Where should we protect biodiversity?

An example in Dunn County, ND

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Introduction

Across the United States, land use changes have caused disruptions in habitats for vulnerable wildlife species and has dramatically changed the biodiversity of our nation's public and private lands. Some of the biggest land use changes across the US landscape has resulted from the sprawl of urban areas and the expansion of agricultural production.[1]

The state of North Dakota has a very large agricultural economy and it is the state's leading industry sector. Close to 87% of land use in North Dakota is devoted to agricultural production, while urban land has increased over the past 15 years.[2] North Dakota has also experienced an increase in oil and gas production, making North Dakota the second largest oil producer in the US, with a projection of positive increases in production[2]. All of these changes in agricultural production and land use can affect the natural biodiversity of the state. Land use change even around protected areas changes the protected biodiversity.[1]

Biodiversity is important because it provides us with many ecosystem benefits such as clean surface water, carbon sequestration, cultural value[3] and successful pollination of wild and agricultural plants.[4] With a decline in biodiversity, there is an interruption in these ecosystem processes which poses a threat to human and environmental health, as well as the success of the large agricultural sector in North Dakota. Therefore, this geospatial investigation will assess the impact of current land use and land classification (LULC) on terrestrial biodiversity in the state of North Dakota through a case study on Dunn County, ND. This is an important question to answer in order to assist policy makers and environmentalists in prioritizing areas for conservation projects and funding.

Dunn County was chosen as a case study because majority of it's land is used for agricultural purposes (including grasslands and pasture) as can be seen in image 1 and has a good spread of developed land. Additionally, Dunn County still has forested lands, wetlands, and freshwater of high quality habitat and biodiversity worth protecting. Other Counties in the state are almost completely agriculture and thus much of the land is already degraded and would not benefit from protection; rather they would benefit from other types of analyses and interventions not included here.

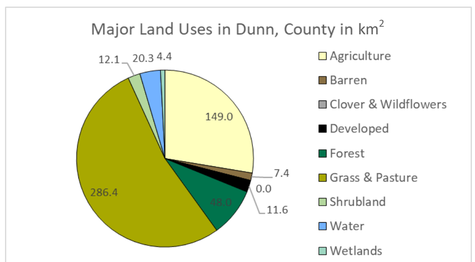

Figure 1. Breakdown of land uses across Dunn County, ND. Landscape is primarily made up of grass and pasture land followed by agriculture.

Land Use Across North Dakota and Dunn County, ND in 2018

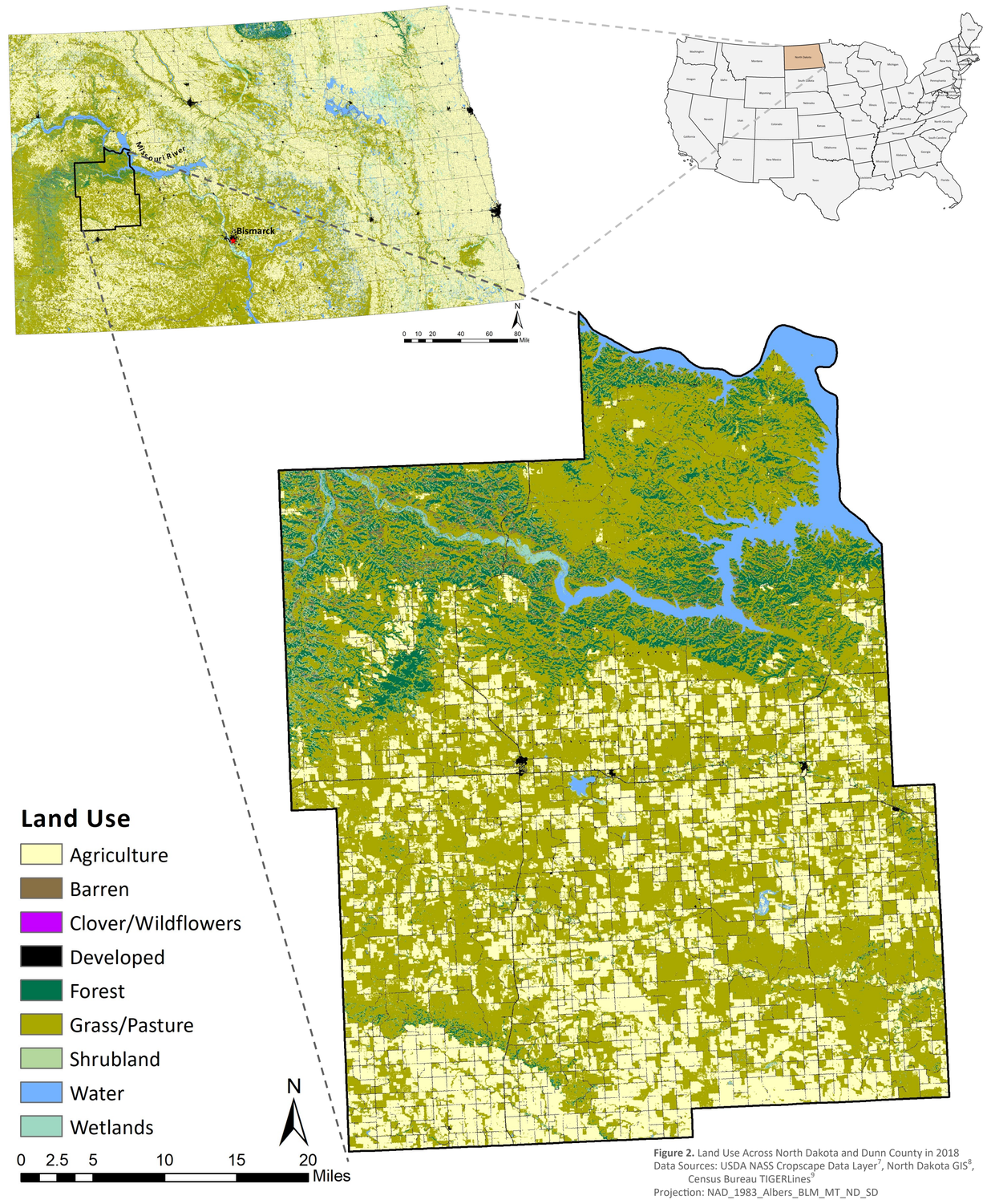

Figure 2. Land Use Across North Dakota and Dunn County in 2018
Data Sources: USDA NASS Cropscape Data Layer[7], North Dakota GIS[8], Census Bureau TIGERLines[9]
Projection: NAD_1983_Albers_BLM_MT_ND_SD

Data and Methods

Data layers classifying the land use across North Dakota for 2018 were collected from the USDA National Agricultural Statistics Service Cropland Data Layer. This data is in a TIFF format and has a resolution of 90 m^2 pixels. US Census Bureau TIGER Line shapefiles were used for North Dakota County boundaries and US state boundaries. Data on State and Federal lands under conservation or protection were obtained from the North Dakota Geographic Information System.

The InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) modeling tool developed by Stanford Department of Biology, Stanford Woods Institute for the Environment, The Nature Conservancy, University of Minnesota Institute on the Environment, and the World Wildlife Foundation was used for this analysis. Methodology for the use of the tool was taken from the InVEST user guide and Polasky et al. (2011).[5,6] The habitat quality model was run for analysis of general biodiversity in the landscape.

Figure 3. LULC threats and assigned values for use in InVEST model

THREAT	Max Distance (Km)	WEIGHT	DECAY
Cropland	4	0.8	exponential
Developed	5	1	exponential
Grass/Pasture	1	0.3	exponential

Raster maps of North Dakota were developed for each threat to biodiversity, where the presence of the threat was given a value of "1" and all else, a value of "0." These maps were generated by reclassifying the cropscape data layer. The threats included in this model were agriculture, developed land and grassland/pasture. Threats were given values of weight (0-1), maximum threat distance, and decay (how the threat impact decreases with increasing distance) as can be seen in figure 3. LULC were reclassified into the nine classes indicated in Figure 2 and Figure 4. A table for threat sensitivity was generated and is represented in Figure 4. LULC were assigned as habitat with a value from 0-1, with 1 being best habitat (most biodiverse) and 0 being not habitat. Also, values for sensitivity to degradation by each threat were appointed to each LULC (range 0-1, with 1 being most sensitive). Values in figure 3 and 4 were based on the denominations used in the study by Polasky et al. (2011).[6] The four raster maps, and the two tables were used in the InVEST model, which then output raster maps for habitat quality (range 0-1, with 1 being best) and potential degradation by threats (range 0-1, with 1 being most degraded). These maps were clipped to the Dunn County layer., followed by reclassification resulting in figure 5 and 6. Next, these maps were added together through raster map algebra to generate figure 7. This map helps determine which areas have high quality habitat (or greatest biodiversity), but also have the highest degradation potential and thus require protection to generate figure 7.

LULC	HABITAT	Cropland	Developed	Grass/ Pasture
Agriculture	0.2	0	0.5	0
Barren	0	0	0	0
Clover/Wildflowers	0.85	0.6	0.7	0.25
Developed	0	0	0	0
Forest	1	0.8	0.8	0.25
Grass/Pasture	0.85	0.6	0.7	0
Shrubland	1	0.8	0.8	0.25
Water	1	0.8	0.8	0.5
Wetlands	1	0.8	0.8	0.5

Figure 4. LULC across the North Dakota Landscape. LULC assigned habitat values and sensitivity of those habitats to each threat.

LULC Analysis on Biodiversity in Dunn County, ND in 2018

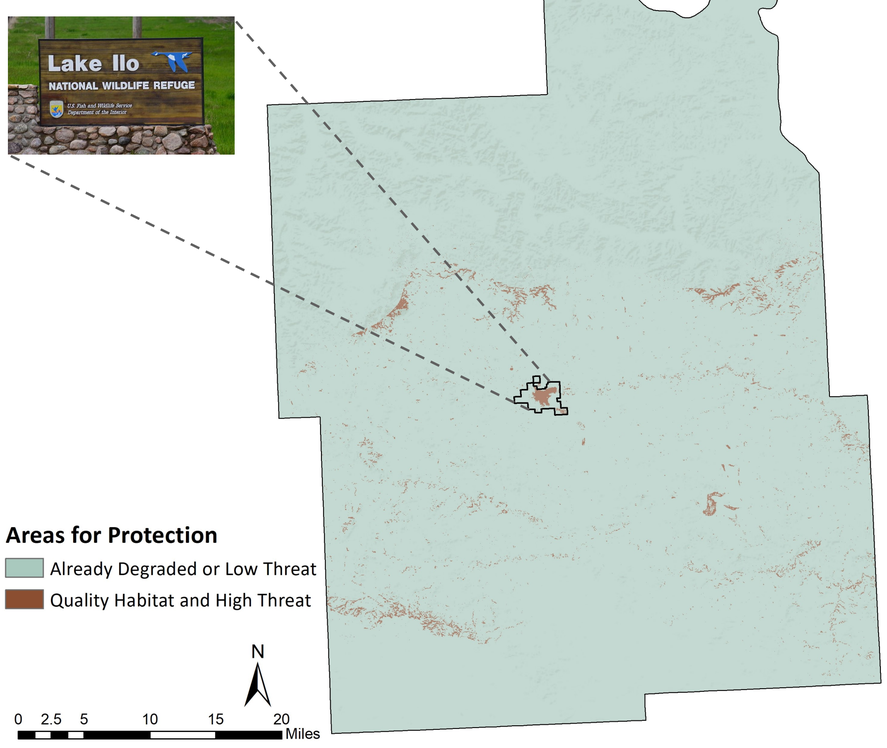

Figure 7. Areas Targeted for Protection to Maintain Biodiversity from LULC Threats
Areas that require protection are areas that have a combined score from map algebra of figure 5 and 6 ranging from 8-10. This equates to areas with high habitat quality and high threat to biodiversity. These areas are relabeled as High Quality Habitat and High Threat.

Data Sources: USDA NASS Cropscape Data Layer[7], North Dakota GIS[8], Census Bureau TIGERLines[9]
Projection: NAD_1983_Albers_BLM_MT_ND_SD

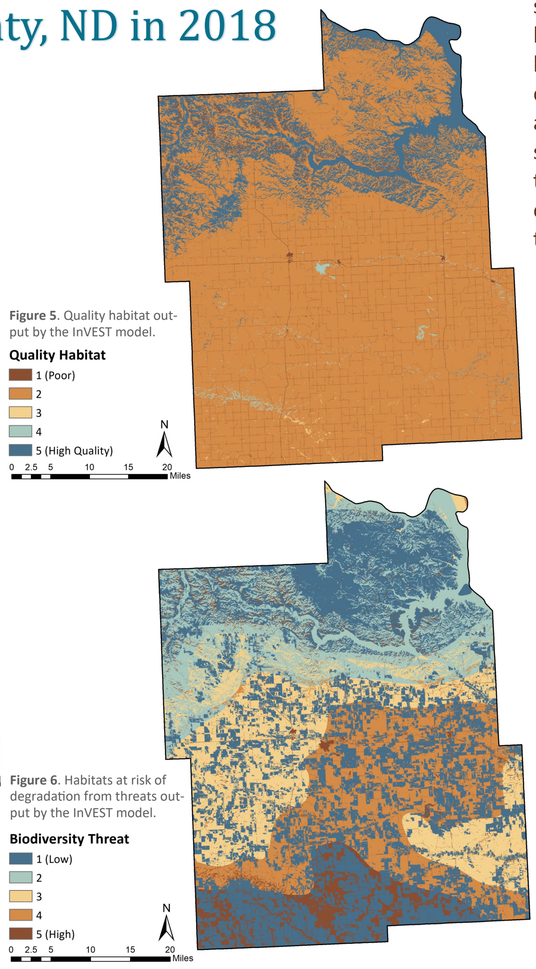

Figure 5. Quality habitat output by the InVEST model.

Figure 6. Habitats at risk of degradation from threats output by the InVEST model.

Results

In Dunn County, about 15.2% of the land is high quality habitat, while 83.7% is poor quality habitat (see figure 8). In assessing the degradation potential, 42.1% of the land has low degradation potential (see figure 9), but this includes LULC that are already considered degraded or unthreatened since these LULC are the threats used in the model. This can be seen by comparing the dark blue areas (low threat) in figure 5 and the LULC in figure 2; much of the dark blue in the southern part of the county corresponds to agricultural areas.

Overall, about 4% of the total land area, about 23 km^2, in Dunn County should be protected against the other current land uses to maintain biodiversity. These areas are either small bodies of freshwater or forested areas along the fringe of the more densely forested areas bordered by agriculture, grassland and pastureland. The small area called out in Figure 7 is the only currently protected area in the county. This is a national wildlife refuge, mostly made up of freshwater in the form of Lake Ilo. Even though this land is protected, the county may want to consider expanding the protected area since there are a few developed roads nearby as well as grassland/pasture that could expand into agriculture.

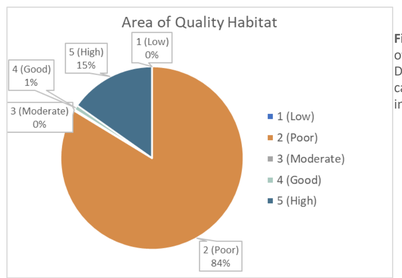

Figure 8. Percentage of Quality Habitat in Dunn County calculated by output in Figure 5.

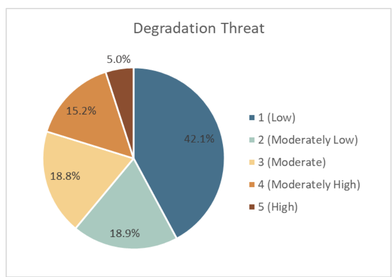

Figure 9. Percentage of Habitat Threatened by LULC calculated by output in Figure 6.

Discussion

Since 15% of Dunn County is high quality habitat with high biodiversity, but only 4% is highly threatened, funds should be allocated to the protection of this land. This not only will protect the areas that are threatened but it will also ensure the non-threatened habitats are buffered against other threats to ensure biodiversity is maintained. These lands should be incorporated into a state park, or be protected through zoning and land use restrictions.

This analysis also shows that even though there is not a lot of developed land in the county, agriculture poses a large threat to biodiversity, which is in line with previous literature. This analysis did not take into consideration practices used on agricultural land or specific crops grown. A more detailed analysis could include more LULC with different weights to account for various practices and crops that may impose less threat to biodiversity. In addition, more granularity to analysis could be added by accounting for differences in developed land and their relative threats to biodiversity. This analysis should be repeated across all counties in North Dakota to address other habitats at risk of biodiversity loss.

Cartographer: Katie Harrigan

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Agriculture Food and Environment Program

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Sources:

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Image Source: USDA NRCS