Locational Hospital Accessibility and the role of the Federally Recognized American Indian Reservation within Washington State

A RESEARCH REPORT

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Disclaimer

Availability of Dataset

The GIS data that support the findings of this study are available in the Montana State University Library database with the identifier [http://doi.org/] [Reference number].

Acknowledgement

This research was supported by the Small Urban Rural Tribal Center on Mobility (SURTCOM) a Tier 1 University Transportation Center funded by the U.S. Department of Transportation. Federal grant number: 69A3551747122.

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1.1 Access to Hospitals

Health disparities among both rural and American Indian (AI) populations have been well documented (Jones, 2006) with both communities seeing significantly lower health outcomes than urban populations (Indian Health Service, 2017; Meit, Knudson, Gilbert, Tzy-Chyi Yu, Tanenbaum, Ormson, Popat, 2014). One of the possible factors that may affect these negative health outcomes is limited access to healthcare resources.

Though a significant percentage of American Indians reside in urban areas (Dewees, Marks, 2017), it may be that these health disparities are due to the rural nature of many tribal lands, with rural AI being subject to diminished health disparities and outcomes (Holm, Vogeltanz-Holm, Poltavski, & McDonald, 2010). In this study, the role of access to healthcare is examined from the perspective of locational access, which is executed by obtaining and comparing distances and drive times to the nearest hospitals from tax parcels located in rural non-reservation, rural reservation, urban non-reservation, urban reservation, and small-towns within Washington State.

Hospitals are an effective indicator of healthcare for a number of reasons, including their ability to provide specialty services for observed and documented chronic health disparities in rural and AI populations, and the universal need for emergency medical care. Like AI populations, rural non-AI populations face similar health disparities (Eberhardt & Pamuk, 2004), which suggests that there may be a relationship between negative health outcomes and rurality. Rural areas are characterized by reducedaccess to a wide range of resources (Jones, López-Carr, Dalal, 2013) and this reduced access likely plays a role in the greater health disparities of both rural and AI populations.

1.2 Problem Statement

As stated, there are health disparities that affect both AI population and rural populations disproportionally (Eberhardt & Pamuk, 2004). This study explores the relationship between rurality and locational access to healthcare resources, as well as the differences in locational accessibility between tribal and non-tribal lands.

Measuring locational accessibility can support efforts to reduce the observed health disparities, as well as, assist in proper mitigation of health planning and resource distribution. The results of this study could possibly help not only rural and AI populations in Washington State, but could potentially impact the health of rural and AI populations across the United States.

1.3 Purpose of Study

This research seeks to more clearly identify areas of limited accessibility to hospital resources within Washington State, as well as, gain an understanding of where these areas of limited access are, in the context of rural or urban and tribal or non-tribal. Although other studies have examined the relationship between healthcare access and outcomes (Wonderly, 2017), one of the major deficiencies of their research involves the amount of raw data available for American Indian Reservations and rural areas. Rural areas tend to have less centralized populations (Health Resources & Services Administration, 2018) which creates greater variation in distances between resources and the population in which they are attempting to serve.

Although the concept of access has been explored in depth by many scholars who have concluded that it is a multidimensional concept (Penchansky & Thomas, 1981; Ribot & Peluso, 2003; Bernard, Charafeddine, Froholich, Daniel, Kestens, Potvin, 2007), having an

understanding of the locational dimension of accessibility, specifically for hospitals, and its relationship to the identified vulnerable communities might possibly help provide a clearer picture of whether or not being located further away from healthcare resources is a major factor in the presence of observed health disparities.

2.0 Literature Review

This chapter provides a review of the existing literature as it relates to rural and American Indian healthcare accessibility including: (a) an overview of the concept of access; (b) case studies relating to healthcare accessibility in both rural and Al communities; (c) literature relating to distance as a measure of accessibility, (d) an overview of healthcare utilization in rural and AI communities, and (e) and explanation of Medically Underserved Areas.

2.1 Defining Access

Definitions of access have been attempted by multiple scholars (Ribot & Peluso, 2003; Bernard et. al, 2007) including Penchansky and Thomas (1981), who define access as: "representing the degree of fit between the clients and the system".

This is contrary to Bernard et. al (2007) who created a set of rules to assist in the determination of neighborhood resources. Penchansky and Thomas's (1981) dimensions of access consist of availability, accessibility, accommodation, affordability, and acceptability. Availability describes the relationship between volumes and the types of existing services; for example, the number of cardiologists located in a small-town. Accessibility describes the relationship between the location of the supply and the location of the clients. Such as a cardiologist located five hours away from a farmer's house. Accommodation considers the ways in which the supply of resources is organized to accept clients. For example, how soon

can the farmer schedule an appointment with the cardiologist, within a week or longer than a month? The dimension of affordability is self-evident. It describes the relationship between the cost of services, in relation to a client's income.

Contrary to Penchansky and Thomas's dimensions of accessibility, Bernard et al. (2007) have created a set of rules to help define access: (1) proximity, (2) prices, (3) rights, and (4) informal reciprocity. These four rules provide the basis for the five specific domains that can be used in assessing the accessibility to resources for a specific group of people, or neighborhood. These domains are: physical, economic, institutional, local sociability, and community organization. The rule of proximity relates to the physical domain, meaning the concept of proximity is a real-world issue that can be quantified, which is similar to Penchansky and Thomas', (1981) dimensions of availability and accessibility, while the other rules (prices, rights, and informal reciprocity) exist within the other four domains, which can be grouped together in a more general term as the social environment, which means that they exist within the sociological makeup of the community.

The dimension-based definition of access proposed by Penchansky and Thomas implies that multiple factors need to be taken into account when attempted to examine accessibility to resources, in this instance, healthcare. This dimensional concept of access reinforces the importance of this issue, and why is critical when attempting to remedy the health disparities seen in American Indian populations. Given these challenges, building more hospitals and preventative health clinics is probably not going to be sufficient in fixing these health issues in American Indian and rural communities.

The major theme observed in both of these definitions of access is that accessibility has both a physical and social component.

2.2 Health Disparities in Rural American Indian Communities

In a survey of American Indians residing in the Northern Plains area of North Dakota, participants showed a significantly higher prevalence of diabetes, coronary heart disease, myocardial infarction, smoking, obesity, and heavy alcohol use compared to the national sample (Holm et al., 2010). Holm et al. recommend improved access to healthcare, better preventative screenings, and culturally appropriate community-based health care programs as possible ways to reduce health disparities. The AIs who participated in this survey made it a point to reinforce the need for culturally appropriate community-based healthcare programs, which relates back to Penchansky and Thomas' dimension of acceptability and Bernard et al.'s rules of rights (Penchansky & Thomas, 1981; Bernard et al., 2007). As noted in Holm el al.'s article, the need for culturally appropriate community-based healthcare programs is a concept that is very important to American Indian communities and creates a unique barrier in providing healthcare options to AI communities. This social dimension of healthcare accessibility presents the idea of quality over quantity. Just because there is a hospital within a hundred miles of a reservation, does not mean that the services provided by that hospital are the services that are required by the reservation community, or that those services are sensitive to the cultural needs of said community. This idea of culturally sensitive services is a very important aspect of accessibility for American Indians living in rural regions.

2.3 Distance as a Barrier to Treatment

Distance is the first major conceptual barrier when one thinks of limited accessibility. Buzza, Ono, Turvey, Wittrock, Noble, Reddy, and Reisinger (2011) examined accessibility as a form of distance. Buzza et al. argue that that distance is the most important barrier to rural

populations seeking healthcare. Their article states that distance remains a significant barrier as related to three specific factors: (1) patients with limited health, functional, or financial restrains; (2) for routine, specialty, and diagnostic services; and (3) emergencies. This implies that distance is an important factor for healthcare in rural and isolated areas but is not a comprehensive explanation for these health disparities, which reinforces the multi-dimensional approach to access taken by Penchansky and Thomas (1981) and Bernard et al. (2007). Buzza et al's study was conducted in a rural community but was not in an American Indian community. The findings of this study suggest that the importance of culturally appropriate community-based healthcare programs, as seen in (Holm et al., 2010), might be an attribute of the healthcare system that is more important specifically to AI communities, as oppose to, rural communities are a whole.

2.4 Healthcare Utilization and Access

One of the major factors of healthcare accessibility in rural areas is the amount that the current healthcare infrastructure is utilized. According to Arcury, Gesler, Preisser, Sherman, Spencer, and Perin (2005) there are several major contributing factors to healthcare utilization in the rural context, including having a driver's license, use of provided rides, and distance for regular care. Using the model presented in the study, other factors, such as predisposing conditions like: age, gender, ethnicity, household income, and need (physical and mental health measures, number of conditions), also played a role in utilization of services. The findings of this article are very similar to those in Buzza et al. (2011). An emphasis is placed on the importance of distance as a primary contributor to access in rural regions of the United States. This again reinforces Penchansky and Thomas' (1981) availability and accessibility dimensions of access, as well as the rule of proximity, as presented by (Bernard et al., 2007). This study brings

attention to the role that mobility plays in rural healthcare access. It is almost impossible for a resident of a rural area to have adequate access to a range of resources, healthcare or otherwise, without access to a car and the ability to drive. The problem is that the populations who live in rural American Indian Reservations tend to have lower incomes than the rest of the country(Kaufman, Dicken, and Williams, 2014), and tend to have higher elderly populations with mobility issues. Since these populations are so vulnerable there should be an emphasis placed on the availability of well-planned and maintained tribal transit systems. Currently, tribal transit programs exist on an inconsistent basis throughout rural American Indian Reservations (National Congress of American Indians, 2013). Funding tribal transit programs, and road improvement measures on and around American Indian Reservations, might not only have the obvious impacts on improving mobility, and reducing environmentally related accidents, but it may also lead to more positive health outcomes due to the increased mobility of the populations in which these improvements exist.

2.5 Medically Underserved Areas

The most prominent method for classifying areas of limited healthcare access is by identifying an area as either a "Medically Underserved Area" or identifying a group as a "Medically Underserved Population". A Medically Underserved Area (MUA) is defined as "an area with a lack of access to primary healthcare services" and can exist on several geographic scales, including: a whole county, a group of neighboring counties, a group of urban census tracts, or a group of county or civil divisions (Health Resources & Services Administration, 2016). This is opposed to Medically Underserved Populations (MUP), which are defined as "specific subgroups of people living in a defined geographic area with a shortage of primary healthcare services" (Health Resources & Services Administration, 2016).

The process for designating an area as Medically Underserved Area takes into account several indicators, including: providers per 1,000 population ratio; percent population at 100% of the Federal Poverty Level; percent population age 65 years and over; and infant mortality rate (Health Resources & Services Administration, 2016). The fact that percent population age 65 years and over is taken into account within the designation process is curious and may be present due to a number of factors, including: age 65 being the qualifying age for Medicare coverage, mobility challenges, or the general increasing medical concerns of senior citizens.

The process for identifying a Medically Underserved Population is a little more involved and requires a specific recommendation from either the governor or State Primary Care Offices, followed by a detailed application process as to why the population in question should be identified as a Medically Underserved Population (Health Resources & Services Administration, 2016).

In Washington State, the process of identifying both MUA and MUPs has been taken up by the Washington State Department of Health (WSDOH). Areas identified as MUAs by the WSDOH include the entire counties of: Pend Oreille, Ferry, Okanogan, Douglas, Grant, Franklin, Columbia, Asotin, Yakima, Pierce, and Pacific. There are also portions of Stevens, Spokane, Lincoln, Adams, Island, Snohomish, King, Kitsap, Thurston, Mason, Clallam, Jefferson, Grays Harbor, Cowlitz, and Clark Counties that contain areas that have been identified as MUAs by the WSDOH (Washington State Department of Health, 2018). Areas that have been identified as containing MUPs in Washington State include portions of Spokane, Whatcom, San Juan, Clallam, Kitsap, King, and Thurston Counties, while the entirety of Kittitas, Lewis, and Klickitat Counties has also been identified as containing MUPs.

This research furthers the advancement of the identification of medically vulnerable areas by shrinking the scale in which the identification process is taking place from the county and census tract to the individual tax parcel.

2.6 Summary

Access is not the same or as simple as a measure of distance, but rather a multi-dimensional, theoretical concept that has been defined by multiple scholars, including Penchansky and Thomas (1981) and Bernard et al. (2007). These authors take in consideration the multiple factors, beyond distance, that affect one's ability to access healthcare. For American Indians who live on rural reservations there is a need for culturally appropriate community-based healthcare programs that cater to unique characteristics of American Indian culture, as noted in Holm et al. (2010). Even though access is a multi-dimensional concept, Buzza et al. (2011) argue that distance remains a pivotal factor in accessibility to healthcare resources in rural communities. Indeed, as suggested by Arcury et al. (2005) utilization of existing healthcare services in rural areas is important and may be impacted by the level of access to transportation resources, including cars and transit options, of the population. The literature examined in this study suggests that reduced access to resources plays a pivotal role in reduced rural American Indian healthcare utilization rates, which, in turn, may be one of the primary contributors to the health disparities displayed throughout both rural and American Indian populations.

3.0 Data Sources and Methodology

In this chapter, the individual data sources used within this study are identified, along with the specific Geographic Information Systems (GIS) tools used to produce both the drive times and distances from parcels to hospitals. This includes a database of hospitals within Washington State, a tax parcel database, a street network, and the tools used in the production of spatial data.

3.1 Data: Hospitals

A database of all 118 hospitals located in Washington State was obtained from the Washington State Department of Health's GIS data portal in September of 2018 (Washington State Department of Health, 2018). Seventeen of these hospitals were removed from the analysis thus decreasing the sample of hospitals to 101(see Figure 2: Hospitals (101 Used Within This Study)). Since military hospitals are not open to the public, eight hospitals were removed from the dataset including: The Jonathan M. Wainwright Memorial VA Medical Center (Walla Walla), Madigan Army Medical Center (Ft. Lewis), VA Puget Sound Health Care System (Tacoma), VA Puget Sound Health Care System (Seattle), Naval Hospital (Bremerton), US Air Force Hospital (Fairchild Airforce Base), Mann-Grandstaff VA Medical Center (Spokane), and Naval Hospital Oak Harbor (Oak Harbor). Nine additional hospitals were removed because they do not provide a range of services for the treatment of observed chronic conditions, these include: Lourdes Counseling Center (Richland), Cascade Behavioral Health (Tukwila), NAVOS Psychiatric Hospital (Seattle), Eastern State Hospital (Medical Lake), Kindred Hospital- First Hill (Seattle), St. Luke's Rehabilitation Institute (Spokane), Daybreak of Spokane (Spokane), Lakeside Milam Recovery Center (Kirkland), and Peacehealth Peace Island Medical Center (Friday Harbor).

3.2 Data: Tax Parcels

The *Washington State Parcel Database* (University of Washington, 2017) is a GIS dataset containing locational information on 3,110,282 tax parcels from 38 of the 39 counties in Washington State (see Figure 1: All Parcels in Washington State). Parcel data from Whitman County are not available in digital format. Also, not included in the dataset, are national parks, conservation areas, and military and other federally owned land. The analytical sample for this study consists of 482,078 tax parcels comprising all 73,060 parcels located within Federally recognized American Indian Reservations, all 253,915 located within Census defined small-towns, and a random sample of urban and rural non-reservation parcels (57,126 rural and 77,464 urban), (see Figure 5: Parcel Categories).

The 73,060 reservation parcels were designated though the usage of GIS, by executing a section query of parcels contained within the US Census designated American Indian/Alaska Native/Native Hawaiian Areas (US Census, 2018) (see Figure 3: American Indian Reservations). The small-town parcels were assigned by using the Census Designated Places (US Census, 2017) GIS layer and the US Census Urban Areas layer (US Census, 2016). Areas located in urban areas were removed, leaving only non-urban Census designated areas. The parcel database was then used in a selection query to only include the parcels located within the non-urban Census designated places. The urban and rural samples were obtained by executing a section query for parcels within the database that were located within the US Census Urban Areas layer, as well as, parcels located outside of the Census designated urban areas, which are defined as rural. These parcels were then assigned a random number through the usage of python coding, and a sample of each parcel group were removed from both the urban and rural datasets.

3.3 Data: Street Network

Street network data come from ESRI's *Street Map North America* dataset (ESRI, 2017). This dataset includes all major interstates, state highways, major roads, arterials, and streets located within the state of Washington (see Figure 4: Street Map North America).

3.4 Network Analyst

ESRI's ArcGIS 10.6 Network Analyst tool identifies the shortest distance between any two points located on a network. This tool was used to estimate distances and drive time measurements from individual tax parcels to the nearest hospitals. This tool allows the user to define the level of restriction places on the roadways, allowing for certain roads or turn types to be excluded while the analysis is being performed. The possible road restrictions include: four-wheel drive roads, alleys, ferries, one-way roads, pedestrian ferries, pedestrian walkways, toll roads, and turn restrictions. For the purposes of this project none of the restrictions were used.

First, ArcMap was used identify the centroids within each tax parcel. The Network Analyst tool then connected those centroids to the closest hospital along the *Street Map North America* network. The network location search tolerance was set to 5,280 feet to compensate for the longer distances from parcel centers to the street network for larger parcels. Because larger parcels have centroids further removed from the street network, this number was chosen based on the U.S. Land Ordinance Survey of 1785 which originally divided the western half of the United States into square-mile parcels.

The OD Cost Matrix analysis tool, which was the specific network analysis type used within this study, performs a network analysis from a set of origins (tax parcels), to each

individual destination. Using this method allows for the production of mass amounts of parcels to be ran through the Network Analysist at a time. Although, OD Cost Matrix analysis tool not produce accurate visible geographic results; e.g., a polyline of the route from origin to destination. The tool instead, provides network drives times and distances in the table format, as well as, a straight polyline depicting the starting point (tax parcel) and the ending point (hospital). Removing the production of the polyline data allowed for the processing of all 482,078 parcels to be completed in a reasonable amount of time. The OD Cost Matrix also provides a field entitled “Destination Rank”, which allows one to select the closest facility, with the Destination Rank of one. Overall, the OD Cost Matrix tool is a faster, and more efficient way of calculating network distances and drive times when work with large datasets, as was the case in this study.

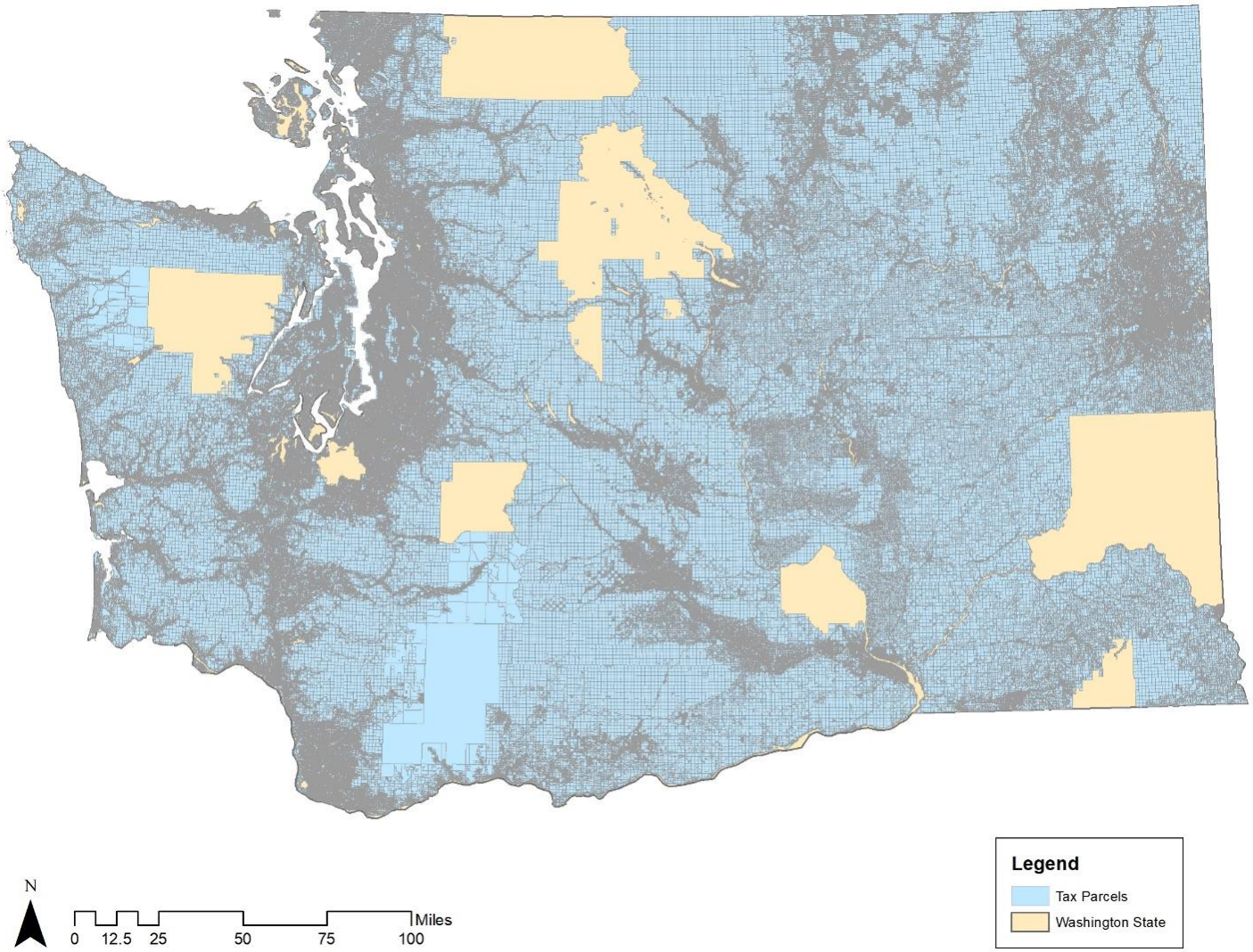

Figure 1: All Parcels in Washington State

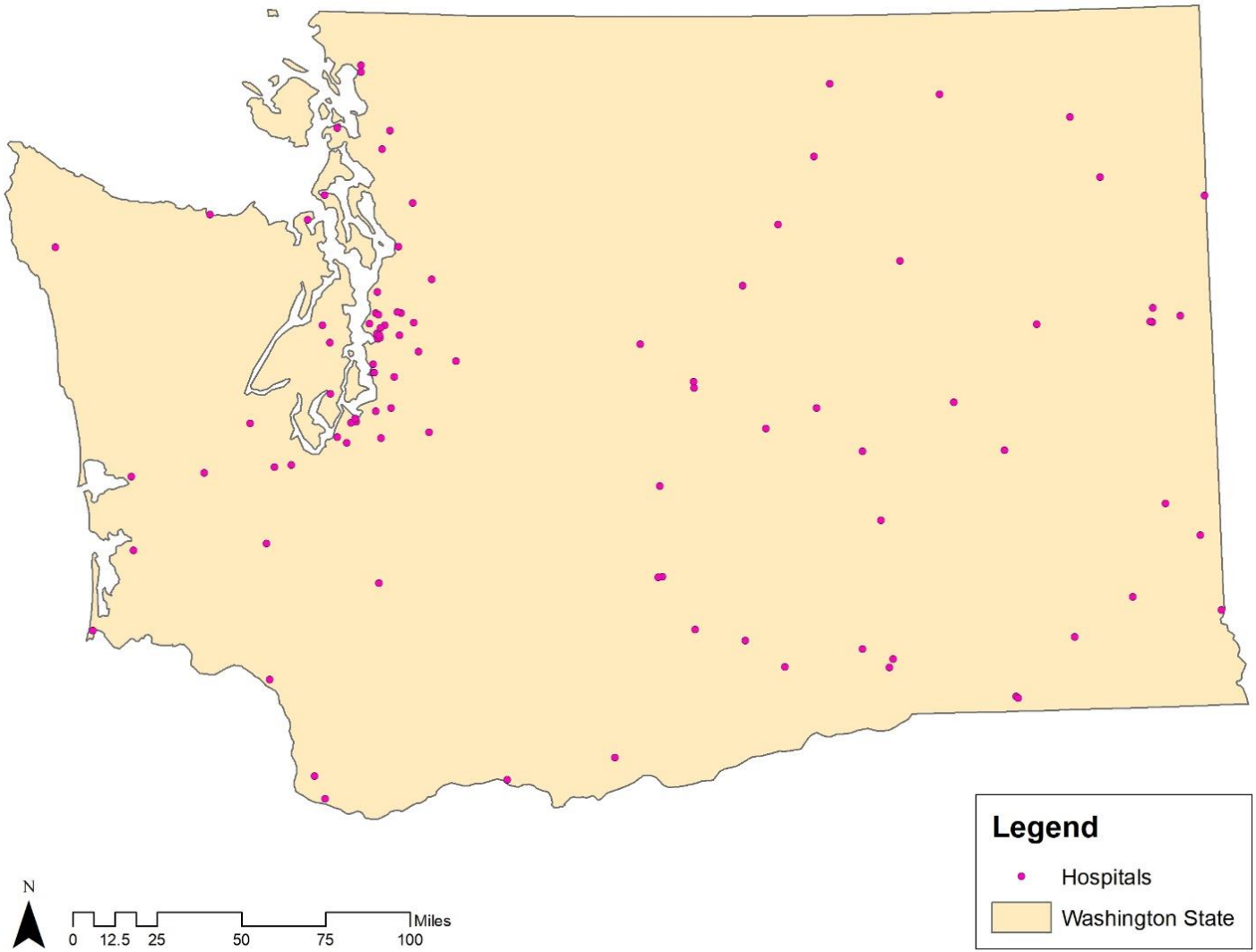

Figure 2: Hospitals (101 Used Within This Study)

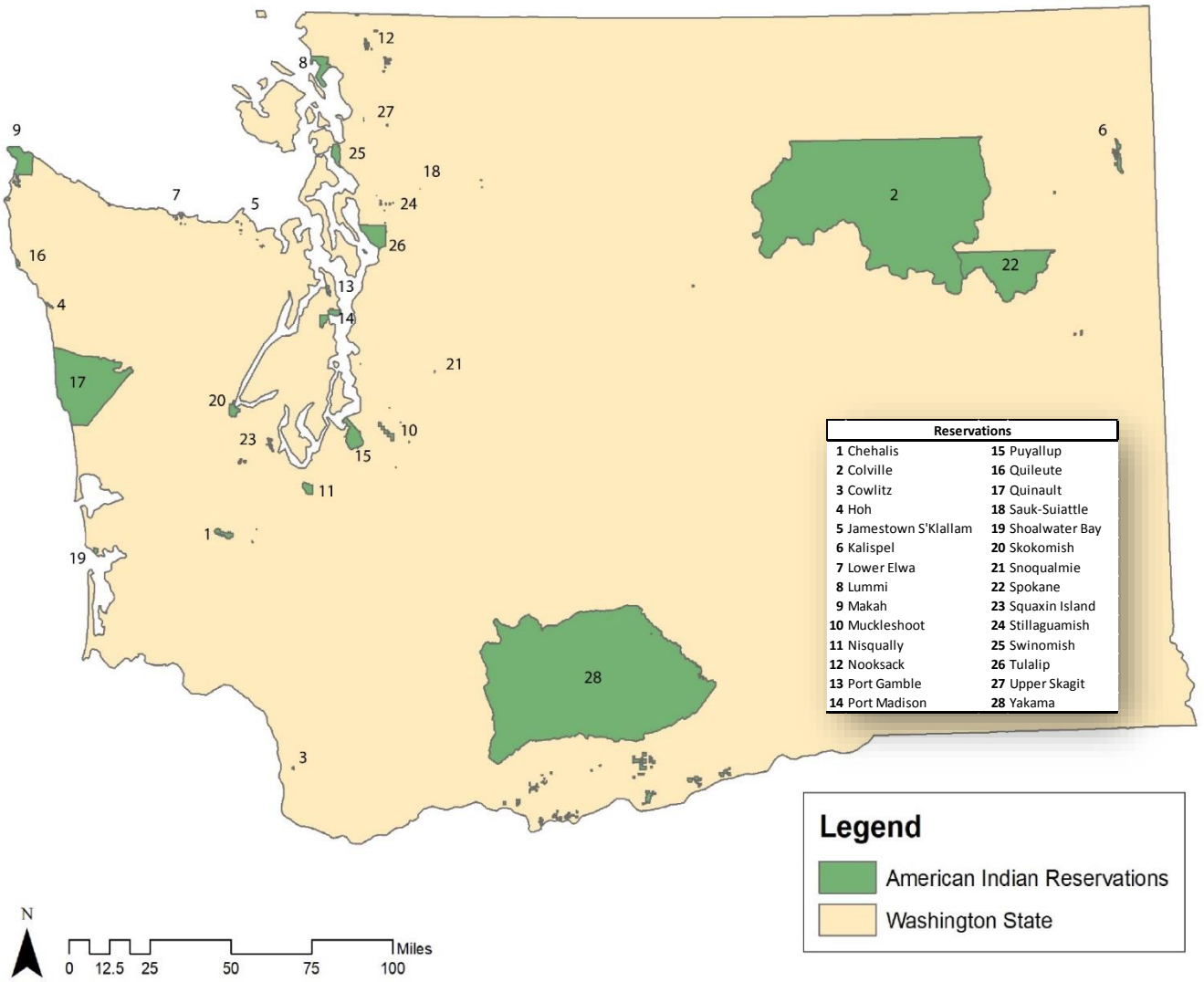

Figure 3: American Indian Reservations

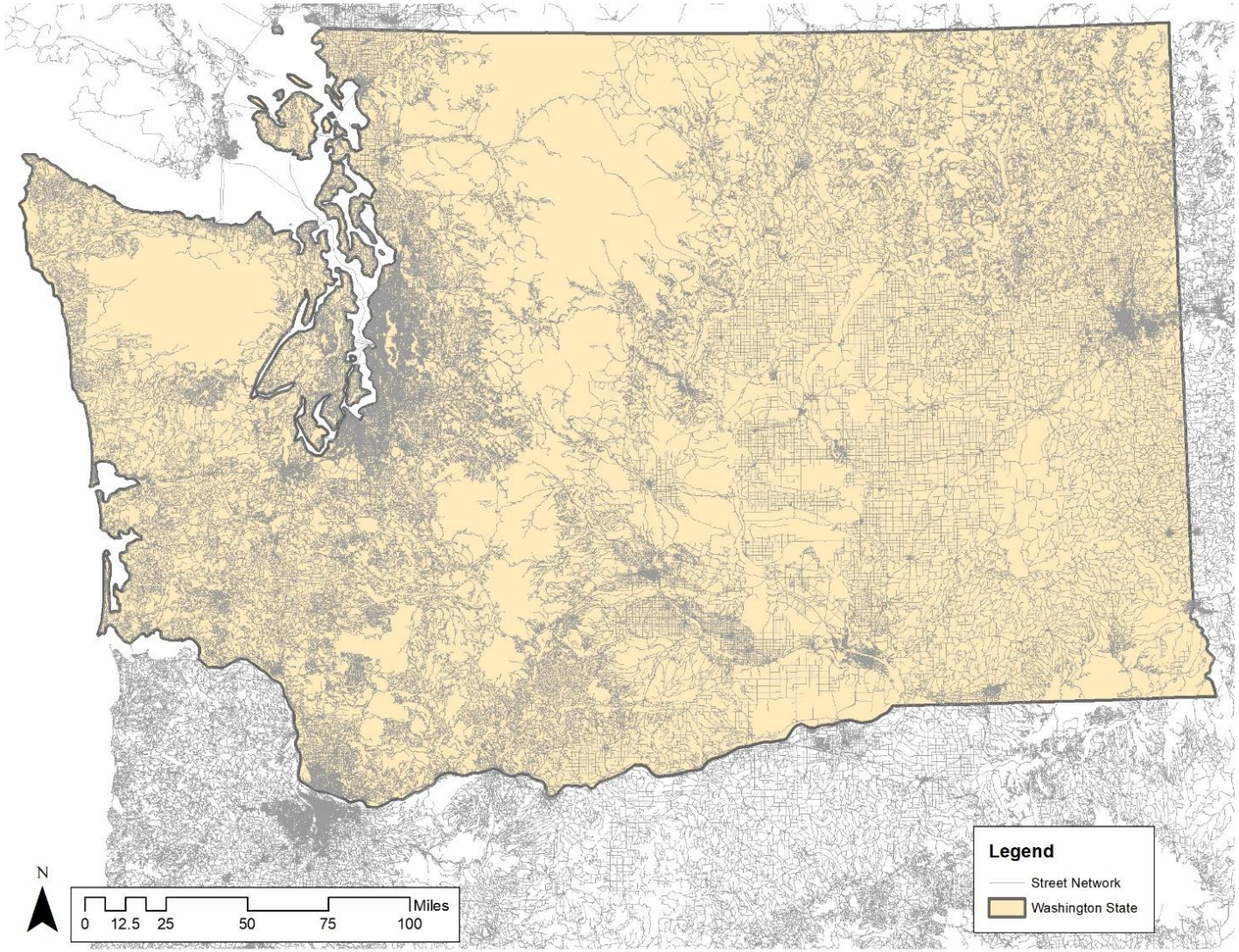

Figure 4: Street Map North America

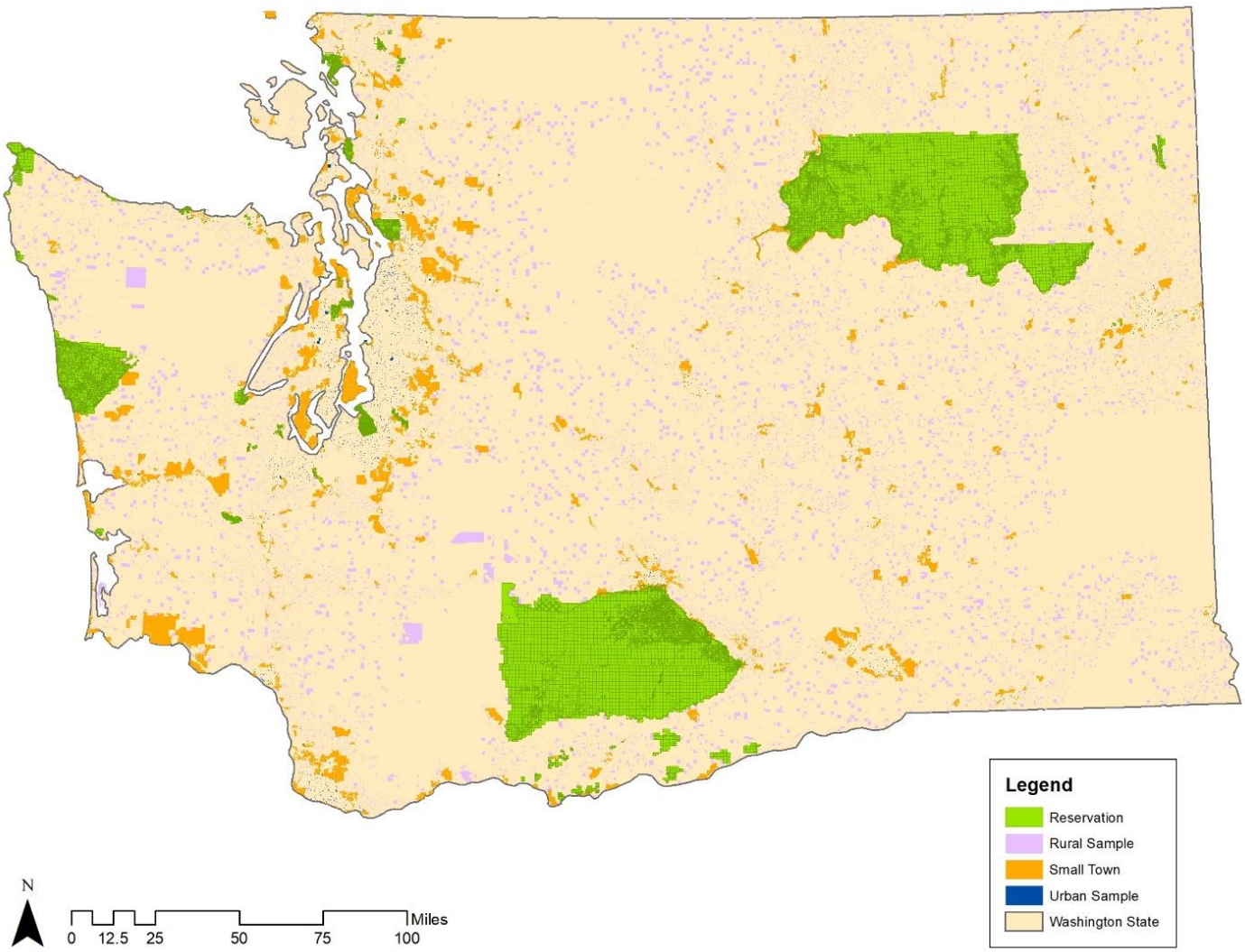

Figure 5: Parcel Categories

4.0 Results

This chapter provides a discussion of the descriptive statistics of the dataset including, a series of maps visualizing the results of the study. Also provided is a discussion of the dataset categorized by the interquartile range of the distance attribute, as well as, maps describing the individual parcel types.

4.1 Descriptive Statistics

This study calculated the network drive times in minutes and distances in miles to nearest hospitals for 461,565 individual tax parcels in Washington State. These parcels were classified into four parcel types: reservation parcels, small-town parcels, non-reservation-rural parcels, and non-reservation urban parcels. Representing 15.83% of the total 461,565 parcels in the dataset, there were 73,060 American Indian Reservation parcels. In addition, there were 253,915 small-town parcels (55.01%) and a sample of 57,126 non-reservation rural parcels (12.38%), and a sample of 77,464 non-reservation urban parcels (16.87%).

The minimum number for both minutes and miles was zero representing the 101 parcels with hospitals located on them The longest drive time was 499.48 minutes for a parcel in the rural sample, while the longest distance was 107.20 miles for a separate parcel also in the rural sample (see Table 1: Descriptive Statistics (Minutes) & Table 2: Descriptive Statistics (Miles)).

The mean drive times for the parcel types varied from 9.06 minutes (standard deviation= 7.17) for the urban sample, to 32.52 (standard deviation= 53.55) for the rural sample. The reservation parcels drive times had a mean of 26.23 (standard deviation= 26.64), small-town parcels had a mean of 29.61 (standard deviation= 36.05), with the overall mean of the entire dataset being 25.98 minutes (standard deviation= 35.38).

The mean distances had a low of 5.36 miles (standard deviation= 4.62) for the urban sample parcels, and a high of 16.50 (standard deviation= 10.74) for the rural sample parcels. The reservation parcels had a mean drive time of 14.74 miles (standard deviation= 13.59), the small-town parcels mean distance was 15.18 (standard deviation= 10.37), and the dataset as a whole had a mean drive time of 10.96 miles (standard deviation= 11.16).

The median drive times for all parcel types were shorter than their corresponding averages. The urban parcels had the lowest median with 7.48 minutes (interquartile range= 7.34), while rural parcels had the highest median at 24.53 minutes (interquartile range= 21.21). This was followed closely by the small-town parcels with a median drive time of 23.70 (interquartile range= 25.47) and the reservation parcels with a median of 18.03 (interquartile range= 19.82). The median drive time of the entire dataset was 18.57 minutes (interquartile range= 24.92).

The median distances for all parcel types were also shorter than their averages. The urban parcels had the shortest distances with a median of 4.23 miles (interquartile range= 4.48), while the rural parcels had the longest (14.45 miles, interquartile range= 13.08). This, again, was followed very closely by the small-town parcels with a median distance of 14.03 miles (interquartile range= 19.92) and the reservation parcels with a median of 10.51 miles (interquartile range= 11.84). The median distance for the entire dataset was 11.16 miles (interquartile range= 11.16).

4.2 Data Categorized by Interquartile Range

As evidenced by the differences between medians and means discussed above, the distributions of both miles and minutes to nearest hospital were positively skewed. At this point, it was determined that the dataset should be categorized based on distances, as opposed to drive times, for reasons that are discussed in the limitation section of this report, including significant

inflation of drive times due to unreliable ferry travel times for certain areas located within Puget Sound. Because this study is exploratory, Tukey's fences (Tukey, 1977) were used to identify outliers rather than the more common practice of selecting all observations greater than three times the standard deviation (see Figure 6: Box and Whisker Plot). Tukey's fences were assumed to be less conservation than using standard deviations. Tukey fences uses the formula Q1 - 1.5 x IQR and Q3 + 1.5 x IQR to identify the upper and lower limits for outliers within the data based on dividing the data into quartiles. In this formula, Q1 represents the middle value between the smallest number in the dataset and the median of the dataset, and Q3 represents the middle value between the largest number and the median within the dataset. IQR, or interquartile range, is the difference between the Q1 and Q3, and describes the variability of the dataset. Any number higher or lower than the Tukey's fences is deemed an outlier. Using this method, it was determined that 14,690 parcels were outliers (see Table 3: Parcel Types by Interquartile Range Group). Using the Tukey's fences method, as opposed to the traditional mean based method, identified an additional 6,198 tax parcels as outliers.

4.2.1 Data Below the Interquartile Range (Q1 - 1.5 x IQR)

The first group of data comprised parcels whose distances were below the 25% quartile. Since this dataset contains no lower outliers, this group contains 25% of the entire dataset, which amounts to 115,391 parcels (see Table 4: Interquartile Range Groups Descriptive Statistics, Figure 10: Parcels within the Lower Whisker & Figure 11: Lower Whisker Parcel Categories). Of those parcels, 17,878 were reservation parcels, 5,698 were from the rural sample, 45,755 were small-town parcels, and 46,060 were from the urban sample. Since the rural sample, urban sample, and reservation datasets had significantly less parcels than the small-town dataset, it was determined that the best way to describe each parcel type's (reservation, small-town, rural

sample, and urban sample) representation with each parcel grouping (lower whisker, IQR, upper whisker, and outliers) was to obtain the percentage of each parcel type present within each group in reference to its total size. Using this method to determine the representation of each parcel type within the group, the results were: 9.97% of the total rural sample was represented, with 18.02% of small-town parcels, 24.47% of reservation parcels, and 59.46% of the urban sample also being represented.

The largest data type represented within the lower whisker is the urban sample parcel group. Spatially, the urban sample parcels tend to be within the city centers of the state's major metropolitan areas, including: Seattle, Tacoma, Olympia, Spokane, Moses Lake, the Tri-Cities, Walla Walla, South Bend, Aberdeen, Longview, Vancouver, Bellingham, and Arlington.

The reservation parcels within the lower whisker seem to be highly clustered in only a handful of Reservations, including the Yakama Reservation, where the parcels are clustered around eastern portion of its boundaries, as well as, along the major highway that runs through the Reservation. This is expected, due to the fact that the Yakama Reservation is the only Reservation within the state that has a hospital location within its boundaries. Other Reservations of note are located within urban areas in western Washington, including the Puyallup Reservation and portions of Muckleshoot and Tulalip. There is also a cluster of parcels on the Colville Reservation near Omak.

The small-town parcels found within the lower whisker tend to be clustered within the west side of the state in areas that tend to be located along major highways and outside of the major mountain regions (Cascade and Olympic). Some areas of note include: Arlington, Monroe, Gold Bar, Silverton, Port Townsend, Elma, Aberdeen, Hoquiam, and South Bend. On the east side of the state, the parcels tend to be located within suburban clusters, including areas around:

Walla Walla, Kennewick, Sunnyside, Moses Lake, Ephrata, Wenatchee, and Chelan. There also seems to be a relationship between major highways and east side parcels located within the lower whisker.

The last set of parcels within the lower whisker are the rural sample parcels. This parcel type is the least represented parcel type within this group. These parcels also seem to have a relationship with major roads within the state and exist outside of small-town and urban areas including areas around: Davenport, Ritzville, Brewster, Chewelah, Colville, Mt. Vernon, Monroe, Port Angles, Forks, Elma, Centralia, Enumclaw, Goldendale, and Prosser.

4.2.2 Data within the Interquartile Range (IQR)

The interquartile range accounts for 50% of the entire dataset. After isolating the individual data groups, there were 230,782 parcels that fit within the IQR for distance. Of these parcels, 39,123 were reservation parcels, 34,042 were parcels from the rural sample, 127,867 were small-town parcels, and 29,750 were parcels from the urban sample, (see Table 4: Interquartile Range Groups Descriptive Statistics, Figure 8: Parcels within the Interquartile Range & Figure 9: Interquartile Range Parcel Categories). Using the same method as was used in determining representation in the lower whisker, it was determined that the IQR group also represented 59.59% of the rural sample, 50.36% of the small-town parcels, 38.40% of the urban parcels, and, as stated, 50% of the total parcel dataset.

This data group contains more parcels that any other parcel grouping, with most of the data types being represented at around 50%, with slight variations in the rural and urban samples. The reason the rural sample is slightly over represented, and the urban sample is underrepresented is because of the massive amounts of urban sample parcels that fall within the

lower whisker data group, due to majority of urban samples distances to hospitals generally being significantly shorter, when compared to the other three parcel types.

Spatially, the parcels that fell within the IQR for distance seemed to be distributed in many different areas throughout the state. The reservation parcel types saw high representation on the following Reservations: Lummi, Nooksack, Swinomish, Tulalip, Lower Elwa, Port Madison, Skokomish, Chehalis, eastern portions of the Yakama Reservation, western portions of the Colville Reservation, and northeastern portions of the Spokane Reservation. In general, the majority of the reservation parcels within the IQR group were located within Puget Sound and along the interior coast of Washington State.

The rural sample parcels that fell within the IQR were not necessarily centralized in a specific area, but more interspersed throughout the state. There is some centralization on the outskirts of metropolitan areas in places like: Puget Sound, Spokane, Longview, and Vancouver. There was an absence of parcels within the Cascade Mountain region, and some minimal clustering of parcels close to major roads within rural areas.

The small-town parcels within the IQR tended to be more clustered as opposed to interspersed throughout the state. There were high concentrations of parcels located in the areas between the Cascade Mountain region and Puget Sound, as well as, the interior Olympic Peninsula. Some other areas of note include the surrounding areas around the Tri-Cities (Kennewick, Richland, and Pasco), Spokane, and Vancouver. In general, the small-town parcels appear to heavily feature parcels that can be described as “suburban”.

Lastly, the urban sample parcels within the IQR tended to be more spread out, and less condensed within urban areas of the state. These parcels existed within the major metropolitan

areas of the state including: Seattle, Tacoma, Olympia, and Spokane, but usually not around the city center. These parcels could be described also as borderline suburban.

4.2.3 Data Above the Interquartile Range (Q3 + 1.5 x IQR)

The third data grouping, or the upper whisker, exists about the 75% quartile (Q3) and was not determined to be an outlier (see Table 4: Interquartile Range Groups Descriptive Statistics, Figure 12: Parcels within the Upper Whisker & Figure 13: Upper Whisker Parcel Categories). The upper whisker, in theory should contain 25% of the dataset, but since outliers are present, this group contain a total of 100,702 parcel which is 21.82% of the total dataset. The largest parcel type represented within this group were the small-town parcels at 28.77%. The next largest parcel group being represented were the rural sample parcels at 27.09%. Other parcel types in this group include: 14.40% of reservation parcels and 2.17% of urban parcels.

Spatially, the small-town parcels tend to be highly clustered and exist in various areas of the state. There are several clusters of coastal communities on the western shore of the Olympic Peninsula including: Pacific Beach, Copalis Beach, and Westport. There are also a several communities along the Columbia River on the southern edge of the state including: Roseburg, Skamokawa, Cathlamet, Amboy, Carson, and Stevenson. There are several communities located within the Puget Sound area including: Blyn, Quilcene, Port Landlow, Hansville, and Cameno. The last major clusters of parcels in the upper whisker are found along the major highways within the Cascade Mountain region. These areas include: Snoqualmie Pass, Cle Elem, Sultan, Gold Bar, Baring, and Skykomish. There are also several communities throughout the east side of the state that tend to be located along state highways, as opposed to interstates, and tend to be located further away from urban centers that parcels within the lower whisker.

The rural sample parcels are only slightly less represented than the small-town parcels within the upper whisker. The rural sample parcels exist periodically throughout the state, but have clusters along the Cascade mountain region, the Olympic Peninsula, and the Okanogan National Forrest. The spatial dispersion seems to have an inverse relationship to urban and suburban areas, as well as, being located further away from major interstates and highways. There seems to be clusters of parcels located just outside of the Yakama and Spokane Reservations, and also throughout large areas of central Washington.

The next parcel type that is most represented within the upper whisker are the reservation parcels. These parcels tend to be located within the larger more rural Reservations, including: Colville, Spokane, Kalispel, western portions of Yakama, Quinault, southern areas of the Makah Reservation, Port Gamble, Squaxin Island, and the eastern portion of the Port Madison Reservation.

The last parcel type within the upper whisker are the urban sample parcels. These parcels are extremely limited with only 2.14% of the entire urban sample being represented. All of these parcels are located within western Washington and exist within smaller urban areas including: Ocean Shores, Bainbridge Island, and Blaine.

4.2.4 Data Outliers

The last data group created were the outliers. These parcels exist beyond the upper whisker (Q3 + 1.5 x IQR). Representing 3.18% of the total data set, this data group contains 14,690 parcels (see Table 4: Interquartile Range Groups Descriptive Statistics, Figure 14: Parcels Classified as Outliers & Figure 15: Outlier Parcel Categories). The reservation parcel type is the most represented group in the outliers with 7.58% of the total reservation parcels

present. Other parcel types represented within this group include: 3.35% of the total rural sample, 2.85% of all small-town parcels, and zero urban sample parcels.

The outlier group may be the smallest of the four data groups but may be the most important in understanding where the most isolated areas of the state are located. The parcel type with the largest representation within the outlier group are reservation parcels. Spatially, the outlier reservation parcels tend to be found exclusively on larger, more rural reservations. These areas include large sections of both the Quinault and Makah Reservations in western Washington, as well as, large areas of the western portion of the Yakama Reservation, western Spokane, eastern Colville, and northern Kalispel in eastern Washington.

After the reservation outliers, the representation of the other three parcel types is less prominent. The next highest represented parcel type is from the rural sample parcels. The rural sample outliers tend to be semi-clustered in areas that one would assume to be difficult to reach. These areas include: the central Cascade mountain region, the area surrounding Mt. St. Helens, areas around Metaline Falls and the Colville National Forest, areas outside of Yakima near the Hanford Site, as well as, areas that tend to be located around the larger rural reservations including the Spokane, Colville, and Quinault Reservations.

Among the urban sample there are no parcels identified as outliers. The small-town parcels tend to be clustered within areas that exist further away from both interstate and state highways. One area of note is Point Roberts, which is an area in the most northern portion of Washington State, and is surround by ocean to the south, east and west, and Canada to the north. This area may have special access to hospitals located within Canada and should be viewed as an exception within this context. Port Roberts makes up 54% of the small-town parcels that have been identified as outliers, which makes the small-town parcels prevalence within the outlier

group less that it appears at first viewing. The remainder of small-town parcels that exist within the outlier group are mostly found in: Marblemount, Winthrop, Metaline, Metaline Falls, Easton, Mattawa, Altoona, Dahlia, northern Bonneville, Roosevelt, and Kahlotus.

Table 1 Descriptive Statistics (Minutes)

Parcel Type	*n*	*%*	*Min*	*Median*	*IQR*	*St. Dev*	*Mean*	*Max*
Reservation	73,060	15.83%	0.05	18.02	19.81	24.82	26.01	262.73
Rural Sample	57,126	12.38%	0.00	24.47	21.12	33.01	30.42	499.48
Small Town	253,915	55.01%	0.00	23.70	25.44	35.49	29.44	446.20
Urban Sample	77,464	16.78%	0.02	7.48	7.34	7.17	9.06	88.97
Total	461,565	100.00%	0.00	18.55	24.87	31.48	25.59	499.48

Table 2: Descriptive Statistics (Miles)

Parcel Type	*n*	*%*	*Min*	*Median*	*IQR*	*St. Dev*	*Mean*	*Max*
Reservation	73,060	15.83%	0.02	10.51	11.84	13.59	14.74	76.34
Rural Sample	57,126	12.38%	0.00	14.45	13.08	10.74	16.50	107.20
Small Town	253,915	55.01%	0.00	14.03	19.92	10.37	15.18	54.07
Urban Sample	77,464	16.78%	0.01	4.23	4.48	4.62	5.36	39.76
Total	461,565	100.00%	0.00	11.16	14.64	10.96	13.63	107.20

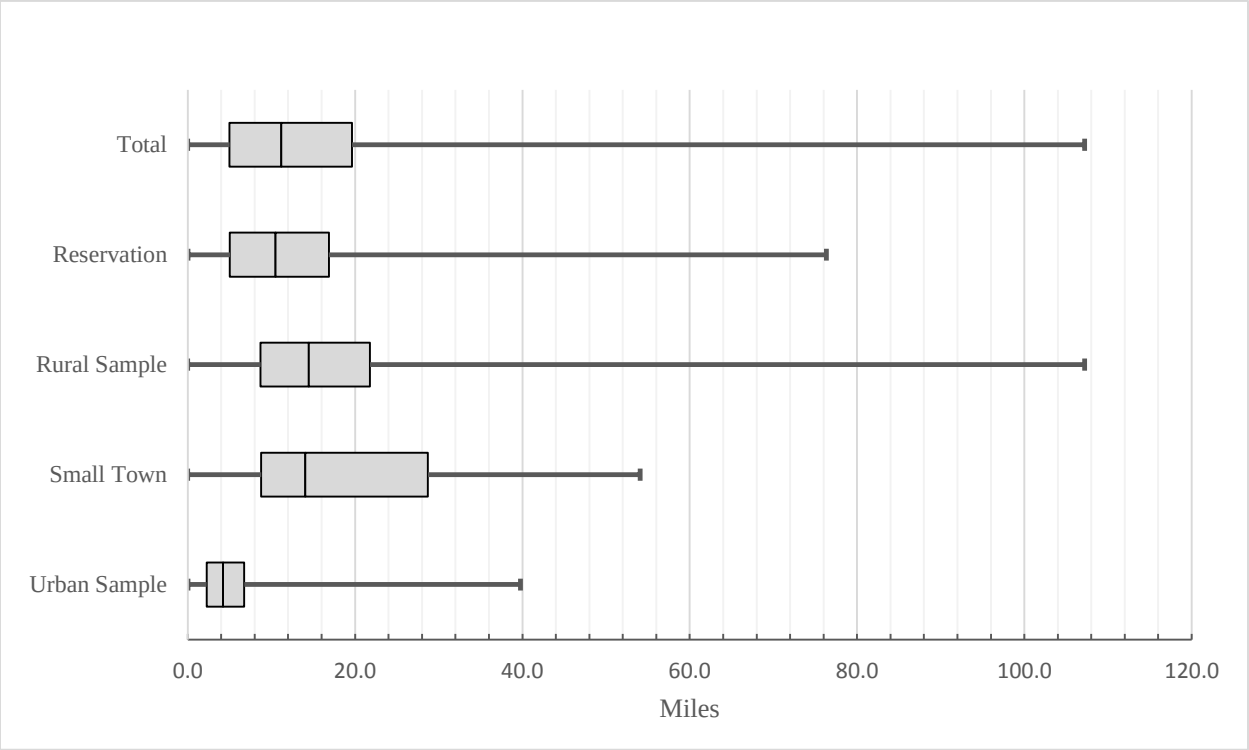

Figure 6: Box and Whisker Plot

*

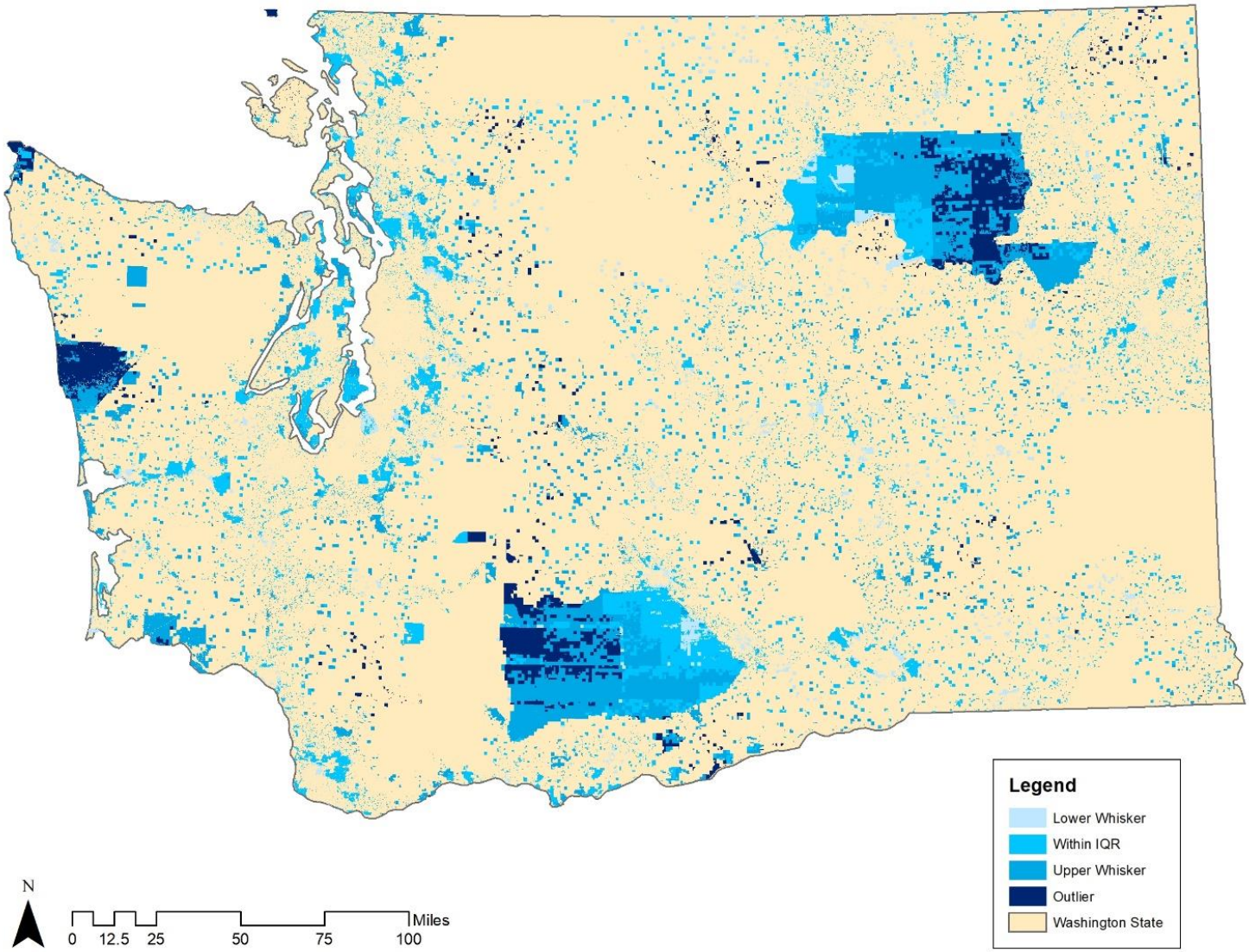

Figure 7: Parcels by Interquartile Range Grouping

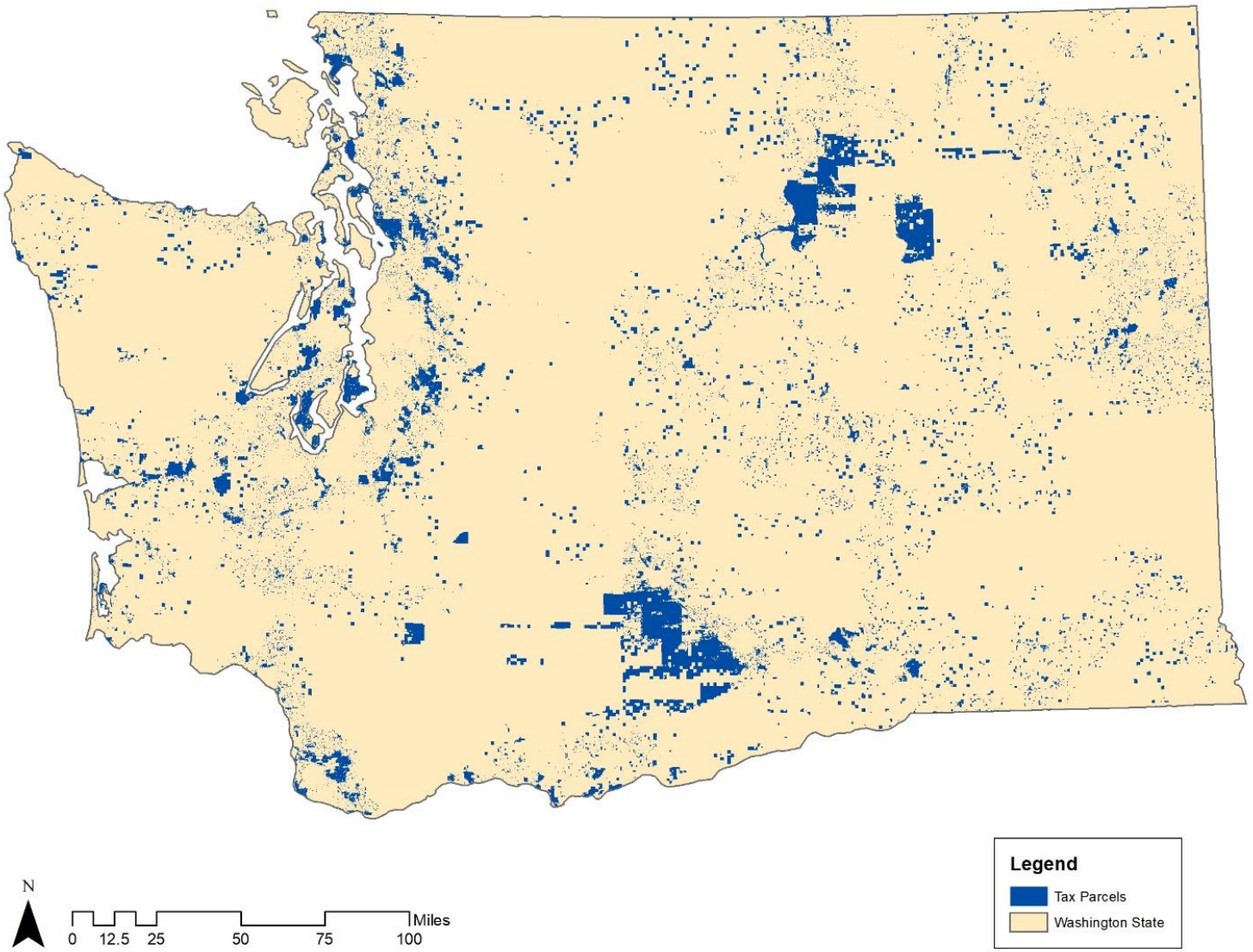

Figure 8: Parcels within the Interquartile Range

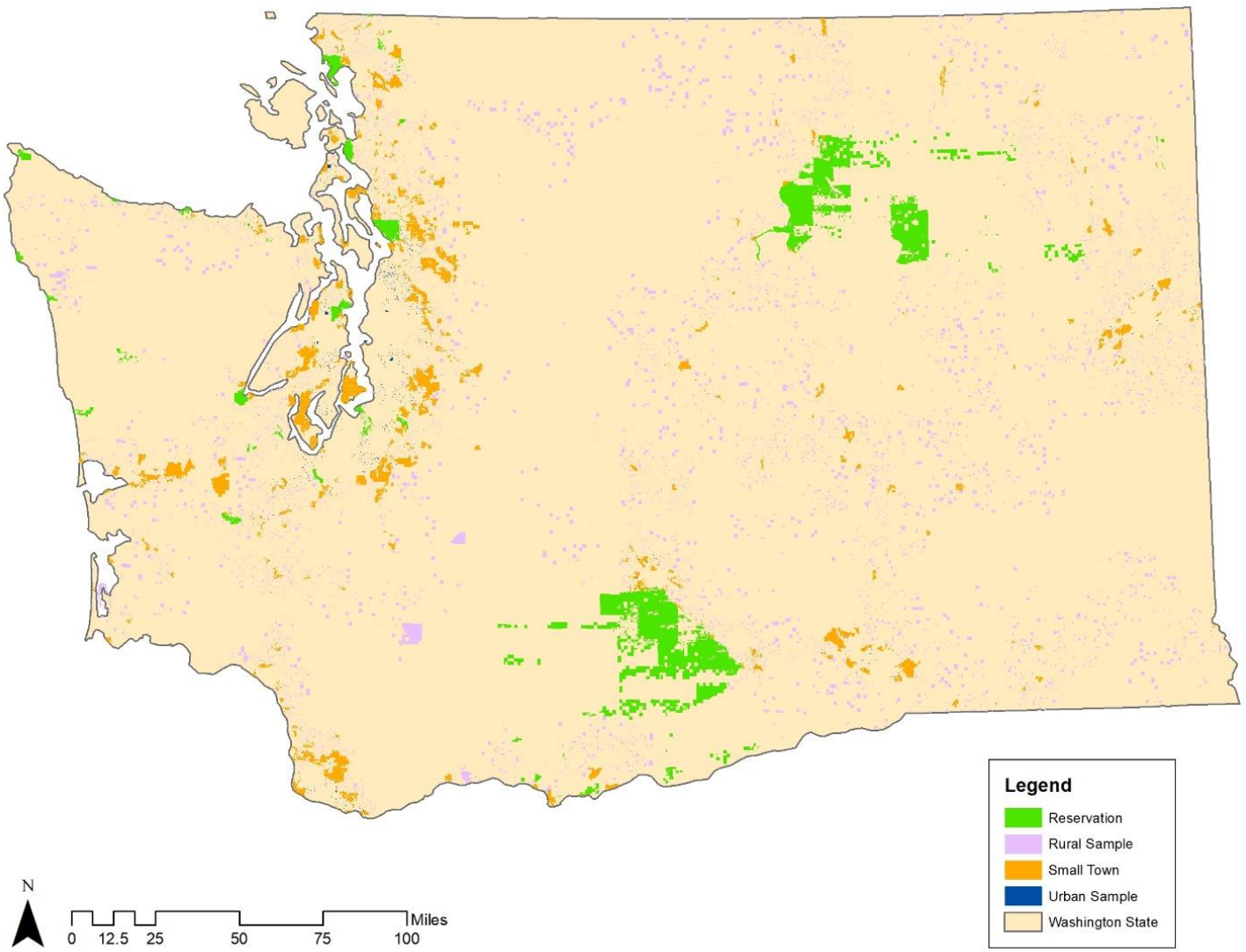

Figure 9: Interquartile Range Parcel Categories

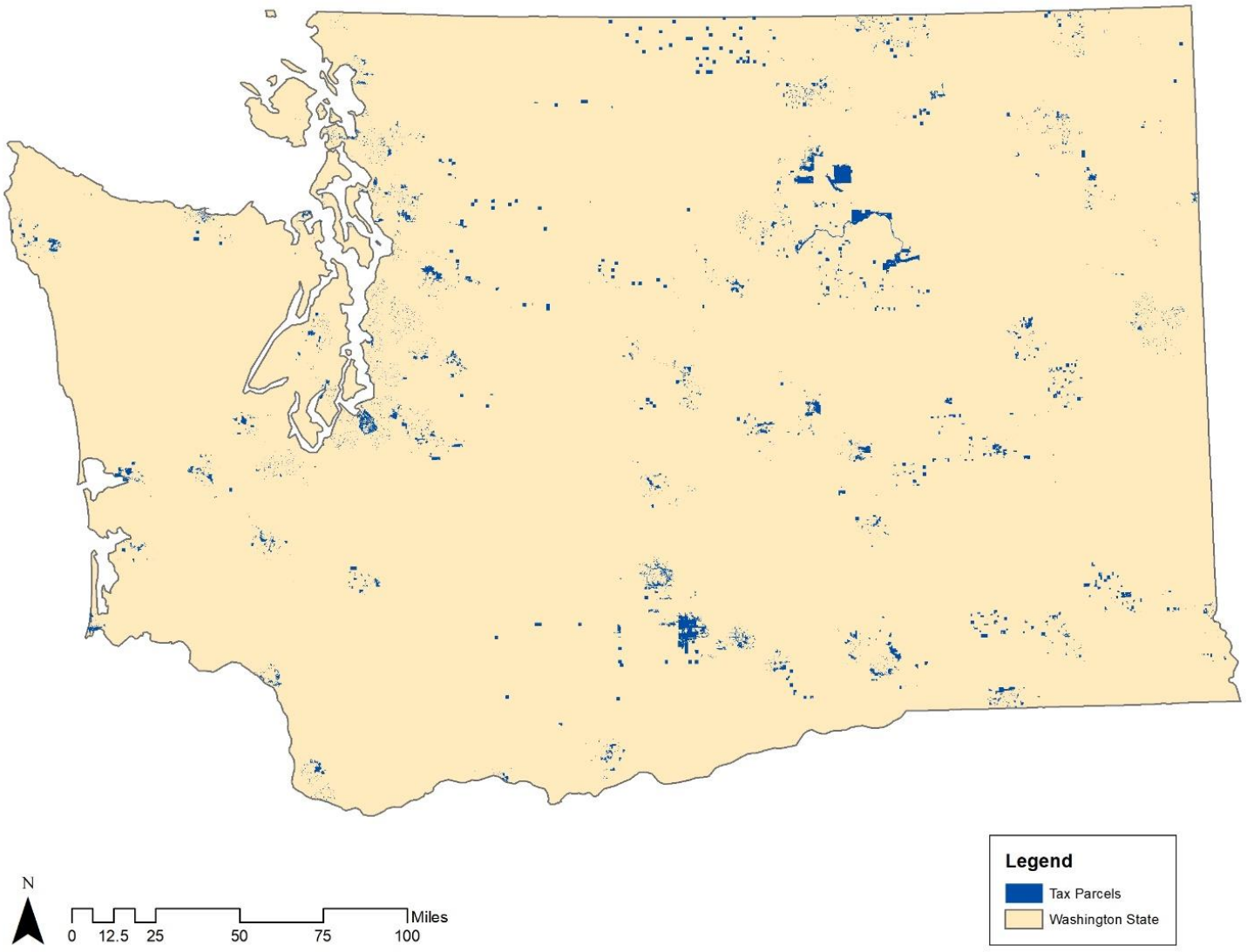

Figure 10: Parcels within the Lower Whisker

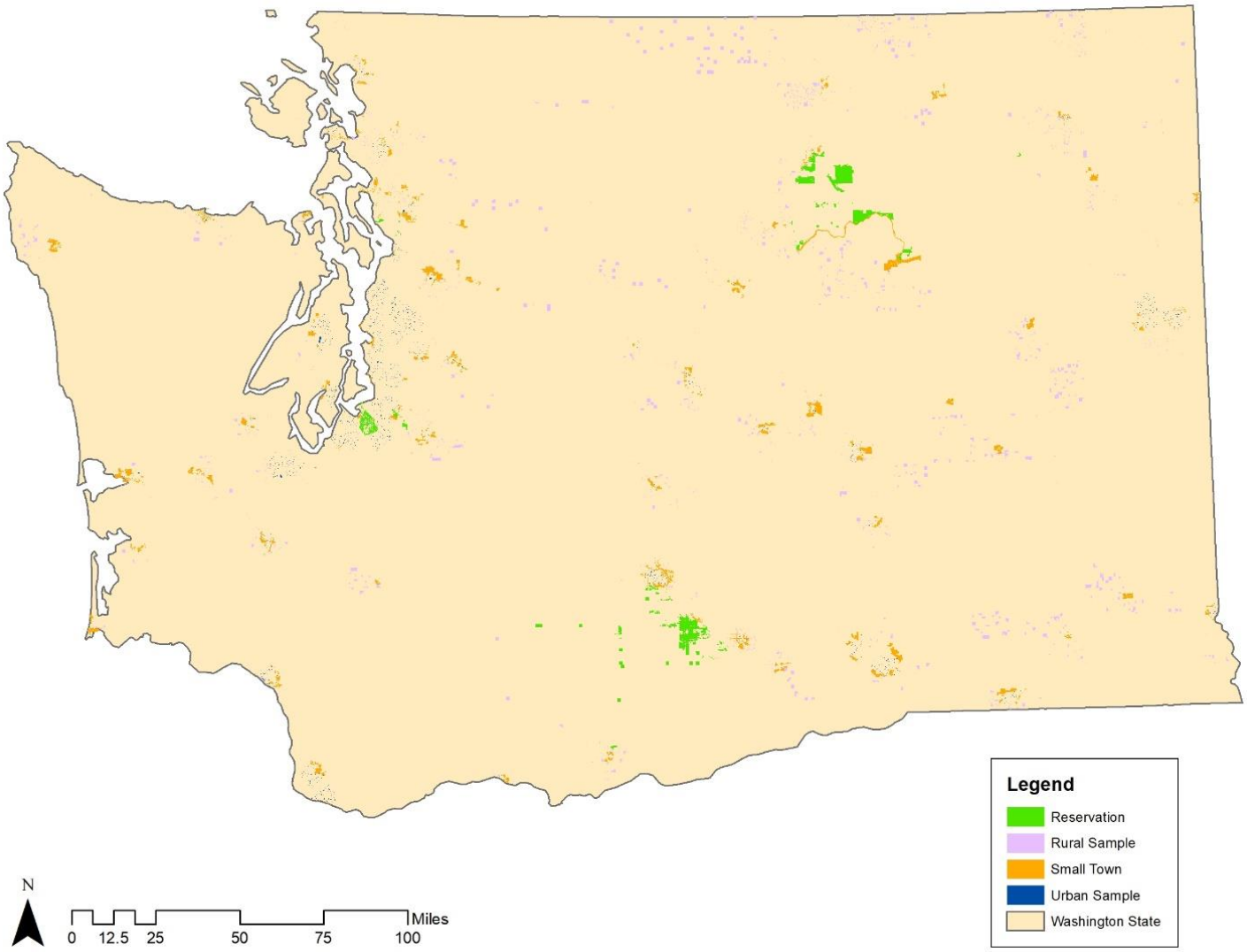

Figure 11: Lower Whisker Parcel Categories

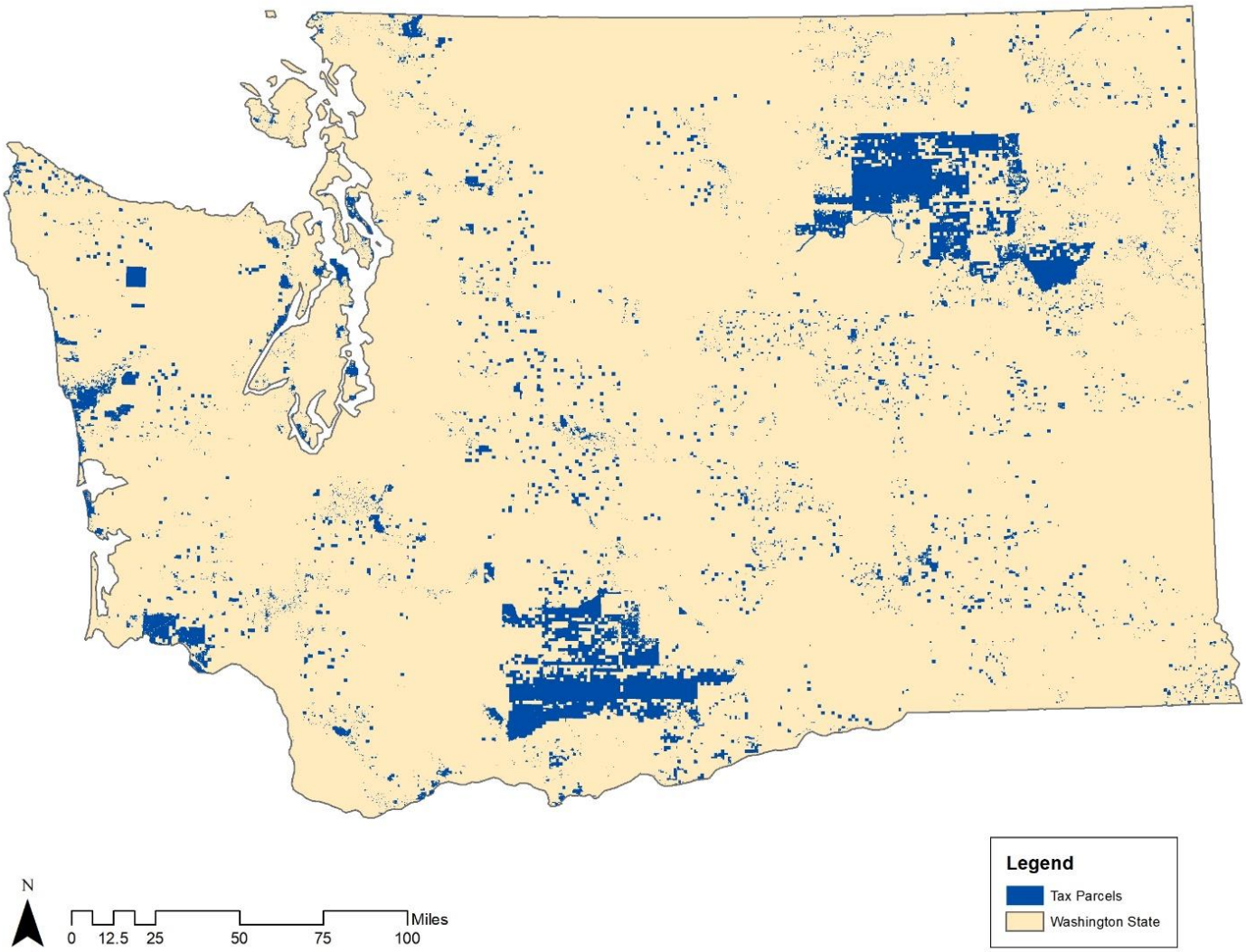

Figure 12: Parcels within the Upper Whisker

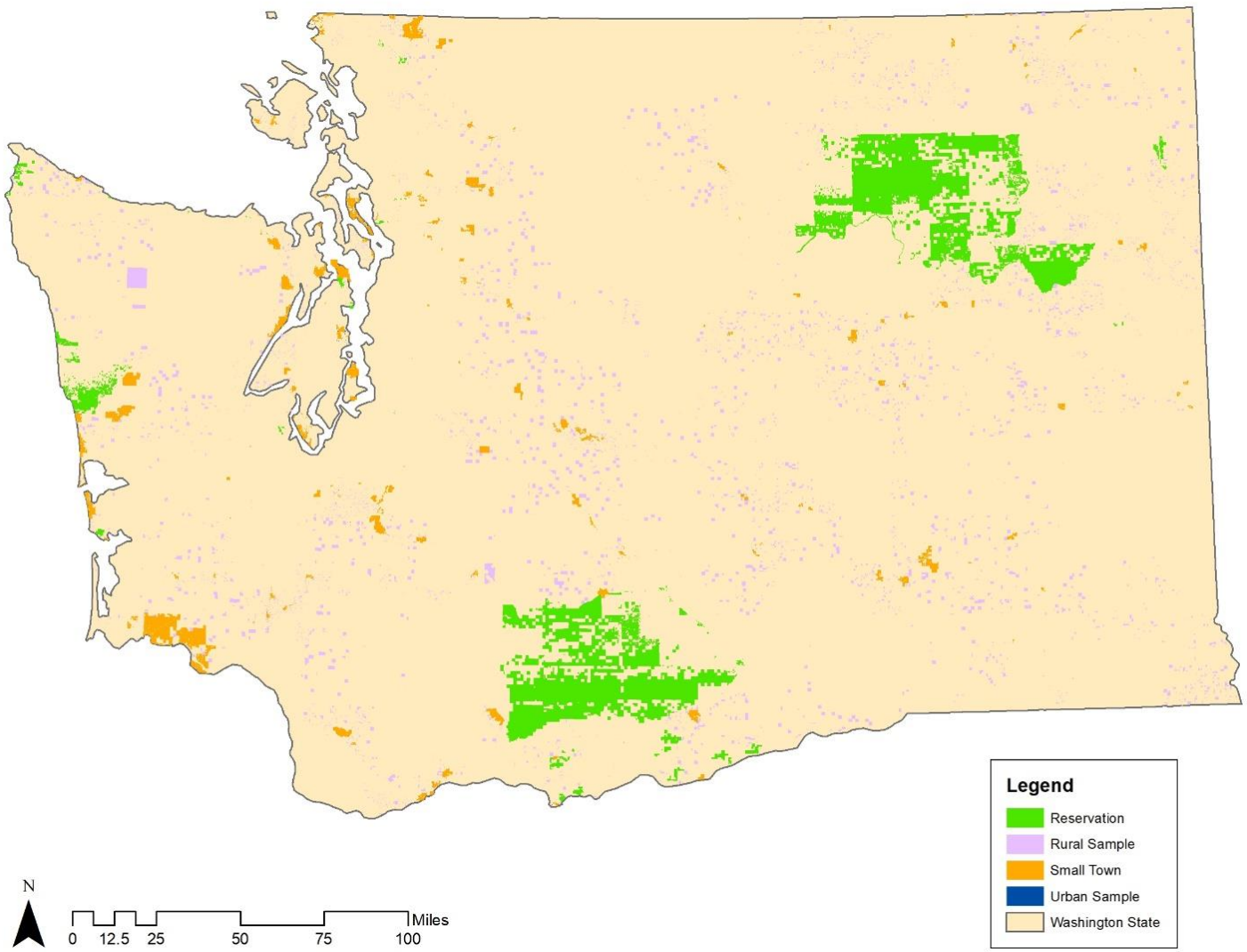

Figure 13: Upper Whisker Parcel Categories

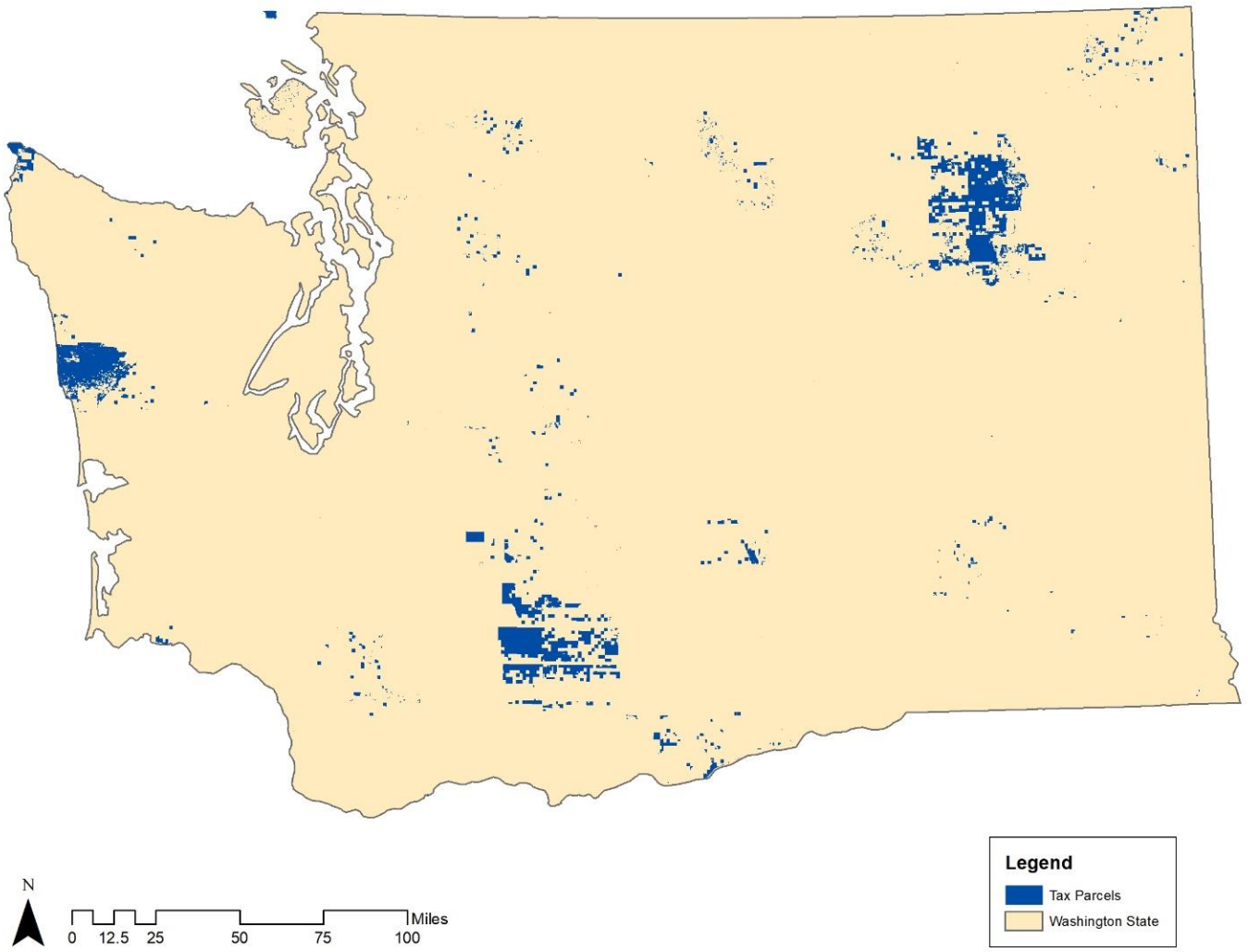

Figure 14: Parcels Classified as Outliers

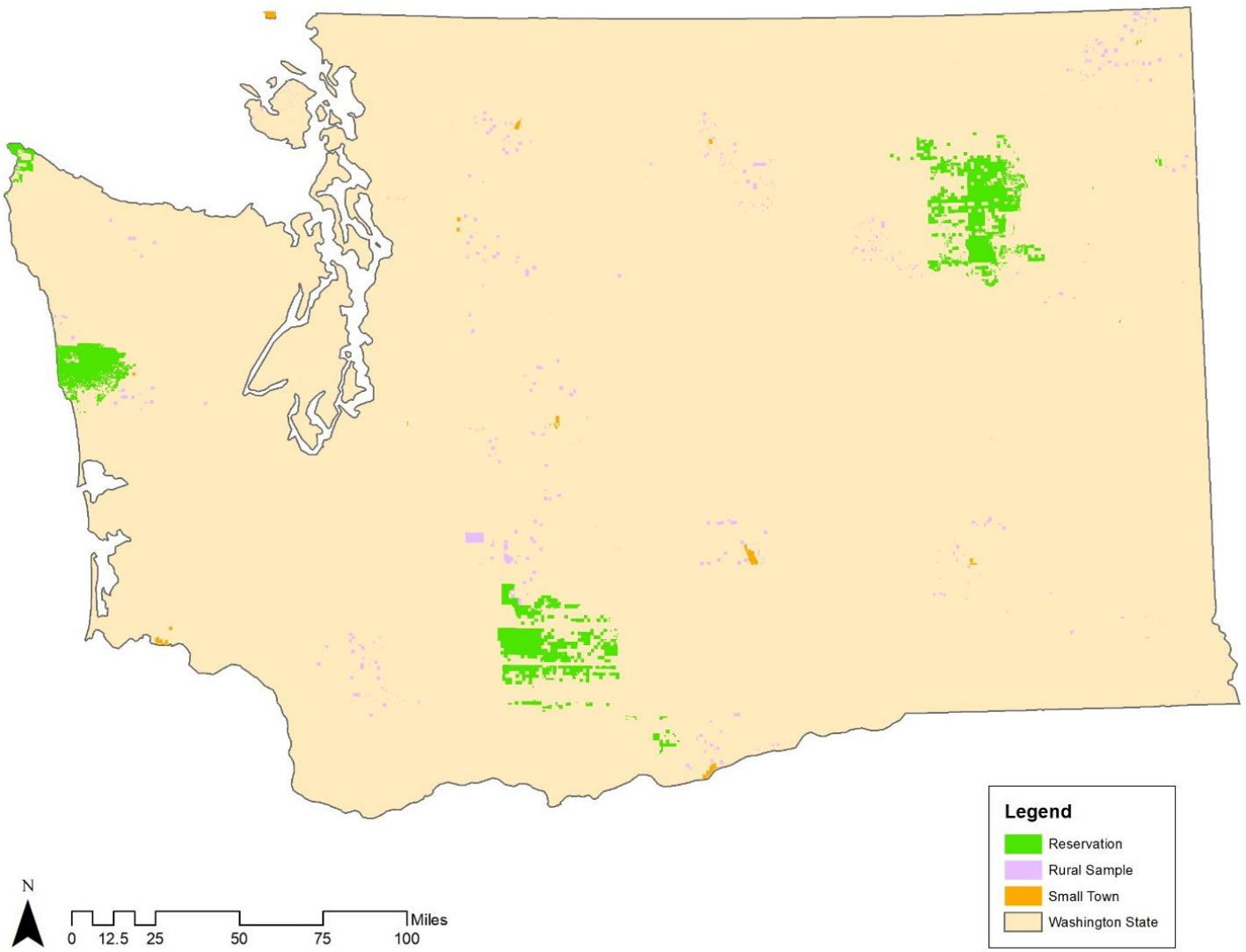

Figure 15: Outlier Parcel Categories

Table 3: Parcel Types by Interquartile Range Group

Parcel Type	*n*	*Lower Whisker n (%)*	*IQR n (%)*	*Upper Whisker n (%)*	*Outliers n (%)*
Reservation	73,060	17,878 (24.47%)	39,123 (53.55%)	10,522 (14.40%)	5,537 (7.58%)
Rural Sample	57,126	5,698 (9.97%)	34,042 (59.59%)	15,475(27.09%)	1,911(3.35%)
Small-Town	253,915	45,755 (18.02%)	127,867 (50.36%)	73,051(28.77%)	7,242 (2.85%)
Urban Sample	77,464	46,060 (59.46%)	29,750 (38.40%)	1,654 (2.14%)	0 (0.00%)
Total	461,565	115,391 (25.00%)	230,782 (50.00%)	100,702 (21.82%)	14,690 (3.18%)

Table 4: Interquartile Range Groups Descriptive Statistics

Parcel Type	*n*	*% **	*Min*	*Q1*	*Median*	*IQR*	*St. Dev*	*Mean*	*Q3*	*Max*
Lower Whisker										
Reservation	17,878	24.47%	0.02	2.73	3.52	1.63	1.25	3.32	4.36	5.00
Rural Sample	5,698	9.97%	0.00	1.85	3.31	2.45	1.43	3.02	4.30	5.00
Small Town	45,755	18.02%	0.00	0.91	2.51	3.07	1.56	2.47	3.98	5.00
Urban Sample	46,060	59.46%	0.01	1.58	2.60	2.20	1.31	2.66	3.78	5.00
Total	115,391	25.00%	0	2.72	3	4	1	2.70	7	5.00
IQR										
Reservation	39,123	53.55%	5.00	7.19	10.87	7.26	3.96	10.90	14.45	19.64
Rural Sample	34,042	59.59%	5.00	8.67	12.09	6.92	4.10	12.17	15.59	19.64
Small Town	127,867	50.36%	5.00	8.40	11.94	7.15	4.20	12.07	15.55	19.64
Urban Sample	29,750	38.40%	5.00	5.97	7.42	4.08	3.21	8.46	10.04	19.63
Total	230,782	50.00%	5.00	7.62	11.16	7.20	4.21	11.42	14.82	19.64
Upper Whisker										
Reservation	10,522	14.40%	19.64	23.78	30.18	10.91	6.61	29.87	34.69	41.59
Rural Sample	15,475	27.09%	19.64	22.34	25.77	7.97	5.59	26.96	30.32	41.58
Small Town	73,051	28.77%	19.64	21.89	24.49	6.01	4.70	25.57	27.89	41.59
Urban Sample	1,654	2.14%	19.64	22.20	24.48	4.81	3.43	24.87	27.01	39.76
Total	100,702	21.82%	19.64	22.08	24.87	6.77	5.23	26.22	28.85	41.59
Outliers										
Reservation	5537	7.58%	41.60	45.19	49.59	7.87	6.07	49.96	53.06	76.34
Rural Sample	1911	3.35%	41.60	43.64	46.77	8.12	8.18	49.11	51.76	107.20
Small Town	7242	2.85%	41.59	43.29	46.56	4.50	2.41	45.68	47.78	54.07
Urban Sample	0	0.00%	NA	NA	NA	NA	NA	NA	NA	NA
Total	14,690	3.18%	41.59	43.55	47.13	5.96	5.44	47.74	49.51	107.20

* % represents the percent of parcel type represented within each grouping

5.0 Discussion

5.1 Discussion of Findings

As stated, the majority of the representation within the outlier group belongs to the reservation parcel type. These parcels tend to be located in larger, more rural reservations. Since the land use data associated with the parcel database was determined to be unreliable, especially for areas located on AI reservations, it is difficult to know for certain whether populations are present within the identified outlier parcels. If there are populations in these areas, they may be more isolated from specialized treatments for chronic conditions that disproportionally effect both American Indian and rural populations (Holm et al., 2010).

There are several conclusions that can be inferred through the data presented within this report. Firstly, the data concludes that, in general, urban tax parcels within Washington State have low locational access to hospitals than rural tax parcels. This is shown through the parcel representation within the lower whisker (59.46% of all the urban sample tax parcels) of the interquartile range categories. This finding can be extended to tax parcels located in urban areas within reservations (24.47% of all reservation tax parcels) as well.

This conclusion can be attributed to a few different factors with the major factor being parcel density. The more parcels that are located within a smaller area allow for the distances between parcels to be shorter, and since urban tax parcels tend to be smaller, more tightly compressed, and located closer to hospitals, the finding that these parcels have better locational access than non-urban tax parcels were as expected.

Another conclusion from the results of this study is that tax parcels located within rural areas of Washington State have lower locational access to hospitals than tax parcel located within urban areas. This conclusion is based on the finding that the rural sample tax parcels mainly fall within the interquartile range (59.59 %) of the dataset, which, in general, represents

average locational access, as well as, the upper whisker (27.09%), which represents low locational access.

One reason rural sample parcels might be located further from hospitals is that the rural sample parcels tend to be much larger (mean of 41.56 acres) compared to the urban sample parcels (mean size of .75 acres). Also, the rural sample tax parcels tend to be located further away from city centers, where healthcare resources tend to be centralized.

Locational accessibility to hospitals for tax parcels located on American Indian reservations in the state of Washington varies from what has been observed in both the rural and urban sample tax parcels, but this should be expected, due to the diversity of rural and urban parcels within the reservation parcel group. Tax parcels located on AI reservations in Washington State vary from some of the most densely populated areas of the state to some of the most isolated areas of the state. This is why some of the reservation parcels are so well represented in the lower whisker (24.47%), as well as, rural reservation parcel being some of the most isolated tax parcels in the state (7.58% representation within the outliers). This creates a unique situation where some reservations appear to have great locational hospital access, for example, portions of Puyallup, Tulalip, and Muckleshoot, while others, like Spokane, Quinault, Colville, and Makah, have very low access to hospitals.

When compared to reservation tax parcels, parcels located in small-towns tend to have slightly lower locational hospital accessibility. This conclusion is based on the percentage of the small-town tax parcels being represented within the lower whisker (18.02% of small-town compared to 24.47% of reservation parcels), as well as, the percentage of small-town tax parcels being represented within the upper whisker (28.77% for small-town compared to 27.09%).

As mentioned in the results section, Port Roberts, is represented as an outlier when realistically, its parcels probably have special access to Canadian hospitals. This is important to note, because about half of the small-town parcels within the outlier category are located within Port Roberts, which means that if those parcels are disregarded, small-town parcels have better access than what is currently being reported. Overall, small-town tax parcels appear to have very similar locational hospital accessibility when compared to reservation tax parcels, with the major difference being that reservation tax parcels have a higher percentage of areas that are located within very isolated areas (outliers).

Distance as a measure of access has been identified as one of the major factors for healthcare utilization in rural areas (Buzza et al., 2011). Location is one of the most basic dimensions of accessibility, especially for populations who are isolated from healthcare resources and in identifying specific areas where vulnerable populations may exist.

Again, it is true that transportation for emergency medical care can be expedited through the usage of medivacs, but this service is not, and should not be, intended for the treatment of chronic conditions. Currently, there are efforts to increase the amount of screening services available to rural and AI populations throughout the country (Rural Health Information Hub, n.d.), but, as useful as a screening services are, they stop being useful to individuals the moment a diagnosis has been made. This study hopes to assist in the process of identification of Medically Underserved Areas and Medically Underserved Populations, by providing parcel level geographic data where vulnerable populations may be present.

5.2 Limitations of the Study

One of the main limitations of this study involves the accuracy of the travel times in certain areas of the state. Some of the maximum drive times approach the 500-minute mark,

which does not seem to be a realistic amount of time. A large percentage of the parcels that have driven times over 180 minutes tend to be located within areas of Puget Sound that require ferry travel to the nearest hospital. These areas include parcels located within San Juan, Island, Kitsap, and Jefferson counties. The variability of ferry travel within these areas may either inflate or deflate the observed travel times. This is one of the major reasons that the distances, as opposed to the drive times, were ultimately used as the identifier for locational hospital accessibility when categorizing tax parcels using Tukey's fences.

As stated, there have been studies that have identified distance as the first and most influential barrier to healthcare utilization for vulnerable communities (Buzza et al., 2011), but, admittedly, the utilization of healthcare resources has many other factors that may influence outcomes other than distance traveled. It has been identified that for AI populations, culturally appropriate healthcare options are of great importance (Holm et al., 2010), and other dimensions of access including affordability, availability, and accommodation (Penchansky & Thomas, 1981) should be considered when attempting to develop a true understanding of healthcare utilization for vulnerable communities. This study should be seen as a first step in that process of identifying areas in need of the most basic of needs within healthcare accessibly.

A next step for this project would be to integrate the produced data with geographic health outcomes data, including mortality rates, or another overall health indicator. Having geographic health outcomes data to use to compare and contrast with areas identified within the study as having low locational hospital accessibility would help establish the validity and usability of the data produced in this study.

5.3 Applications to Planning and Public Health

When considering the conclusions presented within this chapter planning and public health officials have a myriad of options available to help serve these populations. One of the first tasks that public health and planner professionals should take would be to cross-reference with the Washington State Department of Health to ensure that these areas are have already been identified as medically underserved, or areas containing medically underserved populations. This would allow planning and public health professionals to utilize the current resources in expanding healthcare utilization options for these populations.

Secondly, for planning professionals, the data presented in this report can be used as a guideline for potential development. Areas identified as having low locational hospital accessibility might be areas to avoid when considering residential development. Conversely, planning professionals will want to consider areas of low locational hospital accessibility as areas to be designated with open space or noncommercial forests to prevent residential development from happening.

5.4 Applications for American Indian Communities

Throughout this report the role in which locational hospital access has been discussed within the context of Washington State. Since AI reservations in the state exist in such a variety of places (urban areas, rural areas, and small-town areas), it makes it difficult to generalize across all AI residents in Washington State. Instead of making general statements, it may be more useful to focus on the reservations that have parcels identified as outliers within their borders.

Areas that have been identified as having very low locational hospital access include portions of the Quinault, Makah, Yakama, Spokane, Colville, and Kalispel Reservations. .Tribal

officials should make attempts to ensure that public transportation infrastructure, preferable in the form of a fully operational Tribal Transportation Program (National Congress of Indians, 2013), are in place to ensure that the treatment of chronic conditions for these populations is a priority, especially for individuals of limited mobility. Public transportation options may be as inclusive as a bus route or as exclusive as a shuttle service, but accessibility to the medical resources of the local hospital should be made a priority for tribal officials who serve these vulnerable populations.

5.5 Conclusion

Through the usage of GIS, drive times and distances to the nearest hospital from a sample of both urban and rural tax parcels, all of the tax parcels that may be defined as small-town, and all tax parcels located on Federally Recognized American Indian Reservations in Washington State were obtained. These tax parcels were then separated into three groups, based on the distance variable, using Tukey's fences (Tukey, 1977), to identify which areas of Washington State were the most isolated from hospitals.

With an average of 47.74 miles to the nearest hospital, the 14,690 parcels identified as outliers were located in some of the most isolated areas of Washington State. A little more than seven percent of all reservation parcels are within this outlier group, these data may be most concerning to rural AI communities. Populations residing within these areas have limited accessibility to the multitude of heath resources that hospitals provide, specially, the resources needed to treat chronic health conditions that disproportionally affect both rural and AI comminutes (Indian Health Service, 2017; Meit, et al., 2014).

Conversely, this study also found that parcels within the lower whisker (best access to hospitals) averaged about 2.7 miles to the nearest hospital. The lower whisker group represented

59.46% of all urban sample parcels, which may imply that tax parcels located within urban areas have better access to hospitals than tax parcels located outside of urban areas.

The findings of this report are important to both rural and AI communities, because they display how the treatment of chronic conditions in identified areas of low accessibility may be a huge challenge, especially in areas where public transportation may be limited. Distance to the nearest hospital is not the only factor impacting the treatment of the observed health conditions, but it may be the most important for rural communities (Buzza, 2011). As previously stated, this research should be seen as initial step in the process of identifying issues of healthcare accessibility for vulnerable populations in Washington State.

References

Arcury, T. A., Gesler, W. M., Preisser, J. S., Sherman, J., Spencer, J., & Perin, J. (2005). The effects of geography and spatial behavior on health care utilization among the residents of a rural region. *Health Services Research*, 40(1), 135–55.

Bernard, P., Charafeddine, R., Frohlich, K. L., Daniel, M., Kestens, Y., & Potvin, L. (2007). Health inequalities and place: A theoretical conception of neighborhood. *Social Science & Medicine*, 65(9), 1839–1852.

Buzza, C., Ono, S. S., Turvey, C., Wittrock, S., Noble, M., Reddy, G., Reisinger, H. S. (2011). Distance is relative: unpacking a principal barrier in rural healthcare. *Journal of General Internal Medicine*, 26 Suppl 2(Suppl 2), 648–54.

Dewees, S., & Marks, B. (2017). Twice Invisible: Understanding Rural Native America. *Research Note*, 2. Retrieved from https://www.usetinc.org/wp-content/uploads/bvenuti/WWS/2017/May2017/May 8/Twice Invisible - Research Note.pdf.

Eberhardt, M. S., & Pamuk, E. R. (2004). The Importance of Place of Residence: Examining Health in Rural and Nonrural Areas. *American Journal of Public Health*, 94(10).

ESRI. (2017). *Street Map North America* [Computer software].

Health Resources & Services Administration. *Defining Rural Population*. (2018, December 01). Retrieved from https://www.hrsa.gov/rural-health/about-us/definition/index.html

Health Resources & Services Administration. *Medically Underserved Areas and Populations (MUA/Ps).* (2016, October 01). Retrieved from https://bhw.hrsa.gov/shortage-designation/muap

Health Resources & Services Administration. *Medically Underserved Area/Population (MUA/P) Application Process*. (2016, October 01). Retrieved from https://bhw.hrsa.gov/shortage-designation/muap-process

Holm, J. E., Vogeltanz-Holm, N., Poltavski, D., & McDonald, L. (2010). Assessing health status, behavioral risks, and health disparities in American Indians living on the northern plains of the U.S. *Public Health Reports* (Washington, D.C.: 1974), 125(1), 68–78.

Jones, D. S. (2006). The persistence of American Indian health disparities. *American Journal of Public Health*, 96(12), 2122–34.

Jones, I.,López-Carr, D. & Dalal, P.. (2013). Responding to rural health disparities in the United States. *Netcom*, (25), 273-290.

Indian Health Service (n.d.). Disparities. *Fact Sheets*. (n.d.). Retrieved April 17, 2018, from https://www.ihs.gov/newsroom/factsheets/disparities/

Kaufman, P., Dicken, C., & Williams, R. (2014). Measuring Access to Healthful, Affordable Food in American Indian and Alaska Native Tribal Areas, 29. https://doi.org/EIB-131

Medically Underserved Area & Medically Underserved [Map]. (2018, December 11). In *Washington State Department of Health*.

Meit, M., Knudson, A., Gilbert, T., Tzy-Chyi Yu, A., Tanenbaum, E., Ormson, E.,Popat, S. (2014). *The 2014 Update of the Rural-Urban Chartbook*(Rep.). Grand Forks, ND: Rural Health Research & Policy Centers.

National Congress of American Indians. (2013). *Tribes & Transportation: Policy Challenges and Opportunities*. Retrieved from http://www.ncai.org/resources/ncai_publications/ncai-tribal-transportation-report

Penchansky, R., & Thomas, J. W. (1981). The concept of access: definition and relationship to consumer satisfaction. *Medical Care*, 19(2), 127–140.

Ribot, J., Peluso, N. (2003). A Theory of Access. *Rural Sociology*, 68(2), 153–181.

Rural Health Information Hub. Rural Project Examples: Health screening (n.d.). Retrieved from https://www.ruralhealthinfo.org/project-examples/topics/health-screening

Tukey, John W.: Exploratory Data Analysis. Addison- Wesley Publishing Company Reading, Mass. — Menlo Park, Cal., London, Amsterdam, Don Mills, Ontario, Sydney 1977, XVI, 688 S.

University of Washington. (2017).*Washington State Parcel Database*. Retrieved September, 2018, from: URL (https://depts.washington.edu/wagis/projects/parcels/)

US Census Bureau. (2018). *American Indian/Alaska Native/Native Hawaiian Areas National.* Retrieved September, 2018, from: URL (https://catalog.data.gov/dataset/tiger-line-shapefile-2017-nation-u-s-current-american-indian-alaska-native-native-hawaiian-area)

US Census Bureau. (2016). *2016, 2010 nation, U.S., 2010 Census Urban Area National.* Retrieved September, 2018, from: URL (https://catalog.data.gov/dataset/tiger-line-shapefile-2016-2010-nation-u-s-2010-census-urban-area-national)

US Census Bureau. (2017). *2010 Census Designated Places.* Retrieved September, 2018, from: URL (https://www2.census.gov/geo/tiger/GENZ2017/shp/)

Washington State Department of Health. (2018). *Clinics.* Retrieved September, 2018, from: URL (https://www.doh.wa.gov/DataandStatisticalReports/DataSystems/GeographicInformationSystem/DownloadableDataSets)

Washington State Department of Health. (2018). *Hospitals.* Retrieved September, 2018, from: URL (https://www.doh.wa.gov/DataandStatisticalReports/DataSystems/GeographicInformationSystem/DownloadableDataSets)

Wonderly, C. (2017). *Spatial Primary Health Care Access Disparities within the Seattle-Tacoma Combined Statistical Area* (Unpublished master's thesis). Eastern Washington University.