Supporting Conservation and Decision-Making in the Northwoods: Mapping Forest Values, Services, and Threats

By

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Abstract

Land managers and resource and conservation professionals across political and organizational boundaries (e.g. state and federal agencies, non-governmental organizations, private landowners) often lack a common framework for planning and coordinated decision-making on a regional scale. We created and implemented such a framework and demonstrated its application through Story Maps, an interactive web-based communication tool. Story Maps facilitate collective understanding and decision-making by displaying interactive maps and spatial data with narrative text and multimedia. We developed a framework for coordinated development of Story Maps, integrating both the Ecosystem Services and Human Well-Being frameworks used by conservation planners in order to understand the following: (1) how people value the Northwoods forest ecosystem of Michigan, Wisconsin, and Minnesota; and (2) threats to these values.

For this pilot study, we used our framework to map three human well-being values and threats to those values across the Northwoods region of Minnesota, Wisconsin, and Michigan. The three values included forest products sector jobs, water quality, and non-consumptive recreational experiences in nature (outdoor recreation). Each value was explored in a story map designed to communicate through spatial indicators, descriptive text, and graphics the extent and distribution of values and threats.

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Table of Contents

Introduction

The Northwoods ecoregion comprises over 26 million hectares of forest in northern Michigan, Wisconsin, and Minnesota (Figure 1). Across the ecoregion, these forests provide important economic, ecological, and cultural resources to 124 counties across the three states (Figure 1). Successful conservation and management of land and resources across such a large area requires coordinated action at a regional scale by land managers and other stakeholders. This coordinated action is impeded by jurisdictional boundaries and agency missions that constrain the purview of individual managers as well as their institutions. In addition, the primary duties of a natural resource professional may not include communication with counterparts in another state or agency, even though many of the issues they confront would benefit from regional scale thinking. The Upper Midwest and Great Lakes Landscape Conservation Cooperative (UMGL-LCC) remedies this by providing data, strategies, and support to promote coordinated conservation practices and planning across the Northwoods (Pearsall *et al.*, 2015). The present project builds on the LCC's regional coordinated approach. We created an online platform to help decision makers preserve forest values by mapping those values and their threats across the Northwoods.

Each SNRE Master's Project works with an external client with a current problem or need that the project helps to address. For this project our client was the The Nature Conservancy (TNC) of Michigan. More accurately, TNC served as a liaison to the UMGL-LCC, many members of which participated actively in advising and guiding this work. Working with the LCC, we identified key values provided by the Northwoods as well as threats that could degrade those values. We spatially linked the values and threats by synthesizing publically available data. Spatial products were used to create interactive web maps using Story Maps in the ArcGIS online platform created by Environmental Systems Research Institute (ESRI), Redland, CA. The goal of these Story Maps is to help groups form conservation strategies that benefit the entire Northwoods by providing information so managers can know how action within their jurisdictional boundaries can protect values more broadly.

Figure 1: Spatial extent of the "Northwoods" shown in green. This includes the area within province 212 Laurentian Mixed Forest (Bailey, 1995) that occurs in northern areas of Michigan, Wisconsin, and Minnesota. While province 212 extends across a larger area, in this project we considered only the area within these three states.

Methods

Our project took place over five phases: orientation and planning, value exploration, threat assignment, spatial data linking and acquisition, and presentation of our findings. These phases were designed to create a smooth progression of research and development including input and feedback from our collaboration network (The Forest Conservation Work Group of the UMGL-LCC) at critical junctures.

Phase 1: Orientation and Planning

Phase 1 began with creating a logistical foundation for developing the project. This included producing a project proposal, creating a budget, developing relationships with our client and collaboration network, and defining the audience of the project. An important product from this phase was the framework we developed to form the foundation of the project. Through the development of this framework we also created plans for feedback and evaluation of our work.

Framework

We created a framework to visually represent the process of creating a multimedia tool, a Story Map in this case, to spatially depict landscape values and threats. This framework (Figure 2) outlines the stages of the project (top-row of numbered boxes), which include identifying the values to be mapped, linking these values to threats, and creating the multimedia tool. Below each stage, the diagram depicts the flow of information that was used to create the maps: We used Domains of Human Well-Being (Smith *et al.*, 2013), a framework used by conservation planning organizations like The Nature Conservancy, to broadly categorize the values of interest, selecting three domains for this pilot project. We used an Ecosystem Services framework (Millennium Ecosystem Assessment, 2005) to understand the relationships between the values of interest and ecological processes on the landscape.

With these relationships in mind, we conducted a literature review and asked managers from our collaboration network to brainstorm drivers, conditions necessary to sustain these relationships, and threats, i.e. changing conditions that could limit the future provisioning of these values in the Northwoods. When possible, we took into account management targets, drivers that LCC members can impact through management decisions. In preparing the map we also took into account information relevant to the decision-making context faced by managers such as landscape features, developed land, and land ownership. Finally, we compiled publicly available geospatial data and multimedia to produce a Story Map that describes the relationship between values and threats across the region.

This framework was developed by our team to conceptualize the development of a Story Map as pilot project, with the goal of illustrating the possibilities of visualizing values across the Northwoods landscape. However, it may also be useful for other, more comprehensive efforts to map priority values and threats at a landscape level and to understand relationships between management decisions and values.

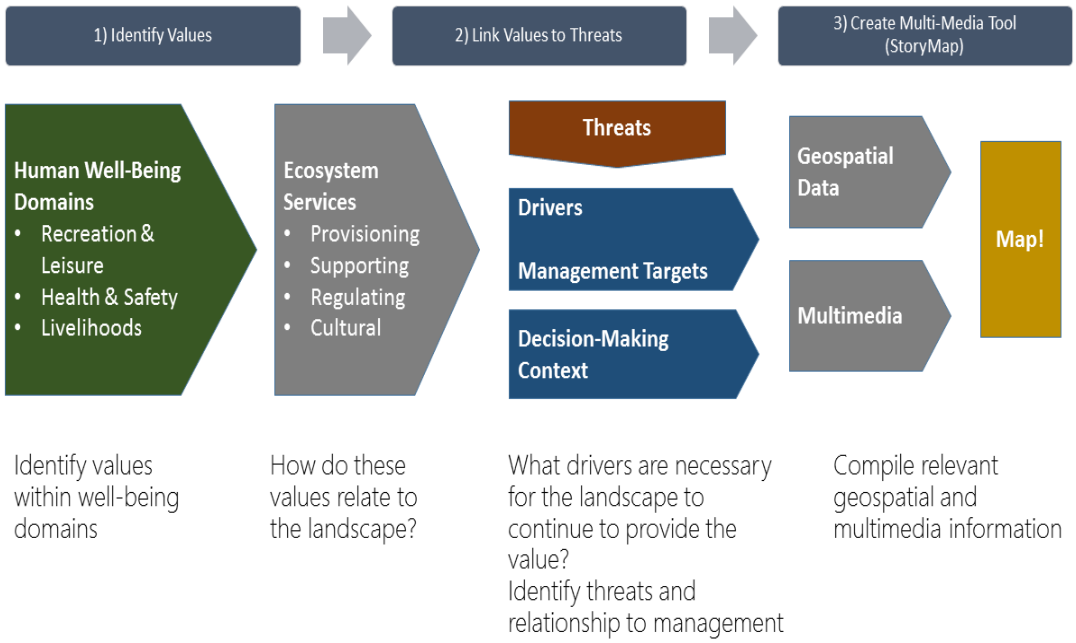

Figure 2: A framework outlining project stages and a process for mapping landscape values and threats.

Evaluations and Feedback

A vital component of this project was gaining input from our collaboration network. At the beginning and completion of each stage we facilitated dialogue to guide development and revision of the project. This took the form of in person brainstorming sessions, webinars, and online feedback forms. Comments were used to guide our research and development, clarify scope and purpose, connect to previous work, and ensure utility and usability of the final product.

The June 2016 annual meeting of the LCC Forest Conservation Work Group provided an important opportunity for early feedback on our project. At this face-to-face meeting among LCC members that took place in Sault Ste. Marie, MI in June 2016, we facilitated a brainstorming session following a brief presentation. During this session, participants gave input on which drivers and threats were deemed to be important for each of the selected values. In addition, we solicited and received feedback on the clarity of our framework, how participants envisioned using the Story Maps that we planned to produce, and research worth exploring. This session was run using the “think-pair-share” method. Participants were asked to consider the questions individually, then in groups, before coming together as a single group and discussing responses together. Responses and thoughts were recorded for future use. A summary of feedback from this session is provided in appendix C.

At several steps in our project we talked with LCC members through webinars and conference calls. During these sessions we presented our progress, asked for specific feedback, and allowed for open input on ideas for the project. We also used online tools to gather feedback on our products to give longer response times and to allow participation by those who were not available during the sessions. This also allowed us to be more methodical in following up on feedback.

In October of 2016 we travelled to the Upper Peninsula of Michigan to visit a range of publicly managed forested sites and meet with management professionals. This trip was undertaken to deepen our understanding of the Northwoods landscape, better understand how our selected well-being values manifest, and get more perspectives on how managers make decisions regarding those values. The sites we visited were the Seney National Wildlife Refuge, Hiawatha National Forest, the Two Hearted River Forest Reserve, and Tahquamenon Falls State Park. At each of the sites we discussed the role of the values in the functioning of the site and how managers consider those values in their planning efforts.

Phase 2: Value Exploration

Phase 2 began with a cursory literature review to identify potential values we could explore with this project. Next, we identified the top three values we wanted to pursue and conducted a literature review specific to those three values.

We established three criteria for selecting values that would function with our framework. First, the value should be well represented in the literature and among stakeholders. This means it can be understood scientifically and reduces unfounded assumptions during the mapping process. Secondly, there must be a way to create informative maps of both the value and the drivers and threats that relate to it. Lastly, the values should be mappable across the entire Northwoods study region. Major spatial data gaps would undermine the maps' value for regional decision making. In addition, there should be minimal conceptual and practical overlap among values being considered.

For this project, we focus on human well-being values, deriving broader value-categories from the "domains of human well-being" outlined by Smith *et al.* (2013). In order to keep the project within scope, we focused on the following three value-categories: recreation and leisure, health and human safety, and livelihoods. We selected one specific value from each category. Those specific values were Forest products sector jobs, Water quality, and Non-consumptive recreational experiences in nature (Outdoor Recreation). Working with our collaboration network, we created specific definitions for these values to refine the scope of our maps.

Forest products sector jobs:

> This value includes jobs sustained by the provisioning of forest products, including paper, timber, and furniture, as well as non-timber forest products to the extent that the landscape may be managed for them. Also includes associated jobs in transport and processing that rely on these products.

Water quality:

> This value focuses on the condition of the water kept clean by regulating effects of the Northwoods ecosystem, especially for public health considerations (e.g. without focusing

on fishing conditions), or the impact on water quality by ecosystem factors. We did not consider water quantity (i.e. drought, water scarcity, groundwater replenishment, or flooding).

Non-consumptive recreational experiences in nature (Outdoor Recreation):

This value focuses on the experience of nature through non-consumptive means, such as camping, hiking, backpacking, wildlife viewing. While consumptive outdoor recreation, such as hunting and fishing provide important services and are culturally important in this region, and while they also impact management decisions, for the purpose of limiting our scope we did not include these. We also did not consider high impact activities such as off road vehicles use or snowmobiling.

Phase 3: Threat Assignment

With our values precisely defined and scoped, the purpose of the next phase was to identify threats to those values using feedback collected during the initial brainstorming session with managers at the Upper Midwest and Great Lakes LCC meeting in Sault Ste. Marie (see Phase 1). Responses from this session and from worksheets distributed at the meeting were compiled and classified into groups to align with the IUCN-CMP Unified Classifications of Direct Threats and Conservation Actions (IUCN-CMP, 2006a; IUCN-CMP, 2006b). Forest Action Plans for Michigan, Wisconsin, and Minnesota identify many of these same threats. From this categorized list of threats, multiple threats were identified as mappable and relevant to the LCC based upon conversations at the meeting. From this selection, only a few were mapped for the purposes of this pilot study.

To identify threats, we used the three criteria developed for identifying values in addition to a fourth criteria: threats should be among those that were suggested by members of the LCC. This is to ensure that the project aligned with client and audience needs. It was important that the final threats used were suggested from our group of experts during our formal brainstorming session.

To narrow down the project's scope, we prioritized threats based on perceived relevance to our client and audience as well as mapping feasibility. Mapping feasibility included both a conceptual element, i.e. that the threat something that could be understood or usefully depicted on a map, and assessing whether spatial data were likely to be available across the Northwoods region. Our goal was to propose 2-4 threats per value to our client for feedback as to which should be included in the final product.

We utilized the Open Standards for the Practice of Conservation Threats and Actions Classifications and IUCN-CMP Unified Classifications of Direct Threats and Conservation Actions (IUCN-CMP, 2006a; IUCN-CMP, 2006b; Salafsky et al. 2008) as a basis for framing our threats to be consistent with the literature. We also used the Functional Analytic Approach from Waller and Rooney (2009), emphasizing ultimate and proximate causes of environmental change.

Selected threats: forest products sector jobs

Of the threats that were suggested by members of the LCC, four were repeatedly suggested for forest products sector jobs: the threat of losing infrastructure (namely mills), social changes affecting land use and management preferences by forest owners, climate change factors, and invasive pests. We pursued the first two suggested threats because of their prevalence throughout the region and accessibility to data. Climate change had many potential indicators and effects making it very broad conceptually. We did not to include climate change as a set of threats in our Story Maps but this could be a useful area for future expansion. Data on invasive pests were not consistent across the region, however, we were able to use Michigan as a "spotlight," demonstrating how such data would be useful if it were available across the whole region. Michigan was chosen for the spotlight on pests because it had the most thorough, complete, and up to date data on pest problems that we could find.

Selected threats: water quality

Clean water is essential to human life and health of the environment. People in the Northwoods largely depend on surface water as the source of drinking water. Thus water quality in this area is especially important for public health. Human activities, including agriculture, logging, human settlement, and road construction can threaten water quality. Erosion and sedimentation as well as land use, particularly agricultural land use, were often listed by LCC members as important factors influencing water quality in the Northwoods region. Other threats affecting water quality included degradation of wetlands, conversion of forest to agriculture, and the development of urban areas and roads, especially in areas of high erosion potential and close to surface water (Pearsall *et al*., 2015).

Selected threats: non-consumptive outdoor recreation

Outdoor recreation is a highly social phenomenon. As such, the degree to which something poses a threat to recreation is dependent on the recreational activity in question, the participant, as well as the location and other factors. This makes it difficult to come up with factors that are universal threats to recreation across such a large spatial and socio economic extent. We considered several factors such as changing demographics, reduction or restructuring of organization budgets, competition for space with other values (such as timber harvest), and overuse or misuse of recreational resources leading to their degradation. Of the options considered, changing demographics was the most viable candidate in terms of mappability. Participation in outdoor recreation differs by demographic characteristics such as age, race, and economic situation. For example, nationally, younger generations are becoming less involved in outdoor recreation than their parents. In addition to changes in overall participation rates, the type of preferred activities and desired setting in which to do those activities may shift as different populations become more dominant. In Wisconsin, for example, the population is shifting to become more urban and there is relatively low growth overall. At the state level, some activities, such as adventure racing and kayaking, are increasing in popularity while others are becoming less popular. Participation in other activities like walking for pleasure and running remain stable (Michigan Department of

Natural Resources, 2012; Wisconsin Department of Natural Resources, 2011; Alig and Voss, 1995)

Phase 4: Spatial Data Linking and Acquisition

During phase 4 we developed methods and acquired data to spatially describe our values and threats and link them spatially. Data was obtained from sources listed in appendix B. We also acquired qualitative data from land managers and natural resource professionals during discussions in our June 2016 workshop in Sault Ste. Marie, Michigan and our trip to the Michigan Upper Peninsula, described in Phase 1. This section describes maps generated for the Story Map including data and structure.

Forest products sector jobs

Live Trees on Timberland map:

This map focused on understanding where timber jobs are, and, specifically, which counties have the most timberland and most number of trees per acre of timberland. The map uses county level data, the smallest spatial unit available, and is color coded by total timberland divided by area of the sampled land/water, in an effort to normalize the data and understand how much of the sample land is timberland. The highest percentage of timberland in a county was 92%. Overlaid on this is a squared symbol in each county, the size of which represents the number of live trees per acre of timberland. More data is found by clicking on each county. A pop-up provides estimates on number of trees and total acres of timberland in the county, as well as a pie chart depicting timberland ownership.

Mills, Curtailments, and Closures Map:

To understand how loss of infrastructure may threaten the forest job industry, the Mills, Curtailments, and Closures map includes the same base layer of percentage timberland in each county, and is overlaid with wood using mill data and number of jobs lost through mill curtailments and closures from 1990-2015. In this map we see how mill closures and job loss has occurred in the region relative to the amount of timberland on a county-by-county basis.

Northwoods Housing Density Map:

Growth in housing density may indicate demographic change in an area of the Northwoods and a change in values among family forest owners (Ward *et al.*, 2005). The map of Northwoods housing density draws on projections of housing density at the partial block group level for the year 2030 produced by the University of Wisconsin-Madison SILVIS lab (http://silvis.forest.wisc.edu/). This map shows housing units per square kilometer and, when clicked on, a popup displays estimated growth in density between 2010 and 2030 for the selected polygon. When the view is zoomed out, the information is summarized at the block group level, along with information about the amount of family forest contained within the block group.

Family Private Forest map:

The Family Private Forest map shows the location of private forest owned by families in the Northwoods to indicate where changing values with respect to management for timber may be of concern. At coarser scales, the map displays a hexagonal grid, with color variation indicating the amount of family forest in a given cell. Clicking on a cell shows the total area of forest within that cell as well as a breakdown into six ownership types described below. At finer scales the actual location of all forestland is displayed, with family forest emphasized in the symbology. The map of Family Private Forest is derived from the Forest Service's dataset, Distribution of Six Forest Ownership Types in the Conterminous United States which is derived from remote sensing data on land cover, overlaid with layers to classify the ownership of the forest land. The dataset is unique in that it is divided into public and private forest and further disaggregated into family, corporate, and other private forest, as well as federal, state, and local, public forest.

The Family Forest Near Recreational Lakes Map:

This map highlights areas where recreational lakes are likely to influence family forest owner values. Private family forest, from the Forest Service dataset described above, are overlaid with the locations of lakes 1 acre or larger. We considered lakes of this size to be recreational lakes, based on our assumptions of recreation potential from opinions and research on real estate sales websites. We created a 1 mile buffer around lakes to suggest areas where family forest owners may be most influenced by the presence of recreational lakes. At coarser scales the map summarizes this information to a hexagonal grid, coloring cells based on the total area of family forest within the buffer zone. At finer scales, the map highlights family forest with the buffer zone in red.

Spotlight: Michigan's Invasive Pests Map:

For the final timber jobs map, we spotlight threats from invasive pests in Michigan's. The map shows where most timberland can be found along with the location of invasive pests. Combining these layers gives better understanding of which counties are most important to the timber industry and most at risk from pests. In the map symbology, invasive pests are distinguished by color and size. The color indicates what invasive pest was found and the size indicates total reported acreage of the pest.

Water quality

Water quality is an important regulating ecosystem service provided by the forests in the Northwoods region. Surface water provides an important source of drinking water to people living in the Northwoods, as well as habitat for fish and other wildlife.

Water quality is influenced by natural processes and human activities. Land use and land cover change as well as erosion and sedimentation are considered as two top threats to water quality. We used four maps to present the values and threats of water quality and a map to present a case study spotlight of sedimentation in the Two Hearted River in northern Michigan

Water Quality in Watershed Map:

Water quality is commonly defined by physical, chemical, biological and aesthetic characteristics. We use several indicators to represent water quality: total phosphorus (TP), Kjeldahl nitrogen (ammonia plus organic nitrogen, KN), inorganic nitrogen (IN), total suspended solid (TSS), and dissolved oxygen (DO). These indicators were well represented across the Northwoods region and commonly measured by the U.S. Geological Survey at river monitoring sites. We averaged the TP, KN, IN, DO of each monitoring site from June to September, 2011, because the environmental risk reaches the highest in the summer (Fuller and Taricska, 2012). Data were obtained from the U.S. Geological Survey National Water Information System.

We included 6 sub maps in this tab: levels of DO, TP, TSS, KN, and IN, together with the distribution of the monitoring sites, as well as the aggregate indicator of water quality.

Dissolved oxygen (DO) was classified based on the EPA-ambient water quality criteria for DO:

< 3 mg/L: Limit to avoid acute mortality
3 - 4 mg/L: severe production impairment
4 - 5 mg/L: moderate production impairment
5 - 8 mg/L: slight production impairment
> 8 mg/L: no production impairment

Kjeldahl nitrogen (KN) was classified based on quantiles of the KN data:

>1 mg/L: High concentration
0.6 - 1 mg/L: Medium concentration
0.4 - 0.6 mg/L: Low concentration
<0.4 mg/L: Very low concentration
-256: NoData

Total phosphorus (TP), was classified based on water quality standards for Wisconsin surface water (Wis. Admin. Code Trans. § NR 102.06(3){2010}).

< 0.015 mg P/L: Very low concentration
0.015 - 0.03 mg P/L: Low concentration
0.03 - 0.04 mg P/L: Medium concentration
0.04 - 0.075 mg P/L: High concentration
> 0.075 mg P/L: Very high concentration
-256: NoData

Total suspended solid (TSS) was classified based on the Michigan water quality standard for TSS (MDEQ, n.d.).

< 20 mg/L: Very clear
20 - 30 mg/L: Meet municipal wastewater treatment criteria
30 - 40 mg/L: Clear but need to be treated
> 40 mg/L: Cloudy
-256: NoData

Inorganic nitrogen (IN), was classified based on the quantile of the IN data.

> 0.3 mg N/L: High concentration
0.15 - 0.3 mg N/L: Medium concentration
0.05 - 0.15 mg N/L: Low concentration
< 0.05 mg N/L: Very low concentration
-256 NoData

Aggregate indicator of water quality: was developed based on the relative contribution of each indicator to water quality (Xu *et al.* 2015).

Table 1: Weights used to calculate water quality indicator

Factor	Influence Direction	Weight
Dissolved Oxygen	+	0.38
Inorganic Nitrogen	-	0.06
Total Phosphorus	-	0.30
Kjeldahl Nitrogen	-	0.20
Total Suspended Solid	-	0.06

The classification of the aggregate indicator was based on quantiles of the index.

Lowest Quality: >4
Low Quality: 3.5 - 4
Medium Quality: 3 - 3.5
High Quality: 2 - 3
Highest Quality: <2
No Data: -256

Level of Concern for Water Quality Protection Map:

Due to the different situation of each watershed, some watersheds are more likely to suffer from low water quality and merit higher concern of protection. A multiple criteria analysis is developed to identify different levels of concern for the protection of watersheds.

In the selection of evaluation criteria, we used landscape factors, including land use types, slope, precipitation, soil texture and road density corresponding with commonly recognized top threats; land use change and erosion and sedimentation. We also used current water quality metrics as a factor since it is also an important factor representing environmental vulnerability of watersheds and would have significant influence on future water quality. Since these factors have different units and dimensions, they were to be normalized to create dimensionless criteria for multi-criteria analysis. Factors with positive influence on water quality were normalized using equation 1. This included dissolved oxygen (DO), % forest, % wetland, slope, and soil texture. Factors with negative influence on water quality were normalized using equation 2. This included such as inorganic nitrogen, Kjeldahl nitrogen, total suspended solid, total phosphorus, % agricultural land use in the watershed, % forest cover in the watershed, precipitation, and road density. All factors are fixed between 1 and 10 without changing the direction of influence

$10 - 9(n_i - n_{min})/(n_{max} - n_{min})$ Equation 1
$10 - 9(n_{max} - n_i)/(n_{max} - n_{min})$ Equation 2

We used the VIKOR method for the multiple criteria analysis. This method is uses an aggregating function representing "closeness to the ideal", and determines a compromise solution, providing a maximum "group utility" for the "majority" and a minimum of an "individual regret" for the "opponent" (Opricovic and Tzeng, 2004). By using this method, all alternatives are evaluated according to the criteria, and ranked by comparing to the ideal alternative (Opricovic, 1998, and Opricovic and Tzeng, 2004).

The compromise ranking algorithm VIKOR has the follow steps:
1) Identify the maximum f_i^* and minimum f_i^- values among all the alternatives for each criterion:

$$f^*{}_i = \max_j[(f_{ij}|j = 1,2,\ldots,m]$$
$$f^-{}_i = \min_j[(f_{ij}|j = 1,2,\ldots,m]$$

2) Compute the group utility values S_j and individual regret values R_jRj for each alternative:

$$S_j = \sum_{i=1}^{n} w_i(f_i^* - f_{ij})/(f_i^* - f_i^-)$$
$$R_j = \max_i[w_i(f_i^* - f_{ij})/(f_i^* - f_i^-)]$$

Where w_i are the weights of criteria, representing the relative importance.

3) Compute the value Q_j Qj for each criterion:

$$Q_j = v(S_j - S^-)/(S^* - S^-) + (1 - v)(R_j - R^-)/(R^* - R^-)$$

Where

$$S^* = max[(S_j)|\, j = 1,2,\ldots,m]$$
$$S^- = min[(S_j)|\, j = 1,2,\ldots,m]$$
$$R^* = max[(R_j)|\, j = 1,2,\ldots,m]$$
$$R^- = min[(R_j)|\, j = 1,2,\ldots,m]$$

Where v is introduced as weight of the strategy of the maximum group utility and $1 - v$ is the weight of the individual regret. Here $v = 0.5$ (Kackar, 1985, Opricovic and Tzeng, 2004, and Chang and Hsu, 2009)

4) Compute the $Q_j{}'$ by normalization of Q_j to range 1 - 10

$$Q_j{}' = 10/[10 - 9(Q_{max} - Q_j)/(Q_{max} - Q_{min})]$$

5) Rank the alternatives by $Q_j{}'$ in decreasing order. The larger the $Q_j{}'$, the higher priority of the alternative, and the more concern is needed for the protection of the watershed.
We use each watershed as an alternative, and rank the alternatives by VIKOR method to get the priority of protection for the watersheds.

We used Analytical hierarchy process to determine the weights of each factor comparison of criteria to reduce difficulties when assigning weights (Saaty, 2004). Relative weights are determined from similar research projects (Ahearn et al., 2005, Xu and Hu, 2015, Sliva and Williams, 2001), the survey conducted in LCC June meeting, and general linear analysis of the relationships between water quality indicators and landscapes features for sites in the Northwoods.

Table 2: Weights used to calculate criteria for water quality protection strategy

Factor	Influence Direction	Weight
Agriculture percentage	-	0.22
Forest percentage	+	0.06
Urban percentage	-	0.05
Wetland percentage	+	0.06
Soil texture	+	0.10
Slope	+	0.10
Precipitation	-	0.03
Road Density	-	0.07
Water Quality	+	0.30

We classified the protection strategy into five levels using on a combination of natural breaks (for the highest concern) and quantiles of normalized scores:

Highest Concern: 6 - 10
High Concern: 1.5 - 6
Medium Concern: 1.3 - 1.5
Low Concern: 1.2 - 1.3
Lowest Concern: 1 - 1.2

The analysis and classification is based on relative scores across the Northwoods area. If the analysis and ranking were to be applied across the Great Lakes basin, the watersheds in the Northwoods might all fall in the Medium - Lowest Concern categories.

Importance of Drinking Water Map:

Index of surface drinking water importance combines information on the volume of water available, landscape surface flow patterns, natural process affecting water quality, and the need for drinking water downstream (Mockrin *et al*., 2014). While Mockrin *et al*. (2014) performed their analysis using HUC12 units, we averaged values to the HUC8 level to be consistent with our research unit.
We classified the importance of drinking water into 5 levels:

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

Concern of Protection for Drinking Water Map:

To bring attention to drinking water security we introduced importance of drinking water to the evaluation of protection strategy. By weighing the concern of protection strategy with the index of surface drinking water importance, extra importance is given to watersheds which generate more water supply.

We classified the protection strategy for drinking water into 5 levels, based on a combination of natural breaks (for the highest concern) and quantiles of the normalized scores:

Highest Concern: 5 -10
High Concern: 2 - 5
Medium Concern: 1.5 - 2
Low Concern: 1.2 - 1.5
Lowest Concern: 1 - 1.2

Spotlight – Two Hearted River Map:

The Two Hearted River is the only designated wilderness river in Michigan and is one of the largest free-flowing river systems in the Great Lakes region. There are 6 sub watersheds within the Two Hearted River: The Main and West branches, East Branch, Dawson Creek, South Branch, North Branch and Widgeon Creek. The watershed surrounding the river are extremely rural and consists largely of forests. Half of the watershed is now owned by the Michigan Department of Natural Resources and nearly a fifth is owned by The Nature Conservancy (TNC). Isolation from urban centers, prevalence of valuable wetlands, and the large proportion of land owned by the state and by TNC, makes the Two Hearted watershed a unique opportunity for conservation work to restore the health of this watershed (Great Lakes Inform, n.d.).

Sedimentation is one of the largest threats to the Two Hearted River Watershed (Superior Watershed Partnership, 2008). The amount of sediment in a river system varies depending on the size and shape of the river, soil types, and flow velocity. Increased sedimentation leads to suspended and unevenly distributed sediment, and has negative effects on water quality and wildlife. Sediment can also carry nutrients such as Nitrogen and Phosphorus that may change water chemistry and even cause eutrophication. In addition, suspended sediment can wear down fish gills, smother small aquatic organisms, and make finding habitat and food difficult (The Nature Conservancy, n.d.). From 2006 to 2014, TNC and partners identified 27 crossings and man-made eroding stream banks that needed to be repaired. Improvements were made to all of these sites by November 2014, reducing sediment loading by 625.8 tons/year.

The Two Hearted River Spotlight map shows sedimentation within Two Hearted River watershed in 2008. Combined, natural and manmade erosion sites contribute an estimated 2,303 tons of sediment to the Two Hearted River and its tributaries each year. The majority of this impact occurs along the Main and West branches, the East Branch and Dawson Creek with the Main and West branches having the highest number of erosion sites.

Non-consumptive recreational experiences in nature

Recreation Potential – Access Map:

Recreation Potential is the degree to which a piece of land provides opportunity for outdoor recreation. It is determined by biophysical landscape properties and cultural preferences (Weyland and Laterra, 2014). Access to natural lands is one important factor in determining recreation potential. For the recreation potential - access section we used the Protected Areas Database of the United States prepared by the USGS GAP Analysis Program (PAD). The PAD inventories land that is held in trust by governmental and nonprofit organizations for conservation. We used this data to show lands that are known to be open to the public for some forms of recreation. It is important to note that the PAD database is not exhaustive. Not all public recreation lands are represented in this dataset.

Use of recreation resources can be measured directly by surveys and visitation counts. We obtained data from the National Park Service and National Forest Service and mapped changes to the number of visitations to their land between 2006/2007 and 2011/2012. Averaging these years provided the best overlap between the two data sets.

Revealed Preference - Photo User Days Map:

Direct measurement of recreation use is costly and resource intensive. As such, measurement of visitation of trails, lakes, and natural areas is patchy. Some surveys attempt to quantify the public use of natural areas, but differences in methodology and timing can make data integration across surveys difficult. The revealed preference indicators used in our maps are indirect metrics of the relative distribution of recreation use that can be applied homogeneously across the entire study area. These metrics do not directly measure outdoor recreation participation but are attempts to indirectly understand the distribution of recreation activity.

The Natural Capital Project InVEST model was used to calculate "Photo User Days" as a proxy measure of outdoor recreation (Sharp *et al.*, 2016). In this metric, visitation rates are approximated from geotagged photos shared on Flickr.com. The number of unique users posting at least one photo on a given day is the number of photo user days for that day. The number of photo user days over the course of a year is then aggregated to a grid (in this case 16 km) and averaged for the years 2005-2014.

Revealed Preference – eBird Lists Map:

Another revealed preference indicator was calculated using data from eBird, a popular citizen science tool used to report bird sightings to the Cornell Lab of Ornithology. Geotagged lists were obtained across the Northwood for the years 2005-2014 and summarized to a 16 km grid. We used the same grid as for the Photo User Days map for consistency. We restricted the lists to observation types Traveling Count, Area Count, eBird Random Location Count, Historical, and Traveling - Property Specific. These were chosen to try reducing observations made during recreation activities as opposed to observations at feeders or while doing other activities.

Human Population Projection Change Map:

We obtained human population projections at a county level from the Minnesota and Wisconsin Department of Administration. Michigan data did not have temporal overlap to be usable with the other states. Using these data, we mapped projected change to the Population Age Index between 2015 and 2040. Population Age Index is calculated as the number of people over 60 years old per hundred people under 15 years old (United Nations, 2002). Higher scores indicate an older population.

Phase 5: Presentation of Findings

In the last phase of our project, we presented our findings in the Story Map. The Story Map we generated has the following capabilities:

- Interactively displaying relevant layers representing top 3 priority values, and threats to those values, geospatially across the area of interest.
- Overlaying values and threats layers on top of relevant natural/geographical features and management boundaries.

- Easy online accessibility and share ability.
- Displaying narrative text, images and multimedia describing values and threats, as well as features and areas of interest.

Template Selection

There are several pre-configured Story Map templates available developed for different applications: showing a sequence of place-enabled photos or videos, a rich multimedia narrative, a series of maps, a dynamic collection of crowdsourced photos, a curated set of places of interest, one map or comparing two maps.

To increase shareability and better provide context, we embedded three Story Maps, one for each value, into a single Story Map. The “main” map starts with background on the project including our theoretical framework and spatial orientation of the study region. This is followed by the value/threats Story Maps. The main map we built using the cascade template because it could provide a good combination of narrative text with maps and images, and could show them in a full-screen rolling experience with map animations and transition effects.

For the three values/threats Story maps, we used the tabbed story map series layout. We used a tabbed layout because it can show the topic of each map clearly along with a larger number of map titles (7-8) in one screen. Other options were a side accordion or bulleted layout were not sufficient for our application. The side accordion layout features an expandable panel containing the accompanying text. We found that when the panel was expanded, the titles of other maps were difficult to see, especially when the text is quite long or other contents, such as images and tables are added. The bulleted layout option uses bullets or numbers rather than named tabs. This increases the number of tabs that can be added but makes it difficult for users to locate a specific map. This style is more suited for a linear story and is less amenable to freely moving around the tabs as would be required of a decision support tool.

Table 3. Description of pre-made Story Map templates available from ArcGIS online (ESRI, n.d.)

Template Type	Subgroup	Description
A Sequence of Place-enabled Photos and Videos	Story Map Tour	Ideal for presenting a linear, place-based narrative featuring images or videos.
A Rich Multimedia Narrative	Story Map Journal	Users scroll through sections. Each section has a map area and text sidebar.
	Story Map Cascade	Combines narrative text with maps, images, and multimedia content with full-screen scrolling.
Presenting a Series of Maps	Story Map Series - Tabbed Layout	Presents a series of maps via tabs, numbered bullets, or our expandable 'side accordion' control.
	Story Map Series - Side Accordion Layout	
	Story Map Series - Bulleted Layout	
A Dynamic Collection of Crowdsourced Photos	Story Map Crowdsource	Enables publishing and management of a crowdsourced story
A Curated Set of Places of Interest	Story Map Shortlist	Organizes points of interest into tabs for users to explore what's in an area.
Comparing Two Maps	Story Map Swipe	Allows users to interact with two web maps or two layers within a single web map
	Story Map Spyglass	
Presenting One Map	Story Map Basic	Uses a minimalist user interface. Apart from the title bar and an optional legend the map fills the screen.

Discussion

Data access was the biggest challenge we faced in this project. In keeping with the goal of the project, promoting cross jurisdictional decision making, having datasets that cover the entire Northwoods region was a high priority. There were several datasets, such as recreation on state owned land, that were not available or inconsistent across the region. This led us to rely primarily on data collected on the federal level or to combine state level datasets with strict caveats in the written portion of the Story Maps. In addition to inconsistent data, some desired datasets could not be found at all. Issues with data availability could be eased through communication with LCC members who may have access to datasets which may not be found otherwise. One approach to dealing with inconsistent data was to create "spotlights" of an issue in a particular area. For example, this approach was taken for mapping invasive species. Data were collected at the state level and did not have the same species and methods making mapping across the entire Northwoods difficult. Instead, for a spotlight on invasive forest pests, we focused on Michigan where we found the most complete spatial data on this particular threat.

There were some conceptual hurdles to overcome in choosing, processing, and displaying the data, particularly trying to keep in line with our framework. We had difficulty finding threats to outdoor recreation that fulfilled basic criteria such as mappability. In addition, it was difficult to come up with threats that were universal across all types of recreations and consistent throughout the region. Our maps looking at family forests and recreational lakes were based on studies conducted in northern Wisconsin which may not be applicable in all areas of the Northwoods. There were several limitations in analyzing water quality. These primarily stemmed from a lack of information on how to develop a water quality aggregate index. In addition, weighting of parameters is determined by the expertise of a small group of investigators making outputs subjective. This could be ameliorated by soliciting broader expert opinion in the ranking phase of the analysis.

We decided to use predesigned templates available with ArcGIS online to make the Story Maps. This reduced the time needed to develop a new app interface and to conduct testing for performance. However, some desired features were not available in the templates we used. This includes the ability to toggle map layers on and off and tools such as swiping and spyglass which allow the user to view changes in stacked layers. We recommend that future projects consider building custom interfaces, although that would include more technical time and effort.

With this project, we have demonstrated a conceptual model for identifying human well-being values, threats to these values, and for creating interactive maps to describe these values and threats spatially across the landscape. While our project began with human well-being values and moved on to threats, it is easy to imagine how our framework could also useful for mapping from a different starting point. A map of threats or management targets, for example, could be retroactively linked to the human well-being values they impact. This could be useful in decision-making, since most management decisions impact stakeholder values.

Another future opportunity is to explore areas where values overlap or compete with one another. Using our framework, it is possible to understand how the drivers of one value can act as threats to another value. For example, drivers creating forest products sector jobs may threaten outdoor recreation opportunities. Story Maps could be used to elucidate these relationships and communicate tradeoffs.

Because the project is a pilot with limited scope, we have only touched on a fraction of what can be done with Story Maps and other methods of interactive mapping. Our partners in the Upper Midwest and Great Lakes LCC report that the Story Map we created has led them to consider additional ways the medium could be used to convey complex information. By translating abstract values and threats into understandable spatial data and displaying those data in an informative and easy to use product, this project demonstrates techniques to enable cross-jurisdictional, landscape scale management that benefits both society and nature.

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Appendix A: Possible Future Values and Threats to Explore

This appendix includes additional threats and values that were proposed over the course of this project. These were generated from LCC member feedback and literature review. Because of time, data, and conceptual limitations, most of the threats and values were not included in our story maps. However, some, if not all, of them could be used for future projects.

* Bold indicates item was explored in this project

Value	Threat
Outdoor recreation	Economic trends
	Changing demographics and interest
	Damage from overuse or improper use
	Access/ distance to forest
	Resource availability
	Invasive species
	Forest pests/pathogens
	Ownership changes
	Knowledge of opportunities
	Changes in leisure time
Forest products jobs	**Mills closures and curtailments**
	Social aspects of forest owners
	Invasive pests
	Climate change
	Pathogens
	Land use, cover change/ urbanization
	Cooperation of mill owners
	Job training
	Regulations
	Markets and demand
	Maintaining resilient forests
	Levels of harvest
	Declining interest in logging as career
	Global trade agreements
	Sedimentation
	Soil erosion
Water quality	**Sedimentation and nutrients**
	Land use and land cover change
	Roads
	Human settlement
	Privatization of water
	Invasive species (algal blooms)
	Climate change

Water Quality, continued	mismanagement/misconceptions from public Pollution

Values Without Threat Exploration

Forest health

Forest sustainability

Forest diversity

Consumptive outdoor recreation (hunting, fishing, ATV usage)

Scenic beauty

Wilderness/natural process

Cultural values/livelihood

Carbon storage

Financial investment

Appendix B: Spatial Data Layers

This table describes the data layers used in the final Story Map including the name of the originating organization and major edits performed on that data.

Layer Name	Description	Source	Major Edits
Agriculture Percentage	Amount of agriculture in a watershed/ the total area of the watershed	MRLC Consortium, The U.S. Department of Agriculture www.mrlc.gov	Clipped to region; Tabulate Area; Normalization
Dissolved Oxygen	Indicator of water quality, related to the amount of organic matter	National Water Quality Monitoring Council www.waterqualitydata.us	Add XY data; Spatial join, average; Normalization
eBird Grid	Number of eBird lists reported. aggregated to a 16 km grid and summarized from 2005 - 20015	www.ebird.org	Calculated number of lists within 16 km grid cells
Family Forest Area	From 'Map of distribution of six forest ownership types in the conterminous United States'	U.S. Forest Service www.nrs.fs.fed.us/pubs/46386	Clipped to region; Reclassified ownership types
Family Forest Area (Hexagons)	Area data from 'Family Forest' layer summarized to a 12 km hexagon grid	*see Family Forest Area	Summarized total km^2 of family forest within hexagons (12 km side length)
Family Forest Area Near Recreational Lakes	Family Forest Area layer highlighting forest area within 1.6 km of lake in Recreational Lakes layer	*see Recreational Lakes and Family Forest Area Near Recreational Lakes	Reclassified forest area within buffer zone
Family Forest Near Lakes (Hexagons)	Area data from 'Family Forest Area Near Recreational Lakes' summarized to a 12 km hexagon grid	*see Family Forest Area Near Recreational Lakes	Summarized total km^2 of family forest within near lakes within hexagons (12 km side length)
Forest Percentage	Amount of forest in a watershed/ the total area of the watershed	* see Agriculture Percentage	Clipped to region; Tabulate Area; Normalization

Layer Name	Description	Source	Major Edits
Housing Density (1940-2030)	Housing density at partial block group level. (Forecasted for 2030)	Silvis Lab www.silvis.forest.wisc.edu/data/1940-2030-housing-density-pbg	Clipped to region; Calculated change between 2010 and 2030
Inorganic Nitrogen	Indicator of water quality, nitrate and nitrogen	* see Dissolved Oxygen	Add XY data; Spatial join, average; Normalization
Kjeldahl Nitrogen	Indicator of water quality, organic nitrogen and ammonia	* see Dissolved Oxygen	Add XY data; Spatial join, average; Normalization
Live Trees	Number of Live Trees per Acre of Timberland	Miles, P.D. 2017. Forest Inventory EVALIDator web-application Version 1.6.0.03. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northern Research Station. www.apps.fs.fed.us/Evalidator/evalidator.jsp	Joined with county data
MI Invasive Pests	Invasive pests in MI, based on aerial flyover	MI DNR, 2017. Aerial Survey 2015 Disease/Pest DNR Open Data www.arcgis.com/home/item.html?id=ccc9b558497f44cba1c90b1c77aef621	Converted polygons to points
Mill Closures	Mill Curtailments and Closures	Mill Curtailments and Closures (1990-2015).From Pulp & Paperworkers' Resource Council. www.pprc.info/html/millclosures.htm	Data clean up; Join with city point layers (points assigned to city containing mill)
National Land Visitations	Number of visits to National Park Service and National Forest Service lands in 2006/2007 and 2011/2012	National Park Service www.irma.nps.gov/Stats U.S. Forest Service www.fs.fed.us/recreation/programs/nvum	Averaged tabular data and clipped to region
Northwoods	Outline of the Northwoods province ecoregion	U.S. Forest Service www.fs.fed.us/rm/ecoregions/products/map-ecoregions-united-states	Reduced to study area

Layer Name	Description	Source	Major Edits
PAD	Protected Areas Database of the United States. Shows land ownership and degree of public access.	U.S. Geological Survey GAP analysis program. www.gapanalysis.usgs.gov/padus	Clipped to region
Population Aging	Projected Population Age Index for counties in Wisconsin and Minnesota in 2015 and 2040	Projections: Minnesota Department of Administration www.mn.gov/admin/demography/data-by-topic/population-data/our-projections Wisconsin Department of Administration www.doa.state.wi.us/Divisions/Intergovernmental-Relations/Demographic-Services-Center/Wisconsin-Population-Projections County Boundaries: U.S. Census Bureau www.census.gov/geo/maps-data/data/cbf/cbf_counties.html	Calculated Population Age Index; Clipped to region
Precipitation	Average annual precipitation from 1981 to 2010	PRISM Climate Group at Oregon State University www.prism.oregonstate.edu/normals	Clipped to region; Converted from polygon to raster data; Zonal statistics; Mean
PUD Grid	Photo User Days aggregated to a 16 km grid and averaged from 2005 - 2015	Generated using the InVest Recreation and Tourism Model. www.naturalcapitalproject.org/invest	Clipped model output to region
Recreational Lakes	Lakes greater than 0.004 km^2 in size from National Hydrography Dataset waterbody layer	National Hydrography Dataset www.nhd.usgs.gov/data.html	Clipped to region; Removed lakes smaller than 0.004 km^2
Road Density	The length of road in a watershed/ the total area of the watershed	TIGER/Line www.census.gov/geo/maps-data/data/tiger.html	Clipped to region; Dissolve; Identity

Layer Name	Description	Source	Major Edits
Slope	Represents how steep the landscape is	USGS, based on DEM data (30m) www.gapanalysis.usgs.gov/species/data/download	Clipped to region; Zonal statistics; Mean
Soil Texture	Defined sand and gravel as "coarse". The percentage of "coarse" soil in each watershed	Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture www.websoilsurvey.sc.egov.usda.gov/App/HomePage.htm	Clipped to region; Reclassified sand and gravel related to coarse; Calculated the % of coarse in each watershed: zonal statistics, sum
Timberland	Percent of Land that is Timberland	Miles, P.D. 2017. Forest Inventory EVALIDator web-application Version 1.6.0.03. St. Paul, MN: U.S. Department of Agriculture, Forest Service, Northern Research Station. www.apps.fs.fed.us/Evalidator/evalidator.jsp	Joined with county data; timberland was normalized by area of sampled land/water
Total Phosphorus	Indicator of water quality	* see Dissolved Oxygen	Add XY data; Spatial join, average; Normalization
Total Suspended Solid	Indicator of water quality, related to erosion and sedimentation	* see Dissolved Oxygen	Add XY data; Spatial join, average; Normalization
Urban Percentage	Amount of urban in a watershed/ the total area of the watershed	* see Agriculture Percentage	Clipped to region; Tabulate Area; Normalization
Wetland Percentage	Amount of wetland in a watershed/ the total area of the watershed	* see Agriculture Percentage	Clipped to region; Tabulate Area; Normalization
Wild and Scenic Rivers	Designated Wild and Scenic Rivers	www.rivers.org	Clipped to region
Wilderness Areas	Designated wilderness areas	www.wilderness.net	Clipped to region
Wood-Using Mill	Wood-Using Mill Locations	Wood-Using Mill Locations (2005). From USFS. https://www.srs.fs.usda.gov/econ/data	Clipped to region

Appendix C: Brainstorming Session

In June of 2016, we facilitated a brainstorming session at the annual LCC Forest Work Group meeting in Sault Ste. Marie, MI. We solicited feedback from forest and land managers on potential values and threats as well as project progress and future applications. We developed a handout to describe session logistics, to direct conversation, and to provide space for attendants to record responses and feedback. The forms and a summary of results are presented in this appendix.

Summary of Brainstorming Session Results

Each bullet represents the answers from one group of 3-5 professionals

What do you see as threats to or drivers of <u>forest product sector jobs</u>?

- Threat: climate change; interest in entering career in logging; training; reduced resilience to disease; especially in climate change (lack of planning for); invasive species; regulation; access (trade barrier); markets; economy; urbanization; knowledge of public; different harvest practices that maintain resilient forests
- Driver: quality/availability of timber; maintain resilient forests; logging sector jobs
- Loss of forest land to settlements and agriculture; invasive species
- Threat: forest pests and pathogens; warming temps → conversion of forest to agriculture
- Drivers: markets/demand for forest products
- Decreasing parcel size/division of forest ownership challenging management; need for cooperative management to sustain/ timing of forest product flow for infrastructure
- markets; climate change; invasive/pest species
- Misunderstanding by society of “renewable/replenish able” supply of forest products and materials from consciously managed forest ecosystems; competition from other often “nonrenewable” products (e.g. steel, concrete); cooperation of mill owners
- Global trade and free trade agreements; economy; climate change

What do you see as threats to or drivers of <u>water quality</u>?

- Threats: privatization of water; invasive species (algal blooms) impact on forest communities and hydrology; climate change; land use (nutrient loading); mismanagement and misconceptions from public (hold up harvesting)
- Drivers: increase in forest cover but also loss; hot spots of growth and loss; ag. Markets
- Agriculture and fertilizer use; integrity of streams and riparian zones
- Threats: warming temps → conversion of forest to ag → increase nutrient into water bodies
- Drivers: maintaining adequate forest cover in watersheds; maintaining adequate riparian buffers, and forests in ground water recharge areas
- Conversion to non-forest use; effective and consistent use of best management practices; understanding of watershed thinking/approach for management
- Landscape conversion; pollution; eutrophication
- Poor management of extractive industries; expanding populations in areas of poor quality

- chemical/fertilizer input; forested watershed preparation; erosion/sediment load

What do you see as threats to or drivers of <u>non-consumptive recreational experiences in nature</u>?

- Threat: reduce amount of public land (selling properties); and ownership changes (mining); urbanization; land use changes
- Drivers: accessibility; values and past experience; sustainable forest management (BMP use) and ownership (behavior)
- Loss or degradation of wild, natural, scenic forests; access via roads, boat launches, portage trails (access being a driver of recreational use)
- Threats: invasive species; forest pests/pathogens
- Drivers: biodiversity, fish and game populations
- Access; changing demographics; distance to public forest; knowledge of recreational opportunities
- Unintended consequences of seemingly non-consumptive (e.g. "love it to death"; more urban nature of society generates desire for more
- Urbanization of the population; changes to leisure time and disposable income; facilities (i.e. trails, park facilities, campgrounds)

What were your group's selected threats or drivers for forest product sector jobs? Why those threats or drivers; why are they significant?

- Reduced resilience to disease; lack of planning for climate change; regulations that limit harvest opportunities; declining interest in logging as career; job training; public misconceptions; markets; barriers to trade
- Economy; forest products; pest species; paperless technologies driving down demand; loss of mills that are a result of free trade; lack of labor protections; climate change causing loss of certain species
- Threats: closing of mills; competition from other building materials (steel, petroleum); certification standards
- Drivers: cooperation among mills and forest managers regarding timing of harvests, levels of harvest, must be sufficient to sustain infrastructure; demand for product
- Global trade agreements; economy/demand; climate change; emerging invasive pests; transformation to paperless industries; loss of land

What were your group's selected threats or drivers for water quality? Why those threats or drivers; why are they significant?

- Privatization of water; land ownership and land use (ag.; mining) changes; sustainable forest management and BMP use; invasive species; climate change
- Expansion of human settlements, golf courses; expansion of fertilizer use; draining of wetlands; proportion of watersheds that are forested; erosion and sediments; forested riparian zones; pastureland and livestock access to streams; loss of forest land to agriculture (localized)
- Threat: warming → more ag → more nutrients; export of GL water
- Driver: conversion to non-forest uses; long-term rotation of forest vs. short term rotation of ag; road management BMPs

- Percent of watershed is forested; erosion and sedimentation; forested riparian lands; grazing

What were your group's selected threats or drivers for non-consumptive recreational experiences in nature? Why those threats or drivers; why are they significant?

- Urbanization makes demand go down; changes in leisure time; knowledge of opportunities; access to roads, trails, portage; consumptive uses are a factor affecting non-consumptive; intrusive management (clear cuts) or mining pits. Access to healthy forests; invasive insects or disease-bearing ticks or mosquitos; millennials are more digital, less interested, changing culture; traditional role of agencies is to focus on consumptive use of resources
- Threat: over use by non-consumptive recreators; more urban populations → decrease connection to nature; activists
- Drivers: demand for non-sustainable uses of forest lands; maintaining good condition of forests
- Invasive pests and disease vectors

We created and distributed the following handouts to facilitate and guide the brainstorming session.

Summary of Terms

Terms used in the framework and our discussion are described here. We seek to work within a lexicon relevant to as much of the LCC as possible.

Conservation Management Targets:

We define these as *the things managers actually manage for*, which are informed by an understanding of drivers, threats, and context and which inform our understanding of what is helpful to map. This term is meant to encompass 'ecological targets' as well as 'conservation targets' (e.g. area conserved, contiguousness, species diversity, etc.)

Context:

In our framework, this refers to mappable features relevant to decision-making and/or understanding linkages between the landscape and human well-being values (e.g. jurisdictional boundaries, land ownership, geographic features).

Drivers:

We define drivers as necessary conditions for the servicing of human well-being values by the landscape (e.g. market forces, management directives, political support, etc.)

Human Well-Being Values:

(See 'Values' page)

Multimedia:

We will use multimedia in the Story Map to provide a richer picture of what management looks like in the field. We are conducting interviews with Northwoods conservation managers and others working in conservation in the Northwoods to include as video clips in the map. Images and audio may also be included.

(Ecosystem) Services:

We have used the Ecosystem Services framework as a means to describe the relationship of the landscape to human well-being values. These services are typically grouped into four categories: supporting, provisioning, regulating, cultural. We are not using the framework to assign a monetary value of these services.

Story Map:

Story maps combine geospatial data with narrative text, images, and multimedia content. Although *Story Map* is the name of the ESRI product that we intend to use in this project, other options for this combination of content are available.

Threats:

Threats to the servicing of human well-being values by the landscape. These can be understood as threats to drivers, conservation management targets, context, or the values themselves (e.g. depopulation, changing weather-patterns, invasive species, loss of biodiversity, changing land types, etc.)

UM Student Panel | June 28th, 2016 | Page 2 of 8

Values

The master's project team has identified three values to map as an initial pilot study. We have chosen to focus on human well-being values and have derived broader value-categories from the "domains of human well-being" outlined by Smith et al. (2013).[1] In order to keep the project within scope, we have focused on just three of these value-categories (Recreation & Leisure; Health & Human Safety; Livelihoods), and have defined one specific value from each category for mapping:

Forest products sector jobs:

Jobs sustained by the provisioning of forest products, including paper, timber, furniture, as well as non-timber forest products to the extent that the landscape may be managed for these products. Also including associated jobs in transport and processing that rely on these products.

Water quality:

The condition of the water kept clean by the regulating effects of the Northwoods ecosystem, especially for public health considerations (e.g. without focus on fishing conditions), or the impact on water quality by ecosystem factors. We are not considering water quantity (i.e. drought or flooding).

Non-consumptive recreational experiences in nature:

Experiencing nature through non-consumptive means, such as camping, hiking, backpacking, wildlife viewing. We are not considering consumptive outdoor recreation, such as hunting and fishing or high impact activities such as off road vehicles use or snowmobiling.

[1] Smith, Lisa M., et al. "Relating ecoystem [sic] services to domains of human well-being: Foundation for a US index." *Ecological Indicators* 28 (2013): 79-90.

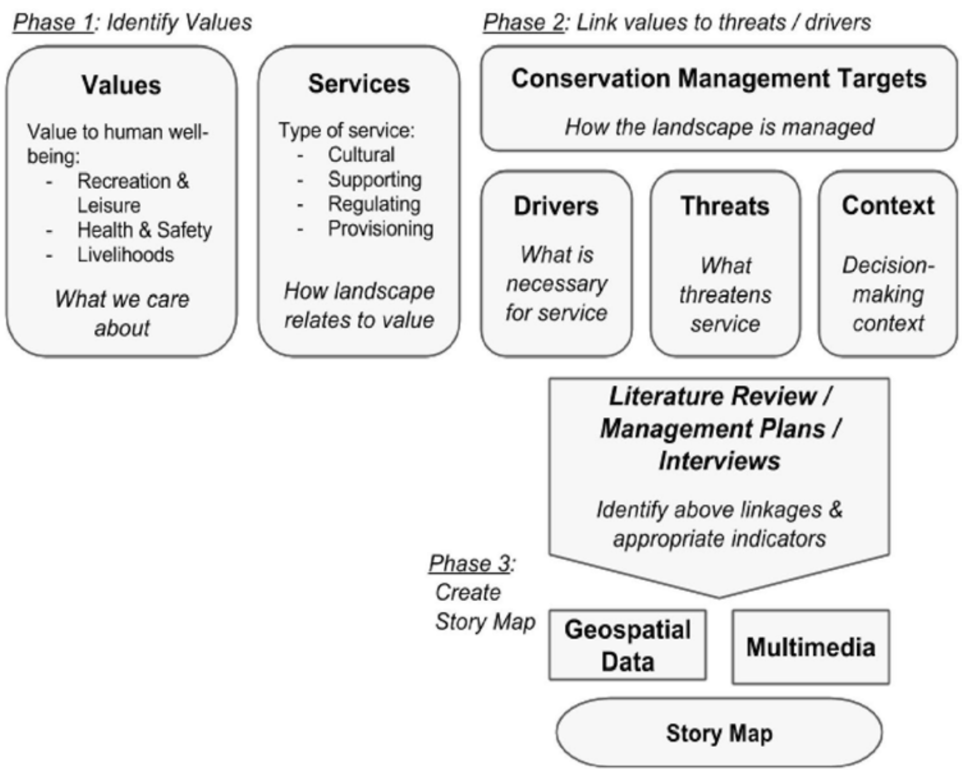
Project Framework

The framework below provides an outline for the master's project and a useful template to guide future values-mapping. The framework outlines three phases:

1. The team has identified three values for the project, deemed to be both important and mappable, with a focus on values to human well-being. An ecosystem-services framework was used to describe the way in which the landscape relates to these values.

2. In this phase (underway now) the team reviews literature and management plans, and engages with experts and managers (e.g. this workshop), in order to link values to drivers and threats; identify relevant decision-making context; and understand conservation management targets as they relate to these factors.

3. To create the Story Map, the team will synthesize existing geospatial data that describe the drivers, threats, and context identified in phase 2. Multimedia, including taped interviews with managers, will be incorporated into the Story Map in order to highlight conservation challenges and provide further context for decision-making.

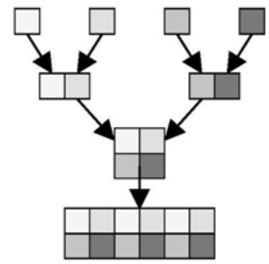


Discussion & Brainstorming Session using the **1-2-4-All** approach

Background

The 1-2-4-All Approach

(also known as "Think, Pair, Share") by Liberating Structures



1 Participants respond to a question by themselves.

2 Participants share their answers with a neighbor, discuss, develop, and focus their responses.

4 Participants expand their ideas further in groups of four.

All Participants come together and share their thoughts with the group.

Brainstorming

The rest of the packet will facilitate the 1-2-4-All brainstorming approach. ***Please tear these last few pages out and submit them at the end of the session.***

3 minutes. Fill out the following by yourself.

Threats and drivers may be varied and span ecological, political, and social topics. See the definitions of threats, drivers, and values above (pg. 2).

What do you see as threats to or drivers of forest product sector jobs?

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What do you see as threats to or drivers of water quality?

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What do you see as threats to or drivers of non-consumptive recreational experiences in nature?

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5 minutes. Pair with a neighbor to discuss and compare. Then focus your responses. Select <u>three</u> significant threats or drivers for each value.

What threats or drivers did you both choose? Are they very similar? Very different?

What were your group's selected threats or drivers for forest product sector jobs? Why those threats or drivers; why are they significant?

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What were your group's selected threats or drivers for water quality? Why those threats or drivers; why are they significant?

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What were your group's selected threats or drivers for non-consumptive recreational experiences in nature? Why those threats or drivers; why are they significant?

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7 minutes. Get into groups of four based on your given color. Discuss the significant threats of drivers you refined in the last step and narrow them further down. As a group of four, select <u>two</u> threats or drivers for each value.

Designated note-takers have been assigned to each group. Unless you're a note taker, you do not need to fill out this section.

What were your group's selected threats or drivers for <u>forest product sector jobs</u>? Why those threats or drivers; why are they significant?

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What were your group's selected threats or drivers for water quality? Why those threats or drivers; why are they significant?

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What were your group's selected threats or drivers for non-consumptive recreational experiences in nature? Why those threats or drivers; why are they significant?

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15 minutes. All participants come back together as a whole group to share what you discussed and thoughts or questions that arose from the previous brainstorming sessions.

Designated note-takers from each group will begin with the top 6 selected threats or drivers their group decided upon. Please feel free to add thoughts and comments throughout this larger brainstorming session. You may also use the space below to add notes.

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Other reflections

When you get a chance, please fill out these additional questions. You may take more time on this section and turn it back in by the end of the workshop if you'd like. Or, email knkeeley@umich.edu with your thoughts/comments.

Feedback on our research/development phase.

What publications, researchers, or other resources/information do you recommend us exploring?

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Feedback on evaluating our project.

How do you envision using the final products for your work?

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Is the framework (page 4) understandable and useful?

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Other comments and feedback.

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Would you be interested in recording your valuable and unique insight (via in person, audio/video options on Skype, phone calls) to supplement our final project (see "Multimedia" definition above; pg. 2)?

If yes, please provide your contact information. Name: _______________

Email: _______________