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Geospatial Considerations Involving Historic General Land Office Maps and Late Prehistoric Bison Remains Near La Crosse, Wisconsin

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Analyzing Late Prehistoric *Bison bison* Remains near La Crosse, Wisconsin using Historic General Land Office Maps

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Abstract: This study used geographic information systems, prehistoric archaeological contexts, and historic General Land Office (GLO) maps to conduct a pilot inter-site analysis involving La Crosse, Wisconsin area Oneota sites with reported *Bison bison* remains as of 2014. Scholars in and around Wisconsin continually discuss the potential reasons why bison remains appear in late prehistoric contexts. This analysis continued that discussion with updated methods and vegetation data and provides a case study showing the strength of using historic GLO maps in conjunction with archaeological studies. This research suggests that creating your own maps in coordination with the GLO's publicly available original surveyor data is more accurate than using the Wisconsin Department of Natural Resources' (DNR) vegetation polygon that cites the same data. This article's research attempted to progress and review analytic methods that, if improved, can be used for future hunter catchment analyses.

Keywords: *Bison bison*, geographic information systems, General Land Office, Wisconsin

Introduction

Modern American bison (*Bison bison*) remains are found in historic and prehistoric archaeological contexts east of the Mississippi River, especially in states that fall within the prairie peninsula biome such as Illinois, Indiana, Ohio, and Wisconsin (Adams and Tankersley 1981; Belue 1996; Boszhardt and McCarthy 1999; Martin 2014; McMillan 2006; Meszaros and Denny 2017; Sasso 2014; Shay 1978; Tankersley 1986). Ethnographic and historic documentation, such as the translated travels of Father Louis Hennepin (1938) and his bison encounters with Miami near southern Lake Michigan, give the early historic era bison discussions weight in northern plains periphery states (Belue 1996). Martin (2014), McMillan (2006), Sasso (2014), and (Theler and Pfaffenroth 2010) have described late prehistoric bison interpretations in southern Wisconsin and northern Illinois as less concrete, due to the lack of bison remains in archaeological contexts. Late prehistoric Prairie Peninsula populations in places like northern Illinois or southern Wisconsin are suggested to have obtained bison parts by way of local or non-local hunting, and trade acquisition (Boszhardt and McCarthy 1999; Martin 2014; McMillan 2006; Sasso 2014; Theler 1994; Theler and Pfaffenroth 2010). This leaves bison part acquisition up for debate. It is known that most bison remains in Wisconsin from late prehistoric contexts should be attributed culturally to an Upper Mississippian "Oneota" presence in the western Great Lakes region (Sasso 2014). Oneota contexts are noted from Nebraska to Michigan, and variability in bison acquisition or use is evidenced archaeologically (Edwards 2010; Hall 1962; Ovestreet 1997; Ritterbrush 2002; Sasso 2014). There are many questions that surround Wisconsin bison. For example, were La Crosse Oneota, the proposed late prehistoric residents who lived near modern La Crosse, Wisconsin along the Mississippi River, hunting local bison themselves, hunting non-local bison elsewhere and bringing remains back to sites in La Crosse, WI, or were these residents trading the remains to obtain bison as food and tools? From La Crosse, to the Hoxie Farm site south of modern Chicago, late prehistoric Oneota populations acquired bison with a primary motivation to obtain scapulae to use later as agricultural hoes (Gallagher and Stevenson 1982; Martin 2014, 188-194; Peske 1971; Sasso 2014, 174-176; Theler 1994). Trade in general would have come with other unique and valuable opportunities besides scapula hoes, and each acquisition type comes with its own set of conceivable advantages or disadvantages (Mason 1981).

The goal of this analysis was to create a pilot study that used the local acquisition explanation put forth by previous scholars. The analysis attempted to evaluate local acquisition likelihood by assessing the available local historic ecological record surrounding known archaeological sites. The research assessed local historic vegetation patterns as an analog for late prehistoric patterns, targeting prairie and prairie transition vegetation (see Edwards 2010 for further methods). The data began to answer whether these patterns could support local bison herds at a basic level. To view the data in a site proximity to vegetation fashion, one-mile catchments were used, and colors were coded to compare vegetation classifications with naming differences. The analysis produced tables to view heavy forest versus light forest versus non-forest environments based on the color codes comparatively. Edwards (2010) used a two-kilometer catchment to analyze Lake Koshkonong Oneota agricultural practices in southern Wisconsin, but a hunter's catchment would most likely be ten-kilometers or more (Arroyo 2009; Attenbrow 2003; Green 2008). With this is mind, this research tested Edward's (2010, Personal Communication 2017) suggestion of Wisconsin DNR data inaccuracy to see if creating custom vegetation shapefiles using historic records, public maps, georeferencing, and digitization via the editor tool in ArcMap created different results near La Crosse, Wisconsin compared to using the publicly available Wisconsin DNR "Pre-European Settlement Vegetation" shapefile with pilot catchments (Edwards 2010; Wisconsin DNR 2017). The main types of data available in notes, or sketch and plat maps, from the GLO surveys include major land features, ecotone changes, and soil information by chains and links along section lines. The DNR provides a lot of specific vegetation and tree species types (see figures below), but the line and feature accuracy skew this information's usefulness (Edwards 2017; Nicholls 2017).

This study implemented geographic information systems (GIS), archaeological sites, and historic GLO maps to create an inter-site analysis of archaeological sites following basic catchment analysis principles (Vita-Finzi and Higgs 1970). An examination of sixteen Oneota sites from the La Crosse, Wisconsin area with *B. bison* remains was conducted using Sasso's (2014, 176) Wisconsin Oneota bison remains table. This table is based on scholarship, reports of investigation, grey literature, and personal communication research (Sasso 2014; Theler 1994, 2000). Based on this table, these sites have a bison or (cf.) bison NISP of 134+, with scapula making up the vast majority of the sample in the form of agricultural hoes (Sasso 2014, 176). Prehistoric vegetation near these sites was modeled, and the accuracy of two different vegetation models was explored visually and mathematically.

The focus of the research was to test whether finer resolution could be sufficiently better than general resolution at predicting the potential for habitats that support bison; at the same time, the techniques are shown to merit the effort rather than falling back on previously generated DNR data. Bison, and the associated research, provided the analytical case to study. The goal for future research is to expand this pilot study to a proper hunter catchment that takes all of the La Crosse, Wisconsin area Oneota sites into account at once, explore Minnesota geospatial and archaeological data related to La Crosse Oneota, and add in-depth vegetation species analysis related to Wisconsin's late prehistoric prairie peninsula. For example, Calenge (2007) has shown that this preliminary single-factor ecological study could incorporate statistical software such as R to analyze vegetation acreage more successfully in relation to animal ranges in the future. In terms of connecting historic GIS data at a state level, Meyer (2018) has shown that this will always be inaccurate between Minnesota and Wisconsin, but are there alternatives? While bison use near La Crosse is evidenced archaeologically, this study explored the utility of vegetation maps ~1847 for investigating earlier contexts, especially with regards to fauna that were extirpated from the state by 1833 (Sasso 2014; Schorger 1937; Theler 1994, 2000; Wisconsin DNR 2006).

Methods and GIS Results

Based on recovered evidence, circa 1300-1650, Upper Mississippian populations in Wisconsin, just east of the Mississippi river, near modern La Crosse, were depositing *B. bison* remains into prehistoric contexts at a higher rate and volume than the rest of the state and previous time periods (Gallagher and Stevenson 1982; Sasso 2014, 176; Theler 1994, 2000; Theler and Pfaffenroth 2010). In order to understand how a bison could be acquired by prehistoric populations at a local level, GIS catchment analysis was applied to help determine whether or not bison could subsist in southwestern Wisconsin near a selected number of archaeological sites.

There are multiple methods to currently view Wisconsin's late prehistoric vegetation. In *The Atlas of Great Lakes Indian History*, one can find the map displayed in Figure 1, adapted from Tanner and Pinther (1987, 14-16), describing southern Wisconsin as a "GF-1" around La Crosse, or a "Grassland with Oak." Although this map may give a general picture, it is not enough for a detailed vegetation analysis at a county, or more localized, level. This is due to the inability to obtain accurate acreage or hectares. Comparatively, Figure 2 illustrates the areas used for the current analysis. With ArcGIS 10.5, we see a modern grey scale base map of the La Crosse area near the Mississippi River accompanied by sixteen orange Oneota sites on the Wisconsin side of the river, with four clusters of sites surrounded by one-mile black buffers. This catchment size was chosen as a pilot to see if future research pertaining to vegetation was worth reconstruction over large swaths of Wisconsin, such as twenty-kilometers. The intent was to zoom-in on each of these four clusters and use more detailed vegetation reconstructions than those provided by the Wisconsin DNR's (2017) "Pre-European Settlement" data to predict whether bison could hypothetically subsist nearby. When reading the DNR's shapefile metadata, the vegetation layer was digitized at a 1:500,000 scale. This scale was found to be inadequate relating to the data used in this study. Zooming into the four clusters, the viewing scales alone were roughly between 1:70,000 and 1:25,000, depending on the size of the catchment. The GLO made it possible to digitize historic vegetation in Wisconsin at a one-square mile accuracy, or section-level though. The notes, at times, even provide information at a chain and link -level along section lines. Edwards (2010) and others have shown that Wisconsin GLO maps, the same maps the DNR (2017) digitized from Finley using a small or coarser scale, warrant a re-digitized larger, finer scale (Fritschle 2008, 30; Moran 1978). The General Land Office's Public Land Survey covered sections of townships throughout the United States in the mid to late 1800's as a part of a U.S. government effort (Board of Commissioners of Public Lands 2017). Instead of bypassing the data from the DNR, this study tested the DNR's publicly available shapefile against a custom digitization in order to highlight the value of these methods (Edwards 2010; Jeske 1990).

In Figure 3, we can see six Oneota sites which contained some degree of bison remains. The Tremaine, Midway Village, OT, Firesign, Filler, and Holley Street sites are all surrounded by a combined one-mile vegetation catchment buffer. According to the DNR, this is what pre-European vegetation looked like around these site areas (Wisconsin DNR 2017). These sites consisted of wetland and waterway areas, prairie areas, wooded areas, and oak opening transition areas. While this information is useful, it lacks precision and accuracy, missing features like creeks and exact ecotone breaks, and this study operated under the suggestion that catchment vegetation acreage available to fauna like local bison would need the best available data and techniques (Edwards 2010, Personal Communication 2017; Nicholls 2017). Heywood et al. (2012) outlines precision and accuracy as a balance. For example, the DNR's data may be accurate at a species level at times, but ecotone break lines lack geospatial precision. To begin to make an accurate local argument that is based on acreage and zoning, ecotone lines need to align better geospatially, though generally speaking, DNR data provides a glimpse.

Although these shapefiles represent the mid-1850s, they could be argued as useful due to pollen data suggesting similar environmental characteristics during late prehistoric occupation around the 1600's in southern Wisconsin and northern Illinois alike (Edwards 2010; Leach et al. 1999; Jeske 1990; King 1978, 44; Meszaros and Denny 2017; Moran 1978). Matching the exact plant species versus known ecotones of the mid-1800's versus bison dietary needs is suggested for future research. Why bison were seen by historic travelers and ended up in late prehistoric contexts is a broad question and narrowing the lens to have a localized ecological perspective by using catchments aided in developing a finer human-fauna interaction perspective, and will continue to do so (Green 2008).

The Board of Commissioners of Public Lands' (2018) website makes available notes and associated maps from the Public Land Survey System (PLSS) conducted by the GLO of the mid-1800's in Wisconsin. Figure 4 shows an example of available historic survey notes dealing with townships, ranges, sections and chain link measures along section lines. In order to digitize vegetation from these notes, one can make vegetation triangles emanating from every section line in La Crosse county, and also trace labeled plat and sketch map features. Figure 5 shows a sketch map of a township and its associated sections. These exact maps were not digitized, but as an example, if a sketch map is combined with notes like Figure 4, it can be useful in helping to decipher some of the handwriting (Edwards 2017; Nicholls 2017). Some of these details were not indicated on the maps used for digitization either, so they helped complete the puzzle section by section. Figure 6 is an example of an archived plat map this study used to digitize, or essentially precisely draw over, sections and townships with ArcMap's editor tool (Esri 2017). This process included downloading and converting maps like Figure 6 into .tiff rasters that were useable in ArcMap, georeferencing the rasters by township, and creating a custom shapefile. This shapefile designated vegetation types based on the PLSS notes, Jeske (1990), Edwards (2010, Personal Communication 2017), and ecotone-break tracing over the georeferenced maps. The created shapefile works best with a geodatabase, as one can control analysis factors more effectively such as coded domains (Edwards 2017; Nicholls 2017). Edwards (2010) specifically found that using this technique near Lake Koshkonong in Wisconsin, larger or finer scale digitization of these maps created more accuracy and precision, which this study supported further. Testing the viability of the model was of interest. Figure 7 shows the interpretation of a more accurate version of Figure 3. In this cluster of sites, the localized analysis shows a different picture, with what the DNR considers "oak openings" more present than forest thickets in Figure 7 versus Figure 3. These openings, in combination with the prairie pockets illustrated in Figure 7 below, are target ecotones essential to understanding the potential for local bison subsistence niches from 1300-1650, and potentially dates before and after that.

The benefit of finer resolution digitization is not limited to one cluster. All clusters show a DNR issue around all sixteen archaeological sites. Figure 8 shows the second cluster of sites with the DNR polygon shapefile just to the southeast of the first cluster. The Sand Lake, Herbert, and Krause sites seem to have been in a large oak opening at the point of the PLSS. When we look at this study's digitized version, Figure 9 shows a prairie pocket surrounded by what was labeled general "light" broken timber from the notes, otherwise known as an "oak opening" in many ecological discussions and the DNR metadata (Jeske 1990; Wisconsin DNR 2017). This map also highlights the advantage of this digitizing in revealing exact waterways branching from the Mississippi River circa 1850. Rivers, and some of the marsh-like environments attributed to their immediate surrounding areas, may have served as advantageous hunting locations in and around the Prairie Peninsula to take bison (McMillan 2006).

Figure 10 identifies the study's third cluster and one-mile catchment, and the trend from clusters one and two continues. The coloration changes, which means the interpretation changes. Figure 11 shows the area is less wooded than the DNR shapefile depicts to the viewer. The DNR shapefile and the custom digitized map show oak openings and prairie openings are present right by water. If one wants to generate vegetation case studies focused on ecotones such as these, the hypotheses will be more accurate with custom digitization (Edwards 2017; Nicholls 2017). Taking a study like this and incorporating more than one variable will further what can be said of the results as well. Future local bison inquiries are therefore suggested to continue this method. The justification for custom digitization is available for comparison, and all of the data used in this study is open to the public for recreation and comparison. When bison arrived in southern Wisconsin is a topic for a different study, and this project built a predictive model for the late prehistoric (Austin 2002; Benton 2001; Guisan and Zimmerman 2000). Figure 12 ends the geospatial analysis with the southernmost cluster of the four. Although these files are projected within the Wisconsin State Plane Coordinate System, meaning everything should align geospatially, the files do not quite match the state line. Figure 13 shows more accuracy and precision within the catchment boundaries, and although the Minnesota side may have been left lacking by the original surveyors and lost in time, generating a custom file still creates a more complete picture (Meyer 2018). Notice the indicated farmland, and how this land is not considered by the DNR within Figure 12's catchment. This supports the claim of digitization inaccuracies, and other areas of the state show heavy discrepancies in indicating this land manipulation in particular.

Taking all these catchments in combination, we can create two predictive sets of vegetation acreage numbers for La Crosse area Oneota sites containing bison remains within the four clusters of one-mile catchments that align with the color coding. Acreage statistics for the four DNR shapefile catchments are considered as a whole in Table 1 to show the strength of the suggested GIS methods in making vegetation inquiries that relate to set variables. Combined are lowland hardwoods and oak thickets, both considered "heavier" timber to make the results comparable following ecotone suggestions (Edwards 2010, 2017; Jeske 1990). The sample size of 1,975 acres does not account for the missing water in Figure 12, leaving the acreage sample size lower than the custom digitized file. Wooded areas are noted in this table as the highest frequency vegetation type at around 659 acres, while prairie and oak openings follow. At first glance, Table 2 suggests that oak openings, or light timber areas, and prairies are at high frequencies, while all other environment types are at a low frequency. This expectedly contradicts the DNR data. The sample size is slightly larger at 2153 acres, but again, this is mostly just added to the waterway variable. This is not to say that the digitized file and acreage from Table 2 is the new vegetation standard, as it has been noted that prehistoric populations manipulated vegetation, affecting PLSS analysis (King 1978; Wagner 2003). Historic notes also present their own obstacles in analysis, as researchers may decipher historic feature or soil notes differently (see the below naming schemes). Despite these challenges, this project has indicated that when considering potential *B., bison* subsisting in environments near the analyzed sites, the level of accuracy and precision of vegetation ecotone representation and acreage was improved, and it allowed better estimates of areal units per vegetation zone. The acreage of oak openings or lightly forested areas transitioning into prairies versus thicker oak areas or forests is useful information as ecotone breaks were important to prehistoric residents (Jeske 1990). These ecotones would provide the main vegetation types that would have hypothetically been what local herds would have needed to subsist in late prehistoric Wisconsin (Edwards 2010; Jeske 1990; McMillan 2006; Sasso 2014).

Discussion

To discuss these results, bison themselves are considered. Herd size and mobility are directly related to available water and grazing land. Bison also have a selective digestive system, are affected by forage seasonality, and can forage in shortgrass, tallgrass, and transitional grasslands as long as the forage meets a certain nutrition level (Bamforth 1988; Knapp et al. 1999; Kruger 1986; Larter and Cormack 1991; Rivals, Solounias, and Mihlbachler 2007; Widga 1997, 14-16). Pollen data suggests that southwestern Wisconsin in late prehistory may have supported an adequate bison feeding environment in terms of edible tallgrass prairie plants (Leach et al. 1999; Martin 2014; McMillan 2006; Meszaros and Denny 2017; Sasso 2014). It falls on the edge of the Prairie Peninsula, through which bison may have traveled as far as Pennsylvania or South Carolina (Belue 1996). This research's approach to digitizing potential grazing acreage could eventually be used to estimate accurate potential herd forage across the whole southern part of the state if it is combined with botanical and soil data (King 1981, 44; Meszaros and Denny 2017). Worth considering, just because possible bison forage exists, does not mean the animals were necessarily there.

The results of this study attempted to address original and decade-old issues and show La Crosse county is more hospitable to bison in late prehistory then Finley's DNR (2017) reconstruction would suggest. Sasso (2014, 176) reports, again, most of the specimens recovered archaeologically are scapulae, with these elements utilized predominantly as hoes for agricultural purposes. The local acquisition and targeting of this agricultural tool would have to exist in larger catchments than this study suggests. It also opens a can of worms relating to the question: what is *local*? If suitable bison environments existed in the past, and bison were observed in southern Wisconsin and northern Illinois in historic times, why is the archaeological frequency of bison remains not higher? Other lines of evidence, specifically non-local indicators on La Crosse Oneota end scrapers, and the documented trade network that connected the Plains to the Great Lakes region in late prehistoric times, have been seen as challenges to the hypothesis of local bison herds (Boszhardt and McCarthy 1999; Martin 2014; Sasso 2014; Theler and Pfaffenroth 2010). The possibility of variation in levels of trade, and combinations of local and non-local acquisition of bison as tools and food seems highly plausible, as well as taphonomic issues that could attribute to specimen transparency in the archaeological record (Binford 1978, 1981; McMillan 2006; Lyman 1994; Rietz and Wing 2008; VanDerwarker and Peres 2010).

The presence of prehistoric populations of local bison herds deserves continued investigation. Bison researchers, such as Sasso (2014), would essentially argue that most populations of prehistoric peoples, when faced with the chance to take or hunt large animals at a low cost, would take advantage of the opportunity. The riverine and marsh environments surrounding the La Crosse sites would have created potential trap situations documented in the same type of environments near the Illinois River if combined with factors such as coordinated fires (Hennepin 1938; McMillan 2006). Upper Mississippian populations recorded these fauna on rock art found near the La Crosse locale as well, notably in the heartline motif, and these animals clearly held some place in prehistoric lifeways (Boszhardt 2000; Salzar 1987, 1997; Schrab and Boszhardt 2016). Just how much tallgrass prairie was available

Many Plains studies have shown over time and space that although bison health and population size was dependent on forage and climate stressors, bison are also capable of foraging in a variety of grassland environments (Coppedge, Leslie Jr., and Shaw 1998; Knapp et al. 1999; Kruger 1986; Larter and Gates 1991; Peden 1976; Widga 1997, 2014). While ideal vegetation conditions for bison may not have been common in historic Wisconsin, documented historic cases suggest the state did at times provide some sort of sufficient conditions post-circa 1500 when bison are proposed to enter the Prairie Peninsula east of the Mississippi River (Belue 1996; Leach et al. 1999; Sasso 2014; Schorger 1937; Wisconsin DNR 2006). The argument is that during the late prehistoric period, these may have been just good enough to support small fringe populations that utilized the vegetation that was available; but, with no indications of long-term grazing or bison trail effects in Wisconsin's section of the Prairie Peninsula, bison may never have become an integral part of any Wisconsin ecosystem (Belue 1996; Leach et al. 1999; Martin 2014; Sasso 2014).

The results of this paper suggest the method of digitizing files to create custom map files can be taken from this pilot and used in many study areas at larger catchment radii following the guidance of previous scholarship (Edwards 2010; Fritschle 2008; King 1978). The maps also continue to support historic GLO digitization at a section and township level, and provide a framework for future local hunting and faunal acquisition inquiries around archaeological sites from the late prehistoric through the late historic. When considering the GLO ecological reconstruction GIS method, georeferencing and digitization can be learned by novice users quite rapidly, but deciphering GLO notes and maps once they are aligned in mapping software becomes the trick. To aid in creating custom digitized maps, experience with GIS and ArcMap's editor toolbar, historic map production, surveyor routes and measurement techniques, georeferencing, local soil and ecotone types, and plat map key words is essential (Edwards 2010, 2017; Nicholls 2017).

The biggest challenge in this type of research will always be the translation of historic notes that may have errors, or lack quality. This challenge is twofold. On one hand, GLO notes were produced by many surveyors, so connecting notes is by no means streamline. On the other hand, the modern analyst may interpret historic surveyor observations differently where, for example, it is unknown how many oaks it takes to call something an oak opening, or an oak forest. If no key words can be found on a map or in the section notes, it becomes a game of connect the dots. With these difficulties in mind, the method is still highly useful and suggested in Wisconsin. Although literary background was provided relating bison to these maps, the catchments need to be larger to apply this animal to historic vegetation.

Conclusion

This study demonstrated the value of using General Land Office plat maps and geospatial information systems to create custom vegetation maps at a finer scale than provided by the Wisconsin DNR's (2017) "Pre-European Settlement" shapefile (using the same GLO data listed in its metadata at a 1:500,000 scale). This study offers a framework for future bison-vegetation related research, as well as providing an updated method for utilizing publicly available GIS data in archaeological studies. One should not assume that because data comes from a scholarly source that the data will fit their study parameters adequately, and this is not an attack on DNR geospatial data, as high-quality exists in other datasets. Although hypotheses collide as to why bison remains mainly end up in La Crosse contexts in Wisconsin, this study shows at the most basic level of this case, digitizing custom vegetation maps in coordination with plat maps provided the best route to linking 1850's vegetation and late prehistory. Developing detailed estimates of acreage of particular color-coded types of vegetation and ecotone breaks then became possible within catchments around sites with *B. bison* remains. Again, the future is bright for this type of comparative research, and it is suggested that increasing the scale and supporting climate data would bolster zooarchaeological arguments that use historic GLO data. In terms future research questions, this pilot can be used as a bridge: what would be the ideal grazing acreage for a small herd ; how general should ecotone classifications be; can the sites be clustered differently? It was the goal of the above research to reveal these types of nuances along with the results.

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Appendix I

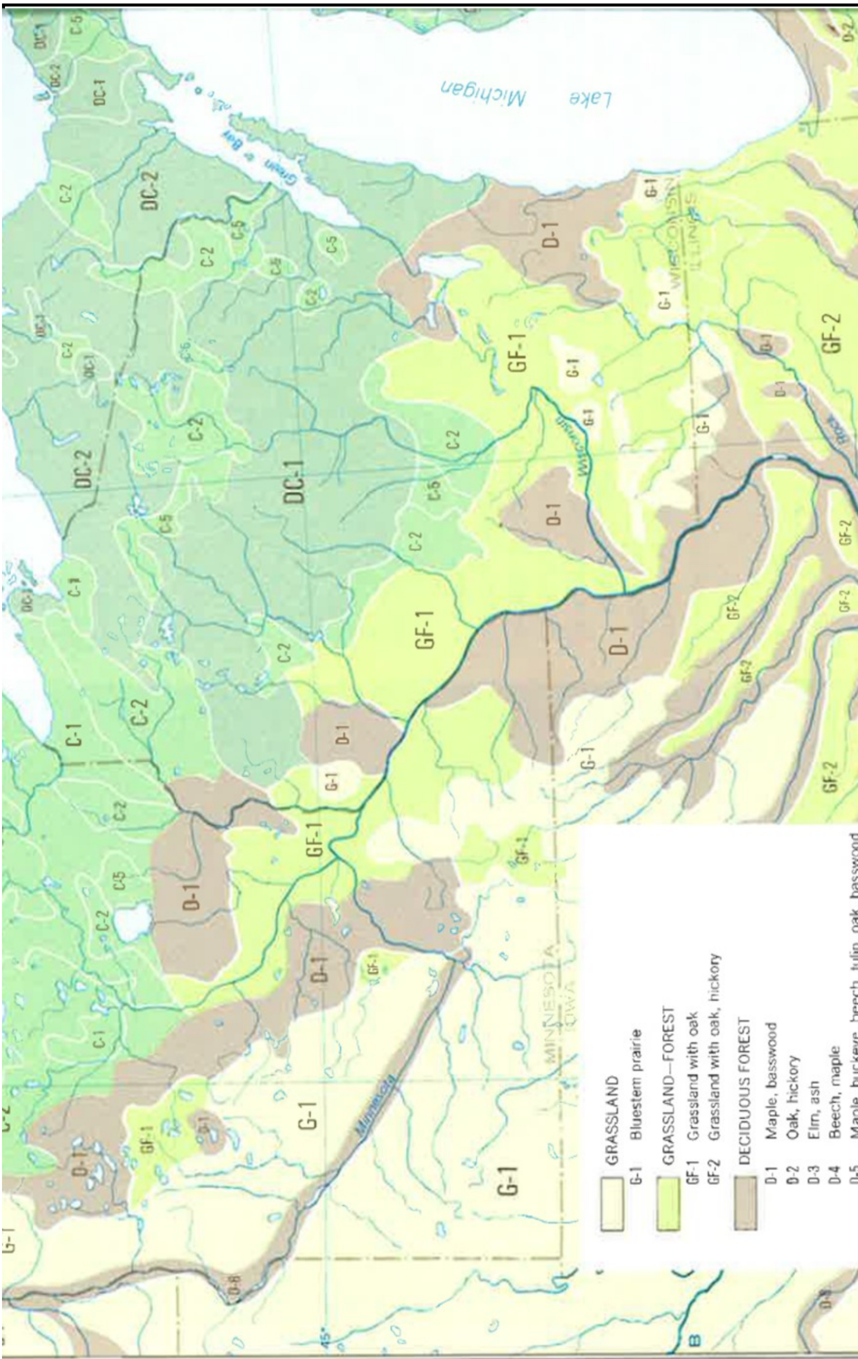


Figure 1. Adapted from the *Atlas of Great Lakes Indian History* (Tanner, Helen Hornbeck, and Miklos Pinther 1987).

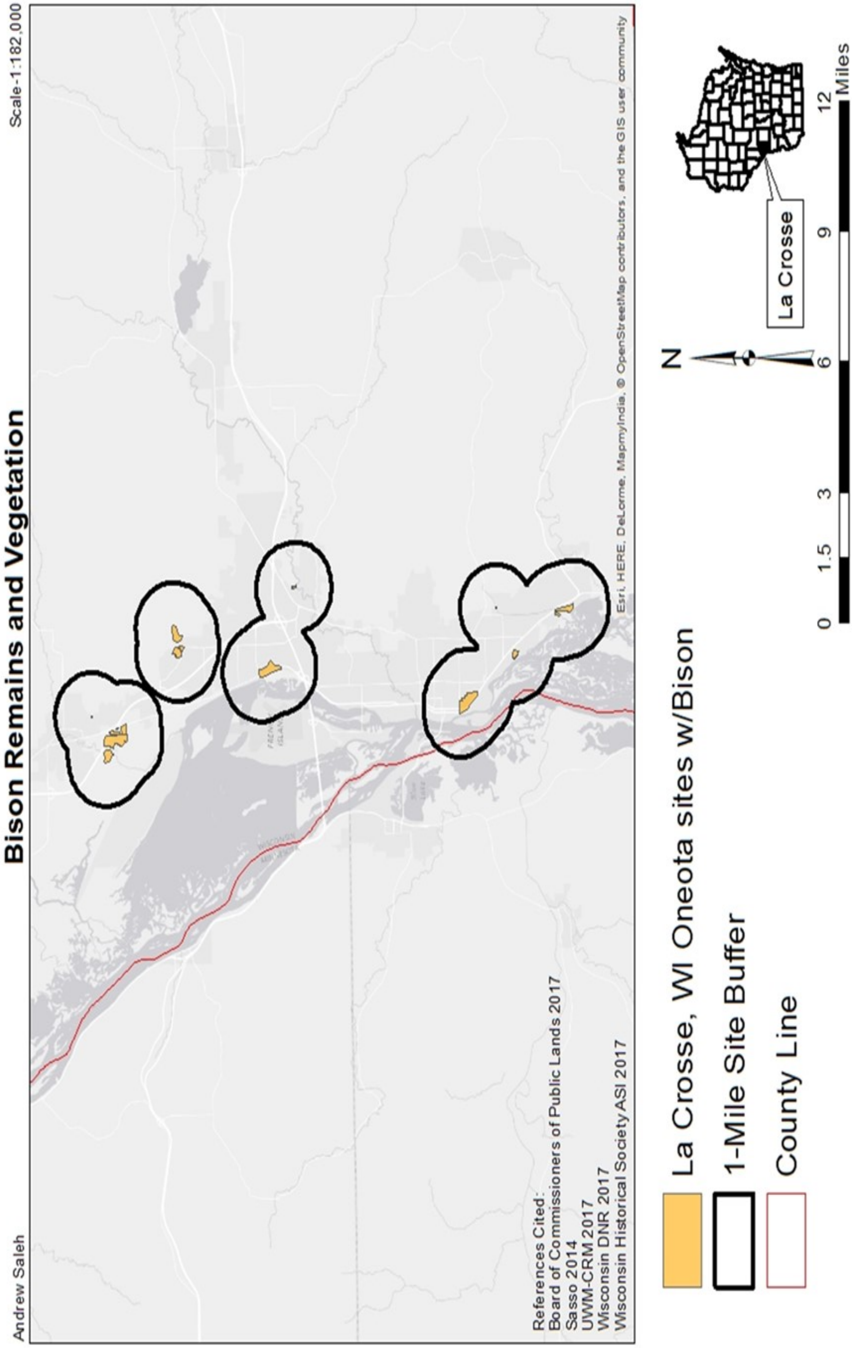


Figure 2: Case study area.

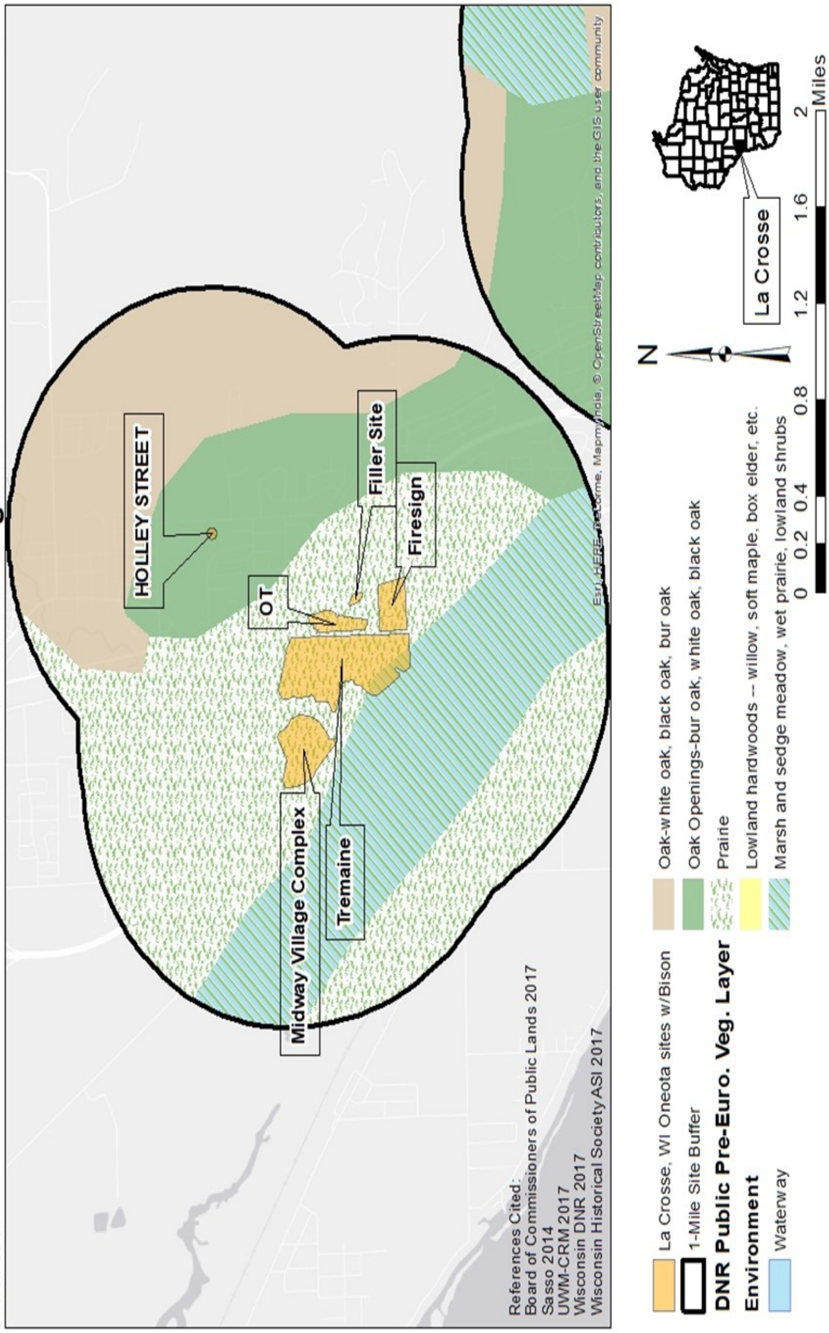
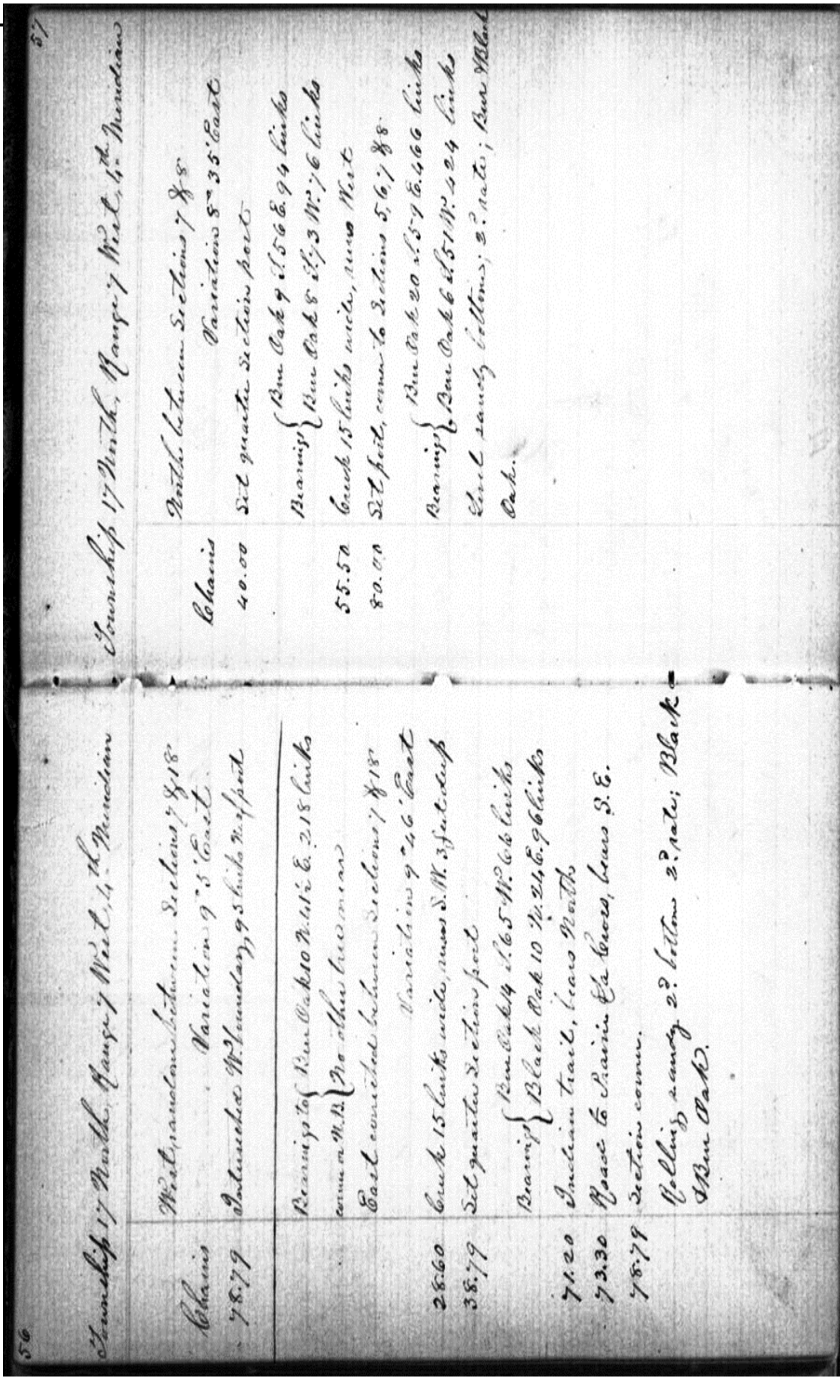


Figure 3. Map of six Oneota sites which contained some degree of bison remains.



56

Township 17 North, Range 7 West, 4th Meridian

Chains

West boundary between Sections 7 & 18
Variation 9° 5' East

78.79 Intersected W. boundary, 95 links N. of post

Bearings to Bur Oak 10 N. 41½ E. 218 links
corner on W. B. { No other trees near

East variated between Sections 7 & 18
Variation 9° 46' East

28.60 Creek 15 links wide, runs S.W. 3 feet deep
38.79 Set quarter section post

Bearings { Bur Oak 14 S. 65 W. 66 links
Black Oak 10 N. 24 E. 96 links

71.20 Indian trail, bears North
73.30 Road to Prairie, bears S.E.
78.79 Section corner.

Rolling sandy 2d. bottom 2d. rate; Black & Bur Oak.

57

Township 17 North, Range 7 West, 4th Meridian

Chains North between Sections 7 & 8
Variation 8° 35' East

40.00 Set quarter section post

Bearings { Bur Oak 9 S. 56 E. 94 links
Bur Oak 8 S. 73 W. 76 links

55.50 Creek 15 links wide, runs West
80.00 Set post, corner to Sections 5, 6, 7 & 8

Bearings { Bur Oak 20 S. 57 E. 466 links
Bur Oak 6 S. 51 W. 224 links

Level sandy bottom; 2d. rate; Bur & Black Oak.

Figure 4: Adapted from the Board of Commissioners of Public Lands (2017).

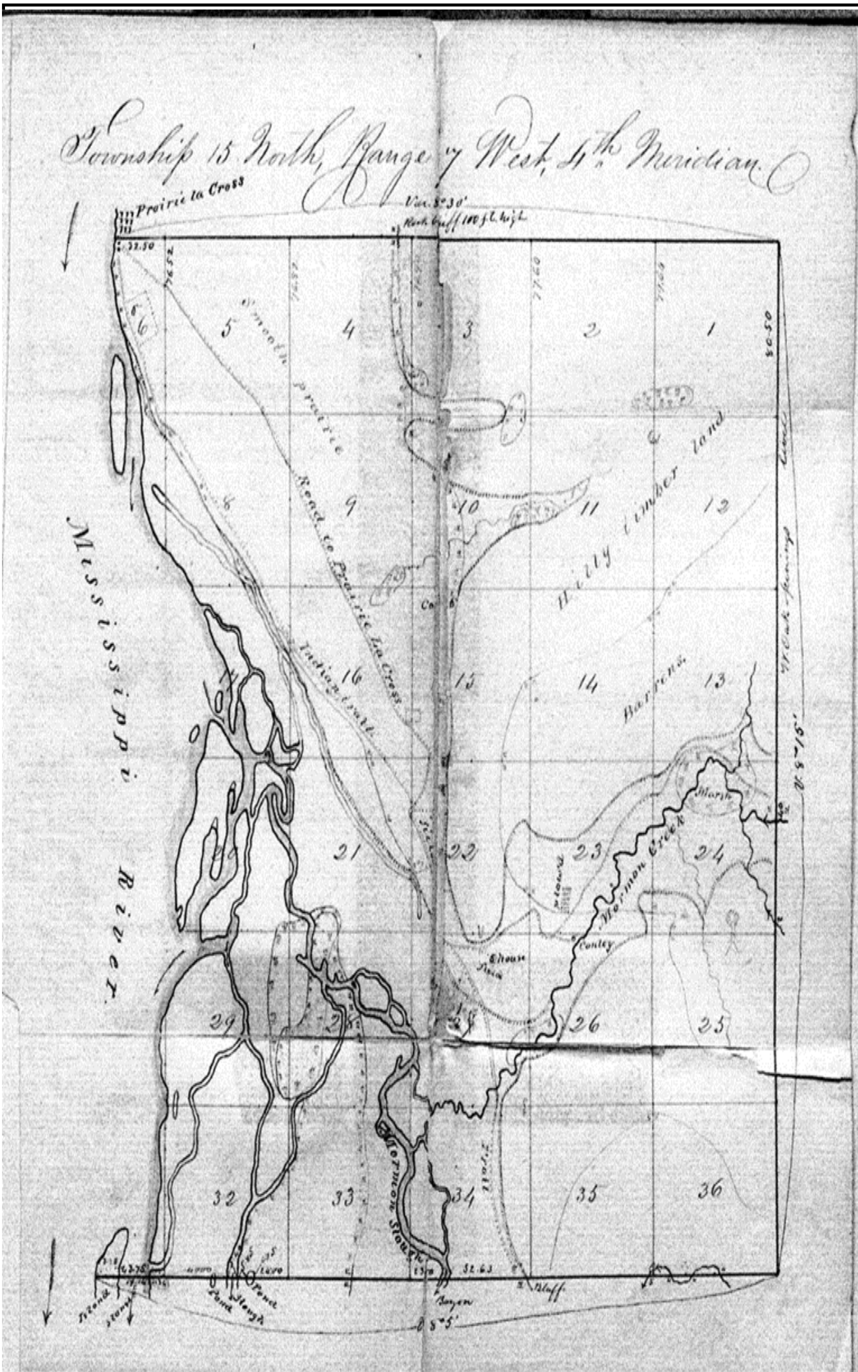


Figure 5: Adapted from the Board of Commissioners of Public Lands (2017).

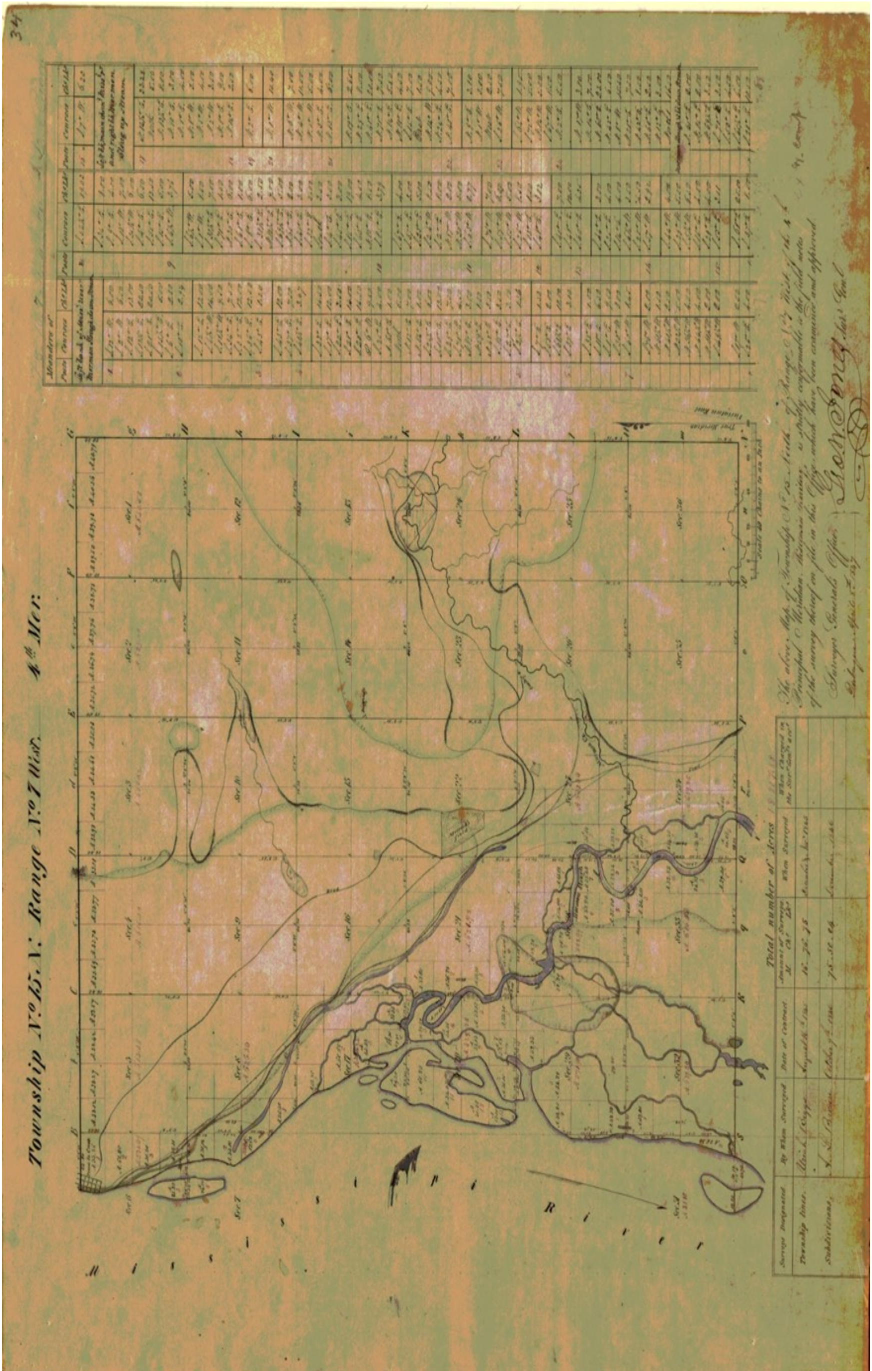


Figure 6: Adapted from the Board of Commissioners of Public Lands (2017).

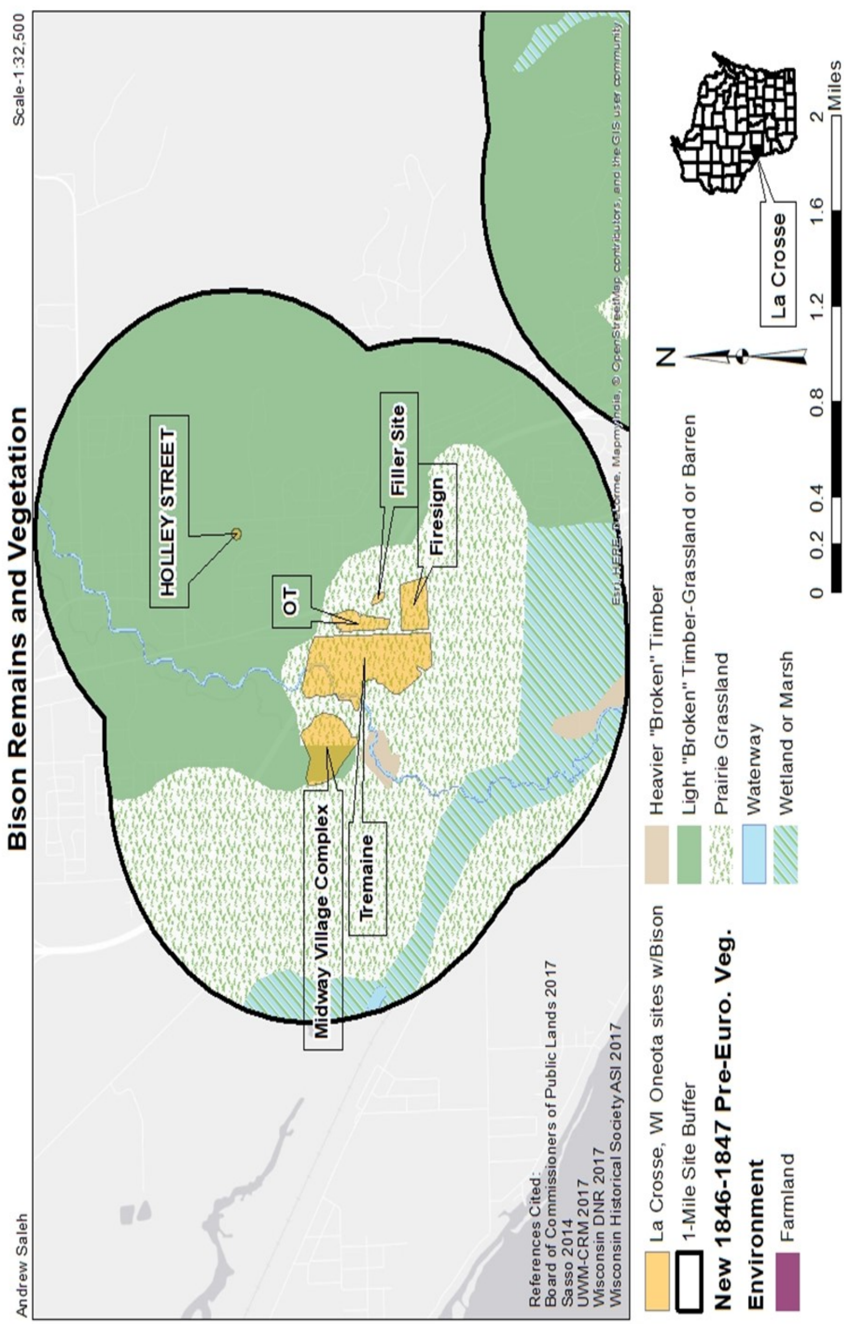


Figure 7. Depiction of a cluster of sites within ecotones revealed with localized analysis in La Crosse county.

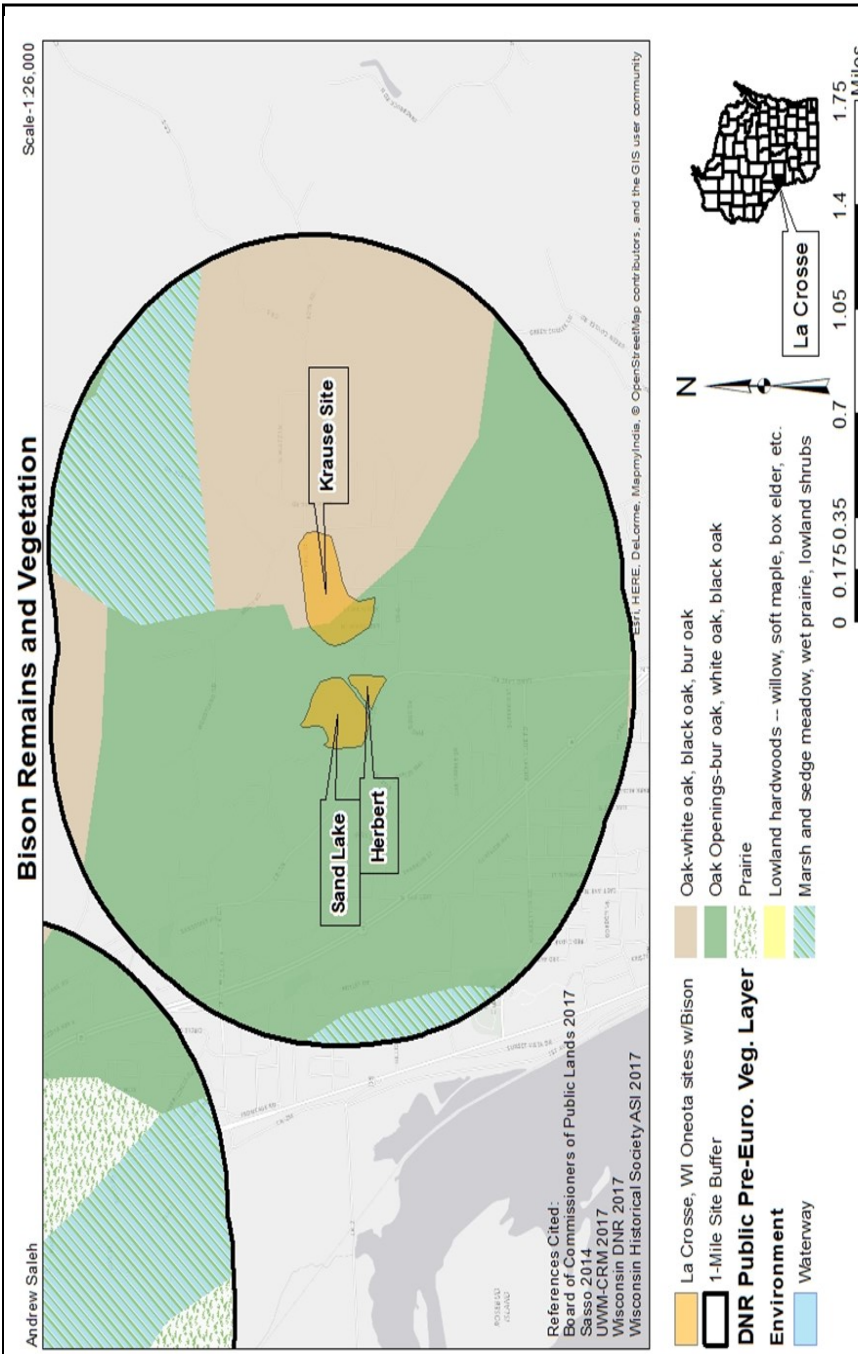


Figure 8. Map depicting a cluster of sites to the southeast of sites in Figure 7 within ecotones revealed with localized analysis in La Crosse county.

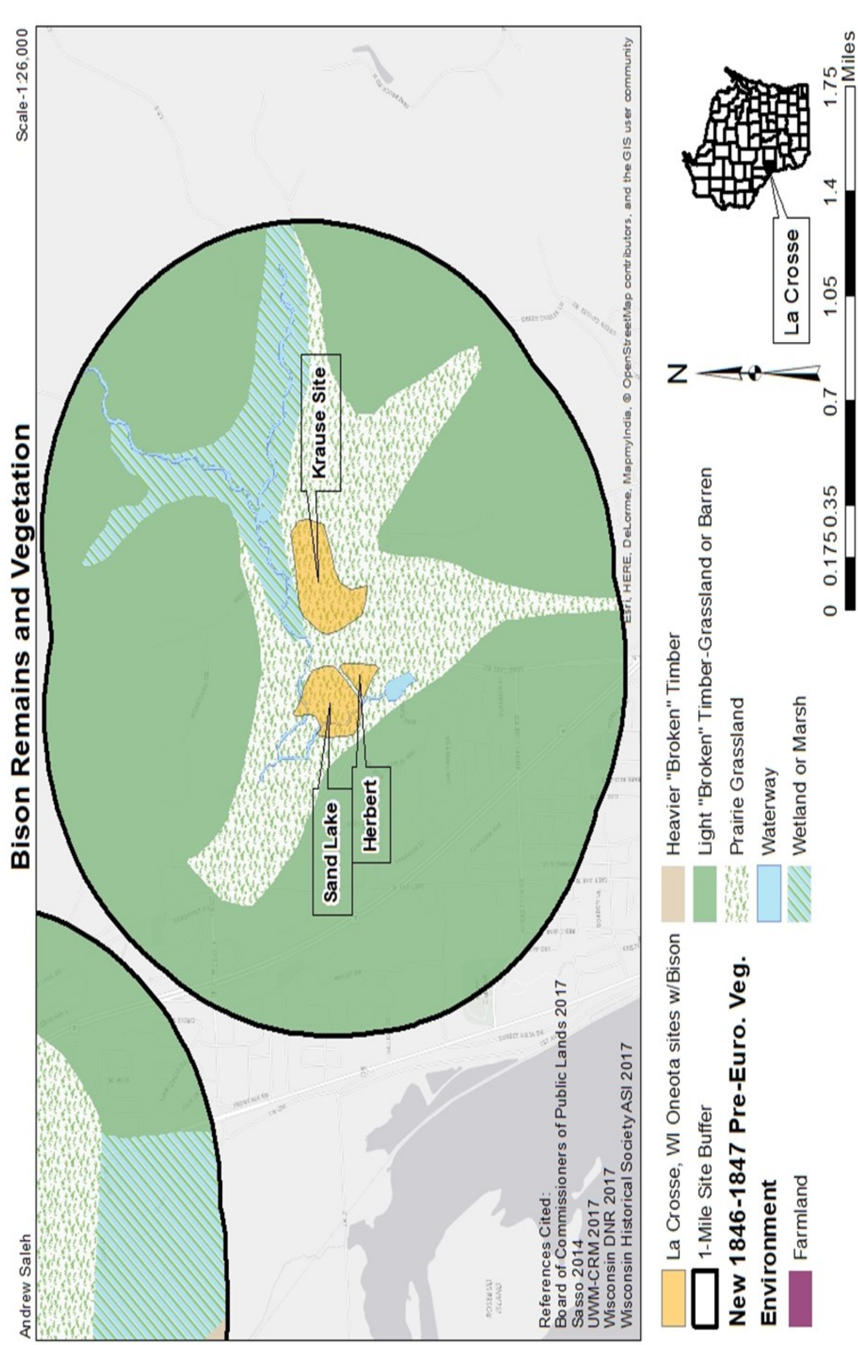


Figure 9. Map depicting a prairie pocket surrounded by an "oak opening" in the DNR metadata (Wisconsin DNR 2017).

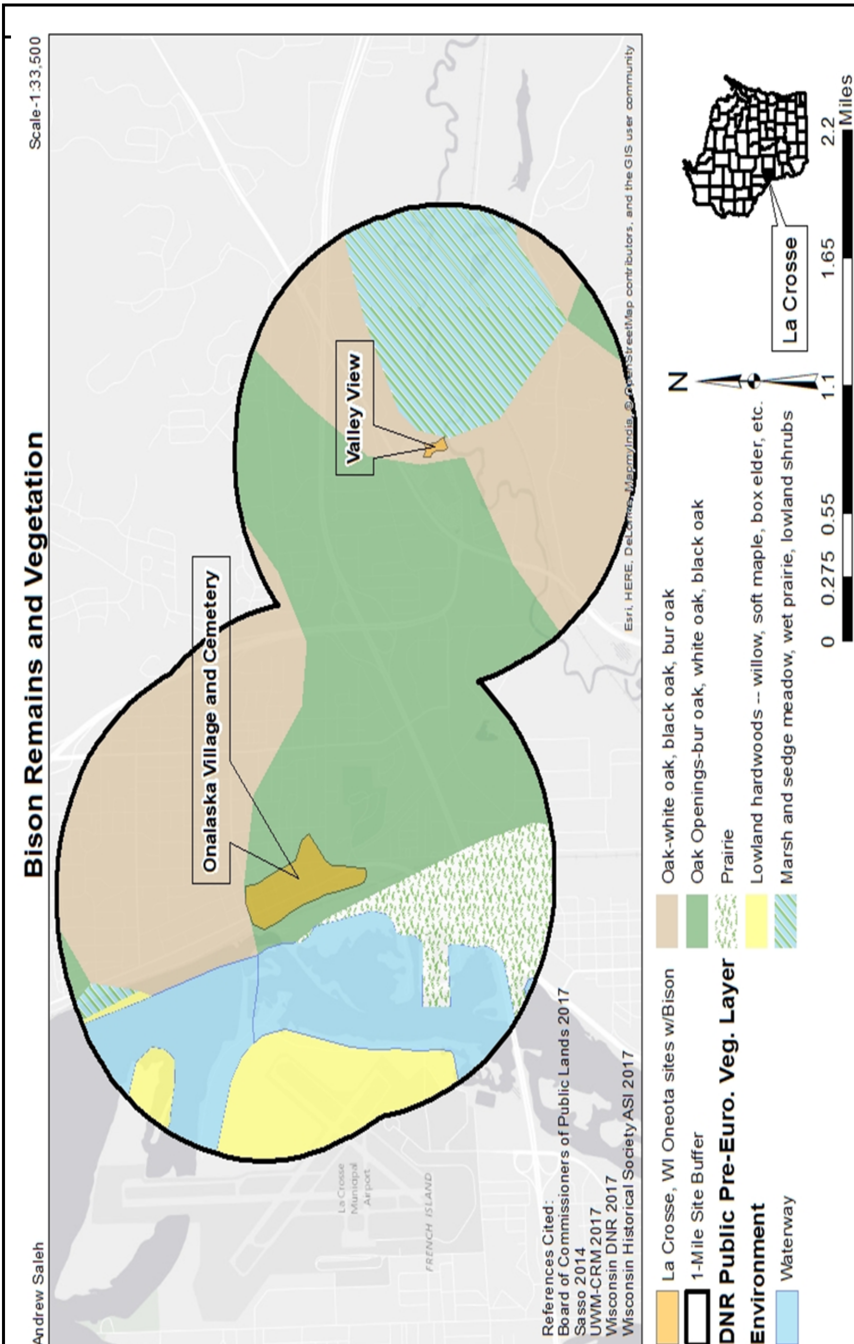


Figure 10. Map depicting the study's third cluster and one-mile catchment, and the trend from clusters one and two continues.

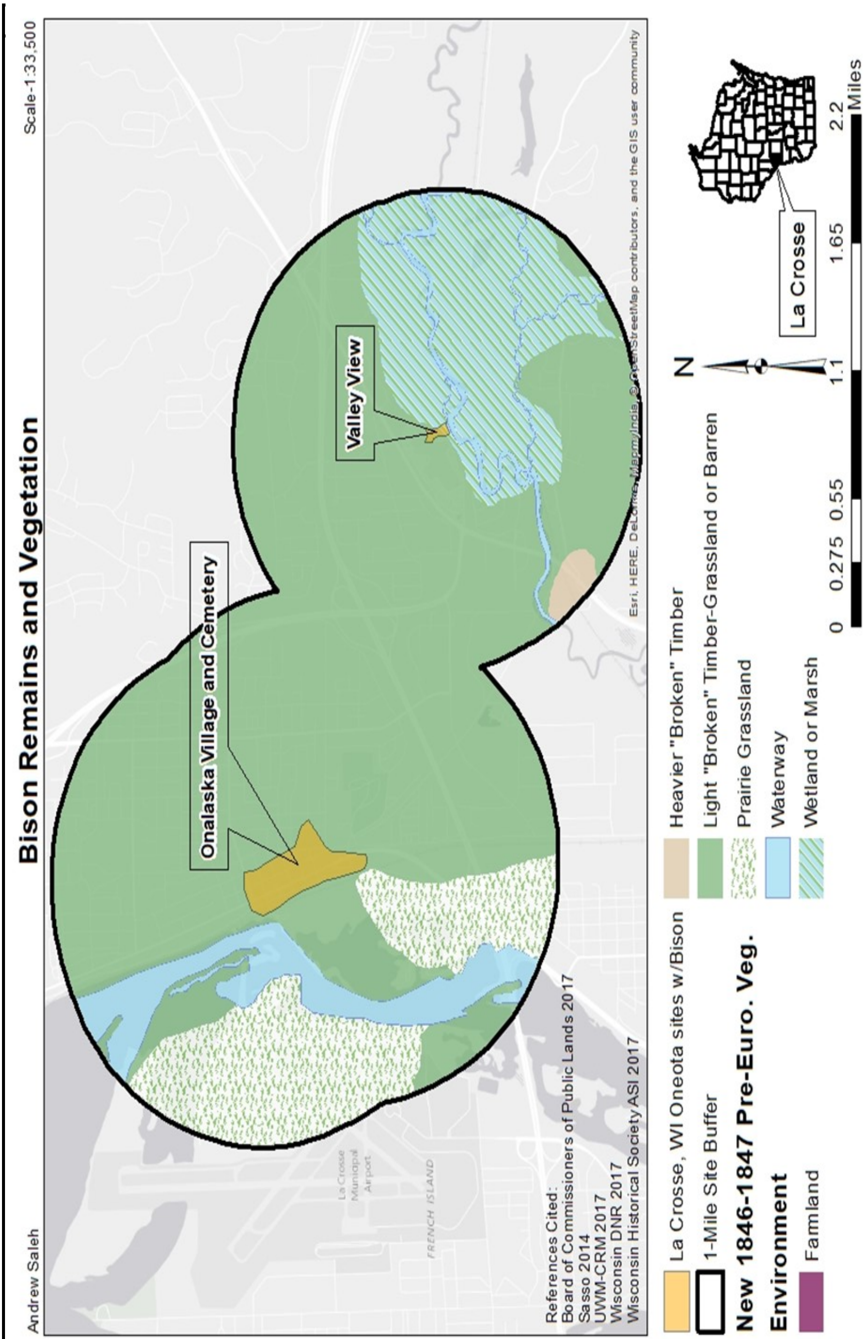


Figure 11. Map depicting the study area is less wooded than the DNR shapefile depicts to the viewer.

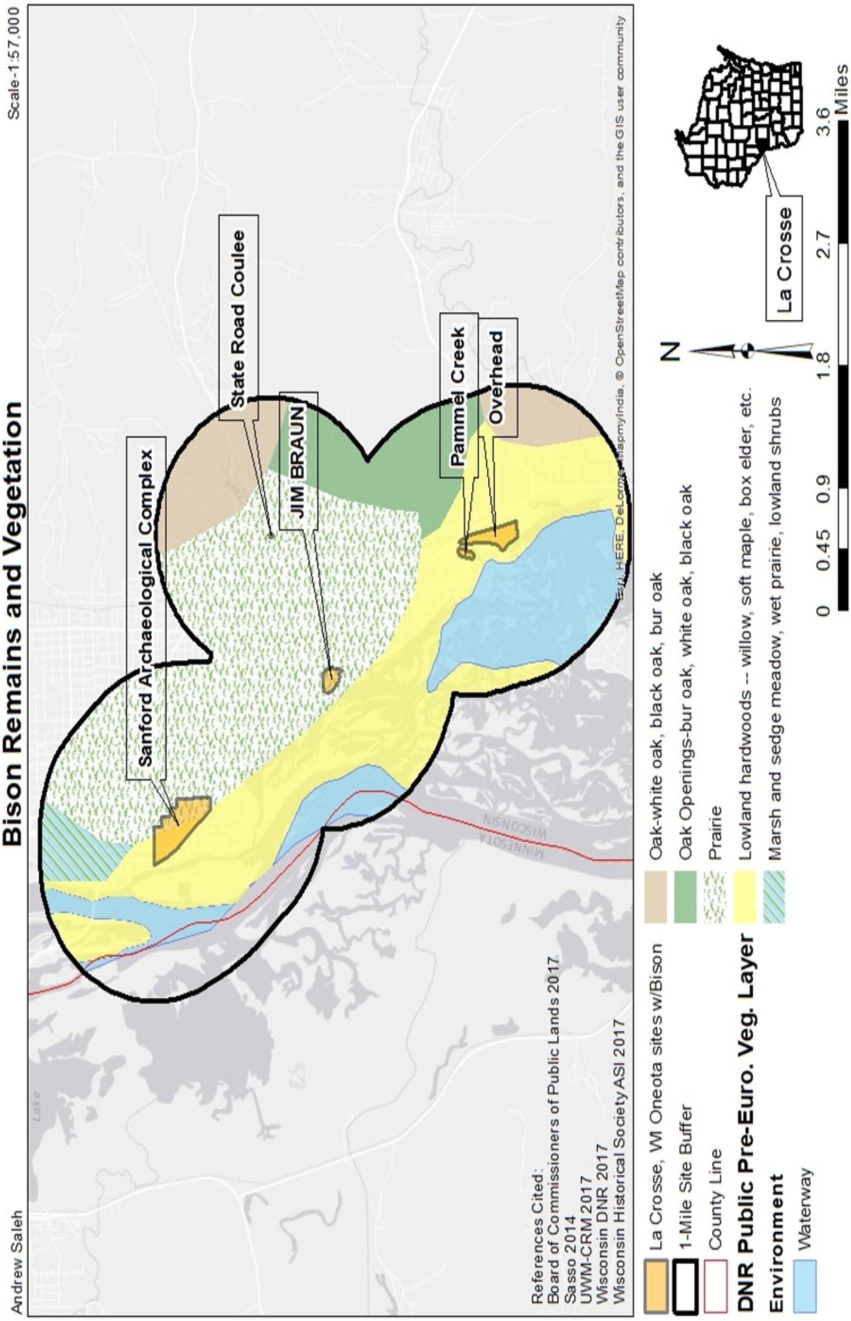


Figure 12. Map depicting local geospatial analysis of the southernmost cluster of sites with Bison remains.

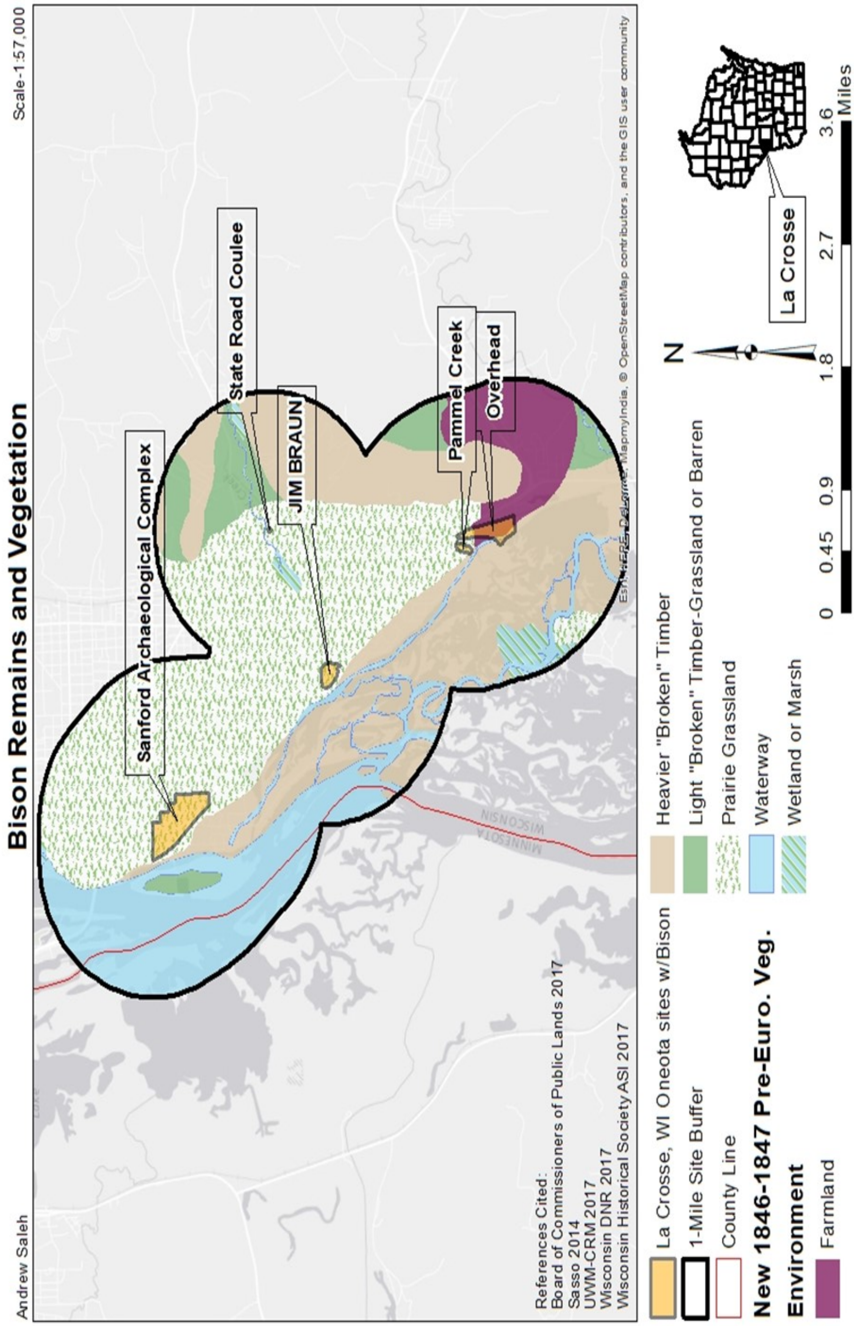


Figure 13. Map depicting greater accuracy and precision of ecotones within the catchment boundaries.

Table 1. Wisconsin DNR (2017). N=1975.563 acres. Table of combined vegetation of the sampled GIS data from the DNR. Arrows = frequency.

Environment		Acres (DNR File)
Lowland Hardwoods/Oak ("Heavier")	↑	659.654
Oak Openings ("Light")	→	474.391
Prairie	→	478.665
Waterway	↓	172.199
Wetland or Marsh	↓	190.654

Table 2. Board of Commissioners of Public Lands (2017). N=2153.898 acres. Table of combined vegetation of the sampled GIS data from the newly digitized vegetation. Arrows = frequency.

Environment	Acres (Digitized File)
Farmland	↓ 47.237
Heavier "Broken" Timber	↓ 274.162
Light "Broken" Timber-Grassland	↑ 815.454
Prairie	↑ 625.546
Waterway	↓ 184.853
Wetland or Marsh	↓ 206.646