The Potential for Gray Wolves to Return to Pennsylvania Based on GIS Habitat Modeling

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Abstract

The gray wolf is an animal that is often misunderstood. Due to negative stereotypes of gray wolves, they were hunted to the brink of extinction in the contiguous United States of America. Presently, numerous states (Minnesota, Wisconsin, Michigan, Idaho, Montana, and Wyoming) are implementing reintroduction and management plans to rebuild the wolf population. Geographic Information Systems (GIS) were used to identify potential areas for wolf expansion based on habitat requirements in the state of Pennsylvania. This study used information from research compiled on existing wolf packs in the contiguous United States, along with management and reintroduction plans to locate suitable land for gray wolves located in the state of Pennsylvania. The approach was to use numerous data layers to determine if any land could support wolf existence and where these ranges would be located. Key layers used to locate wolf pack ranges in this study included: road density, human density, and land cover. The suitable locations were then examined to determine: water availability, prey density, and total range size. Once these locations had been identified, an approximation of potential pack size was then determined based on range size. The results of this study show there are multiple ranges which could potentially be used for gray wolf habitation in Pennsylvania.

Introduction

The historical range of the gray wolf (*Canis lupus*) was the largest of any non-extinct terrestrial mammal and spans most of the Holarctic region (Geffen, Anderson, and Wayne, 2004). The Holarctic region encompasses North America - north of the Mexican desert region, non-tropical regions of Europe and Asia, and Africa - north of the Sahara desert (Holarctic region, 2009). Specifically, within the contiguous United States of America, the historical range for gray wolves covered most of the country, except for part of California, southeast Arizona, and most of the southeastern part of the country (U.S. Fish and Wildlife Service, 2006). According to the U.S. Fish and Wildlife Service (2006), the lack of gray wolves in the southeastern portion of the United States was due to the red wolf (*Canis rufus*) which populated this region. Wolves are deemed top predators so having multiple wolf species in an area greatly decreases the resources available to each species and greatly increases competition. Based on the range provided by the U.S. Fish and Wildlife

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Service (2006), gray wolves historically existed in Pennsylvania but were hunted and trapped to the brink of extinction. The gray wolf was added to the endangered species list in 1973 which protected it from being hunted or killed by humans for any purpose (Dybas, 2008). Under the protection of the Federal Government, the wolf population was given a chance to rebound in the contiguous United States.

Public opinion of wolves began to change in the 1980's and 1990's. Wolves were no longer generally perceived as killing machines, dangerous to humans, or a menace to farmers. They were now being viewed as a valuable natural resource and an integral part of natural ecosystems as seen in McNaught 1987; Bath 1991 (Wyoming Game and Fish Commission, 2007). Currently there are small populations of gray wolves in the contiguous United States. These packs exist in Minnesota, Wisconsin, Montana, Wyoming, Idaho, and the upper peninsula of Michigan. In addition to natural wolf packs, the wolf population includes wolves which have been reintroduced in an attempt to repopulate the species (Dybas, 2008).

The goal of this research was to examine existing wolf populations in the contiguous United States in order to determine the key habitat requirements which allow these wolf populations to thrive. These standards were then applied to the state of Pennsylvania to evaluate the state to see if there was potential for the gray wolf to return to an area that was historically part of their home range. The potential ranges were then analyzed to determine the approximate number of wolves that could survive in Pennsylvania based on land size and available prey. The final calculation determined if the total population of wolves would be viable based on management and reintroduction plans.

Study Area

This study was composed within the state boundaries of Pennsylvania. The state has an area of approximately 116,075 km² and has a total population of 12,448,279 (United States Census Bureau, 2009). Based on the historical range map (Figure 1), gray wolves were present in most of Pennsylvania before European settlers colonized the United States.

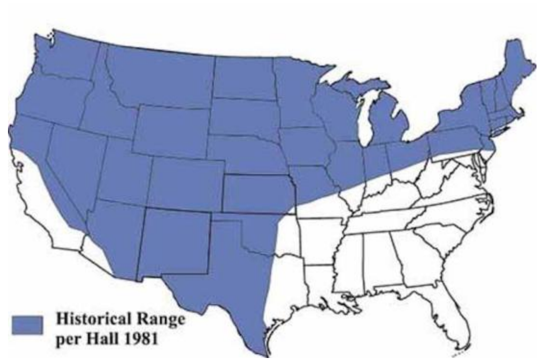

Figure 1. Historic gray wolf range before European settlement (U.S. Fish and Wildlife Service, 2009).

The last positive sighting and identification of a wild gray wolf in the state of Pennsylvania was in 1892 in Clearfield County as seen in Williams et al., 1985 (Merritt, 1987). The disappearance of wolves in Pennsylvania directly relates to the human actions of hunting, trapping, and poisoning (Merritt, 1987).

The state boundary was used as a limiting factor for the calculations of this study. Political boundaries are often not a constraint on animal movement, but for the purpose of this study, all research was performed within the state boundary.

Since the state of Pennsylvania represents a large area of land, for display purposes, Figure 2 represents the sample area which was used to display the data in the methods section.

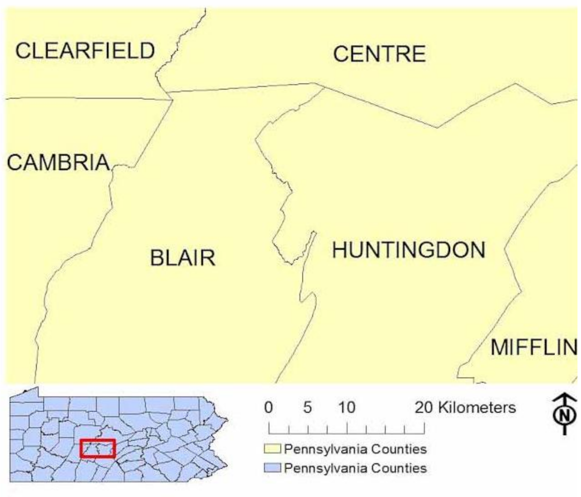

Figure 2. Sample area at a scale of 1:324,000.

Methods

Define Spatial Reference

After all the data were acquired, the spatial references were defined in order to have the same spatial reference for all the layers. This was done to make sure all the data aligned properly without having to project on the fly. The spatial reference selected for all the layers in this habitat analysis was North American 1927 Albers.

Human Density

Harrison and Chapin (1998) defined potential core wolf habitat in the northern United States as areas with less than four humans per km². This figure was similar to results of studies done in the Great Lakes region as seen in Jensen et al., 1986; Fuller et al., 1992; Mladenoff et al., 1995 (Harrison and Chapin, 1998). Dispersal habitat refers to the areas which animals use to travel from an area of high suitability to another region of high suitability. Areas with ten humans or less per km² were identified as potential dispersal habitat, based on wolves in the western Great Lakes region as seen in Berg and Kueh, 1982 ; Fritts, 1983; Wydeven, 1994 (Wydeven, Fuller, Weber, and MacDonald, 1998).

The human density data used in this study were obtained through two different census geographic units. Fifty-three of the sixty-seven counties in Pennsylvania were able to be analyzed through census block classifications. Fourteen counties had large populations and had to be analyzed at the census block group level in order to calculate human density. The reason for needing two separate classifications was due to restrictions on downloads from the U.S. Census Bureau's (2009) website. Counties with significant populations contained too many blocks to be downloaded, so those counties were downloaded at the block group level, the next largest classification. The census data contained the total population for each of the blocks or block groups. The block and block group layers were combined into one layer covering all of Pennsylvania. The total area per each classification was then determined. The total population per classification was then divided by the total area of each classification which resulted in a human density per geographic classification. The layer was then converted to raster format based on the population density with a 10 x 10 meter cell resolution. The raster layer was then reclassified into four different weighted values based on wolf requirements. Areas of zero human density were classified with a value of fifteen while areas of acceptable human density were assigned a value of five. Levels of human density at the dispersal classification were assigned a value of one and levels where human density was too great for wolf habitation were assigned a zero. Figure 3 represents the classification within the sample area.

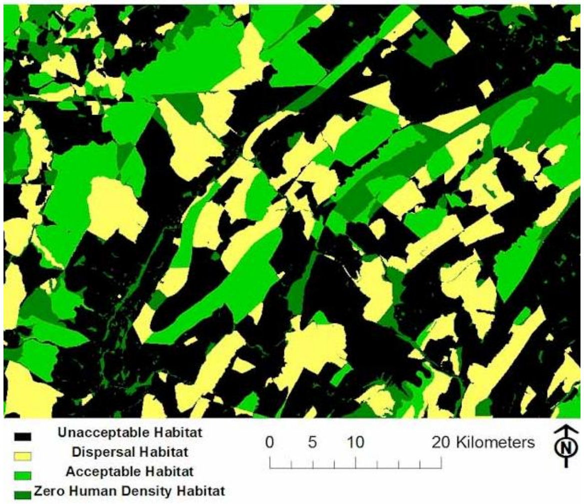

Figure 3. Human population density in the sample area.

Road Density

Roads provide another aspect of human danger to wolves both in regard to motor vehicle collisions and providing humans with greater access to gray wolf habitat. Researchers from the Great Lakes region reported that wolves in their study area did not persist in areas where road densities exceeded 0.58 km/km² as seen in Thiel, 1985; Jensen et al., 1986 (Harrison and Chapin, 1998). In other areas, wolves can persist in areas with road densities as high as 0.73 km/km² if these areas are adjacent to habitat with less human access as seen in Mech et al., 1998 (Harrison and Chapin, 1998). According to Gehring and Potter (2005), the type of road does not matter. All roads were classified equally for this study, without regard to the type or traffic density.

Road density was determined based on the locations of three road layers: state, local, and unpaved. The layers were merged together to create one layer which showed the locations of all the roads in the state. The merged road layer was then used in the spatial analyst density tool to determine the road density throughout the state. A mask of the landuse layer was set on the spatial analyst toolbar before the density tool was run. The mask was set to restrict the density results to the study area. The spatial analyst density test used a search radius of one km and resulted in 10 x 10 meter cells. The resulting raster density layer was then reclassified to meet the requirements for wolf habitation. Areas of zero road density were classified as fifteen, while areas of acceptable road density were assigned a value of five. Levels of road density at the dispersal ranking were assigned a one and areas where road density was too high for wolves were assigned a zero. Figure 4 represents this classification within the sample area.

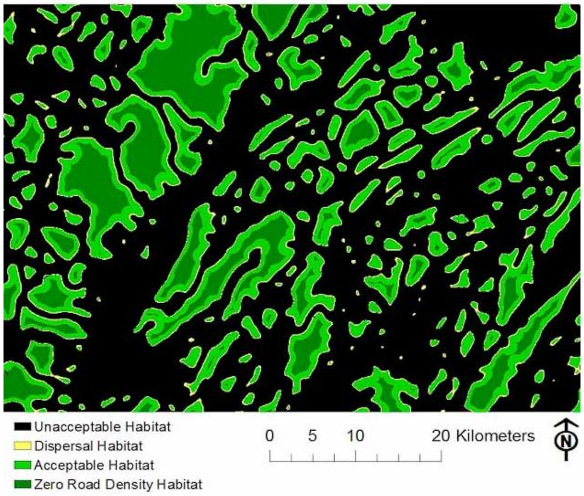

Figure 4. Road density in the sample area.

Human Road Density Calculation

The human density factor was dependent upon road density. Therefore, the acceptable human density level can vary based upon the road density of that area (Carroll, Phillips, Schumaker, and Smith, 2003). The same criteria also applied to the road density layer, based on the fact that road density can also be dependent upon the human population density in the area.

The reclassified human density layer and the reclassified road density layer were then multiplied together through the use of the raster calculator. The acceptable limits can vary for one factor depending on the level of the other factor. For example, if a cell in the human density layer has zero human density or was within the acceptable human density range, then the road density value can be in the dispersal range and the habitat can still be deemed acceptable. The case was the same if the factors were reversed where the roads were nonexistent or within the acceptable limit and the human population was in the dispersal range. The resulting layer from the raster calculation had six total classifications. A zero value represented unacceptable areas, while a value of one represented dispersal areas based on both layers. A value of five represented an area made through the calculation of dispersal and acceptable land. Cells with a classification of twenty-five were the result of multiplying two cells of acceptable land, while cells with a value of seventy-five were the result of multiplying a cell of acceptable land with a cell of no road density or human population density. A final value of 225 was achieved through the multiplication of two cells that had no human population density or road density. This raster layer was still at the 10 x 10 meter cell resolution. For display purposes values of twenty-five and seventy-five were grouped together in the acceptable range. Figure 5 represents this classification within the sample area.

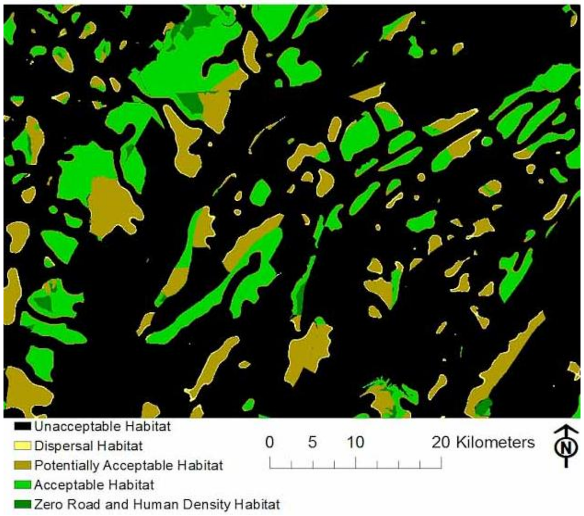

Figure 5. Human road density calculation results in the study area.

Land Use

Wolves will live in virtually any habitat; whether it is a desert, tundra plain, or forest. However, it was noted that the most successful areas of gray wolf habitat consist of land dominated with forest cover (Harrison and Chapin, 1998). Populations of wolves in the Great Lakes region of the United States persist within, or have recently recolonized areas dominated by forest land cover as seen in Kolenosky, 1981; Mech et al., 1988; Licht and Fritts, 1994; Mladenoff et al., 1995; Schadler and Hammill, 1996; Wydeven 1996 (Harrison and Chapin, 1998). Wooded land cover was presumed to be preferred because interactions between humans and wolves tend to be lower in these areas; opposed to open habitat such as agricultural areas and rangelands or urban areas (Harrison and Chapin, 1998). Areas of wetlands and water itself are crucial in a packs home range, and must be found within this range for optimal habitat (Wisconsin Department of Natural Resources, 2006).

The landuse layer had a 30 x 30 meter cell resolution. Since the human road density layer from the previous section had a 10 x 10 meter resolution the landuse layer was resampled to a 10 x 10 meter resolution. Resampling did not improve the quality of the landuse layer. The landuse layer was resampled so when it was multiplied by the human road density calculation layer, the resulting layer was still at the 10 x 10 meter resolution level. The resampled landuse layer was then reclassified into four categories; acceptable, dispersal, unacceptable, and water (Figure 6).

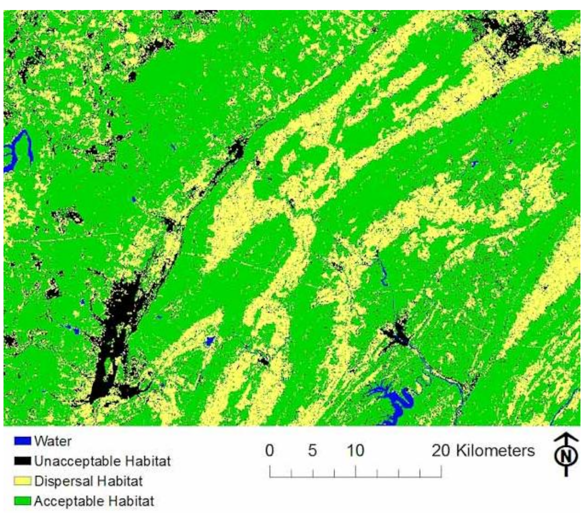

Figure 6. Landuse layer reclassification in the study area.

Land that was acceptable for wolf habitat received a value of ten, while land that would be used as dispersal habitat was assigned a value of one. Areas deemed unacceptable for wolf habitat were reclassified with a value of zero. Water and wetlands were given a separate classification because a water supply is essential to wolf habitat, however wolves cannot thrive on habitats that are entirely water based. A classification of -9999 was used to denote water as neither acceptable nor unacceptable. Table 1 shows the new classification values.

Table 1. Land use reclassification.

Land Use Code	Class	Reclassified Value
1	Water	-9999
2	Low Density Urban	0
3	High Density Urban	0
4	Hay Pasture	1
5	Row Crops	1
6	Probably Row Crops	1
7	Coniferous Forest	10
8	Mixed Forest	10
9	Deciduous Forest	10
10	Woody Wetland	-9999
11	Emergent Wetland	-9999
12	Quarries	0
13	Coal Mines	0
14	Beach	0
15	Transitional	0

Level One Calculation

The reclassified landuse layer and the human road density layer were multiplied together in the raster calculator. The resulting layer was named level one calculation and showed the areas of potential wolf habitat based on road density, human density, and land use. Cells with a negative value were deemed to be water habitat, while values of zero were not acceptable for wolf habitation. Values of one, five, ten, fifteen, twenty-five, seventy-five, and 225 were deemed as dispersal habitat. Dispersal values were a result of two dispersal cells multiplied together or when potentially acceptable, acceptable, or pristine cell were located in a crop or pasture. Cells with a value of fifty, 150, 250, and 750 were deemed to be acceptable habitat. Acceptable values were the result of potentially acceptable or acceptable human road density cells coinciding with forest. Cells that resulted in a value of 2,250 were areas that had zero human population density, zero road density, and were located in forest cover. This layer was then reclassified so all negative values were assigned a value of -9999 and all unacceptable wolf habitat was given a value of zero. Values in the dispersal classification were reclassified as one and values in the acceptable range were reclassified to a value of two. All land that had zero human population density, zero road density, and were located in a forested area were reclassified with a value of three.

Another reclassified raster layer was also created based on the level one calculation layer. This layer combines pristine, acceptable, and dispersal habitats into one classification with a value of one. All other land in this layer was classified as a zero. These two raster layers were then converted to shapefiles. The shapefile created from the first reclassified raster with different classifications for all habitat types was called range_value and the shapefile created from the reclassified raster layer with the classifications of one and zero was called range_size.

Range Size Requirements

A wolf pack consists of at least two wolves that travel together and exhibit breeding behavior (Michigan Gray Wolf Recovery Team, 1997). Each wolf requires approximately twenty-five km² of suitable habitat to thrive based on the statistic of approximately 4.1 wolves per 100 km² that was observed in Minnesota (Erb, 2008). This means a wolf pack requires a minimum range of approximately fifty km² of contiguous land. In order to determine the size of each range a new field was added to the range_size layer. This field was then calculated to show the km² of each range. Areas larger than the minimum size required for a pack of two wolves were selected and exported to a new shapefile called range_size2. Each range in the range_size2 layer was then exported into its own layer.

Habitat Classification Percentage

The percentage of habitat type in each potential range was analyzed to determine if each potential range had enough habitat for a wolf pack to thrive. A new field was added to the range_value layer and then calculated to show the km² of each piece of land depending upon habitat classification values. Each land classification ranking of one, two, and three was then exported into its own shapefile. These new shapefiles were named by the values they represented, either a one, two, or three. Values from these new layers were then selected based on whether they shared a boundary with a value of another habitat layer. This new layer of boundary shared values was named range_value2. Each potential individual site was then used to select values from range_value2 in order to determine the composition of habitat in each range. Through this analysis a few potential sites were deemed unqualified. Some of the sites had a high percentage of dispersal habitat, which often resulted in the total amount of pristine and acceptable land measuring under fifty km².

Water Requirement

To survive, wolves need a source of water. Three layers were used to locate available water in the state of Pennsylvania. The water values were first extrapolated from the land use layer and then converted into a shapefile. The extracted land use water shapefile was then merged with the streams and rivers, and lake layers to create one complete water layer. A buffer of 200 meters was then applied to the merged water layer. This buffer was used since dens are often located within approximately 100-200 meters of water to provide wolf pups with ample drinking water (Wisconsin Department of Natural Resources, 2006). The 200 meters was used because that was the maximum distance wolf pups could travel for water, so as long as the buffer intersected the potential habitat, the water requirements were met. Grown wolves would not require the use of a buffer since they are highly mobile in comparison to the young pups. Mature wolves are known to travel up to approximately forty-eight km per day (United States Fish and Wildlife Service, 2007). In each of the potential ranges, there were numerous water resources, so none of the potential areas were eliminated based on water requirements.

Prey Density Requirements

Wolves, like any other living organism, need a food source in order to survive. On average each wolf can eat approximately 15-18 deer per year as seen in Mech, 1997 and Fuller, 1995 (Michigan Gray Wolf Recovery Team, 1997). This number was derived from wolves that use deer as the majority of their consumption, so the value of 15-18 deer was a good approximation for the rate of deer consumption in the Pennsylvania wolf packs. White-tailed deer were the most prevalent ungulate and are said to be the keystone species in the state of Pennsylvania so it was reasonable to assume they would be the most prevalent part of the wolves' diet (Pennsylvania Game Commission, 2008). With the density levels of deer prevalent at each of the potential pack ranges, prey would not be a limiting factor in the success of each wolf pack. For each potential range of wolves, there would be several hundred deer available.

Wolf Density Calculation

Wolf populations for a range can be approximated in two separate ways. Some studies approximate potential wolves in an area based on available prey density while other models use available land size to calculate the number of wolves which could live in a range. Since there were no existing data with similar deer density to be compared to, wolf density was dependent on the size of the potential range since each range has ample prey density. This approximation for potential number of wolves was based only on the size of available wolf ranges.

Once the wolves recolonized in the state, continued monitoring could be done on the wolf packs to see if the pack sizes expand beyond the predicted areas. A successful wolf pack will not expand beyond what the land can handle so data collected from this new population could show if wolves in Pennsylvania were dependent upon range size, prey density, or were balanced based on both.

Results

Based on the requirements set forth through research of existing and reintroduced wolf packs outlined for this study, the calculations in Pennsylvania determined there was a potential for twelve packs. These twelve packs would give the state of Pennsylvania a population of approximately forty-five wolves. There was approximately 1224.625 km² of land that was suitable based on the qualifications set forth to finding wolf habitat. Appendix A shows the land break down for each wolf range along with the prey density and wolf calculations per range. Appendix B shows all the maps associated with the ranges found in this study.

Human density resulted in 68,036 km² that were deemed unacceptable for wolf habitat. This meant that 49,103 km² or 41.92% of the state was suitable for wolf habitation, based solely on human density requirements. Suitable habitat was then broken down into three separate categories, zero human density, acceptable levels of human density, and dispersal levels of human density. In the state of Pennsylvania, according to the 2000 U.S. Census data, there were 11,873.53 km² of land that have a human population density of zero humans per km². With the classification between zero and four humans per km² there were 17,423.52 km² that fit this classification, which was acceptable wolf habitat. These two values resulted in a total of 29,287.05 km² of land in Pennsylvania that was suitable for wolf pack ranges. Dispersal habitat which was between four to ten humans per square kilometer, resulted in a total of 19,805.91 km².

Road density resulted in 97,337.63 km² that were deemed unacceptable for wolf habitat. This meant that 19,800.976 km² or 16.9% of the state was suitable for wolf habitation based solely on road density requirements. Suitable habitat was then subdivided into three separate categories, zero road density, acceptable levels of road density, and dispersal levels of road density. In the state of Pennsylvania, according to the density calculation performed in the spatial analyst, there were 16,956.527 km² that had a value between zero and 0.58 km of road per km². Land that had zero road density represented 4,170.147 km² in the state while land in the acceptable range of wolf habitat in regards to road density represented 12,786.38 km². Dispersal habitat between 0.58 to 0.73 km of road per km² resulted in a total of 2,844.449 km².

As a result of the human road density layer calculation, 102,065.5 km² or 87.13% of the state was not acceptable for wolf habitation. This meant the remaining 15,076.13 km² could potentially be used for wolf habitat when looking at both road and human density. At this level there was 698.75 km² of land that fit the dispersal classification as a result of this calculation. There were 5,158.889 km² of land that was deemed as potentially acceptable land. This classification meant the cells were deemed as acceptable or pristine in one layer, but only dispersal on the other layer. Based on the human road density calculation there were 8,247.814 km² of land within the acceptable ranges for both variables. At this calculation there were 967.679 km² of land that consisted of zero human population density and zero road density.

When analyzing the landuse layer, it was determined that 67,447.53 km² were classified as acceptable land for wolf habitat. This reclassification also showed that 36,968.14 km² of the land in Pennsylvania fit the dispersal category, while 11,286 km² of the state was deemed unacceptable, based purely on land use.

The landuse layer was then multiplied by the human road density layer in the raster calculator. This calculation resulted in a total of 883.85 km² of land that had zero human population density, zero road density, and was located on forested land. This calculation also showed that 12,249.03 km² of land in Pennsylvania were deemed acceptable for wolf habitat while only 1,352.86 km² of land were classified as dispersal habitat. A total of 102,418.4 km² were deemed unacceptable for wolf habitation at this level of calculation.

The next step in this process was to determine the size of each potential site. With the understanding of a minimum of approximately fifty km² needed per each wolf pack, ranges smaller than this size were disqualified. This process resulted in 1,514.74 km² available for potential wolf habitation. There were nineteen separate pack ranges at this point, ranging from approximately fifty-one km² to approximately 147 km². The composition percentage of each of the potential ranges was then analyzed to determine the percentage and total size of acceptable and dispersal land. If there was not enough acceptable land in the range to support a wolf pack then the range was disqualified. Based on this calculation, seven of the potential zones were disqualified since the total amount of land suitable for wolf habitation was not at least fifty km². Without these seven ranges, the total area of the acceptable wolf ranges totaled 1,115 km².

The next calculation involved the addition of water availability. Each potential range contained numerous water sources so it did not eliminate any of the potential sites. Each site provided numerous water sources which gave the wolves a wide variety of areas that could be suitable for den locations. The ability to choose from numerous areas was desirable for wolves to select a proper den location. After this examination, there were still twelve potential ranges for wolves to establish a pack.

The final requirement used to determine the potential for wolf habitation in Pennsylvania was prey availability. The deer density ranged between 6.6-10.5 deer per km² in the areas where potential wolf ranges were identified. The deer density rates were high enough to support the potential wolf populations. This meant deer density would not eliminate any of the potential ranges. Based on the approximation of one wolf per twenty-five km², ranges in Pennsylvania could support between two to six wolves, depending on range size. With the understanding of a single wolf needing twenty-five km², there was enough land for a population of approximately forty-five wolves in the state of Pennsylvania.

A simple linear correlation test was used to analyze the composition of each of the wolf ranges. The combination of zero density land and acceptable land had the strongest correlation out of all the classifications (0.976). This high correlation would be expected since the ranges were based on an area of at least fifty km². When looking at the acceptable habitat classification there was still a strong correlation between range size and total amount of acceptable land (0.821). This correlation was important because it showed a very strong dependence for the total area of a wolf range and the presence of land in the acceptable range. The correlation between total area of the ranges and pristine habitat for wolves was very poor (0.228). The result of this correlation could be due to the fact that the percentage of pristine land in Pennsylvania was lower than that of acceptable habitat. The presence of pristine habitat was not an excellent predictor of total area of wolf ranges, based on the low level of correlation between the two factors. The correlation between dispersal land and the total area was also low (0.445). The presence of dispersal land was also not a reliable predictor of total area of wolf ranges. A simple linear correlation test was also used to understand the relationship between the wolf ranges and state public land. The correlations between the total area of the wolf ranges and state game land (0.479), state parks (-0.088), and state forests (0.279) were low in every test. This low correlation value meant state public land was not a valuable predictor of wolf ranges in the Pennsylvania.

Conclusion

GIS analysis of the state of Pennsylvania resulted in twelve suitable gray wolf ranges. These ranges were found to have the ability to support approximately forty-five wolves. According to the United States Fish and Wildlife Service Recovery Plan for wolves, a viable wolf population consists of at least 100 wolves in a region (Wisconsin Department of Natural Resources, 1999). If this new population of wolves was more than 100 miles away from the large wolf population in Minnesota, the wolf recovery plan stated that new populations of wolves should consist of at least 200 wolves to be deemed viable (WI DNR, 1999). Based on these levels, the land in Pennsylvania could not support a viable wolf population. The identification of suitable land for wolves is still important information for Pennsylvania officials. If a surrounding state were to reintroduce a wolf population, some wolves may migrate to these identified areas within Pennsylvania.

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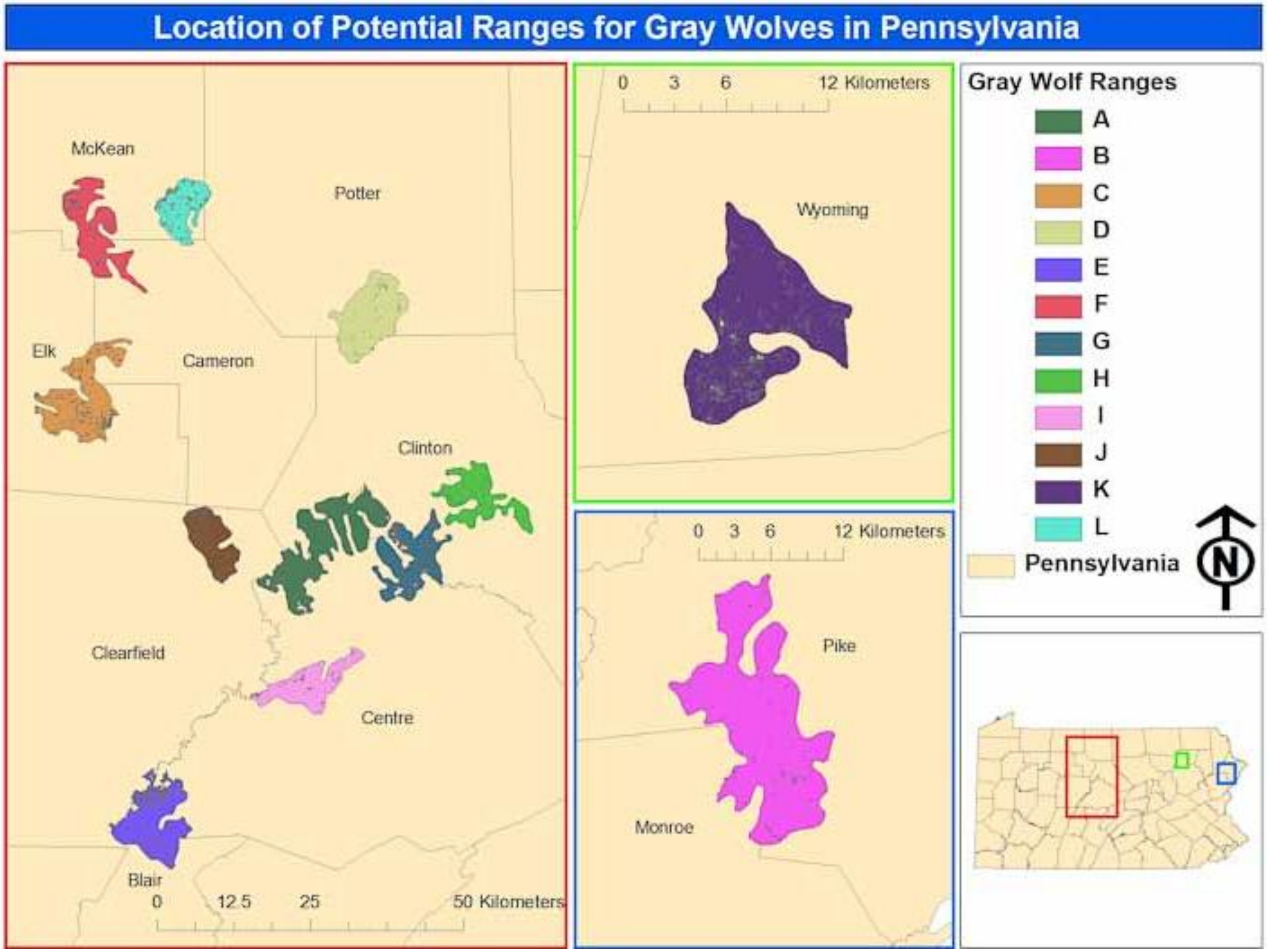
WyomingGrayWolfManagement
Plan.pdf.

Appendix A

Range	Total Area (km²)	Pristine Land (km²)	Pristine Percentage of Range	Acceptable Land (km²)	Acceptable Percentage of Range	Pristine and Acceptable Land (km²)	Pristine and Acceptable Percentage of Range	Dispersal Land (km²)	Dispersal Percentage of Range	Wolves per Range
A	147.75	33.03	22.35%	99.18	67.13%	132.21	89.48%	15.54	10.52%	5.91
B	130.04	23.21	17.85%	98.45	75.71%	121.66	93.55%	8.38	6.45%	5.52
C	118.75	1.54	1.29%	108.8	91.62%	110.33	92.91%	8.42	7.09%	4.75
D	106.52	64.88	60.91%	38.66	36.29%	103.54	97.2%	2.98	2.8%	4.26
E	104.3	10.94	10.49%	66.48	63.73%	77.42	74.23%	26.88	25.77%	4.17
F	92.75	21.23	22.89%	63.78	68.77%	85.01	91.66%	7.74	8.34%	3.71
G	88.01	30.04	34.14%	48.19	54.76%	78.23	88.9%	9.77	11.1%	3.52
H	77.63	23.87	30.75%	46.55	59.96%	70.42	90.71%	7.21	9.29%	3.11
I	71.5	29.68	41.54%	36.45	51.01%	66.13	92.55%	5.33	7.45%	2.86
J	62.37	32.77	52.54%	26.51	42.5%	59.28	95.04%	3.09	4.96%	2.5
K	59.11	0	0%	53.2	90%	53.2	90%	5.91	10%	2.36
L	56.31	7.18	12.76%	43.23	76.77%	50.41	89.52%	5.9	10.48%	2.25

Appendix B


Location of Potential Ranges for Gray Wolves in Pennsylvania
McKean
Potter
Elk
Cameron
Clinton
Clearfield
Centre
Blair
0
12.5
25
50 Kilometers
0
3
6
12 Kilometers
Wyoming
0
3
6
12 Kilometers
Pike
Monroe
Gray Wolf Ranges
A
B
C
D
E
F
G
H
I
J
K
L
Pennsylvania
N