Buffalo Commons Proposal

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GIST 5300

Willem Lee-Stockton – Final Project

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1. Introduction

The purpose of this study is to propose the most suitable location within the Great Plains for Buffalo Commons. If no precaution is taken, the Great Plains and American Bison are on the verge of extinction. New technology caused decrease in the need for farmers, ultimately causing a large population to decrease in the rural regions. Additionally, referring to President Biden's 30 by 30 policy, which is protection of 30 percent of land and 30 percent of ocean water, we should be able to be even more encouraged to preserve national habitat (2). History shows that bisons were destined to eradication because of brutal US policy against Native Americans. In US, the only location which preserved bisons was Yellowstone National Park (1). The regrowth of more than 1,100 animals in Yellowstone Park also encourages to realize this project as a preservation method for bisons (5).

Thanks to Frank and Deborah Popper, the idea of Buffalo Commons was proposed to save the national heritage and improve the agricultural economy to include tourism (6). According to Moran, today we achieved repopulating around 500,000 bison in more than six thousand areas which includes Indian reservations as well (3). The proposal included several benefits, such as tourist industry, repopulate and improve the rural economy. The issues were raised by farmers who have put their time and energy on cultivating these lands and are suspicious of the governments' intentions. To resolve those concerns, the plan below was proposed:

1. Overall, 20B$ would be spent on those lands
2. Landowners might also opt for staying on their own lands and not to move or if they decide to sell, they would be paid twice of the original price of the land
3. Landowners would have permit to stay on their own land and would be obligated to leave in case of death of their spouse (1).

The project was done using ArcGIS Pro software, as well as data from outside sources. Detailed analysis of various variables such as population density, farmland values and so on. Based on multiple variables, we derived a suitability map and proposed locations (4).

2. Methods

To identify the areas with the most suitable location of Buffalo Commons, we derived 5 variables: Population Density, Population Change, Farmland Values, Percentage of Federal Lands and Adjacent Counties to Indian Reservations.

Population Density variable reflects the population per area. The less populated an area is, the more space is available for locating Buffalo Commons.

Population Change is a variable to reflect the growth or decline in the population. The decline of population is favorable, because of availability of space for the commons.

Farmland Values represent the cost of the farms per county in each state. The less a cost is for the land purchased, the better it is for finances.

Percentage of federal lands describe the land that is owned by government. It is always advisable to have more federal owned lands and opt for them when locating a wildlife preserve as commons.

The adjacency to Indian reservations is another variable to help us with the suitability choice. Choosing adjacent counties help with the economic growth of these lands.

Main classification methods used were quantile, natural breaks and manual intervals. The variables were ranked on 1 to 5 scale and were color coded relative to their classification.

Final suitability map was made on the variables as well as other factors such as location of big cities, interstate highways and land cost without exceeding 10B$.
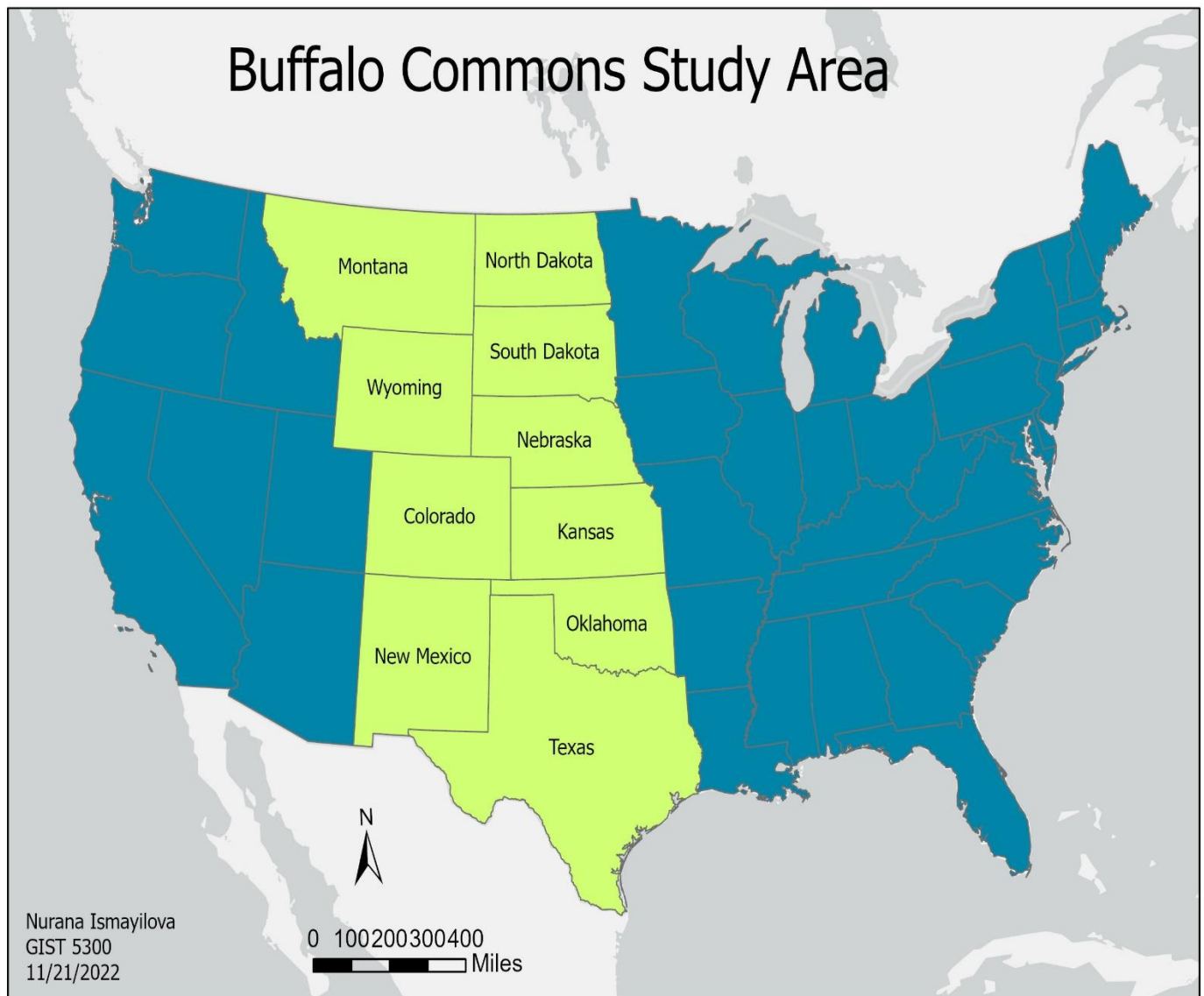
3. Study Area

The study are covers Great Plains States as in the table below. The variables were applied to the Study area throughout the proposal. The area includes 10 states with more than 800 counties. We also find some major cities and interstate highways throughout the whole region. These areas represent Great Plains and extend from north to south of the United States. The study area map is shown in the Figure 1 and states are listed below in the table 1.

States	
Montana	North Dakota
Wyoming	South Dakota
Colorado	Nebraska
New Mexico	Kansas
Texas	Oklahoma

Table 1. Great Plain States

The states extend from north to south with 823 counties present. The area covers Native American Lands as well. The study are covers a large portion of the United States and includes large percentage of federal lands.

Buffalo Commons Study Area

Montana

North Dakota

South Dakota

Wyoming

Nebraska

Colorado

Kansas

Oklahoma

New Mexico

Texas

N

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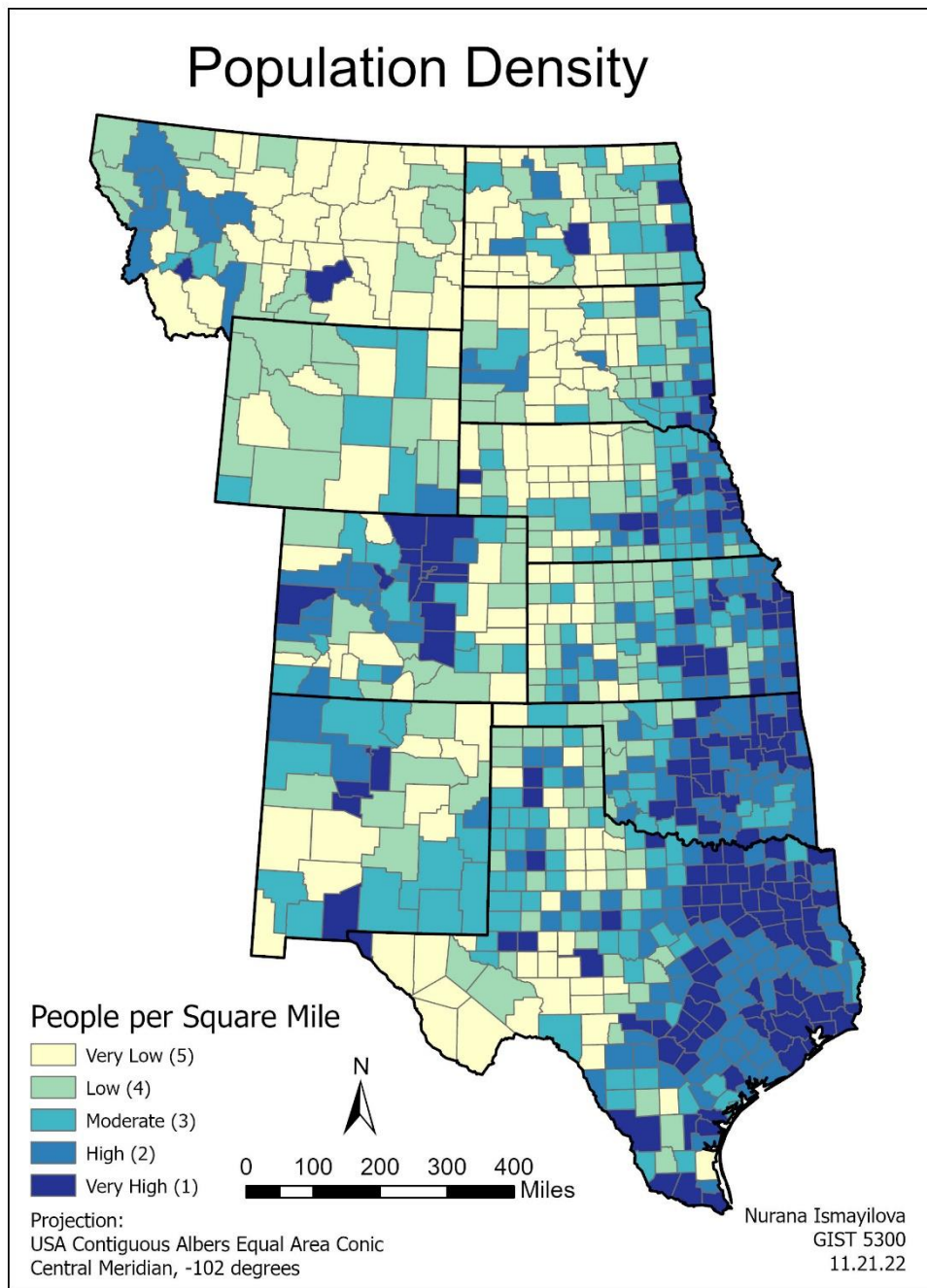Miles

Map 1. Study area, Great Plains

4. Population Density

The first variable was Population Density. It shows the quantity of population a.k.a people per square mile area. While choosing a location for the wildlife preservations, we must try to make sure that the area is not highly populated to give space to the wildlife and not to disturb and citizens. The data was obtained from 2010 Census data from each county of Great Plains area. The density is represented as division of the population per area of each county. The population density variable was calculated based on the Quantile classification method with 5 different classes. The rank "1" represents a very high population density and indicated as darkest color in the map, whereas the rank "5" shows a low population density which is very suitable for the Buffalo Commons location and represented by a light color on the map. The table below shows the range of classification for the population density as well as their corresponding suitability descriptions.

Class Range	Description of Population Density	Suitability Rank	Suitability Description
<= 2.9	Very Low	5	Very High Suitability
<= 6.6	Low	4	High Suitability
<=15.4	Moderate	3	Moderate Suitability
<=42.0	High	2	Low Suitability
<=3,879.7	Very High	1	Very Low Suitability

Table 2. Population Density Class Ranges

According to the map below, the most suitable locations which have the lowest population density are : Montana, Wyoming, North and South Dakota and several places in the states located to the south.

Population Density

People per Square Mile

- Very Low (5)
- Low (4)
- Moderate (3)
- High (2)
- Very High (1)

N

0   100   200   300   400
Miles

Projection:
USA Contiguous Albers Equal Area Conic
Central Meridian, -102 degrees

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Map 2. Population Density

5. Population Change

The Population Change indicates a change in the quantity of the population during 2000-2010 years. The population change between 2000-2010 was calculated as follows:

Population Change = (Population 2010 – Population 2000) / Population 2000 * 100
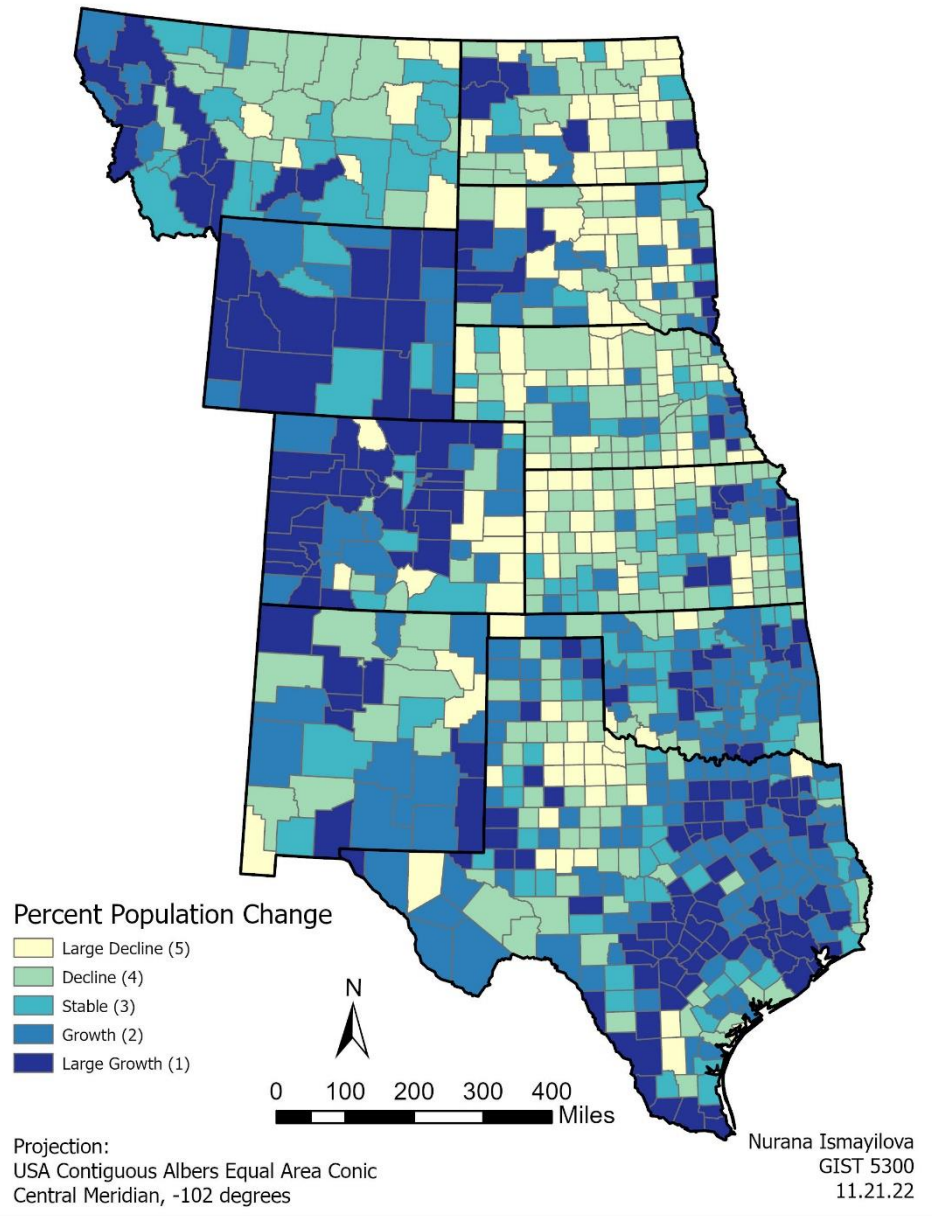
The classification method was done by manual intervals using 5 classes. The suitability rank is the highest (5) for the "Large Decline" of population, whereas it is the lowest (1) for the "Large Growth" of population. The reason for this is that when the population is decreasing, the areas are more available for locating the Buffalo Commons. The table 2 shows that classification in an ordered manner.

According to the classification, the most suitable location, which has the largest decline and ranked as 5, has the lightest color – yellow in our case. On the other hand, the locations with the largest growth are colored with darkest blue, indicating least suitable locations. Analyzing the map, one can see that the highest suitable states are North and South Dakota, Nebraska and Kansas. The states on the west side are, in general, not so suitable considering higher growth rate of population.

Class Range	Description of Population Change 2000-2010	Suitability Rank	Suitability Description
<= -10	Large Decline	5	Very High Suitability
<= -2	Decline	4	High Suitability
<= 2	Stable	3	Moderate Suitability
<= 10	Growth	2	Low Suitability
<= 85.8	Large Growth	1	Very Low Suitability

Table 3. Population Change

Population Change 2000-2010

Percent Population Change

- Large Decline (5)
- Decline (4)
- Stable (3)
- Growth (2)
- Large Growth (1)

N

0 100 200 300 400
Miles

Projection:
USA Contiguous Albers Equal Area Conic
Central Meridian, -102 degrees

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Map 3. Population Change

6. Farmland Value

Next variable is the farmland value of Great Plains. Since the initial budget for the proposal was 20B$, it is essential to manage the finances while purchasing the farmlands. In general, the lower the price of the land is, the higher is its suitability.

The classification method used here is Quantile with 5 different class ranges. The "Very Low" farmland value corresponds to the "5" in suitability ranking which indicates the "very high suitability". This is because the lowest costing farmland are the most beneficial ones.

In the map below, the highest suitability is indicated using the lightest color – light yellow – and the lowest suitable lands having the highest costs are indicated with darkest shade of blue. The areas with the highest cost and lowest suitability are in the southeast states. The lowest farmland values are on the northwest of the map such as Montana, Wyoming, North and South Dakota and New Mexico – which is in the southwest.

Quantile intervals	Class Range	Description of Farmland Value	Suitability Rank	Suitability Description
0-237	<= $237	Very Low	5	Very High Suitability
238-336	<= $336	Low	4	High Suitability
337-461	<= $461	Moderate	3	Moderate Suitability
462 - 720	<= $720	High	2	Low Suitability
721 - 2698	<= $2698	Very High	1	Very Low Suitability

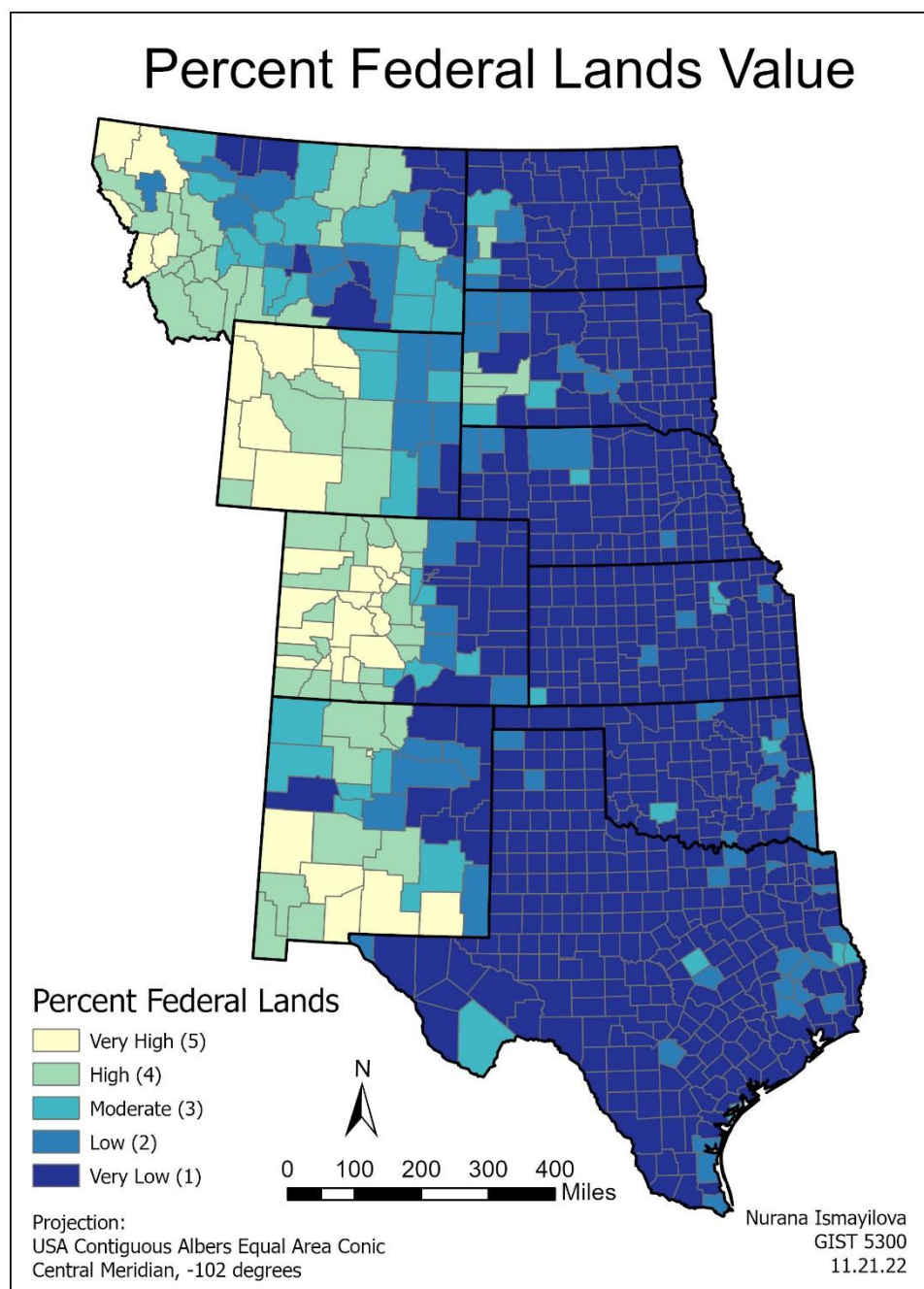Table 4. Farmland Value
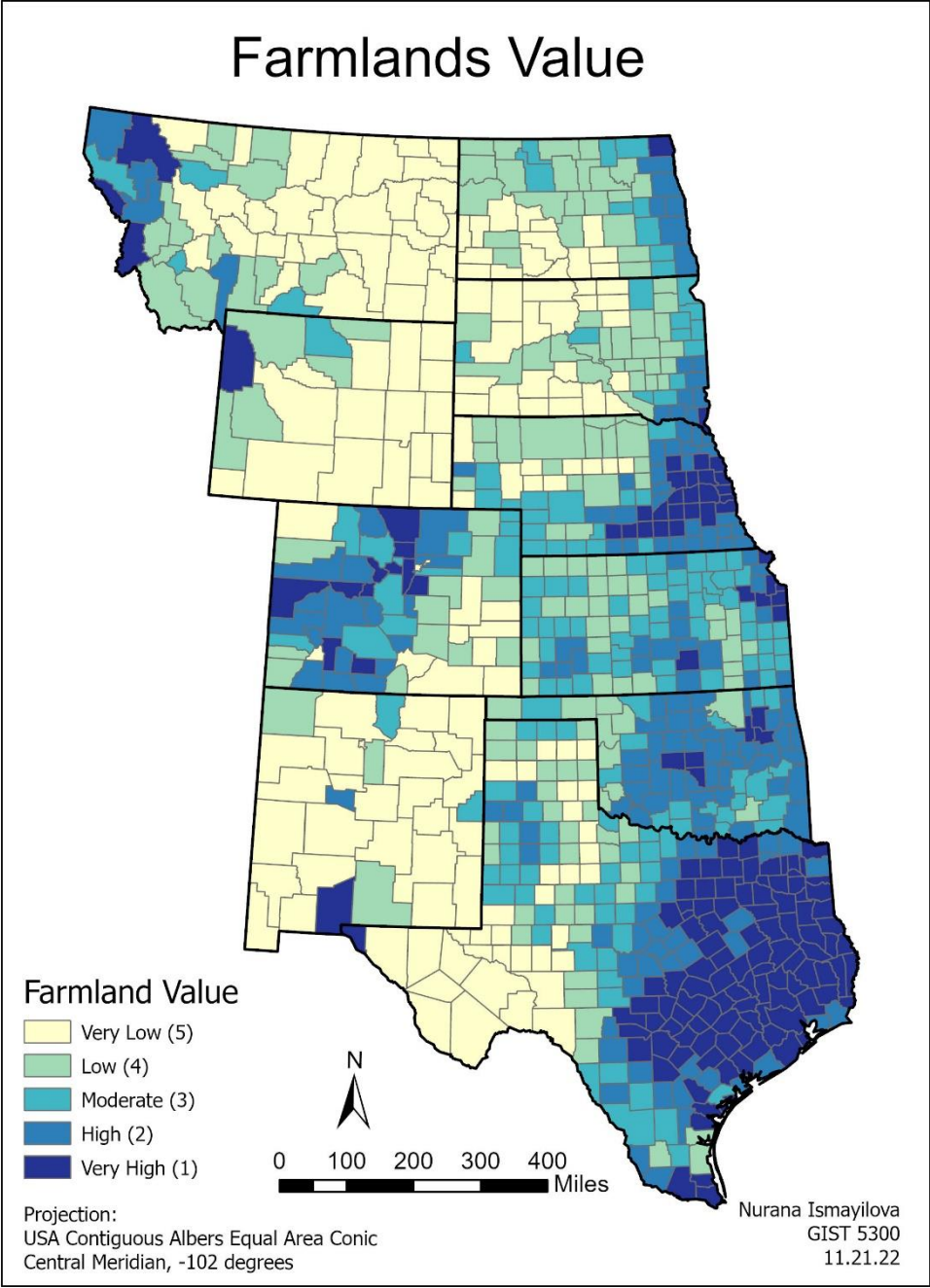
Map 4. Farmland Value

7. Percent Federal Land

The percent federal land value describes the percentage of federal lands in each county. The classification method used was natural breaks with 5 different class ranges. The lowest percent of federal land corresponds to the lowest suitability, whereas the higher the availability of federal lands, the higher is the suitability. The counties with higher federal land are very suitable for the Buffalo Commons.

Higher suitability areas are denoted as lighter yellow colored and lower suitability is shown as darker blue colors. The map indicates that the most suitable and lightest colored areas are west part of the westside states such as, Montana, Wyoming, Colorado and New Mexico.

Natural Breaks Intervals	Class Range	Description of Percent Federal Land	Suitability Rank	Suitability Description
(0%-4.8 %)	<= 4.8%	Very Low	1	Very Low Suitability
(4.9% – 15.4%)	<= 15.4%	Low	2	Low Suitability
(15.5% – 31.8%)	<= 31.8%	Moderate	3	Moderate Suitability
(31.9% – 60.1%)	<= 60.1%	High	4	High Suitability
(60.2 %– 95.0 %)	<= 94.9%	Very High	5	Very High Suitability

Table 5. Percentage of Farmland Value

Percent Federal Lands Value

Percent Federal Lands

- Very High (5)
- High (4)
- Moderate (3)
- Low (2)
- Very Low (1)

N

0   100   200   300   400
Miles

Projection:
USA Contiguous Albers Equal Area Conic
Central Meridian, -102 degrees

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Map 5. Percent Federal Lands

8. Counties Adjacent to Indian Reservations

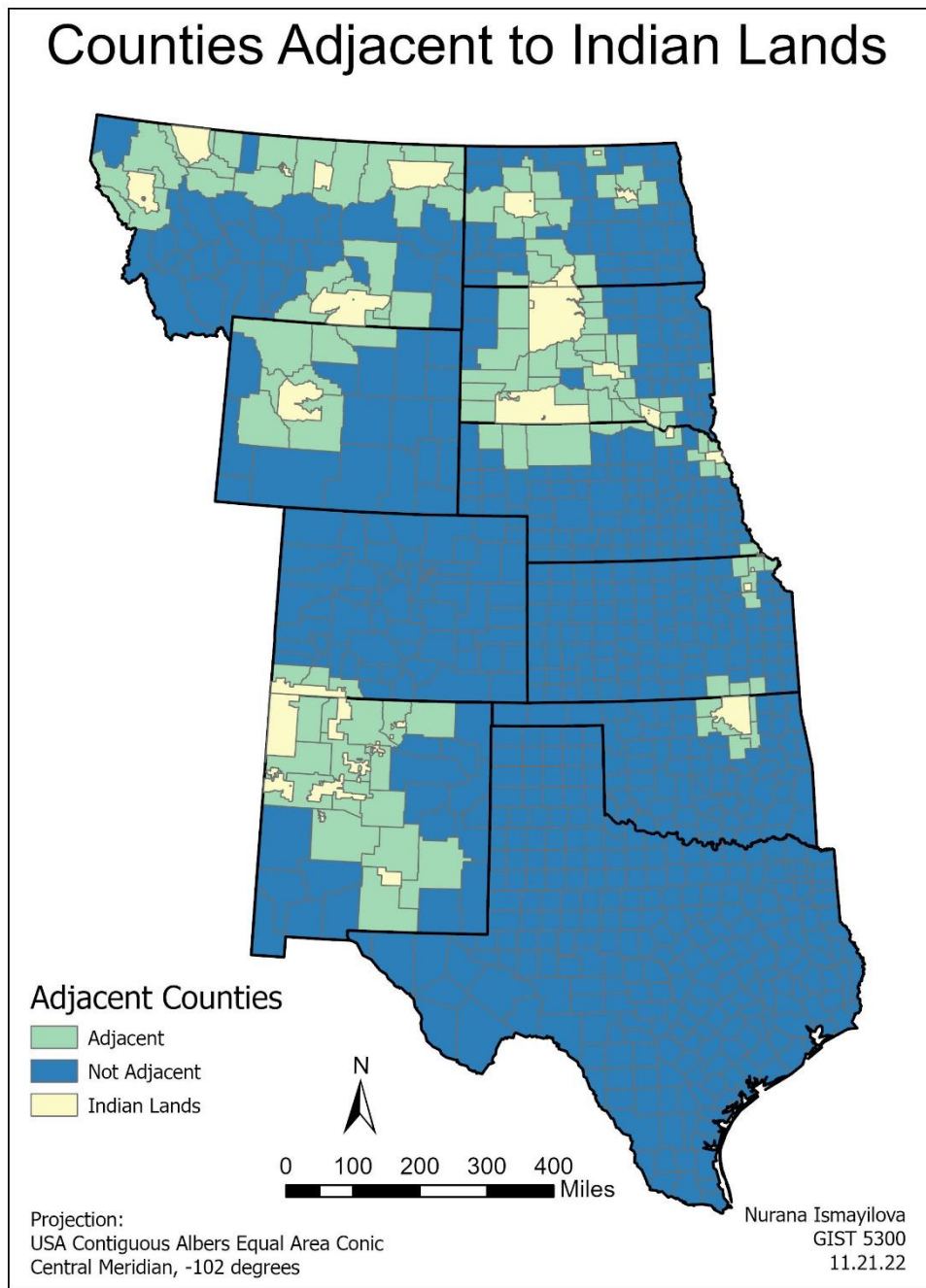The adjacency to the Indian Reservations is important for the commons. The closer the c

The classification method was made using natural breaks with 2 classes. The lands adjacent to the reservations were noted as "1" and the others were denoted as "0". Table 5 shows the suitability and adjacency relation of the counties.

Map shows the adjacent counties, Indian lands, and the non-adjacent counties. The adjacent lands were colored green, Indian lands are yellow, and the rest of the counties have dark blue color. The adjacent counties are mainly in Montana, Wyoming, New Mexico, North and South Dakotas.

Class Range	Description of Population Change	Suitability Rank	Suitability Description
1	Adjacent	High	High Suitability
0	Not Adjacent	Low	Low Suitability

Table 6. Adjacent Counties

Map 6. Counties Adjacent to Indian Lands

9. Final Suitability Results

The final suitability map was created using different variables.

The method of classification was Quantile using 5 different classes. The ranking was done by adding the ranking of all the variables above and adding their maximum ranking and dividing by the number of variables. The maximum ranking for each variable is as follows:

Population Density – 5

Population Change – 5

Farmland Value – 5

Percent Federal Lands – 5

Adjacent Counties – 1

Sum of them would give us: 5+5+5+5+1 = 21. Dividing by 5 gives us: 21/5 = 4.2.

4.2 is the value that we will be dividing the sum of the rankings to get a final suitability value. The table below shows the corresponding suitability rankings of each class. Low suitability is denoted as darkest colors and high suitability has the lightest colors.

Quantile interval	Class Range	Description of Percent Federal Land	Suitability Rank	Suitability Description
0-1.7	<= 1.7	Very Low	1	Very Low Suitability
1.8-2.4	<= 2.4	Low	2	Low Suitability
2.5-3.1	<= 3.1	Moderate	3	Moderate Suitability
3.2-3.6	<= 3.6	High	4	High Suitability
3.7-4.5	<= 4.5	Very High	5	Very High Suitability

Table 7. Final Suitability Results

According to the suitability map, the highest suitability values are located on the northwest states such as Montana, Wyoming, North and South Dakota and New Mexico.   10

Final Suitability for Buffalo Commons
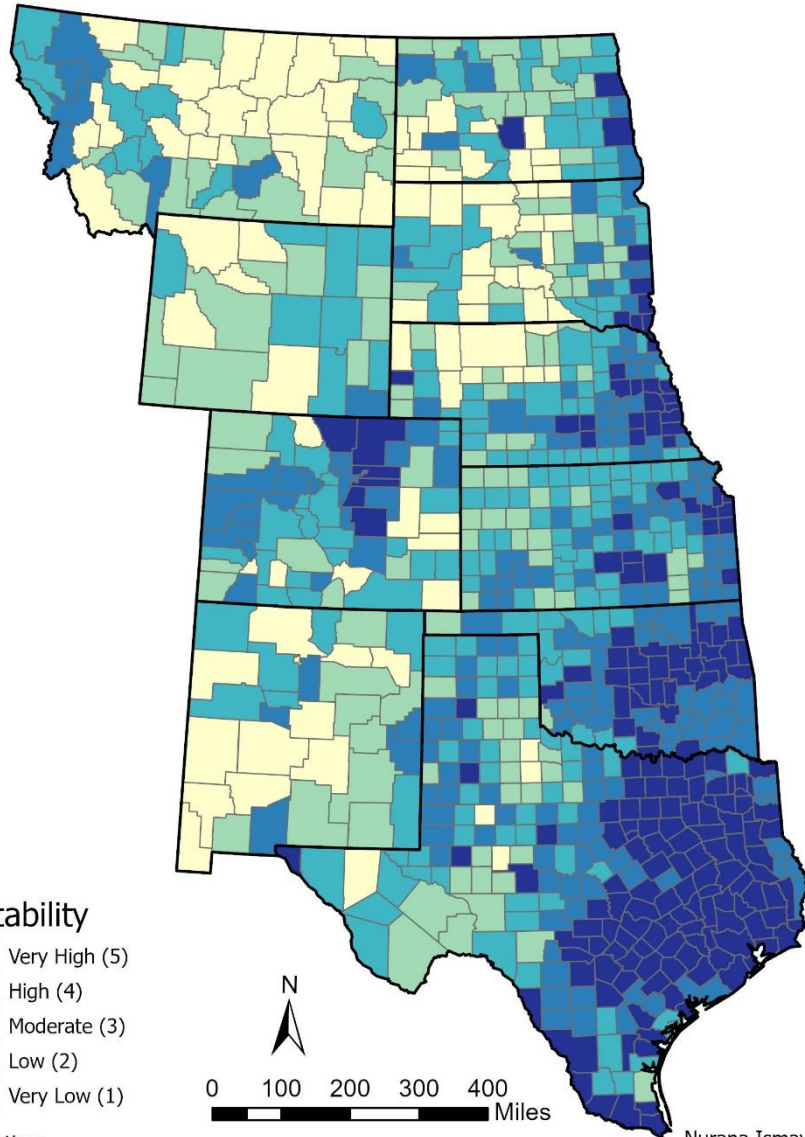
Suitability
- Very High (5)
- High (4)
- Moderate (3)
- Low (2)
- Very Low (1)

N

0   100   200   300   400
Miles

Projection:
USA Contiguous Albers Equal Area Conic
Central Meridian, -102 degrees

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Map 7. Final Suitability
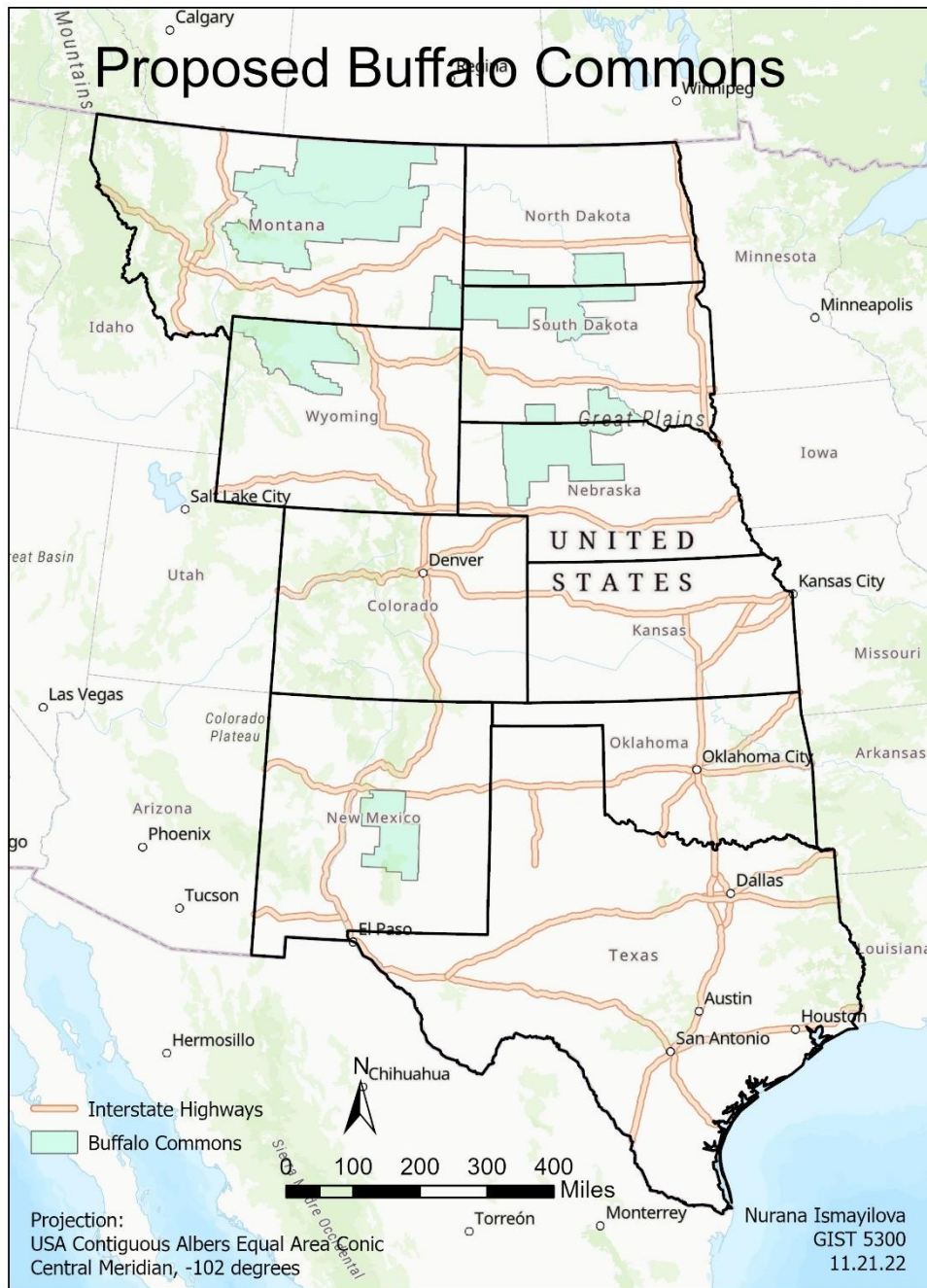
10.   Proposed Buffalo Commons Locations

Considering above results derived from variables, several counties were selected within the most suitable states. The states of the counties involve: Montana, Wyoming, New Mexico, North and South Dakota and Nebraska. There are 47 counties selected and overall cost is approximately 9.9B$. The counties per state and their statistics are listed below in the Table 7.

	Montana	Nebraska	North Dakota	South Dakota	Wyoming	New Mexico
Land Cost	2.9 B$	2.3 B$	1.1 B$	2.3 B$	739M$	500 M$
Percent Federal Land	15.2%	36.6 %	9.1%	10%	68.4%	22.1%
Number of Counties	14	9	7	11	4	2
Total Land Cost	9.96 B $					

Table 8. Statistics per county

The county names per state are given in the Appendix 1.

The reason for choosing these counties was based on the location regarding interstate highways, big cities and 5 different variables stated above. Overall, the final price does not exceed 10B$ which was allocated for land purchase. The percentage of federal lands are good and suitability ranking for these counties were the highest. Their location does not cross main roads and are in less populated rural areas.

Map 8. Proposed Buffalo Commons

11.   Conclusion

In the Buffalo Commons Proposal Project, 5 different variables were used to identify the most suitable areas in the Great Plains: Population Density, Population Change, Farmland Value, Percentage of Federal Lands and Adjacency to Indian Reservations. The variables were ranked on a scale from 1-5. Each variable was represented as a distribution over the Great Plains area. The variables were combined, and final suitability map was derived based on the rankings of each variable. The suitability map and other factors such as proximity to big cities, interstate roads, cost of the purchased lands were considered, and a final Buffalo Commons Proposal map was created. According to the map, the Buffalo Commons should be in following states: Montana, New Mexico, Wyoming, North Dakota and South Dakota. The county names selected from each state are given below in the Appendix 1. The overall idea of Buffalo Commons and the repopulation of the rural areas as well as economic growth can be achieved using the methodology described here. The adjacency to Indian Lands will help the Native American lands to regrow their economy by increasing the tourism which will increase number of people staying at the resorts and visiting casino places.

12. Bibliography

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3. Popper, Frank and Epstein, Deborah. "The Great Plains: From Dust to Dust.". *Planning* December 1987. Online. Internet. 26 Aug. 2004.

4. Moran, Matthew D. "Bison Are Back, and That Benefits Many Other Species on the Great Plains". *The Conversation*. Beth Daley. June 11, 2021.

5. Conniff, Richard. "The Bison Returns to the Great American Plains". Smithsonian Magazine. November 2018

6. Chibber, Kabir. "The buffalo will soon be roaming the American plains once more". *Quartz*. October 24, 2018.

Appendix 1

Montana:

Sheridan	Montana
Blaine	Montana
Phillips	Montana
Valley	Montana
Daniels	Montana
McCone	Montana
Garfield	Montana
Fergus	Montana
Petroleum	Montana
Judith Basin	Montana
Golden Valley	Montana
Wheatland	Montana
Carter	Montana
Powder River	Montana

Wyoming:

Park	Wyoming
Big Horn	Wyoming
Hot Springs	Wyoming
Sublette	Wyoming

South Dakota:

Campbell	South Dakota
Harding	South Dakota
Perkins	South Dakota
Corson	South Dakota
Dewey	South Dakota
Potter	South Dakota
Faulk	South Dakota
Tripp	South Dakota
Gregory	South Dakota
Fall River	South Dakota
Bennett	South Dakota

Nebraska:

Sioux	Nebraska
Sheridan	Nebraska
Keya Paha	Nebraska
Cherry	Nebraska
Grant	Nebraska
Loup	Nebraska
Thomas	Nebraska
Blaine	Nebraska
Garden	Nebraska

New Mexico:

Torrance	New Mexico
Lincoln	New Mexico

North Dakota:

Grant	North Dakota
Logan	North Dakota
Emmons	North Dakota
Slope	North Dakota
McIntosh	North Dakota
Bowman	North Dakota
Adams	North Dakota