Public Land Access for Populations of Wisconsin

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Objectives

Some urban areas are closer to public land than others. Historically, a community's access to public land has relied heavily on its geographic location. We want to evaluate which populations in Wisconsin have the easiest access to public land. By observing the demographics of each municipality, we hope to understand which communities and which variables have a correlation with distance to public lands. Because access to nature is important for all people, we will be assessing the ease at which people who live in metropolitan areas can get to public land, in order to highlight differences in accessibility between populations.

Introduction

America has millions of acres of protected public land. While some communities can merely step outside of their house in order to be in this land, others must take long commutes only to find a public campsite crawling with hundreds of other city-dwellers. Public land in the United States has often been referred to as 'America's Cathedrals', drawing in as large of crowds as Europe's most prominent churches. Many visit public lands to get a respite from today's modern world infiltrated by technology. Others go to connect to their own senses of spirituality, to feel their own ephemerality amongst landscapes that predate humanity itself. As all of us have spent time in America's outdoors. We understand that one can have incredibly powerful experiences on public land. The ability to have a connection to the land we live on should be something that everyone can experience. However, reality is not equitable. Most American resources, especially natural resources, are unevenly distributed across the population, and are unevenly distributed between different American demographic groups.

There are many in the United States who live incredibly far from any amount of public land. Since we attend UW-Madison, we will be looking at a given metropolitan area's access to public land on a state-wide basis. Because of the importance in visiting public land, we want to examine what populations have an easier time getting to public land specifically within the confines of Wisconsin. We will be particularly looking at municipalities with a population greater than 5,000 people. Here, we also leave room for examining who has access to public land on a nation-wide level as well as city-wide levels. Through this project we ask the question of whether or not specific metropolitan areas and demographics have an easier time getting to

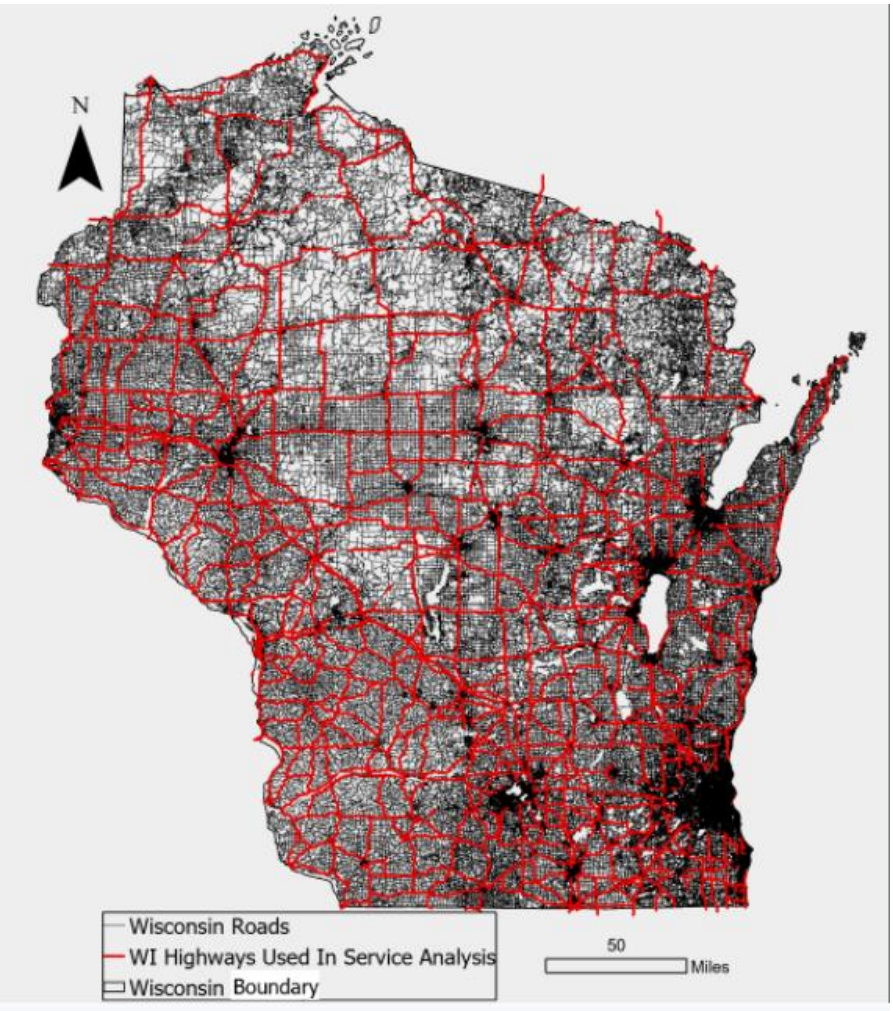
public land than others. We hope to understand if this question can be answered within the confines of a metropolitan area's geography, or if there might be more variables that contribute to why some municipalities have better access than others.

Methodology: Data Acquisition

This study aims to compute and describe the differences between areas with the least and most accessible routes to public land. To discover these discrepancies, spatial accuracy of our public lands and municipal boundaries is crucial. After attaining data of where these boundaries are from Esri, Wisconsin public lands DNR, Geodata@Wisconsin and the US Census, we found where all road-accessible public land is. We then joined and intersected these layers with a layer of all the state roads in Wisconsin. For our Wisconsin State Roads layer, we edited out tertiary roads**,** including roads within cities that do not lead to any piece of public land. From these two data sources, we found all entrance points to any one area of public land and all entrance points to a municipal boundary.

From the United States Census, we acquired metropolitan area data of the largest 61 metropolitan areas within Wisconsin and along Wisconsin's borders. We used a threshold of 5,000 people as our metric for deciding which metropolitan areas to measure in this analysis. Our data also includes appending demographic data including median household income and percent non-white for every metropolitan area. Each polygon boundary is correlated to the size of a given metropolitan area.

For the Public land data, we gathered data from DNR Managed Lands, Federal Lands, and Non-Profit Public Lands which in our case was The Nature Conservancy. With these land files, we clipped the layers based on the Wisconsin state boundary. We cleaned the data by removing features from each layer that were not needed for the project (Example: Department of Defense Lands). We then added a property ownership to the features for each layer, so we knew who the public land belonged to. Finally, to get the public lands into a more usable file, we merged all the public lands into one feature using the append tool. Using this file, we found the intersection of the roads and the public lands to find the entrance points for the automotive vehicles we were examining.



Map 1.1: All Wisconsin roads and Wisconsin highways used in the Network Analysis

Methodology: Network Analysis

Each of the tools that we used required the use of a network. These networks are made up of lines/polylines that create a flow for the network. This flow contains topology in order to model features such as connectivity, one-way roads, and road capacity. Using a cost attribute, generally time or distance, the network analysis is able to calculate the cost of traveling along a route. Using network analysis tools, we can find the cost between points.

For our dataset the road network was the Esri ArcGIS Wisconsin roads layer. This is a massive dataset with all the roads in Wisconsin represented. It includes residential, primary,

secondary, tertiary, unclassified, service, truck, and interstate roads. The layer contains 906,580 different roads in the state of Wisconsin. The layer comes with the geography of the road (which allows us to measure distance), the max speed one is able to drive on the road, and whether or not the road is one-way. These pieces of information allow us to run Network Analysis on the roads and find distances between points.

The network analysis is evaluated based on points, also known as facilities, which for us would be entrance points on either the public lands or metropolitan areas. From our data, we found thousands of road entrances (Road network and land polygon intersections) to public lands as well as metropolitan areas. To compensate for this issue, we decided to only use intersections from roads that were labeled as highways**.** From our data layers, we used two network tools, one to compute the shortest distance from a metropolitan area to any one given area of public land, and one to show a 15-mile reachable area from the metropolitan area. These analyses helped us understand which piece of public land was closest to each metropolitan area, and how far this area of public land is in miles.

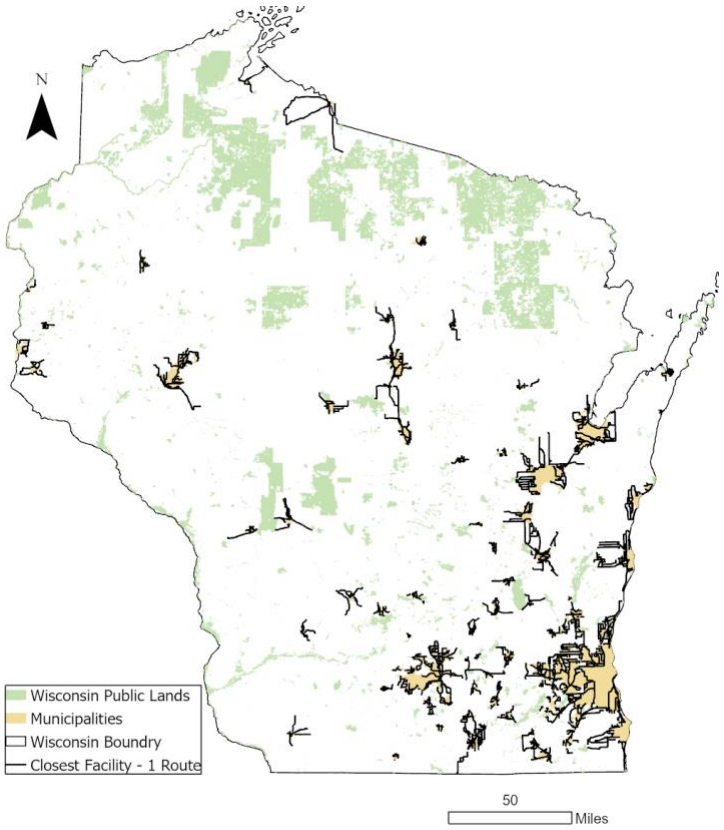
The first Network Analysis tool we used was the Closest Facilities Tool. The Closest Facilities tool takes two sets of points, facilities, and incidents, it finds the closest facility to each incident. In our case, we determined that the metropolitan borders' intersections with our roads layer would be the incidents. We compared them to the public land border and road intersections, which we determined to be the facilities. This allowed us to find the closest public land to the metropolitan areas through the network of roads in Wisconsin. We used a distance in miles to measure the cost of the road network. We were given an output of multiple polylines with a distance in miles from incidents to facilities. Since every metropolitan area had multiple incidents, we used a minimum distance calculation to find which urban incident was the closest to public land. We then used this incident to classify each metropolitan area's proximity to public land. Therefore, using the Closest Facilities Tool gave us the shortest path between each metropolitan area and the closest parcel of public land. This told us how far someone in a metropolitan area would have to drive in order to reach a public land parcel.

The second tool we used was the Service Area Tool service. This service uses the same network as the Network Analysis tool, but only takes one set of points. The Service Area tool examines how far you can travel based on a given cost from each point. The Esri ArcGIS Service

Area tool allows for a service area to be created with a maximum distance of 15 miles. The service area creates a set of lines from the road network based on the established cost. In our case, a 15-mile cost relates to a 15-mile Service Area from a point that is created by the tool. This service area included a set of roads from all the entrance/exit points of a municipality that would allow us to visualize all travel within 15 miles along the road network.

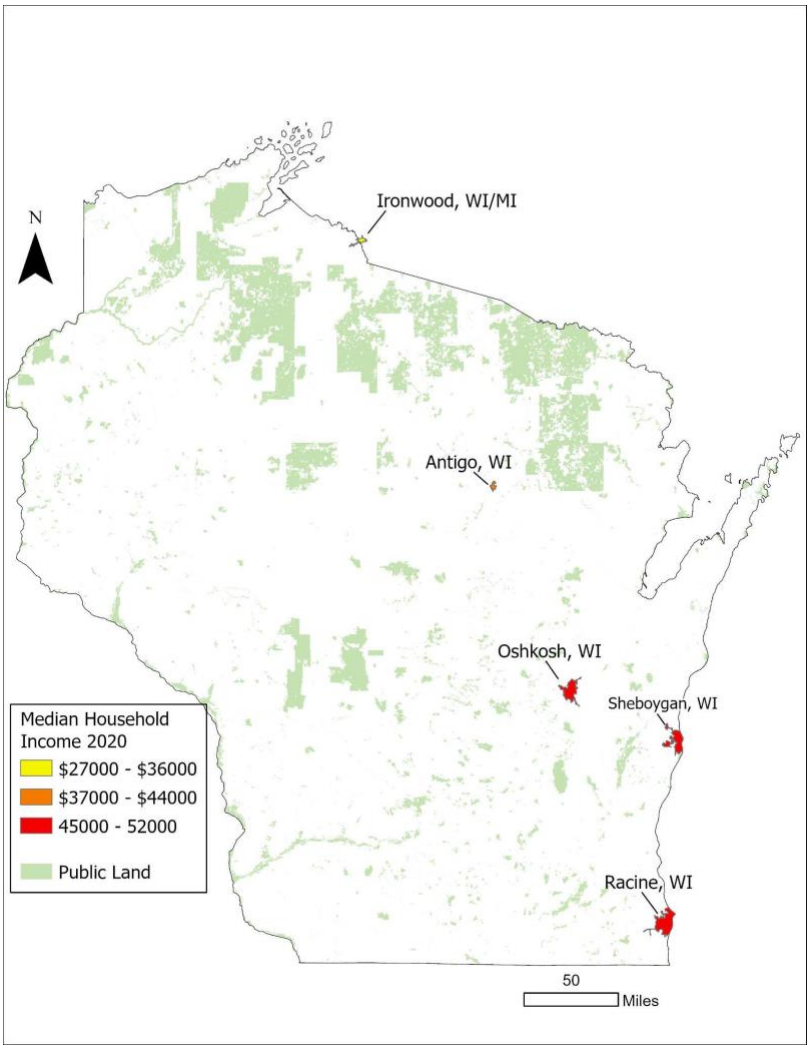
Results

Public land accessibility was examined for municipalities across Wisconsin using two different network analysis methods. The results of the analysis showed trends throughout the state. When combined with the demographic data, we were able to identify unique traits of each municipal population. Map 3.1 and 3.2 show results of both network analysis of the entire state; both maps will be referenced while describing the results of public land access in Wisconsin.



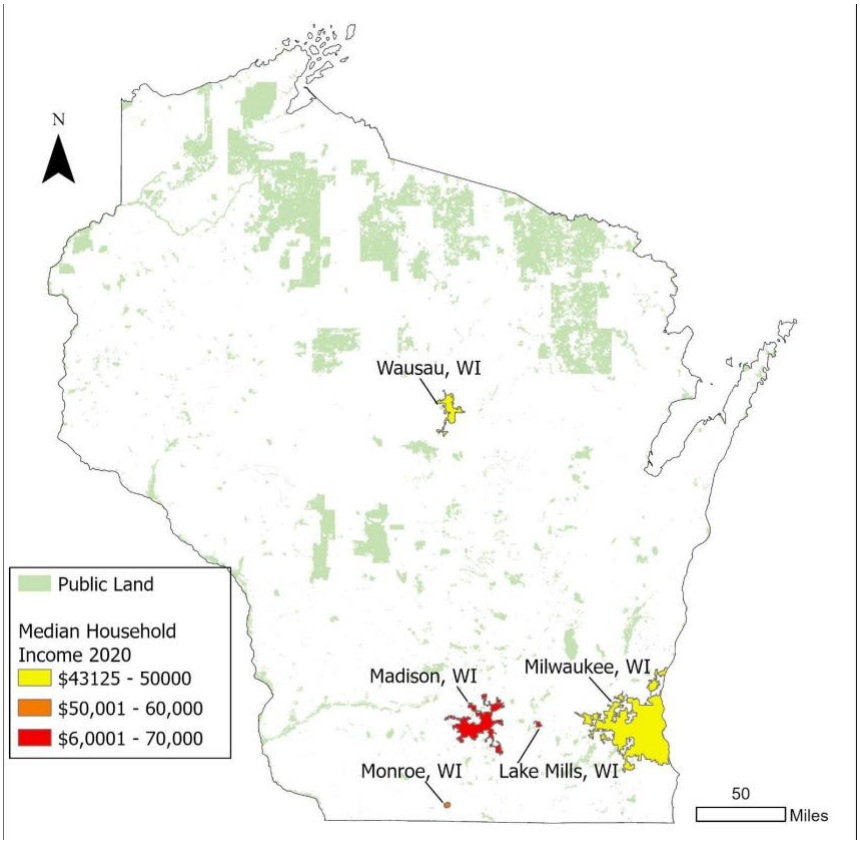
Map 3.1: Closest Facility Analysis, Showing the closest public parcel and road network for each Municipality.

Larger municipalities in southern Wisconsin have more access points and therefore more routes available to get to public land. All of these routes tend to be smaller in distance than routes found in more northern parts of the state.



Map 3.1.1: Closest Facility Analysis, Showing the farthest municipalities from public land and their median household incomes.

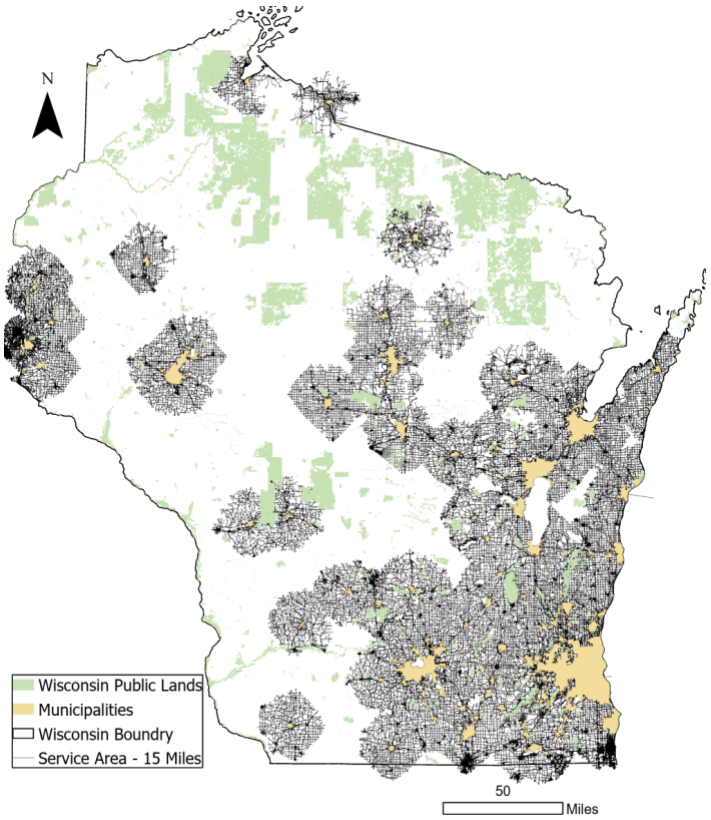
We can visualize the income levels for the metropolitan areas furthest from public land. Ironwood, WI, has the lowest income level for any Wisconsin municipality and is the farthest from public land. Even though we have categorized household incomes, all of the farthest municipalities from public land have a median household income below that of the state average.



Map 3.1.2: Closest Facility Analysis, Showing the closest municipalities from public land and their median household incomes.

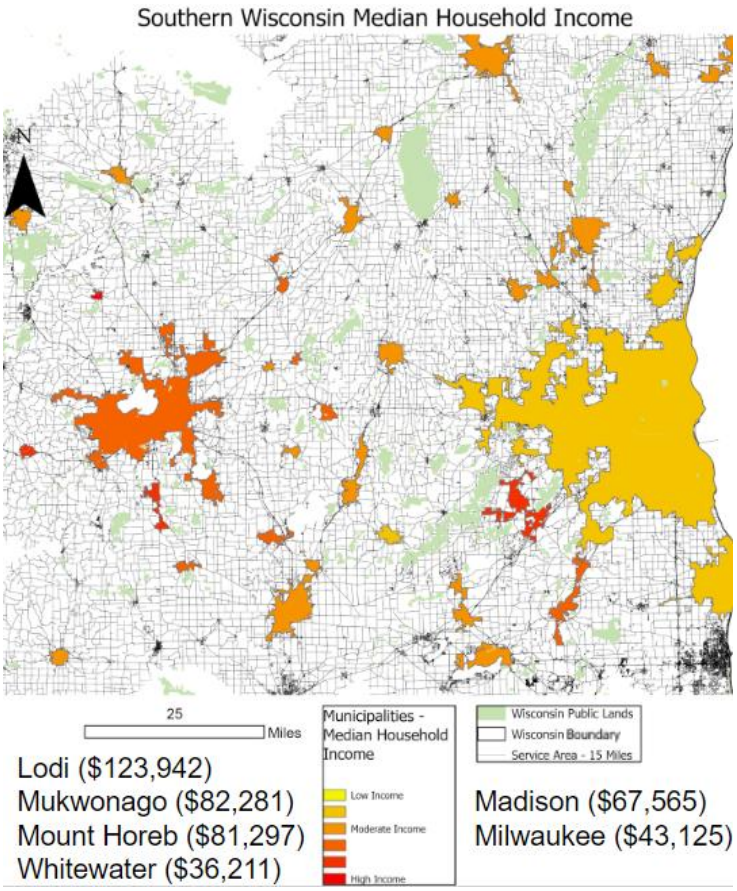
We can visualize the income levels for the metropolitan areas closest to public land. Three out of these five metropolitan areas are at or above the state average annual income. All of these municipalities touch public land.

First, analyzing the statistics of the analysis we found that out of the 61 municipalities that were in the study in Wisconsin, 33 of them are within one mile of public land.

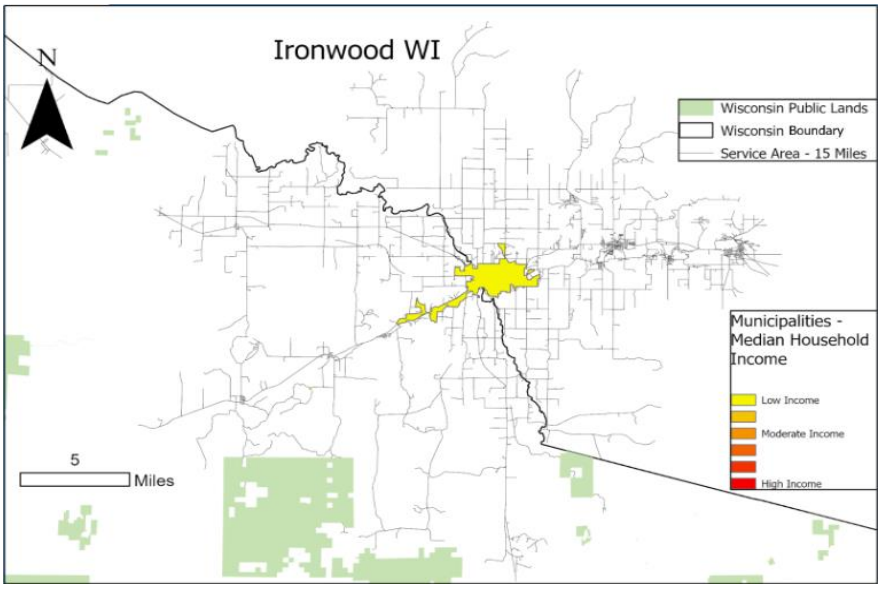


Map 3.2: Network Analysis showing a 15-mile reachable area from the metropolitan area

The demographic information provided by the study showed the average household income in Wisconsin in 2020 was $57,483. This average household income set up a comparison point to look at household income and accessibility of municipalities across Wisconsin. Starting in southern Wisconsin, map 3.3 shows the range of average household income of municipalities along with the network analysis results. southern Wisconsin showcases average household incomes ranging from the upper limit in Wisconsin (Lodi, WI: $123,9420), to the lower limit for Wisconsin (Whitewater, WI: $36,211). Milwaukee, WI located in the southeast is the largest municipality by area and has a moderately low average household income at $43,125. The capital city of Madison, WI is located in the Southcentral and is one of Wisconsin's largest municipalities per capita. Madison has an average household income of $67,595, which is 15% higher than Wisconsin's average household income in 2020. Map 3.4 shows Ironwood, WI which has the lowest average household income in Wisconsin at $27,261. The average household income in Ironwood, WI is 47% lower than the average household income in Wisconsin.



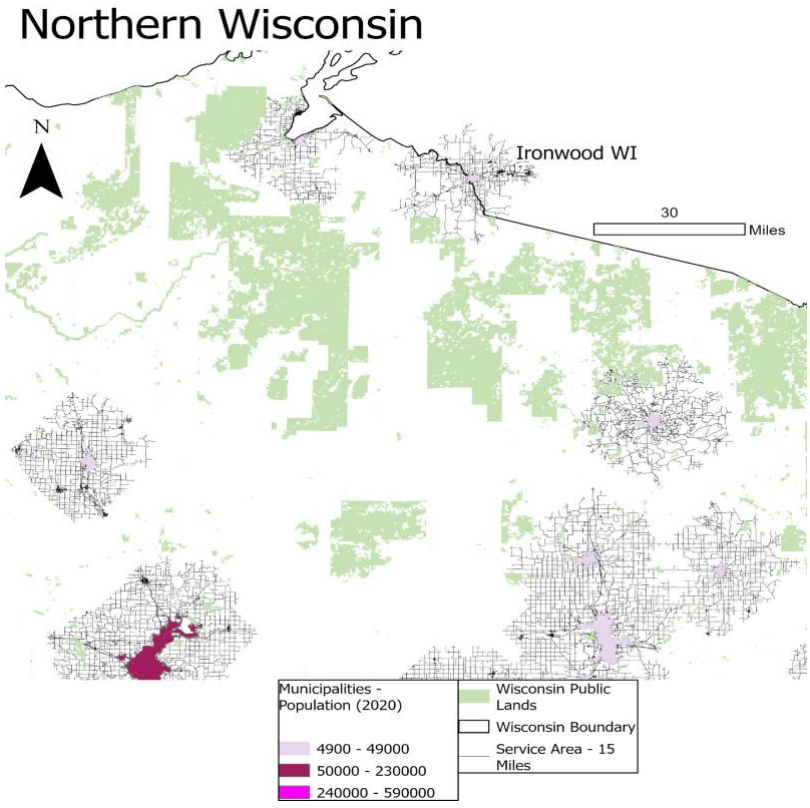
Map 3.3: southern Wisconsin showing the Average household income of municipalities along with the network analysis



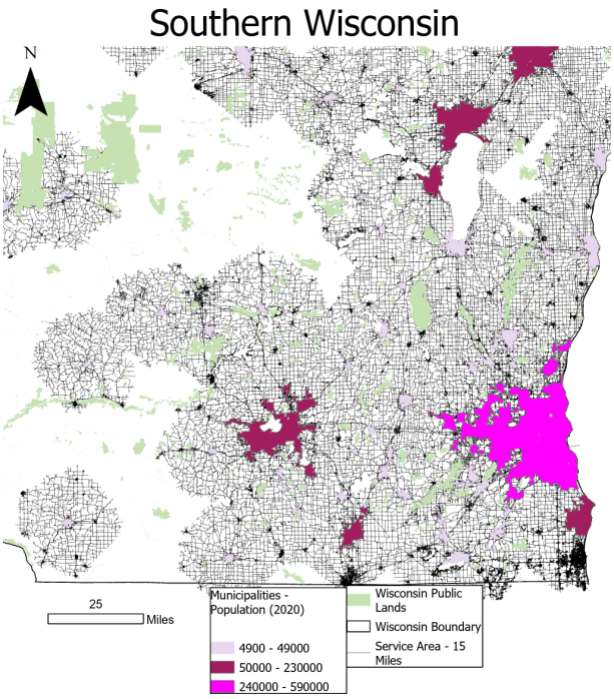
Map 3.4 Ironwood, Wisconsin average household income and network analysis.

The other demographic data that was categorized for this analysis was populations of municipalities. Map 3.5 and 3.6 show populations of municipalities in northern and southern Wisconsin, respectively. Generally, the populations of municipalities in northern Wisconsin are between 5,000-49,999 people. The lowest population of a municipality in this analysis was Ironwood, Wisconsin (population 5,045) located in northern Wisconsin on the border with Upper Michigan. The general trend we observed is the municipalities in northern Wisconsin are far less numerous and have lower population density compared to municipalities in southern Wisconsin.

Southern Wisconsin has populations of municipalities that range from the lower limit (5,000) to the most populated municipality, Milwaukee, Wisconsin. Map 3.6 shows Madison and Milwaukee are the top two most populated municipalities in Wisconsin followed by Green Bay (not pictured), Kenosha and Racine. Four of the top five most populated cities reside in southern Wisconsin and can be viewed on Map 3.6.



Map 3.5: northern Wisconsin categorized population statistics by municipality and the network analysis results.



Map 3.6: southern Wisconsin categorized populations by municipality and their network analysis results.

Discussion

The maps that were presented in the results section showed some general trends in the data concerning the two methods of network analysis and the comparisons in the demographic data throughout Wisconsin. Overall, we were surprised to find out that there are public land parcels available for recreation statewide, varying in size and distance from municipalities. A larger area of state land is located in northern Wisconsin, which also has fewer municipalities with over 5,000 people. In northern Wisconsin access to public land parcels will require a longer drive due to a reduced road network. Many municipalities in northern Wisconsin also have lower average annual household income than municipalities in southern Wisconsin.

Southern Wisconsin almost exhibits the opposite trends found in northern Wisconsin as a result of higher population density and a better road network. Maps 3.3 and 3.6 show good access to public land from large and small municipalities located throughout southern Wisconsin. This can be explained by the numerous roads analyzed during the network analysis methodology.

In southern Wisconsin more developed road network allows more municipalities access to public land. The number of public land parcels may be similar throughout the state but the size of the public land parcels in southern Wisconsin are smaller in area than the land parcels in northern Wisconsin.

Potential Error: Network Analysis

A source of error in this study may be the result of accessibility to public land by only automotive. Many people may use other forms of transportation (Example: biking, walking, ATV/UTVs, snowmobiles) that come with the potential availability of not using the road network defined in this study. An example of this is that most Wisconsin counties have snowmobile trails used explicitly for snowmobiles and only during the winter. Including these different types of transportation networks would increase the size and depth of this analysis.

The large municipalities (Madison and Milwaukee) have populations that live near the center of the city and have low median household income. This demographic may also not have automobile availability and thus would not be able to access the public land in the same manner as the rest of the municipality would. Since this analysis assumes that all populations of each municipality have the same accessibility, this could introduce error between communities within the same municipality.

The 15-mile network analysis was the limit of the GIS technology that was used for this application. Being able to increase the range of the network analysis could improve the results and provide further insight into state-wide accessibility. The 15-mile network used in this study or the possibility of changing the network analysis distance could be a potential source of error in the results.

Potential Errors: Future Points of Entry

Depending on our snapping tolerance, we created between hundreds and thousands of points of entry for each service area. Because of this, we had to whittle down our points of entry by using a very small snapping tolerance. We also used only major roads and omitted tertiary

roads from our road network layer. This likely would not have changed the outcome of distances significantly since most omitted points were extremely close to non-omitted points.

Conclusions

There is a growing belief that spending time outdoors which includes fresh air, exercise and natural beauty can improve mental health, mood, and love for the natural world. We wanted to study how much accessibility municipalities had around the state, since Wisconsin is known as an outdoor destination. This study showed that overall access to public land is possible around the entire state and more depends on an individual's choice for which type of recreational activity they want to participate in.

If your goal is to recreate by yourself, with access to large, quiet areas and little to no people, then northern Wisconsin is the place to go. northern Wisconsin will require further driving to access public lands, but many people enjoy scenic driving around that part of the state, especially during the fall. An individual may have different goals like sightseeing, hiking or recreating with family, which most Wisconsin public land areas fulfill. southern Wisconsin's public land would require shorter drives, but there is a smaller amount of public land that will most likely be accompanied with more people recreating on the same public land.

Overall, many Wisconsinites and tourists visiting Wisconsin are known for driving fairly long distances to recreate and sightsee all over Wisconsin. This analysis may be useful for people visiting Wisconsin to discover which area to stay around. It may also serve residents of Wisconsin deciding on where to live around the state or take a day trip too if a longer drive is not an option. This analysis overall shows a network of accessibility throughout the state but doesn't aim to solve any one problem associated with public land access throughout Wisconsin.

Future Research

This analysis assumes each individual has a vehicle to transport themselves to public land. Obviously, if one does not have a car, our metrics for accessibility are not accurate for this. Not having a car decreases accessibility because one would need to walk, bike, or bus in order to reach the public land.

In future research, one could focus on public land accessibility for a specific metropolitan area, and for this analysis, look at which areas within an urban area have public land accessibility via biking, walking, and bussing. Although we originally wished to include walking and biking paths in this study, many walking and biking paths to state-wide public land require a vehicle to access these paths, except for the metropolitan areas of Madison and Milwaukee. We believe that there is a difference in land accessibility for populated areas such as Madison and Milwaukee but looking at data on a state-wide basis does not give us an analysis for differences in accessibility between communities on a micro-scale. If we were to look at accessibility differences within one municipality, socioeconomic status might play a large role in regard to access. If we were to track which communities had access to an automotive vehicle and bus routes, we would likely get a clearer picture of who can access public land within a municipality. In conclusion, our research would be enhanced with a case study of a specific city to see the accessibility differences between micro-communities in Wisconsin municipalities.

References

Spatial Data:

WDNR: Open Data Portal

https://data-wi-dnr.opendata.arcgis.com/

WI State Cartographer's Office: GeoData@Wisconsin

https://geodata.wisc.edu/

ESRI: Federal Land Data and WI Roads Data

https://www.arcgis.com/home/item.html?id=5e92f2e0930848faa40480bcb4fdc44e

Demographic Information: 2020 Census

https://www.census.gov/library/stories/state-by-state/wisconsin-population-change-between-census-decade.html

Municipal Boundary Data

https://www.census.gov/geographies/mapping-files/time-series/geo/carto-boundary-file.html

Ice Age Trail Photo

Credit: *Joseph Rosnow*