* geodatabase as a point feature class to populate and provide points for analysis in relation to the environmental layers. After processing *SolVES* creates output rasters that depict the average weighted density of value points for each location based on value type and the amount of value points attributed to each location. These rasters are produced with a set cell size of 30 meters to account for the relatively small study area.

Also of note, this study included two more environmental layers than the example used in the Pike & San Isabelle National Forest study. These were used to assess usefulness of fit and statistical relevance based on the values in connection to spatial locations more in relation to the river itself, and landscape specific features such as trails and rapids instead of solely using large sweeping landscape qualities like elevation and land cover.

Chapter 4: Results

This chapter covers the findings of the river corridor social value research. The results are broken down into the following three sections.

1. Survey response results. Included in this section is discussion of variables in survey responses and their implications to the survey methodology.
2. Analysis of the model results produced by *SolVES*.
3. Statistical relevance of the inputs and metrics that produced the *SolVES* results in connection to the river corridor and particular user groups of the river.

4.1 Survey Response

Of 213 surveys administered, 91 completed surveys were returned for a response rate of 42.75%. 31 responses are from Private Users, 33 are from Commercial Guests, and 27 are from Commercial Guides. Through the entire research there were zero refusals to participate in the project. Of the surveys returned, thirty-one were physical copies; sixty survey responses were sent directly as online submissions through a link connecting the participant directly to the survey using the website Formsite.com. The results of the survey data collection period were finalized on a set deadline of December 1st, 2015. This date marked the final point for survey data submission via the online method and by mail-in response. In the case of 5 commercial guides, surveys were filled out the evening of taking off of the Middle Fork of the Salmon River (MFSR) on-site and did not require being mailed back. For all physical submissions data was transcribed into the MFSR survey Formsite.com database. This data entry method sent all data to a common database for analysis. All of the data was finalized for entry and entered into the database during the week after the December 1st cutoff so that unique identifiers could be applied to every response.

4.1.1 Survey Results

Section one of the survey assesses river user demographic information. A summary of age and income show that the average age of respondent is 43.5 years old, with the majority (43.9%) of the respondents falling in the income range of ($0-$50,000). This information is relevant based on the recreational, guiding and commercial use of the MFSR and assessing the effort that is required in accessing the ecosystem services associated with the river resource through time and money invested.

Distinct survey subgroups relating to the number of spatially usable responses for each subgroup were broken down into the following categories in Tables 4.1 and 4.2.

Table 4.1: Response results based on survey subgroups

User Subgroups	Completed Survey Responses
Private Users	31
Commercial Guests	33
Commercial Guide	27
Totals	**91**

Table 4.2: Response results showing the number of surveys providing usable spatial data relating to all survey subgroups

User Subgroups	Viable Spatial Data in Relation to Value Index
Private Users	7 responses (26.9% of Viable Survey Data)
Commercial Guests	4 responses (15.38% of Viable Survey Data)
Commercial Guide	15 responses (57.69% of Viable Survey Data)
Totals	**26 (28.57% of Completed Total Surveys)**

The total number of viable completed surveys was limited to 28.57% of the overall completed responses. Broken into subgroups; 22.58% of Private users produced valid responses, 12.12% of Commercial Guests produced valid responses, and 55.5% of Commercial Guides produced valid responses. It is important to note that the amount of usable responses from the guide subgroup is much higher than the other two subgroups. This distinction makes the models produced by *SolVES* much more representative of the guiding community on the MFSR. The higher responses by the guiding community may be due to a higher familiarity with the river resource.

Disparities that exist between survey subgroups' age, income, and familiarity with the resource are partially due to the intent of time spent using the MFSR. The guiding subgroup also generally was within the lowest income bracket (0-$50,000 yearly) and average age (33 years old). This subgroup commits a larger amount of time and foregoes other means of permanent employ to utilize and work on the MFSR resource. Whereas the other two subgroups are a part of the recreational river users that do not have the time to travel on the river corridor as often. However, all of the subgroups have equanimity in the types of river use. Due to the common ability of all subgroups, analysis of all the usable responses was conducted. In Figure 4.1, the 424 total survey points are shown as point data along the MFSR.

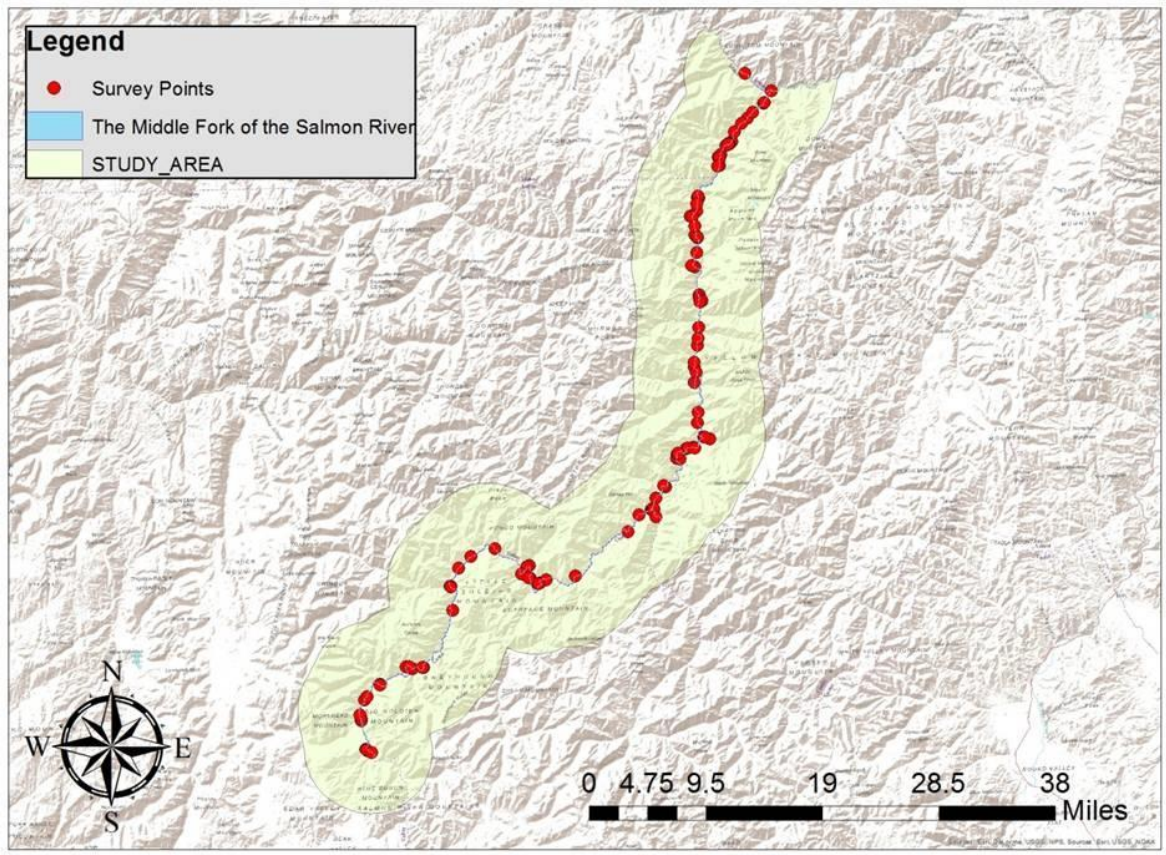

Figure 4.1: Depiction of all subgroup survey points plotted along the MFSR

The correlation of spatial familiarity and number of points attributed to the landscape coincides with conditions discussed by Sherrouse (2011) as "analysis of the survey data describing respondents' familiarity with the study area… could prove useful for identifying selection bias that might influence how values are weighted." This result was seen with the Commercial Guide subgroup. For the guiding subgroup showed that 22 of the 27 respondents had used the river resource 10 or more times. 22 of 33 Commercial Guest respondents reported having used the resource only once. Analyzing the use and bias based on familiarity may correspond to an overall usage trait that accounts for stakeholders or users also have economic ties to the resource as well as have higher value connections. This distinction could be explored further in regard to the locations, regions and stretches of the river resource where specific values are present that users with greater familiarity connect to. A more in-depth survey inventory of the user bias of the MFSR may be used to provide a clearer view into this value connection with spatial familiarity and to further define user subgroups.

For section two of the survey, all 91 respondents who completed the survey (regardless of whether they correctly filled out the spatial location identification section) successfully provided value point allocation to the social values described in the landscape value typology. These values are Aesthetic, Biological Diversity, Cultural, Economic, Future, Historic, Intrinsic, Learning, Life-Sustaining, Recreational, Spiritual, and Therapeutic Values. While analyzing the results it was found that a discrepancy in survey response occurred. For sixty-four percent (59) of completed survey responses, the distribution of the 100 points to each of the landscape values equaled 100. For the remainder of the completed surveys (32), participants attributed 100 value points to *each* of the 12 landscape values. An example of this would be of the 12 values, 90 points were allotted to every single value type. This method does not provide the sum of the allotted values equal 100, therefore the data could not be entered into the SolVES.gdb correctly. A method of accounting for this result is to transform this data to represent a weighted total using the sum of all value point allocations and divide them by the separate value amount attribute to each value. This represents a total percentage of the point values attributed (the total number of allocated points for each participant).

This method of normalization was used in previous applications of *SolVES* to account for similar data entries (Sherrouse. B.C. et al. 2011). An issue of analysis to be aware of with this method of normalization is the potential for the point data potentially representing different forms of value based on the amounts attributed. Namely, those who feel that it is not appropriate to leave out one of the values from point allocation. For this study, normalized and transformed data represents the intent of point allocation based on *overall* user value for the river resource in regard to kernel density within the raster images. For the purpose of creating quantifiable weighted value, the method of normalizing the value points for each value type is effective for mapping based on the percentage to overall value i.e. 100 value points.

This difference in response results is potentially significant when exploring whether or not the intent of quantifying the value index for each of the value types is the same. The implication of this is that there may be difference in how respondents view values along the river. The technical implication affects the ability to enter value allocations into the *SolVES* data tables. To account for the difference in value index, the values for the 32 results with value points >100 were normalized to transform the value points into percentage point value representation of each unique surveys total value point allocation. One concern pertaining to this study is that the two methods of response possibly reflected and represent two distinct types of survey. This implies that some respondents view the point allocation differently than others. Statistically, these respondents may represent an entirely different valuing group. If the groups are different, separate analysis would be necessary and would ultimately provide a smaller point distribution based on the method of value point allocation.

To analyze the potential statistical differences between survey response types, a permutation test was conducted. For those in the category of assigning 0-100 points for each value, Subgroup A: n=32, the value points were normalized to represent a percentage of 100 total points across all values. This manipulation of the data suggests that the values given by Subgroup A could differ in intention for each value due to the tendency to assign value for all values instead of choosing particular values or dividing 100 points equally across values. Subgroup B: n=59 distributed 0-100 points across the values.

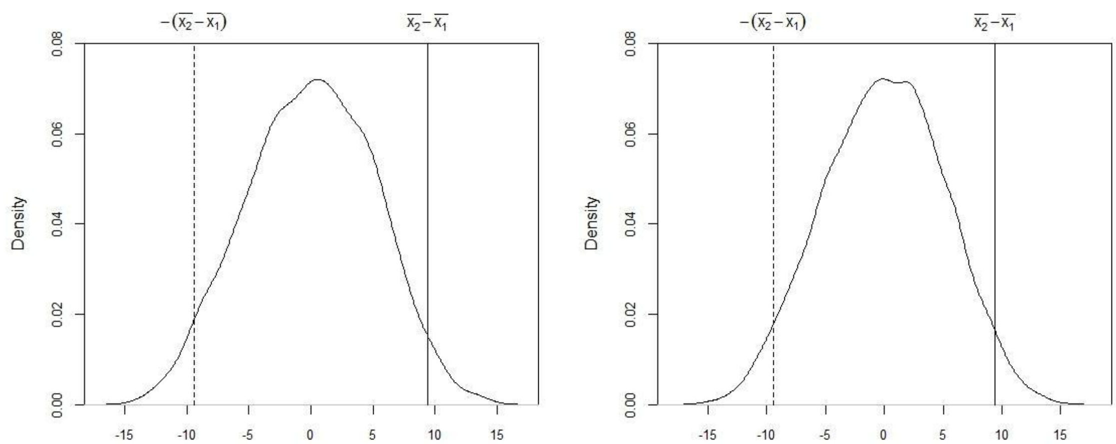

Figure 4.2: Histograms of value points distributed for the value type: recreation using a permutation test. The figure on the left represents survey responses from Subgroup A (Those who attributed 0-100 value points for each Value type)) and Subgroup B (Those who attributed 0-100 value points across all value types). The graph on the left represents value point distribution before normalization of values; the graph on the right represents the test for Subgroup B's value points after normalization.

The permutation test simulated 10,000 regroupings of the responses for all surveys linked to the landscape value *Recreation* the test resulted in a p-value of .0619. This p-value suggests value point allocations do not differ. Also, a permutation test comparing the normalized values for Subgroup A and the values points allocated by Subgroup B produced a p-value = .0651. These tests were conducted using a 95% confidence interval suggesting that there may be a difference between methods of point distribution between subgroups, but the p-value is not low enough to reject the null hypothesis that the means are completely different. This leads to the acceptance that the models produced with the normalized values (Subgroup A) are potentially significant in comparison to Subgroup B's value point responses which allows all surveys to be used in the study.

After concluding that the value allocations for all viable responses were usable in spatial value modeling, the next goal was to connect the value points to specific points along the MFSR corridor. This occurred through analysis of section three of the survey where respondents were asked to notate the names of specific locations along the MFSR that embody the social values so that the quantified values could be applied. The result of this section produced the 424 survey points mapped in Figure 4.1. For specific places pinpointed along the river corridor, the corresponding value or values are assigned to the location to create the point feature class representing values at specific locations.

In total, 26 viable survey results yielded 424 survey points for mapping and value allocation for analysis with *SolVES*. These points represent the combined values of all three user subgroups, Commercial Guides (15 viable responses), Commercial Guests (4 viable responses), and Private Boaters (7 viable responses).

4.2 Spatial Analysis of Survey Data Using *SolVES*

For *SolVES* to produce maps representing the modeled value intensities linked to all viable surveys, data was entered into the required tables in the SolVES.gdb so that the tool was ready to use. After setting the working directory and delineating that all spatially viable surveys from all user subgroups (Commercial Guides, Commercial Guests, and Private Boaters) should be used, the *SolVES* project was started. In the initial stage of the project, the researcher may define the parameters of which survey subgroup is analyzed for specific modeling on values. For this research, all of the viable survey responses (n = 26) were used to represent all of the surveyed river users and their connection to the river corridor.

Using the total number of value points across all subgroups allows the *SolVES* output to create a series of value maps depicting the weighted kernel density of the value index (1-10) for each value within each raster cell. Along with the raster based map output, the analysis also provides graphs showing area under the curve (AUC) statistics for the correlation of points to the environmental layers input. This combination of the output raster layer as well as a model showing the goodness of fit provides representative maps of user values that are tied to the MFSR landscape. The 5 distinct environmental layers (Table 3.1) were used to create raster based outputs confined to the study area boundaries. Nearest neighbor statistics determine spatial connectivity between value points and landscape scale features such as the river itself and designated campsites. For each of the 12 value types, *SolVES* creates a value map with graphs representing the value allocation on the 1-10 scaled index range for each value type in relation to the landscape metrics. Ultimately a series of 12 map products consisting of the raster layer depicting social value intensity for each type (Aesthetic, Biological Diversity, etc), their relation to the environmental layers, line graphs showing the intensity of value allocation for each of the landscape metric, and the AUC values showing the model goodness of fit. Figure 4.3 is a model output for Spiritual Value on the MFSR.

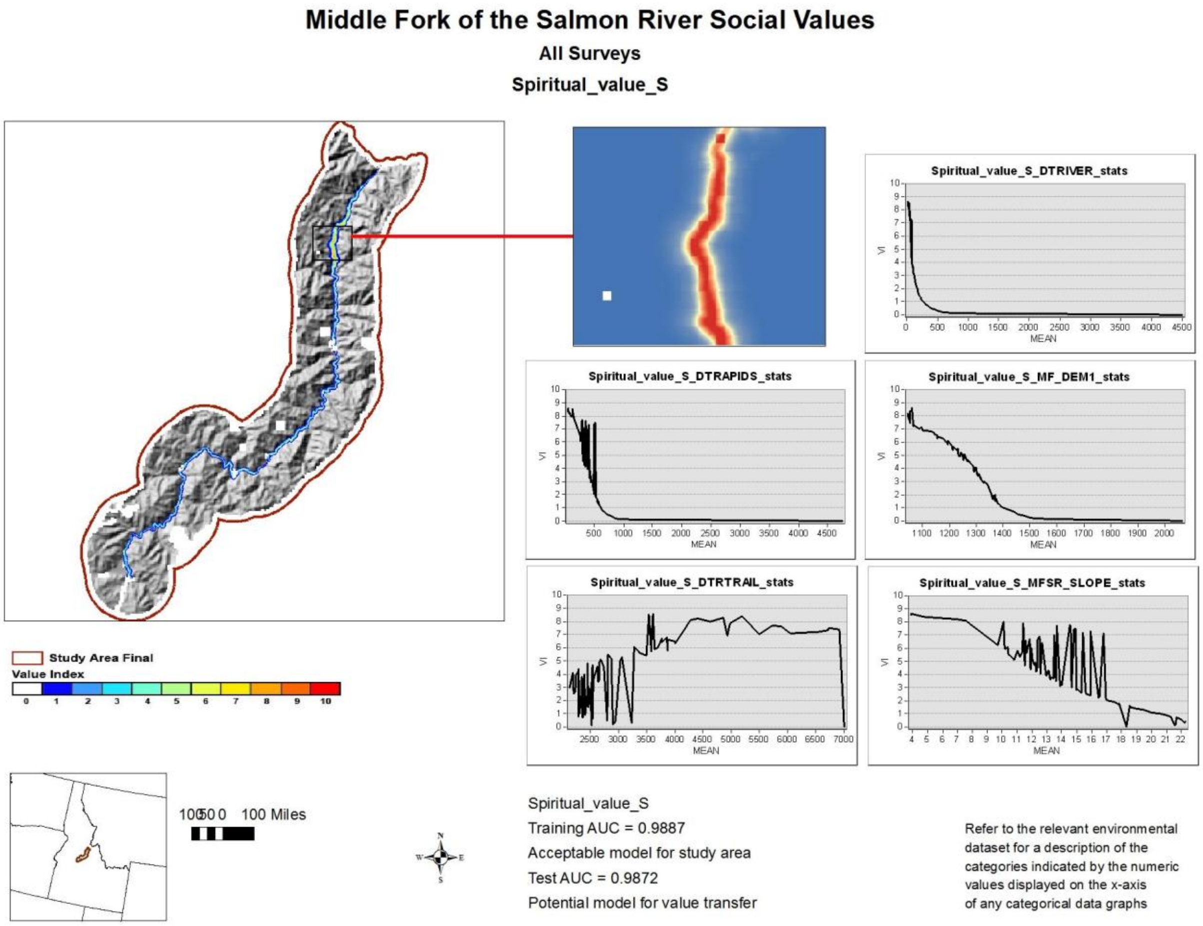

Figure 4.3: Spiritual value output map and corresponding zonal statistics depicting spatial correlation of survey points to environmental parameters. Includes a zoomed-in insert to show detail of the lower MFSR canyon where high Spiritual value intensity is located.

4.2.1 AUC statistical relevance for value models

Following the processing of data through *SolVES*, the outputs were analyzed to understand the connection and relevance of the distinct environmental layers to each of the value models. Analyzing the area under the curve (AUC) statistics for each model provides data on whether or not the model is a suitable geospatial representation of social values in connection to the environmental layers within the river corridor. These environmental layers and their percent contribution are included below in Table 4.3.

Table 4.3: Environmental Variable Percentage of Contribution for all 12 Output Values

Aesthetic Value		
Variable	Percent contribution	Permutation importance
dtriver	93.7	76.9
mf_dem1	2.9	8.2
dtrapids	2	12.4
dtrtrail	1.1	2.5
mfsr_slope	0.3	0.1
Biological Diversity Value		
Variable	Percent contribution	Permutation importance
dtriver	96.6	94.4
dtrapids	2.8	5.4
dtrtrail	0.6	0.2
mfsr_slope	0	0.1
mf_dem1	0	0
Cultural Value		
Variable	Percent contribution	Permutation importance
dtriver	93.1	96.8
dtrtrail	3.2	2.7
dtrapids	2.7	0.4
mf_dem1	0.9	0.2
mfsr_slope	0.1	0
Economic Value		
Variable	Percent contribution	Permutation importance
dtriver	95.1	97.2
dtrapids	3.2	2.8
mfsr_slope	1.6	0
mf_dem1	0.1	0.1
dtrtrail	0	0
Future Value		
Variable	Percent contribution	Permutation importance
dtriver	76.5	70.6
mf_dem1	8.5	23.7
dtrapids	8.4	0
dtrtrail	6.3	5.6
mfsr_slope	0.3	0
Historic Value		
Variable	Percent contribution	Permutation importance
dtriver	89.3	89.9
dtrapids	4.6	0.6
mf_dem1	3.5	7.3
dtrtrail	2.3	2.2
mfsr_slope	0.3	0.1

Intrinsic Value		
Variable	**Percent contribution**	**Permutation importance**
dtriver	80.5	89.7
dtrapids	10.7	0.4
dtrtrail	5.2	3.7
mf_dem1	3.3	5.4
mfsr_slope	0.3	0.8
Learning Value		
Variable	**Percent contribution**	**Permutation importance**
dtriver	100	100
mfsr_slope	0	0
mf_dem1	0	0
dtrtrail	0	0
dtrapids	0	0
Life Sustaining Value		
Variable	**Percent contribution**	**Permutation importance**
dtriver	98.7	94.4
dtrapids	1.3	5.3
mfsr_slope	0.1	0.2
mf_dem1	0	0.1
dtrtrail	0	0
Recreation Value		
Variable	**Percent contribution**	**Permutation importance**
dtriver	78.8	7.6
dtrapids	18.3	88
dtrtrail	1.4	0.5
mf_dem1	0.8	3.6
mfsr_slope	0.8	0.3
Spiritual Value		
Variable	**Percent contribution**	**Permutation importance**
dtriver	87.8	87.9
dtrtrail	8.1	7.6
dtrapids	3.1	3.7
mfsr_slope	0.7	0.5
mf_dem1	0.2	0.3
Therapeutic Value		
Variable	**Percent contribution**	**Permutation importance**
dtriver	91.7	98.1
mfsr_slope	6	1.2
dtrtrail	1.1	0.4
dtrapids	0.6	0
mf_dem1	0.6	0.2

The analysis of AUC statistics is described as;

"Models with AUC values of 0.5 or less perform at the level of random prediction or worse. Models with AUC values beginning at 0.70 and above are considered potentially useful. SolVES instructs Maxent to withhold 25 percent of the points from each user-selected social-value type or survey subgroup as test points so that Maxent can calculate AUC statistics for training points (the remaining 75 percent) and test points. The training AUC indicates how well the model fits the primary study area whereas the test AUC indicates the potential performance of the model in transferring social values to a similar area" (USGS. 2015).

Table 4.4: 'Area Under the Curve' (AUC) statistics for value models and conclusion

Value Model	Training AUC	Conclussion
Aesthetic_value_A	0.9902	Acceptable model for study area
Biological_diversity_value_B	0.986	Acceptable model for study area
Cultural_value_C	0.9887	Acceptable model for study area
Economic_value_E	0.9912	Acceptable model for study area
Future_value_F	0.9891	Acceptable model for study area
Historic_value_H	0.9915	Acceptable model for study area
Intrinsic_value_I	0.9886	Acceptable model for study area
Learning_value_L	0.9882	Acceptable model for study area
Life_Sustaining_value_LS	0.9886	Acceptable model for study area
Recreation_value_R	0.9893	Acceptable model for study area
Spiritual_value_S	0.9887	Acceptable model for study area
Therapeutic_value_T	0.9895	Acceptable model for study area

The AUC test statistics for the MFSR show that all value models fall within the 0.9-1.0 range. This suggests that all outputs are reasonable models of mapped social values within the MFSR corridor. The high AUC model value suggests that the analysis of the data in relation to understanding how users value the resource based on the environmental layers, is founded on strong models of those values.

4.3 Social Value Intensity & Frissell Impact Condition Correlation

After discovering that the models produced by *SolVES* have a strong goodness of fit for social values relating to the environmental layers within the MFSR, correlation tests were conducted to test for connection of location specific social values to the numerical classification of the Frissell Impact Condition of campsites along the MFSR. The correlation test is used to discover whether averaged social values that are tied to specific location along the MFSR, including campsites, correlate spatially to the intensity of the Frissell campsite impact condition class (1-5). The correlation test shows a negative, positive, or no correlation between the increase of averaged social value for a location and the increase of impact severity for campsites. Below are the results of the correlation test.

Table 4.5: Correlation coefficient values between social value type and numerical rating of campsites based on Frissell/Cole condition class

Value Type	Correlation Coeficcient
Aesthetic	0.00140838
Biological Diversity	0.055591472
Cultural	0.065693902
Economic	-0.091063699
Future	0.147506669
Historic	0.036556628
Intrinsic	0.211027503
Learning	-0.121011253
Life-Sustaining	-0.097580081
Recreation	0.019177324
Spiritual	-0.030817772
Therapeutic	-0.190051063

The results show that there is neither a particularly strong negative nor strong positive correlation between averaged social values tied to campsite locations and the Frissell condition classes of each campsite. Although the correlation coefficients are not strong either direction, the strongest positive correlation shows that there is some link to impact condition class increase and the increase of intrinsic value. Also, the strongest negative correlation is to therapeutic value.

This suggests that as the impact to campsites increases, therapeutic value decreases. Potentially the most important correlation found from this test is the almost spurious (>-.05 - <.05) correlation coefficient for aesthetic, historic, recreation, and spiritual values. This means that there is potentially no connection between the severity of campsite impact and the perceived value for the above values. For a land manager this is important to analyze in the face of decision making based on protecting certain wilderness or river qualities that must be accounted for to uphold the mandate of the Wilderness Act (1964) and the Central Idaho Wilderness Act (1980). In the decision making process, the indication of the users perceived quantification of values along the river can help inform decision making.

An example of management concern along the MFSR is near the campsite 'Little Soldier.' This campsite has been inventoried by the USFS as being a class 4 on the Frissell/Cole impact scale. This classification for a river site consists of having multiple pull-out areas as well as compacted and defined social trails as well as satellite camps extending from the predominant campsite (Cole, D.N. 1989). In addition to the higher impact classification of the campsite on September 12, 2015, a Chinook salmon spawning bed (redd) was identified directly off shore from the camp. The recommendation of the USFS researcher was to close Little Soldier camp based on the proximity to the spawning redd. However, this potentially causes contention with river users trying to stay at this campsite and this area later in the season when it becomes one of only a few camps large enough downstream of one of the launch sites to accommodate larger trips sizes. This potential for conflict in the decision making process of whether or not to close the camp based on wild life protection while still providing social ecological services (SES) could be influenced by knowledge of where perceived social landscape values are most intense.

This potential use mirrors similar outcomes of previous research, “given the Forest Service’s 2012 Planning Rule requirement to account for ecosystem services in the development of new Forest Plans (36 CFR 219). Hotspot analysis results enable spatial and visual comparisons between cultural and other ecosystem services, putting difficult-to-monetize cultural services on a level playing field for decision making with biophysically modeled services that are more amenable to monetary valuation” (Bagstad, K.J., et al. 2015). Understanding potential overlap between specific social values and spatially relevant management concerns and ecosystem services can be expressly represented through *SolVES* maps (ex. Figure 4.3). The map addresses these issues while providing an overview of the quantified value of the MFSR stakeholders based on the time frame of data retrieval and goodness of fit for the model outputs.

An example of a visual comparison of value to management concerns is shown in the map below (Figure 4.4). This map was created by averaging the cell values of all social value types to create a value aggregate map of all 12 social values. Figure 4.4 shows the site recommended for closure which sits on an area of high aggregate social value. The overall aggregate social value is represented by the graduated color scale under the legend. Using the color of the cells in relation to value (these color graduations can be modified to fit various applications) the area of concern is in an area of aggregate social value approximate to 5. This is on the upper end of the scale showing higher social value which could lead to contention with stakeholders of the MFSR. This tool can be used to thematically represent the simultaneous concerns anthropogenic, ecological and biological in connection to landscape scale social values of a particular subgroup of user.

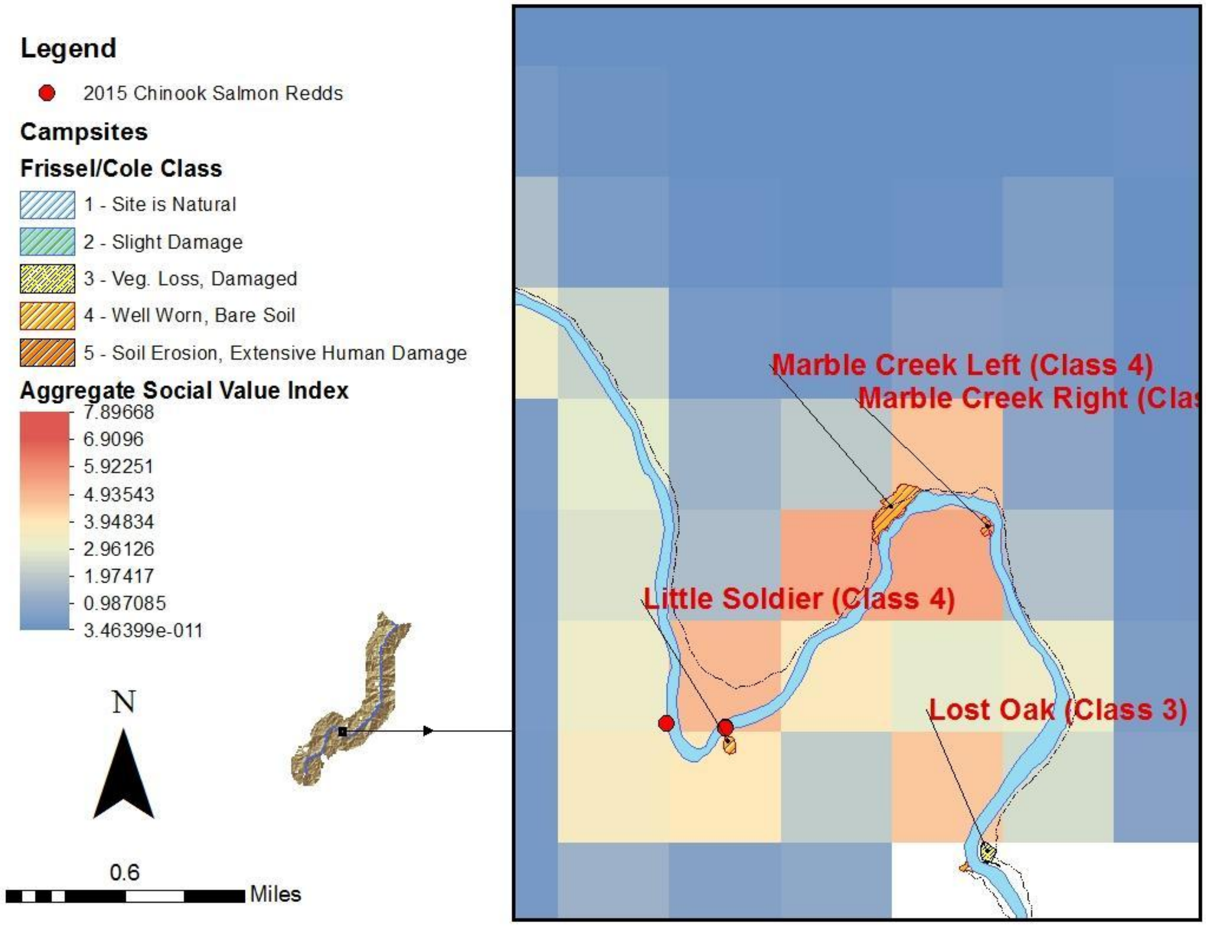

Figure 4.4: The background raster cells in this map show the representation of aggregate social values as they relate to two spatially identified management concerns (higher Frissell impact campsite classification, and proximity of camps to Chinook salmon spawning redds within the MFSR channel).

By creating mapped products that viably represent quantified social values tied to ecosystem services within a river corridor, SES can be taken into account during the decision making process of management. Decisions which incorporate spatially mapped social value could influence records of decision (ROD), operating plans, and long term objective completion focused on accounting for human value in wild landscapes. River management can use these models to define the values of specific user groups in the management river corridor to account for spatially related management concerns and future planning. This connection of spatial location with social value cam assist management reform by addressing regions where the conditions of wild and scenic character is being impacted and therefore degraded which could affect the perceived and experiential social values of the MFSR users. Understanding the correlation of values to the conditions of a landscape is successfully achieved through the outputs of *SolVES* as a spatial analysis tool. More specifically, the values of isolated subgroups can be represented and have further comparison to other user groups within a river corridor. Therefore wild river management can potentially utilize *SolVES* as a means of understanding where and how the users of the river corridor apply value to certain regions based on environmental criteria. The models produced by *SolVES* can then be analyzed for management decision making based on the understanding of how users of the river value specific locations and whether or not there is correlation between certain values and specific landscape scale management concerns.

Chapter 5: Discussion

5.1 Future Applications of Value Mapping for River Corridor Management

After developing and utilizing a unique survey to measure and account for social value locations within the Middle Fork of the Salmon River (MFSR) corridor, maps were created to streamline the interpretation of the results of these surveys. These maps and their results are the direct output of *SolVES.* Specifically, this application applied data to the *Ecosystems Services Social Values Model* as well as the *Value Mapping Model* to model the locations of the MFSR users' and stakeholders' values along the river. The environmental and specific inputs into the *SolVES* program created explicit maps of distinct regions where higher values were present within the river corridor in relation to landscape metrics. Analysis for this research focused on each of the 12 landscape values separately for all surveys of the three user subgroups. All surveys were used together due to their representation of the whole of river users on the MFSR. Also, because the highest physical use of the river corridor is river users (11,284 in 2015) this study examined how mapping social values on a smaller scale creates the opportunity to project and potential transfer landscape scale values of users and stakeholders to other river corridors. Rivers similar to the MFSR geographically will be based on similar landscape metrics and could relate with statistical significance based on the response quality to specific surveys for river users. The results of the 12 value map outputs for this study indicated AUC values between .90 – 1.00 indicating an excellent model fit for the study region as well as potential value transfers based on the environmental inputs. For an accurate value index transferal across riverine applications, distinctions and defining user subgroup thresholds have to be defined in regard to the potential environmental data and analysis transfer for other river corridors based on user preference and defining ecological concerns.

By using models of spatially mapped social values in river corridors, Wild River managers can potentially target understanding landscape scale change in relation to specific types of use within the corridor. By addressing various use patterns and populations regionally, specific management issues can be addressed. An example of this would be a river that is not designated Wild and Scenic but experiences high use, and mixed use year round from fishermen, tribal hunting and recreational floating. By assessing various stakeholder and user groups for their perceived values on the river, problems such as use capacity could be adjusted to accommodate users the benefits provided by the river without detracting from use satisfaction.

Future applications will require more explicit and varied user and environmental data to produce models potentially useful in addressing river specific concerns. In previous studies utilizing *SolVES* this was accounted for with user preferences based on land use. This could be applied to river corridors and watersheds regarding the location of social values for those who feel riparian corridors are under or over utilized for particular management reasons. One approach that can be taken on the MFSR is analyzing the perceived values of the Shoshone-Bannock tribes whose ancestors historically inhabited the MFSR. The tribe's perceived values could present a very different historical, cultural, learning and future value system. Comparison of these values with other user value models could inform management to make decisions on use of certain areas for all stakeholders to benefit while limiting use so that the tribal stakeholders' needs are accounted for. In this study, there were a limited number of spatial points related to some of the values that may be more supported through other user types.

The specific landscape nuances associated with the MFSR that make it a prime location to test the ability to map social values within a river corridor rely on its high use seasonality and the distinct named regions and using a survey method reliant on common names of places in the corridor. This is important to note because the socially held values presented within the corridor are connected to named areas common to the river users. These common names are presented in highly used literature relating to the river (Liedecker, M. 2013). This caveat differentiates the MFSR corridor from larger scale use of landscape value mapping based on the assumption of commonality with the naming of specifics locations themselves. This is not the case with lesser known or lesser utilized river corridors. The yearly and seasonal usage of the MFSR exemplifies the resource as a recreational corridor based on the records of human travel collected by the USFS. For the MFSR specifically, future applications could address other temporal, non-prime seasonal usage and explore how value preferences changes seasonally.

The quality and validity of user responses are based on locations of preference tied to the limited timeframe of study. This baseline of temporal relevance is connected not only to the spatial locations but also to the seasonality of when those values are present along the MFSR. This topic of timeframe based social value location addresses the need for multi-year scaled research in connection to how these values reflect use over varying seasons. Other timeframe specific concerns, such as years of drought vs. seasons following large snowpack could impact modelling. It should be acknowledged that any further research into mapping and finding the spatial locations of these landscape values also should clarify and statistically subgroup the seasonal timeframe of usage along with use type.

It can be understood through this study that the potential to model various stakeholder groups over a wider temporal range is needed to produce a more robust view of social value mapping. This is especially true within the MFSR corridor where use changes dramatically outside of the studied timeframe. The outcomes of this research demonstrate the successful gathering of social value data to show that value mapping applications to a river corridor can locate spatially explicit value while giving correlation of values to potential areas of concern for managers.

5.2 Recommendations

Further research in corridor specific applications of social value mapping will benefit from delineating precise subgroups and time frame application. These more specialized applications can focus on small landscape scales for modeling of values that relate to finite issues tied to particular user group values or spatial locations within the river corridor. Examples of smaller scale and more specific landscape metrics could include the locations of tree stands that could be affected by fire and pose a direct threat to human welfare, archeological sites potentially affected by human use, or private inholdings that affect wilderness character. These types of small scale environmental metrics can provide more defined and useful connective information for land managers through spatially relating values with areas of concern. To achieve this, more precise survey methods need to be developed to ask and assess particular issues.

To define these issues, environmental metrics can be outlined to correspond with the subgroups values. These landscape metrics would be entered into the *SolVES* analysis to produce models of particular values connected to distinct physical landscape properties. Other landscape metrics that can help with management protocols could be regions of coniferous species recruitment, fire ecology, and localized soil compaction. On a broader scale, environmental metrics could represent the confluence of bio-physical, cultural, and ecological processes that convene to create landscape scale connections of human use with overall wilderness quality. To achieve more focal and successful modeling of specific user groups and their connection to the river landscape, a more statistically successful response rate to survey administration needs to occur. Development of a more streamlined and clear method of allowing users to thoroughly complete surveys to quantify landscape values and spatially locate where those values exist is the next step to produce more robust social value models within river corridor.

5.3 Conclusion

Using the GIS application *SolVES* to map user and stakeholder values tied to a landscape successfully produced maps representing social values within the Middle Fork of the Salmon River corridor. By utilizing social data gathered through survey distribution on the river itself, output products depict areas of social value intensity which can be analyzed for connection with specific areas of management concern. These maps show regions of importance based on the perceived location of specific landscape scale values tied to the river users of the MFSR resource. Ultimately these outputs can be used by river managers for the assessment of stakeholder social values as they relate to areas of wilderness, ecological concern, and cultural importance to determine potential overlap of values with management concern to help guide management action to account for the preservation of river resources while also protecting the social benefits and values appreciated by users and stakeholders.

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Appendix A
MFSR SolVES Survey used (July 2015 – September 2015)

Visitor Values and Preferences Relating to the Wild and Scenic Middle Fork of the

Salmon River, Idaho

“Outstandingly remarkable” (Wild and Scenic Rivers Act. 1968) values are said to exist along Wild and Scenic Rivers in America. The 104 mile designated Middle Fork of the Salmon River (MFSR) in Idaho's Frank Church River of No Return Wilderness (FCRONR) is managed by the USDA Forest Service as a Wild and Scenic River to protect the outstanding features within the riverine corridor for future use.

This survey acts as the data collection portion of a Master’s degree thesis project focused on understanding and mapping social values related to ecosystem services, specifically along recreational river corridors. This survey is designed to gather relevant data assessing the perceptions of MFSR users regarding how specific locations reflect the “outstandingly remarkable” values along the river. This data will provide insight into how qualities and characteristics of the river corridor relate to the experiences of the users.

Please take this opportunity to share your opinion of the Middle Fork by completing this survey.

The purpose of this survey is to:

- Discover user’s relationship with the MFSR (Part 1).
- Find out how, and in what ways users value the MFSR (Part 2).
- Learn where these values are connected with specific places along the MFSR (Part 3).

To ensure the usefulness of the survey please complete it fully. Your perceptions of the conditions of this beautiful river will provide valuable insight into further management applications.

The average time to complete the survey questionnaire and locate areas of value and interest on the map takes about 15 to 20 minutes.

Your participation and thoughtful contribution to this study is greatly appreciated.

All of the responses to this survey are completely confidential.

The confidential responses to this survey will be accessible as statistical and spatial reference information for the United States Forest Service for potential use in policy studies and reform.

Thank you.

Part 1: Your relationship with the Middle Fork of the Salmon River (MFSR).

Q-1 Are you a visitor to the MFSR?

1. Yes
2. No. *If no, where is the majority of your time spent living/working/recreating on the MFSR?* _________________________. Please proceed to question 3.

Q-2 How would you describe your visit to the MFSR?

1. Floating/Backpacking/Horse-Packing Privately
2. Floating Trip with a licensed Outfitter or the Boy Scouts of America
3. Guiding
4. Government Employee Work

Q-3 How many times have you visited the MFSR? (Please circle one)

1. 1 time
2. 2 to 5 times
3. 6 to 10 times
4. More than 10 times
5. I care take/own property on the MFSR. *If so, which property?* ____. Please proceed to question 6.

Q-4 What is your zip-code? ____________________________.

Q-5 Roughly, how much did it cost to travel to the MFSR? _____________.

Q-6 What is your age? _______________.

Q-7 In what range is your annual income? (Please circle one)

1. $0 – $50,000
2. $50,001 - $75,000
3. $75,001 - $100,000
4. $100,001 - $125,000
5. Greater than $125,001

Q-8 Do you or anyone in your household earn income from industries using the wild and scenic MFSR that depend on use of the river? (Please circle one response)

1. Yes. Please describe the source of income: ______________________________________.
2. No
3. Unsure

Q-9 Do you think that public perceptions of sites along the MFSR should have a role in the management process? (Please circle one)

1. Strongly support
2. Support
3. Neutral
4. Disagree
5. Strongly disagree

Q-10 Would you support an increase in visitor fees ($1-$3) per day, per person to visit the MFSR. (Please circle one)

1. Strongly support
2. Support
3. Neutral
4. Disagree
5. Strongly disagree

Part 2: How do you value specific areas along the MFSR?

The social values of the MFSR are based on different aspects of the connection with the ecosystem services that the river corridor provides. **We would like to know how the MFSR holds certain landscape values for you.**

The next page is a list of defined landscape values. Imagine that you can attribute 100 points of value to the MFSR broken into the different landscape values listed below. Using the 100 points, please assign relevant number of points to the value types that matter to you, i.e. more points = more important and less/no points = less important/not important.

Example:

- You could fill out the next page to reflect that you value three distinct landscape values, *biological diversity*, 'B' listed below to receive 40 points, *recreational* value, 'R' receives 30 points, and *historical* value, 'H' receives 30 points. And note that it is not necessary to mark every value, you may care about the MFSR in these three ways.)

Please assign value points on the **MFSR Social Landscape Value Allocation** page using the provided dry erase marker. Thank you.

MFSR Social Landscape Value Allocation

______ value points for **Aesthetic value (A)** – I value the MFSR because I enjoy the scenery, sights, sounds, smells, etc.

______ value points for **Biological diversity value (B)** – I value the MFSR because it provides a variety of fish, wildlife, plant life, etc.

______ value points for **Cultural value (C)** – I value the MFSR because it is a place for me to continue and pass down the wisdom and knowledge, traditions, and way of life of my ancestors.

______ value points for **Economic value (E)** – I value the MFSR because it provides timber, fisheries, minerals, and/or tourism opportunities such as outfitting and guiding.

______ value points for **Future value (F)** – I value the MFSR because it allows future generations to know and experience the wilderness and a wild and scenic river as it is now.

______ value points for **Historic value (H)** – I value the MFSR because it has places and things of natural and human history that matter to me, others, or the nation.

______ value points for **Intrinsic value (I)** – I value the MFSR in and of itself, whether people are present or not.

______ value points for **Learning value (L)** – I value the MFSR because we can learn about the natural state of the environment through scientific observation or experimentation.

______ value points for **Life Sustaining value (LS)** – I value the MFSR because it helps to produce, preserve, clean, and renew air, soil, and water quality.

______ value points for **Recreation value (R)** – I value the MFSR because it provides a place for my favorite outdoor recreation activities.

______ value points for **Spiritual value (S)** – I value the MFSR because it is a sacred, religious, or spiritually special place to me or because I feel reverence and respect for nature there.

______ value points for **Therapeutic value (T)** – I value the MFSR because it makes me feel better, physically and/or mentally.

<u>Part 3: Spatially identifying specific areas of importance along the MFSR.</u>

Q-11 What specific sites along the MFSR embody the landscape values chosen in section 2? **Please identify areas along the MFSR that you find most important naming specific locations. (Examples; rapids, campsites, cultural sites, or any other areas along the river that are important to you)**

Note: Please list and specifically describe important locations starting from the beginning of your trip chronologically to the end. Thank you.

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Thank you very much for your participation in this survey and research.

Appendix B

USFS Total Year End Use of the MFSR

2015 Recreation Float Use - Middle Fork of the Salmon River

Number of People Launched by Site and Season 2/20-11/10/15

Recreation Use Permits	Lottery Season (May 28-Sept 3)		Pre & Post Season		**Float Season TOTALS** (March - Nov.)	
Launch Point	People	Permits	People	Permits	People	Permits
Marsh Creek	14	1	102	21	116	22
Boundary Creek	5532	412	904	142	6436	554
Indian Creek	3937	162	176	32	4113	194
Thomas Creek	316	13	207	11	523	24
Loon Creek	3	1	9	3	12	4
Flying B	0	0	32	2	32	2
Bernard	2	1	28	9	30	10
Big Creek	0	0	0	0	0	0
Other	11	2	11	3	22	5
Totals	9,815	592	1,469	223	11,284	815

Administrative Launches	Launches	People	Days	Service Days	Craft
(Includes FS, Fire, Fish & Game, Research)	31	152	206	1024	75

Private and Commercial Lottery Season Use

May 28 thru Sept. 3	Commercial			Private		
	Number of	Average	Percent	Number of	Average	Percent
Permits	250		42.2%	342		57.8%
People (includes guides)	6,340	25.36	64.6%	3,475	10.16	35.4%
Clients	4,522	18.09				
Employees	1,818	7.27				
Total Days	1,431	5.74		2,278	6.66	
***Client Service Days	26,506	106.02		22,969	67.16	
***Employee Service Days	10,425	41.70				
***TOTAL Service Days	36,931	147.72		22,969	67.16	

Private and Commercial TOTAL Use

TOTAL USE	Commercial			Private		
	Number of	Average	Percent	Number of	Average	Percent
Permits	271		33.3%	544		66.7%
People (includes guides)	6,670	24.61	59.1%	4,614	8.48	40.9%
Clients	4,730	17.45	41.9%			
Employees	1,940	7.16				
Total Days	1,546	5.70		3,461	6.36	
***Client Service Days	27,651	102.03		29,663	54.53	
***Employee Service Days	11,096	40.94				
***TOTAL Service Days	38,747	142.98		29,663	54.53	

Average Group Size:	5/28-9/3	Pre/Post
Private:	10.16	5.64
Commercial*:	25.36	15.71

Average # of Service Days* Per Trip:**

	5/28-9/3	Pre/Post
Private:	67.16	33.14
Commercial*:	147.72	86.48

*Commercial averages include guides.

Deadhead permits**: 156

**Deadhead permits are considered part of the original launch and are not included in the Admin trips listed above, or in the Use figures.

BC Road opened 5/6/15. High Water: 4.26 ft on 5/6; <2 ft on 7/1.

No. of Boats	Commercial	Private	TOTALS
Rafts	1291	1443	2734
Inflatables	857	230	1087
Kayaks	224	546	770
Sweep Boats	228	3	231
Drift Boats	123	1	124
Canoes	2	24	26
Catarafts	11	552	563
Inner Tubes	6	1	7
Other	7	15	22
TOTALS	2749	2815	5564
Total All Craft (plus Admin):			5639

***Use/Service Days are no longer adjusted for partial trips (ie: fly-ins/fly-outs). 11/20/2015

Appendix C

Frissell Campsite Condition Class Ranking System (USFS)

The following table provides an explanation of the standards used for the five Frissell campsite condition classes.

Class I	Class II	Class III	Class IV	Class V
Ground vegetation flattened but not permanently injured. Minimal physical change except for possibly a simple rock fireplace.	Ground vegetation worn away around fireplace or center of activity.	Ground vegetation lost on most of the site, but humus and litter still present in all but a few areas.	Bare mineral soil widespread. Tree roots exposed on the surface.	Soil erosion significant (>50% of the area). Trees reduced in vigor or dead.
River: Site looks natural with little or no sign of pull-out.	Well defined pull-out with little or no vegetation loss in other areas.	Obvious pull-out area and vegetation loss. Organic layer present. No satellite areas. Slight damage to trees and brush on the site.	Multiple, well-worn pull-outs and vegetation loss. Satellite sites and trails present.	Obvious bank erosion with several satellite areas and several trails. Extensive human damage to vegetation. No firewood on site or surrounding area.
Land: Site looks natural. No non-native plants. As much firewood as surrounding area. No worn social trails. No tree damage.	Site looks natural with only slight damage to plants. No non-native plants. Less firewood than surrounding area but still abundant. One worn social trail.	Site is less than 50% barren. Few non-native plants. Little tree damage. Little firewood compared to surrounding area. A few worn social trails.	Site is more than 50% barren. Moderate number of non-native plants. Large amount of tree damage. No firewood on site; surrounding area has less firewood than occurs naturally. Many social trails.	Extensive bare area. Non-native plants on most of the site. Extensive tree damage. No firewood on site or surrounding area. Extensive number of social trails and satellite areas.
Stock: Area <100 sq.ft. and often hidden. No tree trunks scarred or mutilated. No dished tree bases. No hay or artificial feed present.	Area >100, <200 sq. ft. Bare soil along hitch line. Minor (<20%) tree trunk scarring and occasional (<20%) dished tree bases. Some trace of feed (<20% of area).	Area >200, <400 sq. ft. Majority (>50%) of tree roots exposed but no circles of radical tree root exposure. Moderate (>20%, <50%) tree trunk scarring. Moderate amounts of manure and artificial feed present (>20%, <50% of area).	Area >400 sq. ft. Only islands of humus/duff. All tree roots exposed somewhat. Most tree trunks scarred. Large amounts of feed & manure (>50%, <80% of area).	Area >400 sq. ft. Bare mineral soil throughout. All tree roots exposed. Many trees dying. Feed & manure over 80% of area.

Appendix D

Middle Fork of the Salmon Frissell Campsite Conditions (2012)

RIVER CAMPS on the MIDDLE FORK OF THE SALMON

No.	Name	River Side (L/R)	River Mile	Low Water Capacity (2.5')	High Water Capacity (6')	Frissell Cond. (I-V)	L**	*Updated November 2012* Remarks
1	Teepee Hole	L	0.7	10	10	I	L	
2	Cable Hole	L	1.6	10	0	I	L	
3	Gardells Hole	R	2.4	20	10	V	L	
4	Spring Camp	L	2.7	10	0	I	L	
6	Velvet Falls		5.1	10	0	III	L	Scout Stop
7	Boy Scout	R	5.5	10	0	I	L	
8	Big Bend	R	6.5	30	30	IV	L	High Use
9	Trail Flat	L	6.9	30	30	IV		Hot Springs
10	Rapid Camp	L	8.1	10	10	II	L	
11	Elkhorn Bar	R	8.2	30	30	III	L	
12	Saddle Camp	L	9.3	30	30	III	L	Tends to be wet
13	Boot Camp	R	9.5	6	6	I	L	
14	Joe Bump Cabin	L	11.8	30	30	IV		High Use- difficult at high water
14.5	Thimbleberry	R	12.5	12	12		L	New Camp for 2013
15	Scout Camp	L	12.7	30	30	IV		Hot Springs
16	Sheepeater	L	13	30	30	V		Hot Springs
17	Fire Island	L	13.8	30	30	IV		High Use- Burned in 2007
18	Lake Creek	R	14.9	30	30	III	L	High Use - Burned in 2007
19	Johns Camp	R	15.2	30	30	III	L	Burned in 2007
20	Oakie Point	L	15.6			I		Hazard trees
21	Greyhound	R	15.9	30	30	III	L	High Use – Burned in 2007
22	Dome Hole	L	15.9	12	12	I	L	Burned in 2007
23	Rapid River	R	16.5	30	30	III	L	Difficult landing
24	Dolly Lake	L	19	30	30	IV	L	High Use (names corrected in 2011)
25	Big Snag	R	19.1	30	30	IV	L	High Use (names corrected in 2011)
27	Pistol Creek Camp	L	21.4	30	30	II	L	High Use
28	Airplane	L	23.9	30	30	IV	L	
29	Indian Creek Beach	L	24.7			IV	L	Restricted Camping
30	Indian Creek Camp	L	26.2	30	30	III	L	High Use
30.5	Anderson Camp	R	27.3	12	12		L	New Camp for 2013
31	Pungo Creek*	L	27.4	30	30	IV	L	Restricted Camping
32	Little Soldier	R	30.8	30	30	IV	L	High Use
33	Marble Cr. Left	L	31.7	30	30	IV		High Use
34	Marble Cr. Right	R	31.7	30	30	IV	L	High Use
35	Sunflower	R	32.6	8	8	IV		Hot Springs
36	Lost Oak	L	32.6	30	30	III	L	
37	State Land (Right)	R	34.6	30	30	IV		High Use
38	Little Creek Camp	R	35.8	30	10	II	L	
39	Hood Ranch	L	35.9	30	30	III	L	No access below 3.5'
40	Jackass Flat	R	37.3	30	30	IV		High Use
41	Lower Jackass*	R	37.6	20	0	III		High Use-No access above 4'
43	Mahoney	R	41.6	20	10	II	L	
44	Pine Cr. Flat	R	43.2	30	30	III	L	
45	Culver Creek	R	45.6	10	0	II	L	Difficult access at low water
46	Whitey Cox	R	46.2	30	30	IV		Hot Springs (mites)
47	Rock Island*	L	46.3	30	30	IV		High Use
49	White Creek*	R	47.3	30	30	III		High Use
50	Shelf	R	48.1	30	30	IV		High Use
51	Big Loon	R	49.3	30	30	IV		Hot Springs
52	Cow Creek*	R	49.9	15	0	IV		High Use
53	Cave Camp	R	51.8	10	0	III	L	
54	Hospital Bar	L	52.1	30	30	V		Hot Springs
55	Horsetail	R	52.7	8	8	I		CLOSED
56	Cub Creek	L	53.5	10	10	I	L	Burned 2007

** Camping areas restricted for cultural resource protection.*

RIVER CAMPS on the MIDDLE FORK OF THE SALMON

No.	Name	River Side (L/R)	River Mile	Low Water Capacity (2.5')	High Water Capacity (6')	Frissell Cond. (I-V)	L**	Remarks
57	Upper Grouse	R	56.4	30	30	IV	L	High Use
58	Lower Grouse	R	56.5	30	30	IV		High Use
59	Tappan Island	C	57	30	30	II	L	
59.5	Tiny Tappan	R	57.3	8	0		L	New Camp for 2013
59.7	Tappan Falls	L	57.9	10	10		L	New Camp for 2013
60	Camas Creek	R	59.9	30	30	III	L	High Use
61	Johnny Walker	L	60.6	30	30	IV	L	High Use
62	Pool Camp	R	61.1	30	30	III	L	
63	Funston	L	61.6	30	30	III		High Use
64	Broken Oar	R	61.9	18	0	III	L	
66	Trail Camp	R	64.5	30	15	III	L	High Use
67	Sheep Creek*	L	65.3	30	30	IV		High Use
68	Flying B Camp	R	66.8	30	30	II	L	
70	Bernard	L	68.7	30	30	II	L	
71	Short Creek	R	68.9	30	30	III	L	
72	Cold Springs	R	70.2	0	0	I		No space; landmark
73	Little Pine	L	71.4	30	30	IV	L	High Use
74	Driftwood Flat	R	72.1	30	20	IV		High Use
75	Wilson Creek	R	72.9	30	20	III		High Use
76	Grassy Flat I*	L	73	30	30	IV		High Use
77	Grassy Flat II*	L	73.1	30	30	IV		High Use
78	Survey Creek*	L	74.8	30	30	IV		High Use
79	Woolard Creek*	R	74.9	30	30	V		High Use
80	Fly Camp	R	75.7	18	0	II	L	
81	Fish Camp	L	77.4	4	0	I	L	Cobblestone with some sand
82	Big Creek	L	77.9	4	4	II	L	
	Only one night per trip below this mileage point during the lottery control period (May 28-Sept. 3):							
83	Last Chance	R	78	20	20	IV		Prone to ground bees
84	Pine Bluff	L	78.7	4	4	I		
85	Cutthroat Cove	L	78.9	10	0	I		
86	Big Pine	R	79.2	4	0	III		
87	Elk Bar	L	79.6	30	20	III		High Use
88	Love Bar	L	79.7	10	0	I		Closed due to Hazard tree
89	Redside	L	82.5	15	15	II		
90	Papoose	L	84.4	5	0	I		
91	Ship Island	L	84.5	30	30	IV		High Use
92	Lightning Strike	L	85	15	2	II		High Use
93	Parrot Placer	R	86.2	30	10	III		High Use
94	Parrot Cabin	L	87.9	6	0	II		
95	Cradle Creek	R	88.6	30	20	IV		Difficult stopping at 6'
96	Tumble Creek	R	88.8	30	30	IV		High Use
97	Ouzel	L	89.6	10	0	II		
98	Cliffside	R	89.7	30	6	III		High Use
99	Stoddard Bar	L	90	30	30	V		High Use- difficult landing
100	Otter Bar	R	90.4	30	4	III		High Use
101	Solitude	L	92.7	12	0	II		
102	Goat Creek	R	94.9	6	0	II		
	Confluence		96.3					
	Cache Bar	R	99.7					Take out ramp

Limit – 1 Hot Springs Campsite (not guaranteed)   Frissell condition classes: I = least impacted to V = most impacted
Group size dictates camp assignments. Coin flip resolves conflict(s), however Forest Service personnel have the final authority.
L** - L = Layovers may be allowed at this campsite, but are subject to checker discretion & daily logistics needs; not guaranteed.
This list does not include state and private lands; may include camps that are not always useable (high/low water, sand bars, etc).

*** Camping areas restricted for cultural resource protection.***

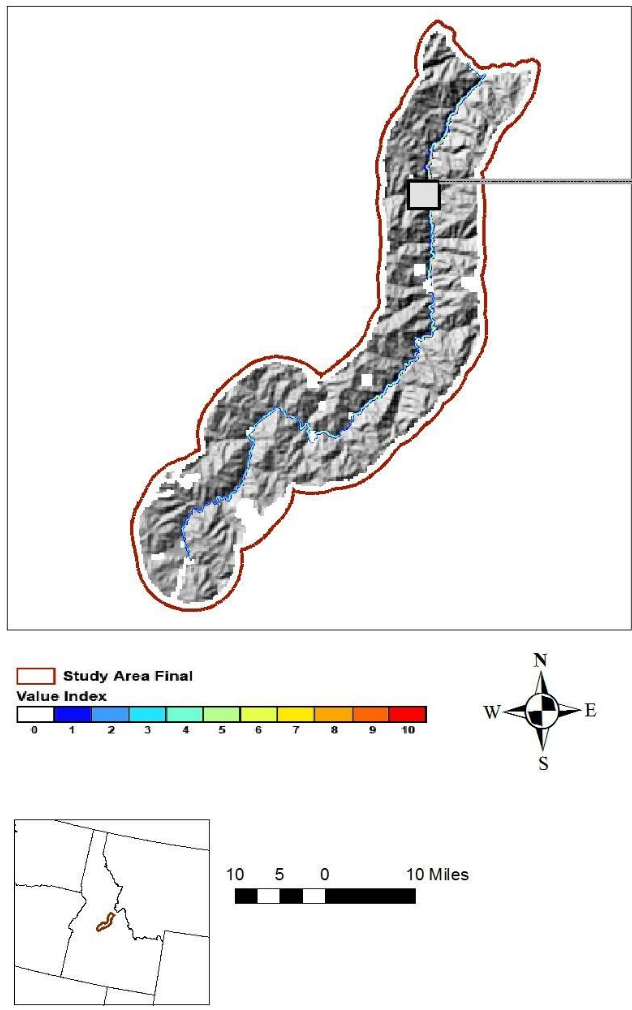
Appendix E

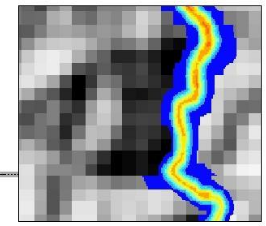
The following *SolVES* Value Map Outputs: Aesthetic, Biological Diversity, Cultural, Economic, Future, Historic, Intrinsic, Learning, Life-Sustaining, Recreational, Spiritual, and Therapeutic.

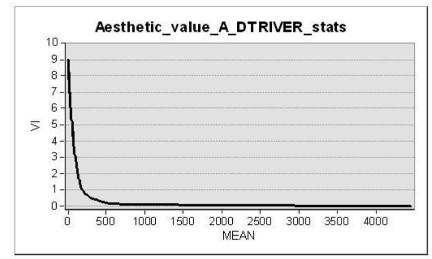
Middle Fork of the Salmon River Social Values

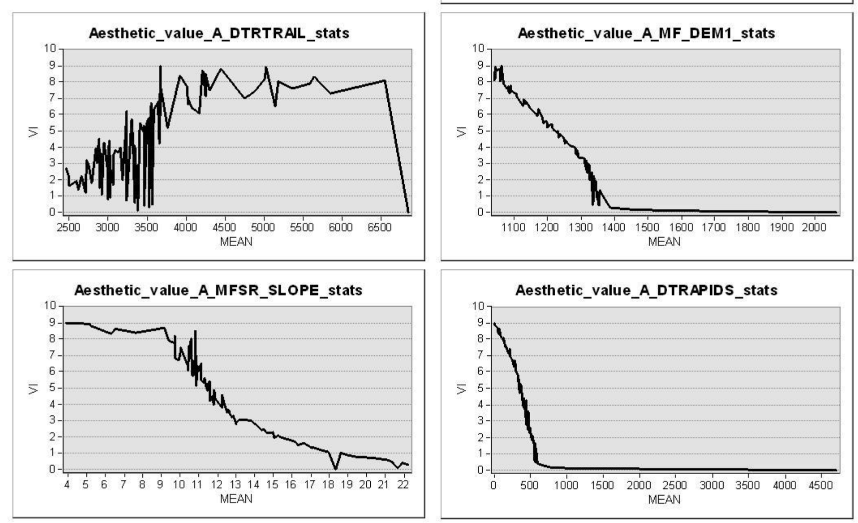
All Surveys

Aesthetic_value_A









Aesthetic_value_A

Training AUC = 0.9902

Acceptable model for study area

Test AUC = 0.99

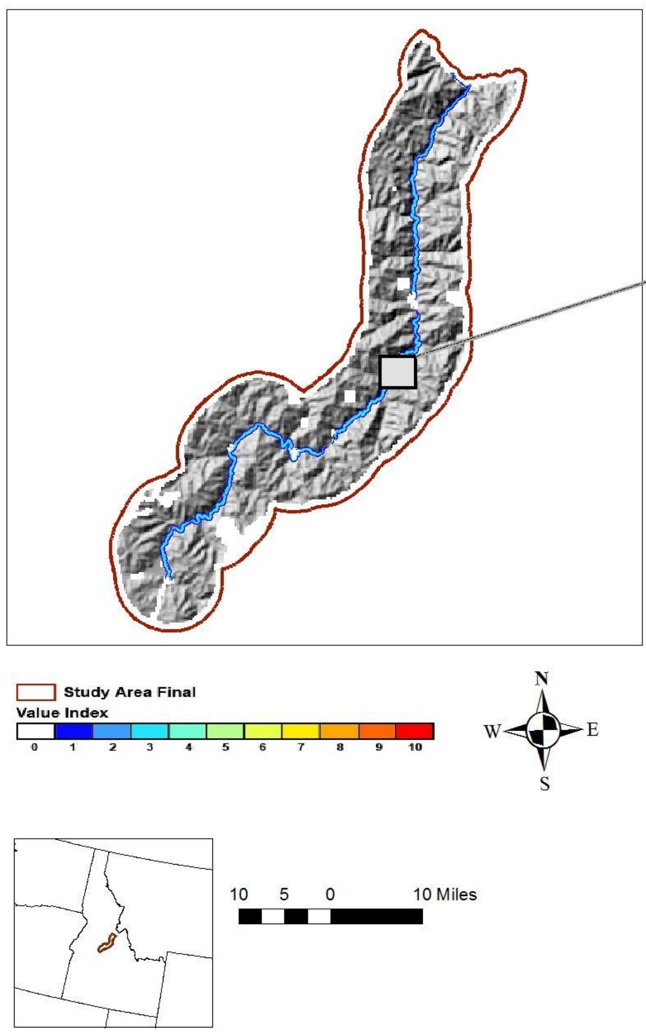
Potential model for value transfer

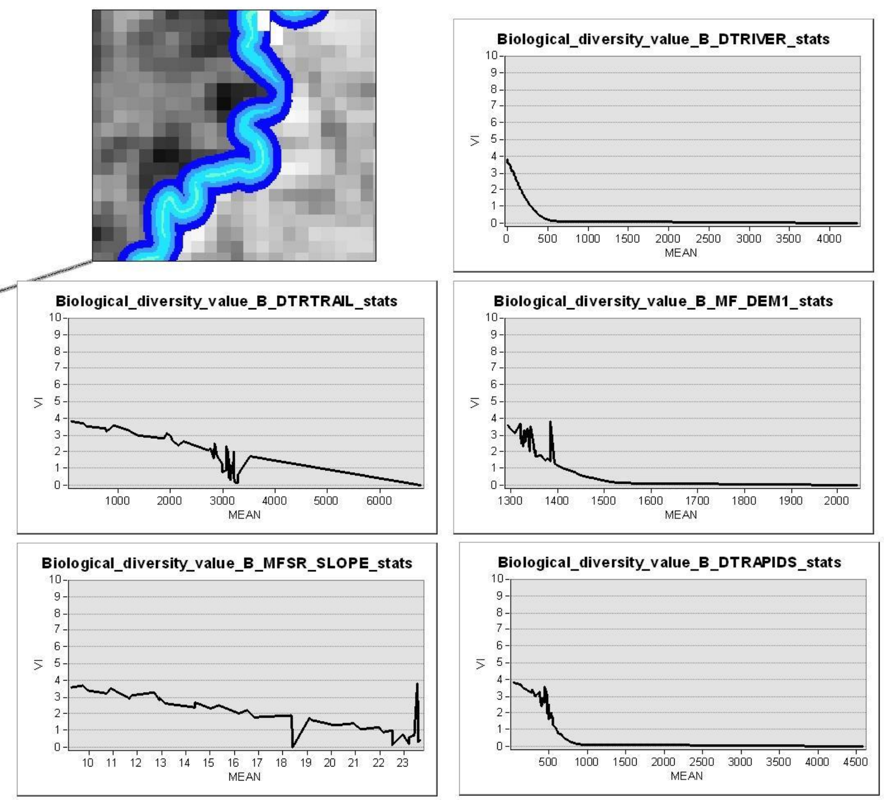
Refer to the relevant environmental dataset for a description of the categories indicated by the numeric values displayed on the x-axis of any categorical data graphs

Middle Fork of the Salmon River Social Values

All Surveys

Biological_diversity_value_B





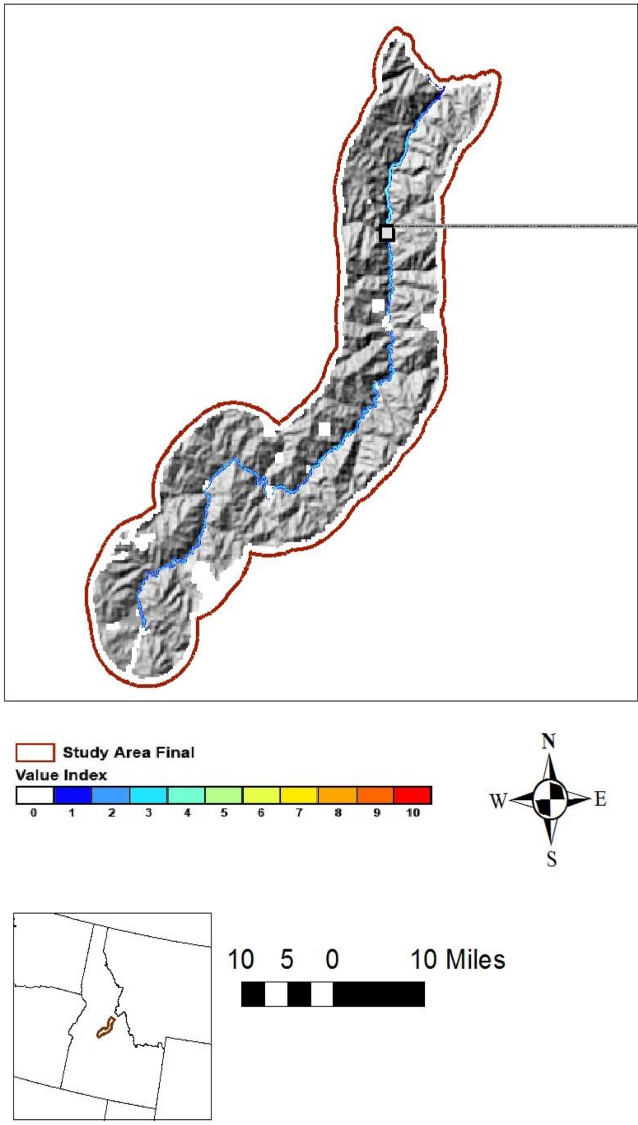
Biological_diversity_value_B
Training AUC = 0.986
Acceptable model for study area
Test AUC = 0.9954
Potential model for value transfer

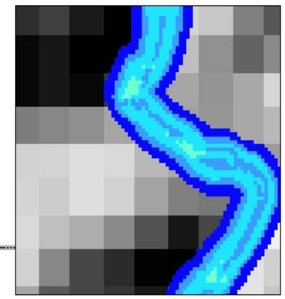
Refer to the relevant environmental dataset for a description of the categories indicated by the numeric values displayed on the x-axis of any categorical data graphs

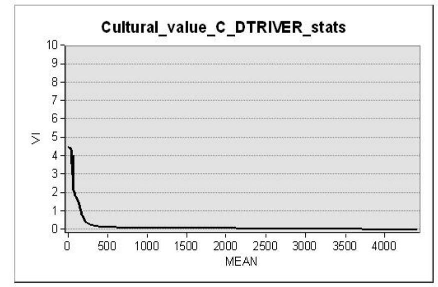
Middle Fork of the Salmon River Social Values

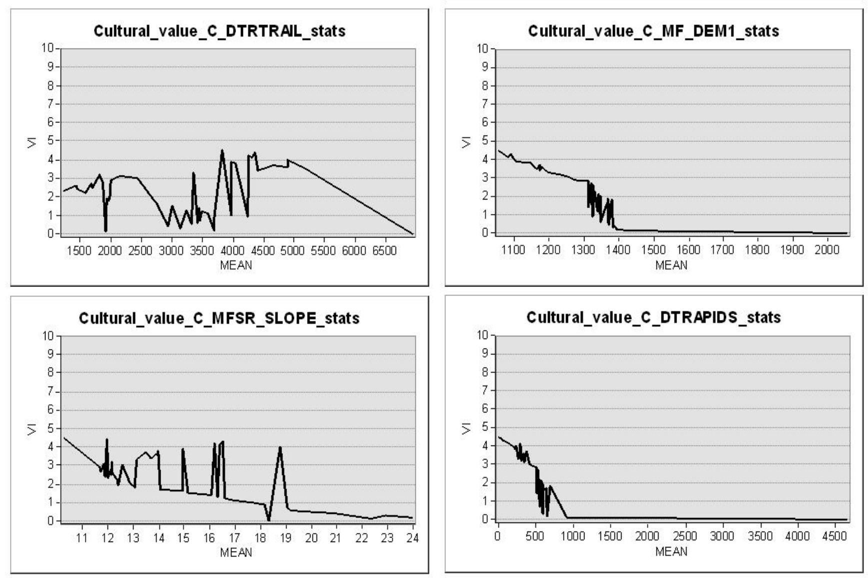
All Surveys

Cultural_value_C









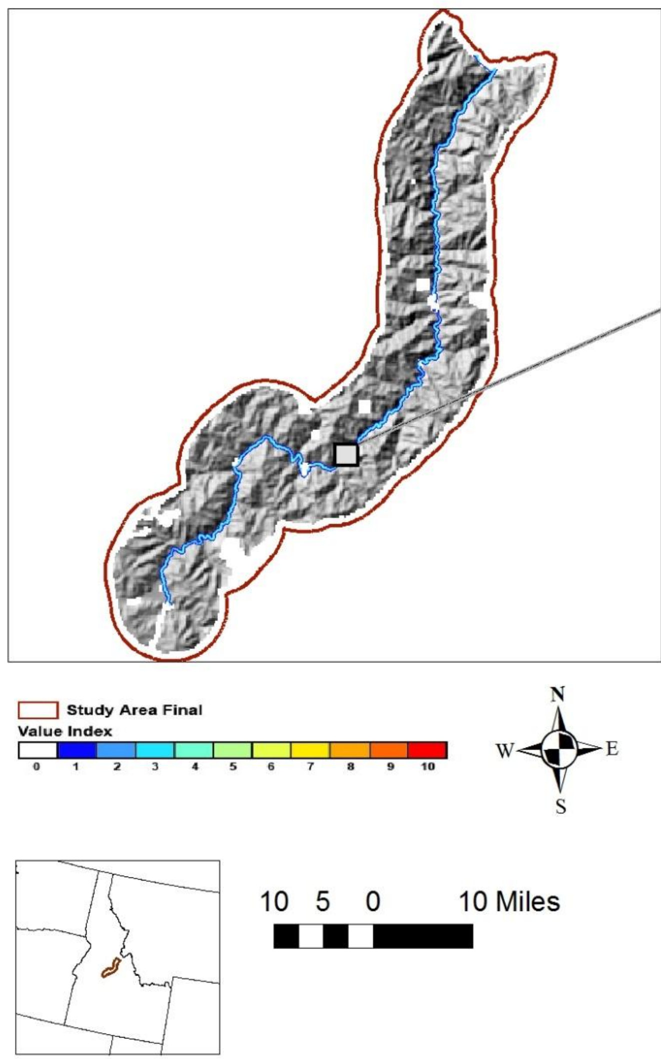
Cultural_value_C
Training AUC = 0.9887
Acceptable model for study area
Test AUC = 0.9946
Potential model for value transfer

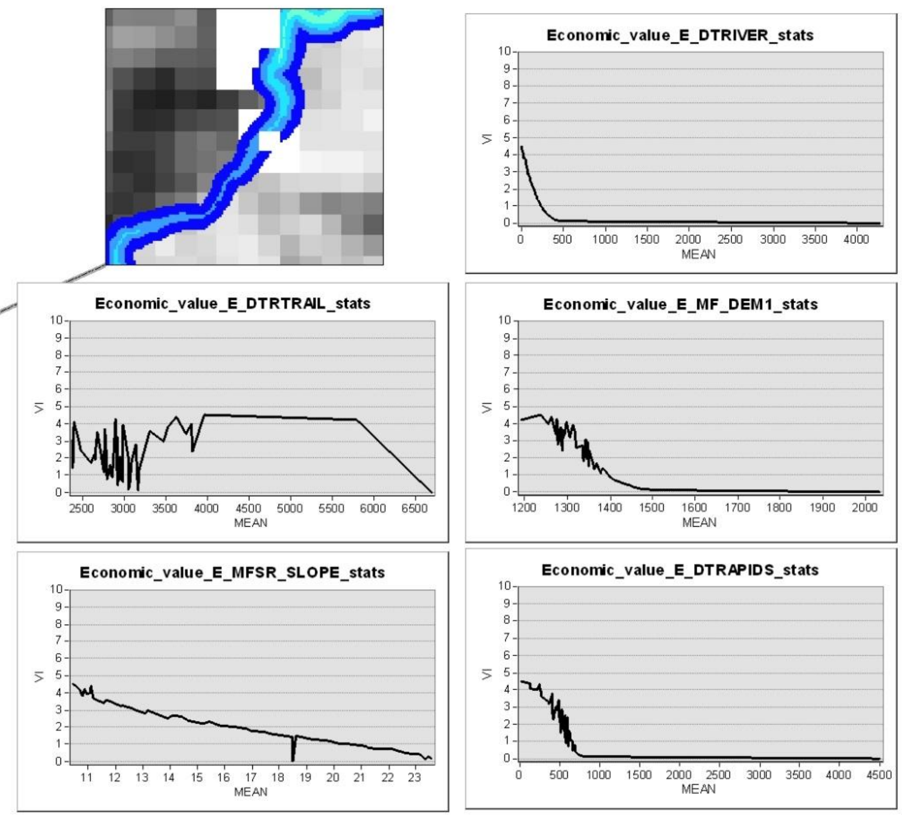
Refer to the relevant environmental dataset for a description of the categories indicated by the numeric values displayed on the x-axis of any categorical data graphs

Middle Fork of the Salmon River Social Values

All Surveys

Economic_value_E





Economic_value_E

Training AUC = 0.9912

Acceptable model for study area

Test AUC = 0.9907

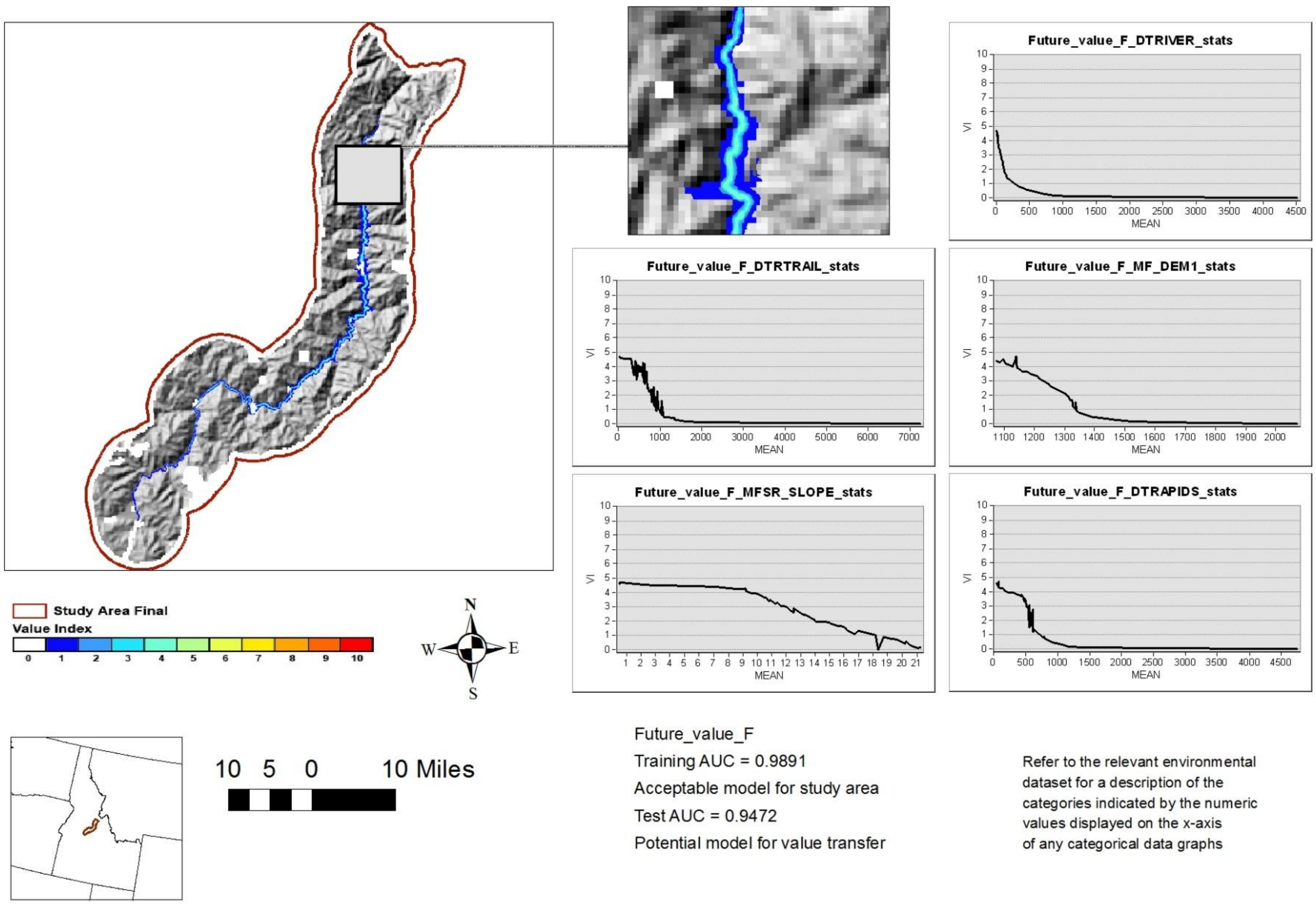
Potential model for value transfer

Refer to the relevant environmental dataset for a description of the categories indicated by the numeric values displayed on the x-axis of any categorical data graphs

Middle Fork of the Salmon River Social Values

All Surveys

Future_value_F



Future_value_F

Training AUC = 0.9891

Acceptable model for study area

Test AUC = 0.9472

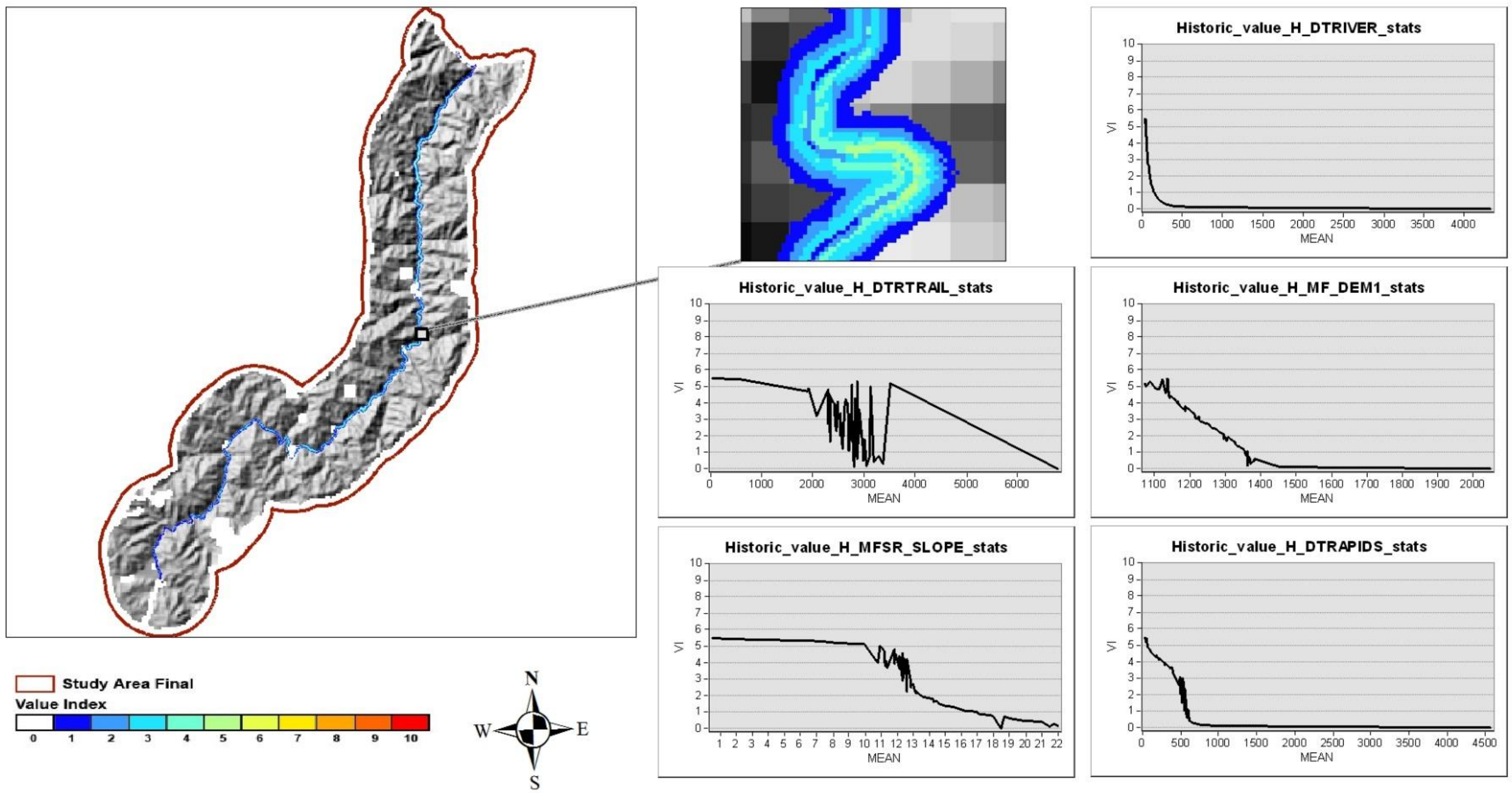
Potential model for value transfer

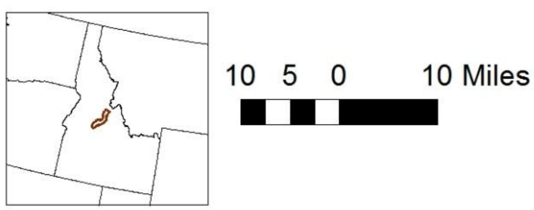
Refer to the relevant environmental dataset for a description of the categories indicated by the numeric values displayed on the x-axis of any categorical data graphs

Middle Fork of the Salmon River Social Values

All Surveys

Historic_value_H





Historic_value_H

Training AUC = 0.9915

Acceptable model for study area

Test AUC = 0.9917

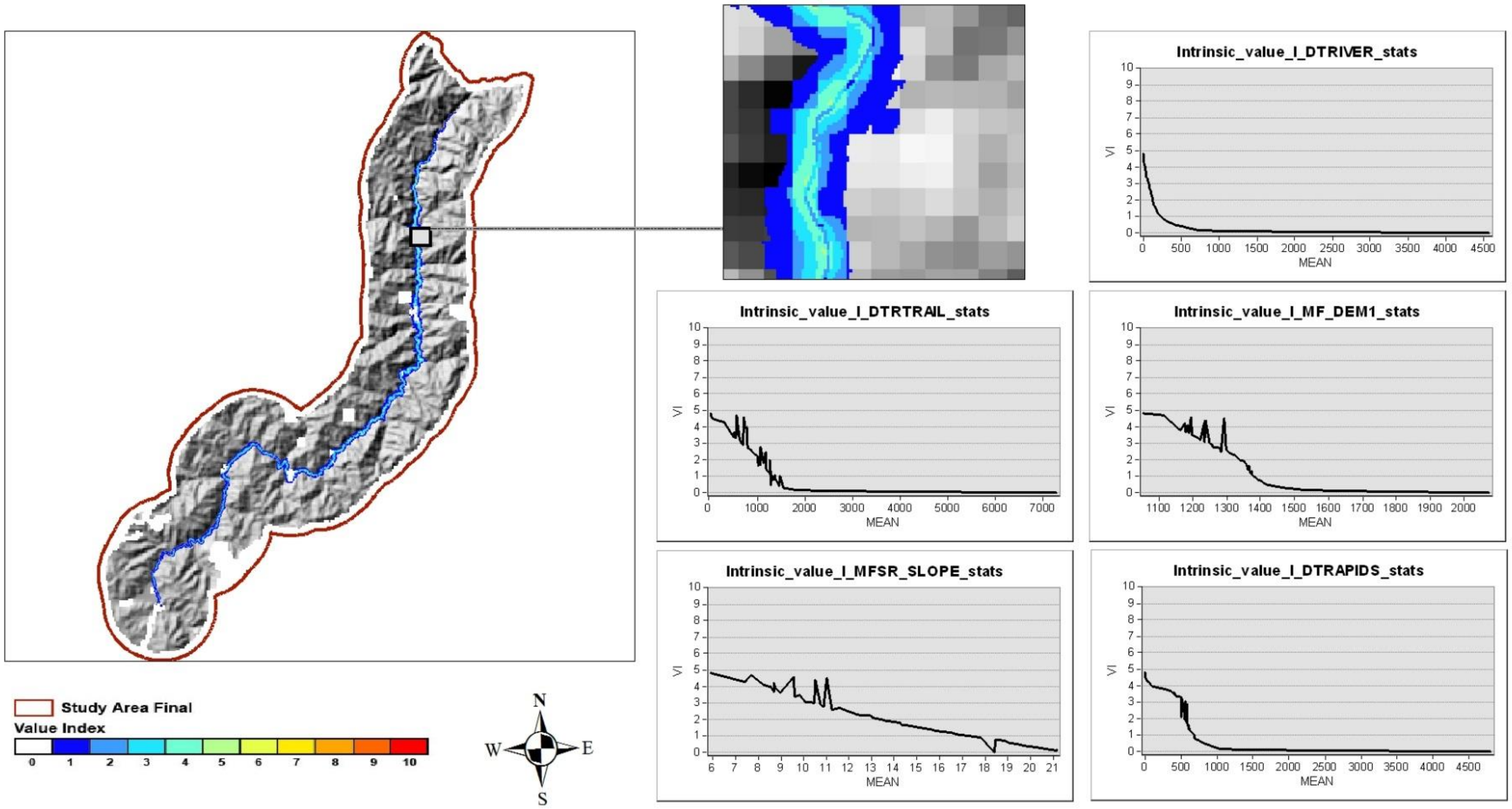
Potential model for value transfer

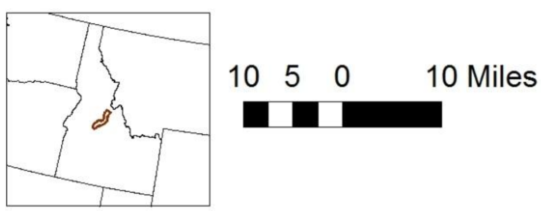
Refer to the relevant environmental dataset for a description of the categories indicated by the numeric values displayed on the x-axis of any categorical data graphs

Middle Fork of the Salmon River Social Values

All Surveys

Intrinsic_value_I





Intrinsic_value_I

Training AUC = 0.9886

Acceptable model for study area

Test AUC = 0.983

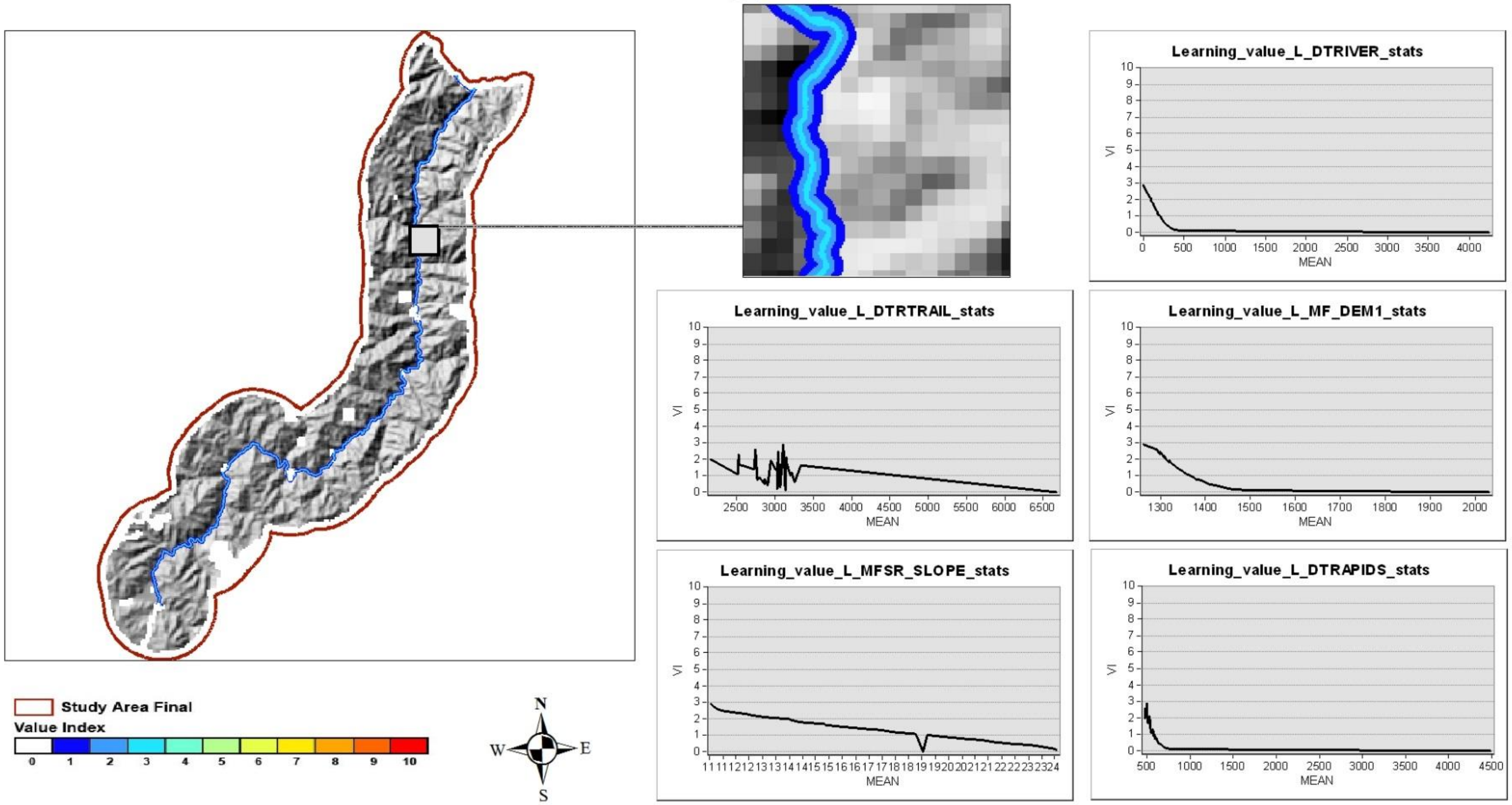
Potential model for value transfer

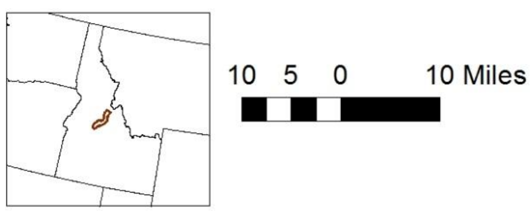
Refer to the relevant environmental dataset for a description of the categories indicated by the numeric values displayed on the x-axis of any categorical data graphs

Middle Fork of the Salmon River Social Values

All Surveys

Learning_value_L





Learning_value_L

Training AUC = 0.9882

Acceptable model for study area

Test AUC = 0.9893

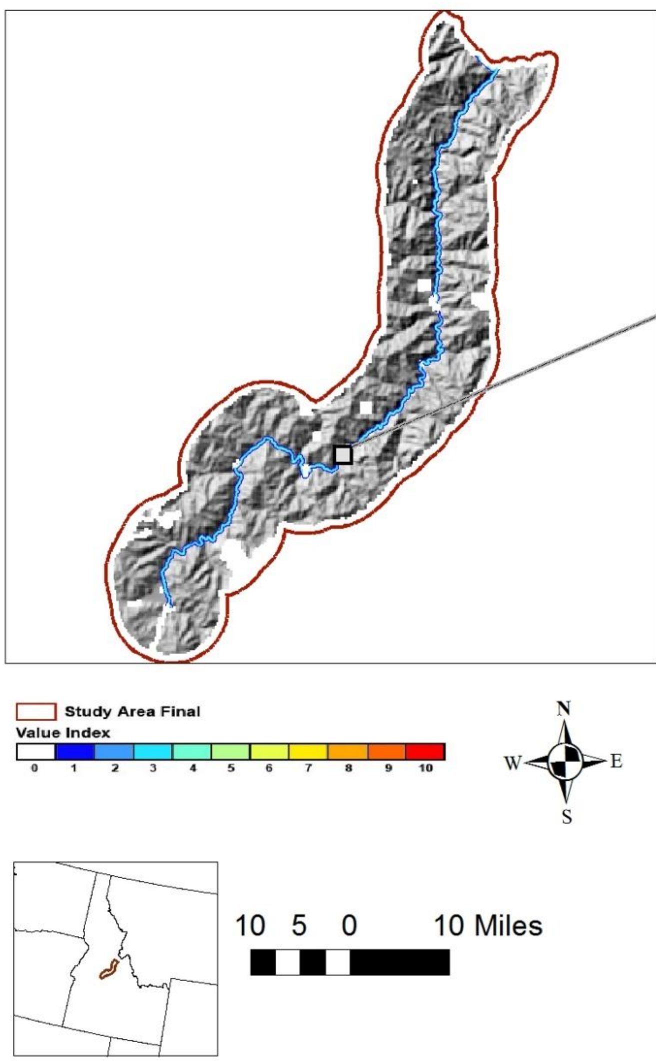
Potential model for value transfer

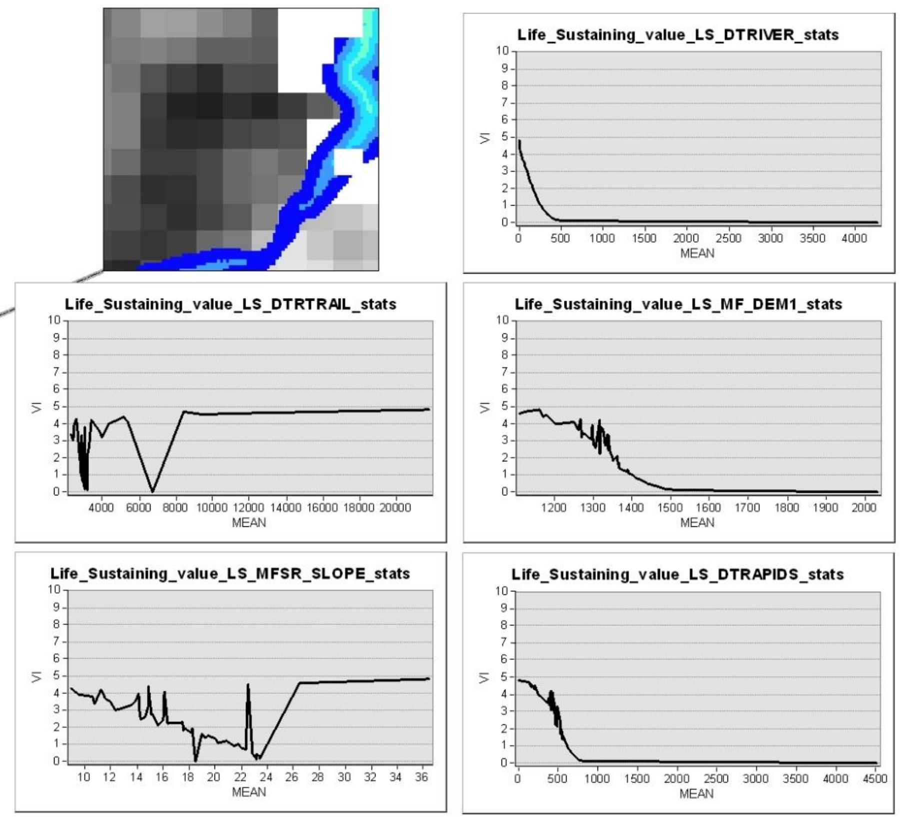
Refer to the relevant environmental dataset for a description of the categories indicated by the numeric values displayed on the x-axis of any categorical data graphs

Middle Fork of the Salmon River Social Values

All Surveys

Life_Sustaining_value_LS





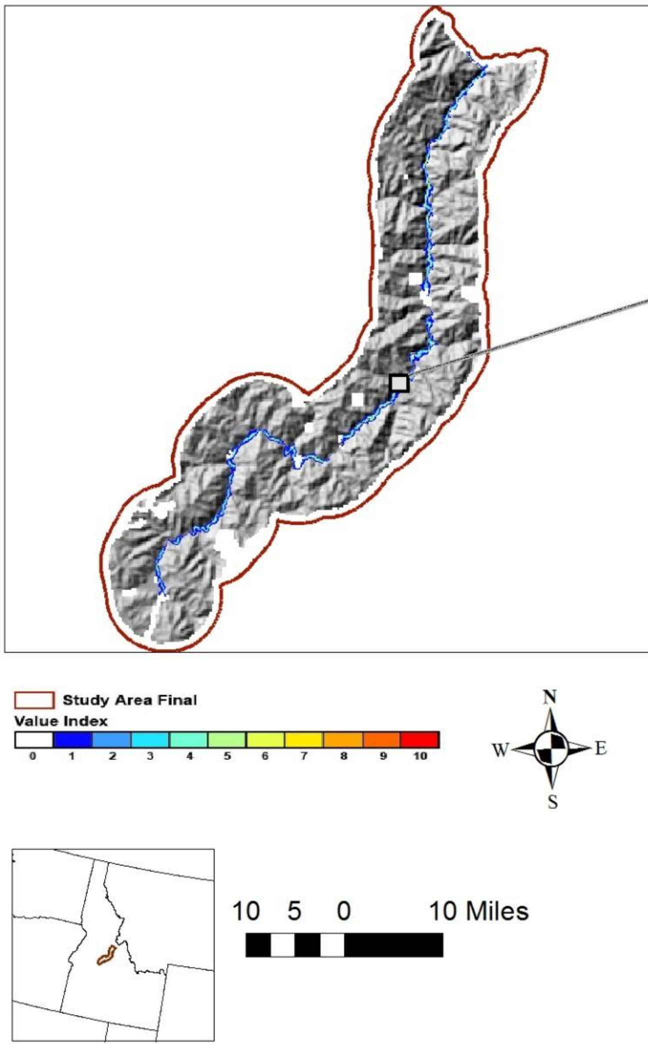
Life_Sustaining_value_LS
Training AUC = 0.9886
Acceptable model for study area
Test AUC = 0.9595
Potential model for value transfer

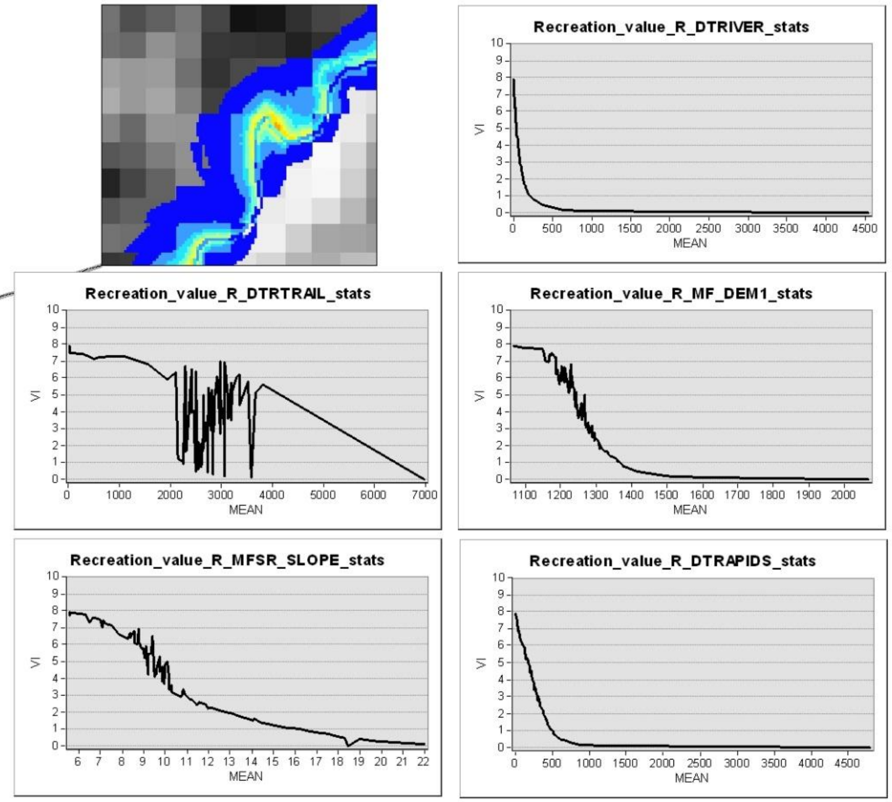
Refer to the relevant environmental dataset for a description of the categories indicated by the numeric values displayed on the x-axis of any categorical data graphs

Middle Fork of the Salmon River Social Values

All Surveys

Recreation_value_R





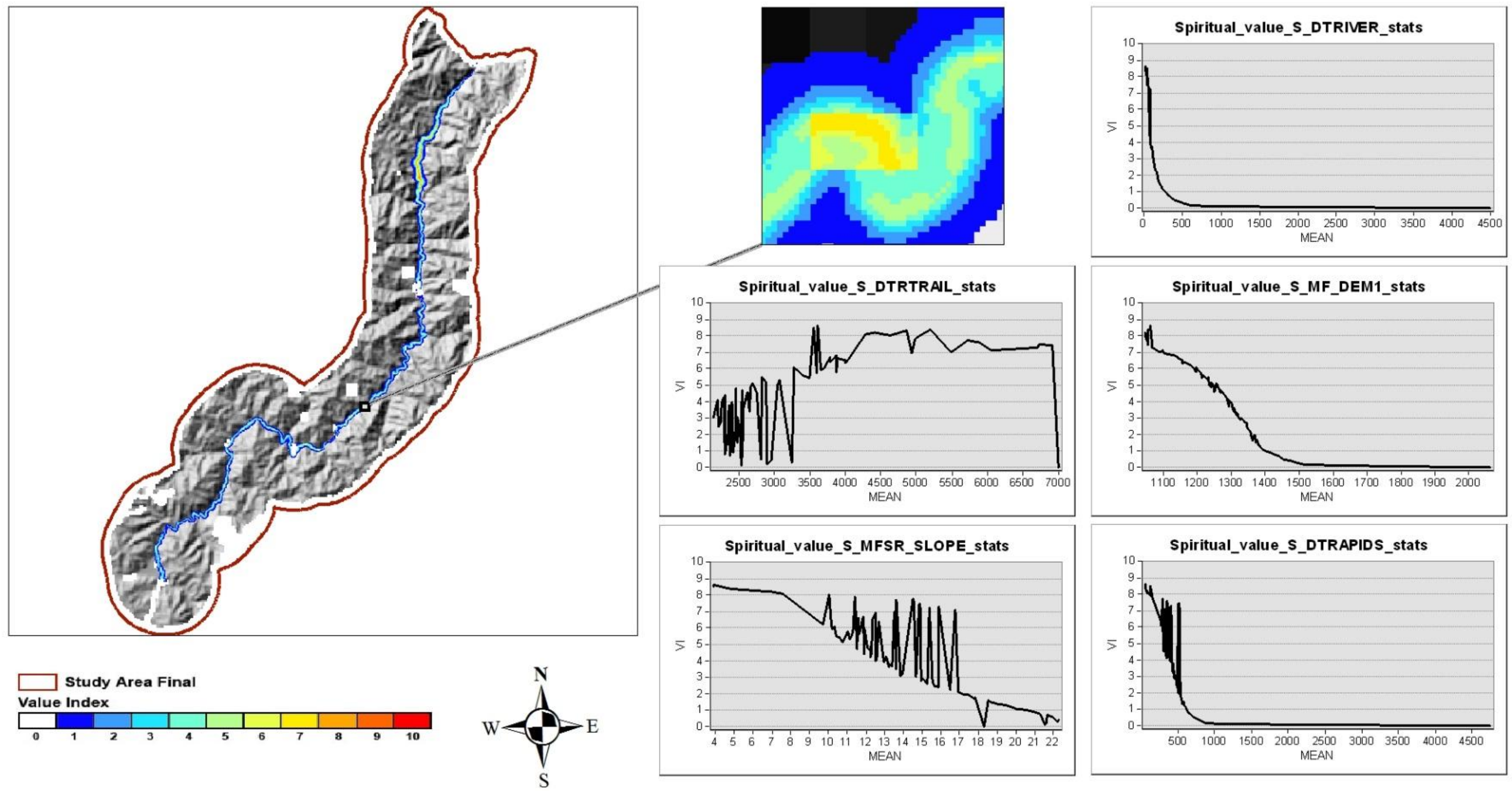
Recreation_value_R
Training AUC = 0.9893
Acceptable model for study area
Test AUC = 0.9828
Potential model for value transfer

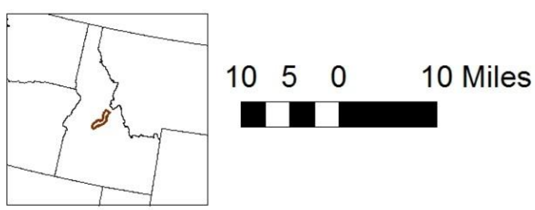
Refer to the relevant environmental dataset for a description of the categories indicated by the numeric values displayed on the x-axis of any categorical data graphs

Middle Fork of the Salmon River Social Values

All Surveys

Spiritual_value_S





Spiritual_value_S

Training AUC = 0.9887

Acceptable model for study area

Test AUC = 0.9872

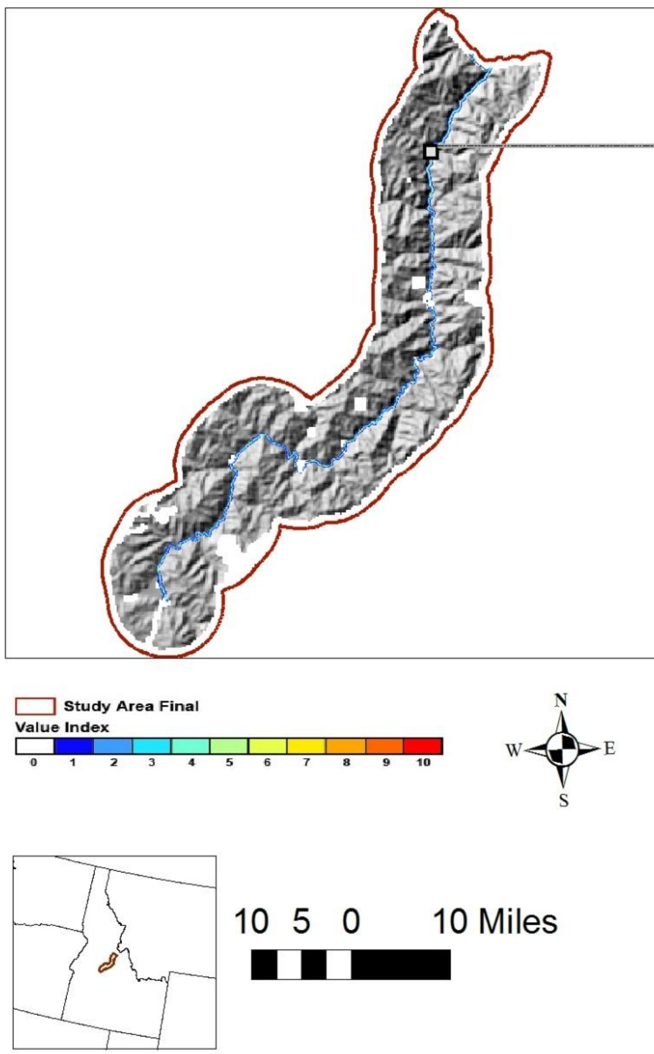
Potential model for value transfer

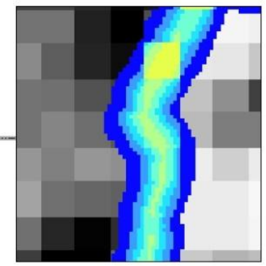
Refer to the relevant environmental dataset for a description of the categories indicated by the numeric values displayed on the x-axis of any categorical data graphs

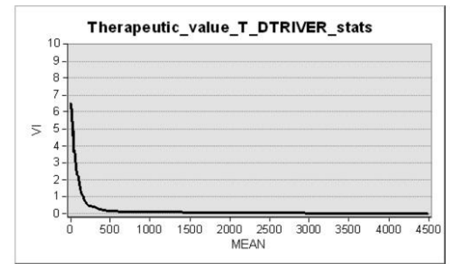
Middle Fork of the Salmon River Social Values

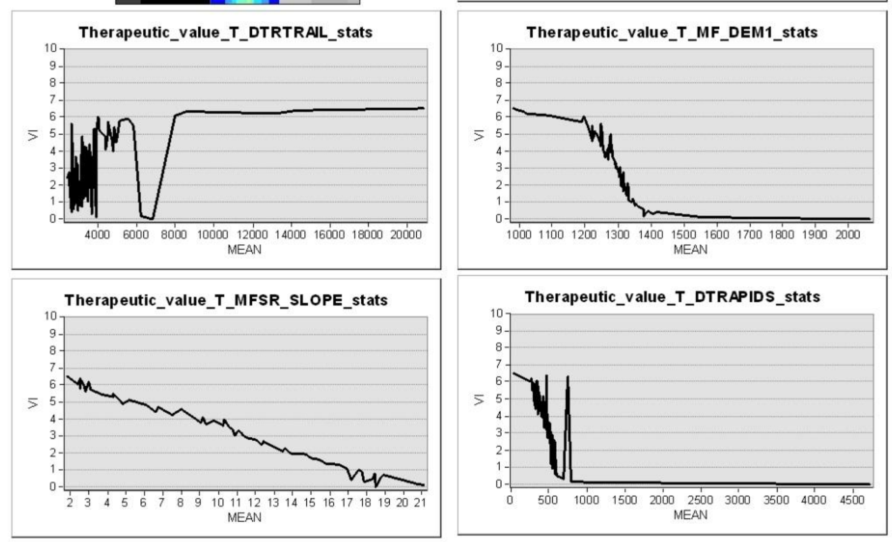
All Surveys

Therapeutic_value_T









Therapeutic_value_T
Training AUC = 0.9895
Acceptable model for study area
Test AUC = 0.9757
Potential model for value transfer

Refer to the relevant environmental dataset for a description of the categories indicated by the numeric values displayed on the x-axis of any categorical data graphs