Home on the Range: Identifying Suitable Habitat for Black Rhinoceros (*Diceros bicornis*) Translocated to Texas

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Figure 1. Black rhinoceros range in Africa

Figure 2. Location of Texas in USA

Critically Endangered

The black rhinoceros (*Diceros bicornis*) is a critically endangered mega-herbivore found in eastern and southern Africa. A flagship species central to African tourism, black rhino are asocial browsers that typically occupy dense bush and woodland habitats. In the 20th century, black rhino population size plummeted 98% due to conflict, provision hunting, habitat loss, and poaching. Today, an estimated 5,000 individuals remain, occupying only a fraction of their native range. Black rhinos are acutely threatened by poaching, which is fueled by the illegal rhino horn trade. Currently, an increased demand for rhino horn has resulted in a dramatic upsurge in poaching, an unsustainable trend accelerating the path to extinction. The remaining black rhino populations, even those managed in Intensive Protection Zones, are not safe.

In 2015, a collaboration between the South African software company GroupElephant.com and the USA Exotic Wildlife Association resulted in the creation of the Rhino1000 initiative. Compelled by the theory that, "If you can't take the danger from the rhino, take the rhino from the danger," the initiative proposes the translocation of viable rhino breeding herds from South Africa to Texas, where the landscape and climate closely resembles that of a rhino's natural habitat. Although Rhino1000 focuses on translocating the near-threatened white rhinoceros (*Ceratotherium simum),* I believe that the black rhino translocation is especially necessary due to the immense pressure from poaching that could lead to the species' extinction in the wild by 2020.

Conclusions

These results indicate that certain areas in Texas could provide a safe haven for black rhinoceros translocated to the United States from Africa. Central and West Texas appear to have the most suitable and largest land tracts with additional but more limited opportunities for establishment in the Southwest. Two of the most important suitability factors, low population density and minimal slope, are much more abundant than expected. Perhaps unsurprisingly, the biggest challenge to rhino habitat suitability are the anthropogenic factors, most especially the nearly inescapable roadways, as well as their noise and that of other human and industrial activities. While rainfall, water source, and temperature do not appear to present a problem for rhino habitat in Texas, a large unknown remains regarding how black rhino would adapt to land cover type, which although appears fairly suitable could pose a significant challenge due to the obvious lack of vegetation indigenous to Africa.

This spatial analysis shows how geographically-explicit data can reveal how challenges to the conservation and management of a critical endangered species differ in a variety of locations. In a black rhino's native range, anthropogenic factors like roadways and population density would likely be far less of a burden, but a completely new set of poaching risk factors not relevant to Texas would have to be taken into account. Regardless of where black rhinoceros are being conserved and protected, spatial analysis should continue to be used not only for further research but most critically for current management in order to provide this species with the best chance of survival.

Methods

Suitability Factors: Five natural and five anthropogenic factors were identified as critical to black rhino habitat suitability based on research from peer-reviewed literature.

Suitability Analysis: Raster calculator was used to perform a weighted suitability analysis. See the reclassification table for weight and description of each habitat suitability factor.

Table 1. Reclassification criteria

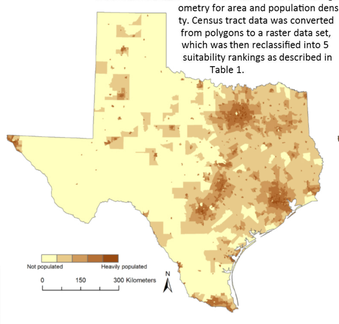
Factors	Weight	Suitability Score 1 (Most Suitable)	Suitability Score 2	Suitability Score 3	Suitability Score 4	Suitability Score 5 (Least Suitable)
Land Cover Type	20%	Mixed forest; sedge/herbaceous	Deciduous forest; grassland/herbaceous; shrub/scrub	Dwarf scrub; evergreen forest	Barren land; pasture/hay; cultivated crops; woody wetlands; emergent herbaceous wetlands	Water; perennial ice/snow; developed open space; developed low, medium, and high intensity
Density Of Water Sources (rivers/streams per square km)	10%	0.06 - 0.08	0.08 - 0.1	0.03 - 0.06	0 - 0.03	> 0.1
Average Annual Precipitation (mm)	10%	600 - 800	400 - 600	800 - 1,000	< 400	> 1000
Slope (degrees)	5%	0 - 8	8 - 16	16 - 24	24 - 32	> 32
Average Annual Minimum Temperature (°F)	5%	45 - 52	45 - 40	52 - 60	38 - 40	> 60
Population Density (persons per square mile)	15%	0 - 10	10 - 50	50 - 250	250 - 5,000	> 5,000
Density Of Roads (roads per square km)	15%	0 - 0.1	0.1 - 0.5	0.5 - 1	1-2	>2
Anthropgenic Noise Level (decibels)	10%	0 - 2	2 - 6	6 - 10	10 - 20	> 20
Density Of Airports (airports per square km)	5%	0 - 0.0003	0.0003 - 0.0005	0.0005 - 0.001	0.001 - 0.0015	> 0.0015
Density Of Active Railroads (railroads/square km)	5%	0 - 0.01	0.01 - 0.03	0.03 - 0.08	0.08 - 0.20	> 0.20

Data Sources: ESRI, TNRIS, USNPS, USGS, NLDC, AFF, Census.gov

Projection: NAD_1983_Texas_Statewide_Mapping_System

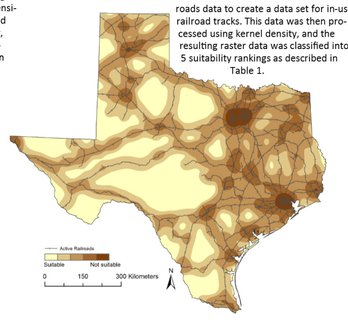
Population Density

Proximity to human settlement is significantly and negatively correlated with black rhino habitat use. Census data from the American Fact Finder was used to calculate geometry for area and population density. Census tract data was converted from polygons to a raster data set, which was then reclassified into 5 suitability rankings as described in Table 1.



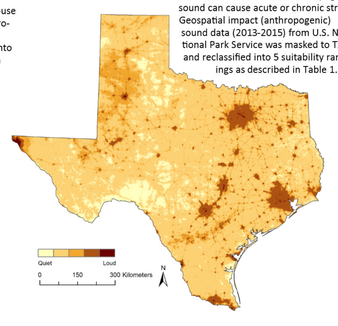
Railroad Density

Railroad traffic is a significant source of noise that can disturb rhino populations and cause high levels of stress. Active railroads were selected from the TNRIS Texas railroads data to create a data set for in-use railroad tracks. This data was then processed using kernel density, and the resulting raster data was classified into 5 suitability rankings as described in Table 1.



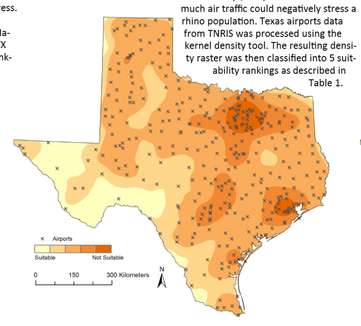
Noise Level

Black rhino are extremely sensitive to sound. With poor eyesight, they rely on their acute hearing ability for survival. As a result, even the mildest levels of anthropogenic sound can cause acute or chronic stress. Geospatial impact (anthropogenic) sound data (2013-2015) from U.S. National Park Service was masked to TX and reclassified into 5 suitability rankings as described in Table 1.



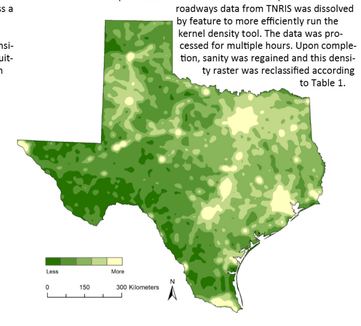
Airport Density

Airports are a significant source of noise to which black rhinos are extremely sensitive. Although airport access is useful for aerial habitat surveys, the presence of too much air traffic could negatively stress a rhino population. Texas airports data from TNRIS was processed using the kernel density tool. The resulting density raster was then classified into 5 suitability rankings as described in Table 1.



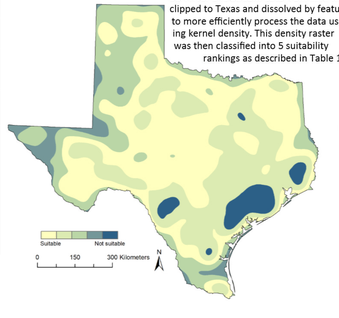
Road Density

Black rhino are extremely road averse. No matter what the level of vehicle traffic, roads are a critical disturbance that disrupt a black rhino's normal behavioral patterns. Texas roadways data from TNRIS was dissolved by feature to more efficiently run the kernel density tool. The data was processed for multiple hours. Upon completion, sanity was regained and this density raster was reclassified according to Table 1.



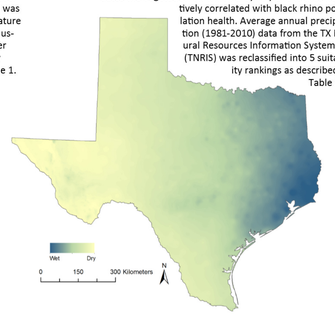
Water Source Density

While black rhino depend on the presence of a reliable water source within their territorial range, the presence of too much water is negatively correlated with habitat use. USA river and stream data from ESRI was clipped to Texas and dissolved by feature to more efficiently process the data using kernel density. This density raster was then classified into 5 suitability rankings as described in Table 1.



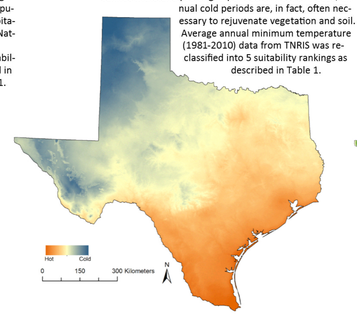
Annual Average Precipitation

While rainfall is necessary to maintain dietary nutrition for these herbivores, too much annual precipitation inundates the vegetation on which they rely and is thus negatively correlated with black rhino population health. Average annual precipitation (1981-2010) data from the TX Natural Resources Information System (TNRIS) was reclassified into 5 suitability rankings as described in Table 1.



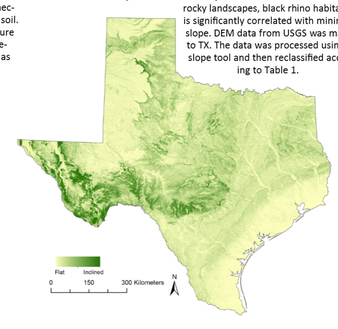
Minimum Temperature

Black rhino inhabit a wide range across Africa and can thus thrive in a wide range of temperatures. Although rhinos cannot withstand prolonged periods of frost or freeze, annual cold periods are, in fact, often necessary to rejuvenate vegetation and soil. Average annual minimum temperature (1981-2010) data from TNRIS was reclassified into 5 suitability rankings as described in Table 1.



Slope

Black rhino much prefer a flat landscape due to the energy and risk burden associated with climbing and descending steep inclines. While they are able to traverse varied and rocky landscapes, black rhino habitat use is significantly correlated with minimal slope. DEM data from USGS was masked to TX. The data was processed using the slope tool and then reclassified according to Table 1.



Land Cover Type

Black rhino occupy a varied landscape ranging from the Namibian desert to the thick Zambezi bush. Land cover data from the NLDC (2011) was masked to Texas, and the land types were assessed as proxies for the woodland and dense shrub habitats black rhinos prefer most. The data was then reclassified into 5 suitability rankings as described in Table 1.