Dabbling Duck Presence in the Prairie Pothole Region:

Presence in Relation to Anthromes

Sarah H. Gosling

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Abstract

Humans are changing the ecological makeup of the earth faster than we realize. By the year 2000, only 25% of the terrestrial biome remained wild (Ellis et al. 2010). Whether we recognize it or not, human influence has reached even the most remote places of the world. It is impractical to use biological ecosystems as predictive models without factoring in human activity. In this study, we looked to use anthromes ("biomes" in the context of human land use) as predictors of waterfowl presence in the Prairie Pothole Region of North Dakota. The prairie potholes of North America is an extremely important breeding ground for the waterfowl of the continent. Recently biologists have been concerned that too few waterfowl are being produced from the region to maintain the breeding populations. This means that areas must be targeted for the protection of waterfowl. Past studies have used biome composition as a predictive tool of waterfowl presence, and have thus targeted areas based on biomes for conservation. In this study, we looked at the presence of mallards (*Anas platyrhynchos*) and northern pintails (*Anas acuta*) in relation to anthromes in North Dakota. We aimed to determine if certain anthrome classes could be used as predictors of dabbling duck presence. We found that Remote Croplands (P = 2e-16), Remote Woodlands (P = 2e-16), and Wild Woodlands (P = 1.04e-14) anthromes were significantly effective at predicting mallard presence. Urban (P = 4.85e-13) and Mixed Settlements (P= 1.51e-6), and Remote Rangelands (P < 2e-16) anthromes were significantly effective at predicting a reduction in mallard abundance. We did not find any anthrome classes that were significantly effective at predicting northern pintail presence.

Introduction

The prairie potholes of North Dakota are water-filled indentations left behind by the glaciers of the late Pleistocene (Sloan, 1972). These potholes form a 300,000 square mile pothole-field that extends from south-central Canada down into South Dakota (Sloan, 1972). They provide the most productive wetland habitat for breeding waterfowl in North America (Smith et al. 1964). Although the Prairie Pothole Region provides habitat for only 10% of breeding waterfowl on the continent, it produces about 50% of the continent's ducks (Smith et al. 1964).

It has been documented that brood success rates have declined in recent years due to the draining of wetlands for agricultural use (Klett et al. 1988). Many biologists are concerned that too few ducks are being produced to maintain the current breeding population levels (Klett et al. 1988). The reason why so much attention is paid to waterfowl conservation is because waterfowl hunting has raised over $800 million, which has been used to purchase over 6 million acres of protected wetland habitat in the United States (US Fish & Wildlife Service). Not only does duck hunting provide the revenue to protect wetlands and ducks, it also provides the revenue to protect other organisms that live within the same habitats.

Previous studies have predicted waterfowl distribution by using "natural" landscapes and biomes (Walker et al. 2013). This method has recently been called into question, as human impact on natural environments has been better understood. In a study done by Ellis et al. (2010), they mapped anthropogenic transformations of terrestrial biomes between 1700 and 2000. In 1700, almost one half of the terrestrial biosphere was considered wild (without human settlements or substantial landuse). Only 45% had minor use for agriculture and settlements. By 2000, the majority of the biosphere was in agriculture and settled anthromes. Less than 20% was considered seminatural and 25% was considered wild. Taking this and other historical parameters into account, we know that humans have altered ecosystem patterns and processes across most of the terrestrial biosphere (Sanderson et al. 2002; Kareiva et al. 2007; Ellis et al. 2008). Predicting the distribution of physiographic variables through biomes may no longer be an accurate method. We must take into account human created anthromes in predicting the distribution of species across the terrestrial biosphere.

This project used GIS and statistical analysis to determine if anthromes can be used to predict waterfowl presence. eBird data for mallards (*Anas platyrhynchos*) and northern pintails (*Anas acuta*) was mapped in conjunction with anthrome data from Ellis et al. (2010). From this, the power of each anthrome to predict species presence was determined.

For mallards (*A. platyrhynchos*), the Populated Rangelands and Wild Woodlands anthromes were the strongest predictor of mallard presence. The Remote Rangelands anthrome was the strongest indicator of a reduction of mallard abundance. For northern pintails (*A. acuta*), the Remote Croplands anthrome was the strongest predictor of northern pintail presence. The Populated Rangeland anthrome was the strongest indicator of a reduction of northern pintail abundance.

Methodology

Mapping:

To map the presence of mallards (*Anas platyrhynchos*) and northern pintails (*Anas acuta*), I used points from the eBird database. eBird is a real-time online checklist program where birders can enter when, where, and how they went birding and then fill out a checklist of birds seen and heard. Our data consists of mallard (*A. platyrhynchos*) and Northern Pintail (*A. acuta*) observations in North Dakota between 1940 and 2012. Most of the observations occurred between 2009 and 2012 for both species. From this data, I was able to use the coordinates of each observation and the number of ducks observed at each point.

To determine the anthromes used by the ducks, I used the Anthrome raster map created by Ellis et al. in 2010. They mapped anthropogenic transformations of terrestrial biomes between 1700 and 2000. We used the map created to represent the anthromes for 2000. The raster had a 5 mile resolution. The raster was created through comparing natural vegetation maps and anthrome maps. Anthromes that fell inside our field of study can be seen in Table 1.

ArcMap v10.3 was used to map both the eBird data points and the anthromes. This data were projected using the USA Contiguous Albers Equal Area Conic projected coordinate system and the North American 1983 geographic coordinate system.

I transformed the anthrome raster into a polygon layer using the "raster to polygon" tool. I then plotted the eBird data points and created a 2.79 mi buffer around each point. I chose this width, as it is half of the raster cell size. I created an intersect between the buffers and the anthrome polygon using the "intersect analysis" tool.

Using this data, I was able to plot total number of observations per point, and the anthromes within each buffer. To map the number of observations per point, I used 5 classes of graduated symbols with equal intervals.

Statistical Analysis:

I used R 2.15.1 for statistical analysis. A Poisson distribution was used to predict the strength of each anthrome as a predictor of mallard and northern pintail presence.

Areal view of prairie potholes in North Dakota.

https://www.dmr.nd.gov/ndgs/NDNotes/images/nn1f8.gif

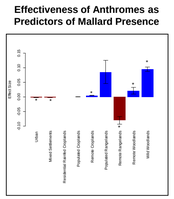

Figure 1. Effectiveness of anthromes for predicting mallard (*Anas platyrhynchos*) presence. Remote Croplands (P = 2e-16), Remote Woodlands (P < 2e-16), and Wild Woodlands (P = 1.04e-14) anthromes were significantly effective at predicting mallard presence. Urban (P = 4.85e-13) and Mixed Settlements (P = 1.51e-6), and Remote Rangelands (P < 2e-16) anthromes were significantly effective at predicting a reduction in mallard abundance.

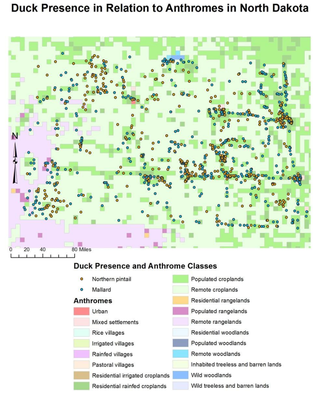

Figure 2

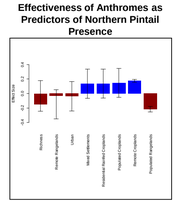

Figure 3. Effectiveness of anthromes for predicting northern pintail (*Anas acuta)* presence. None of the athromes were significantly effective at predicting northern pintail abundance. It appears as though Remote Croplands could be the best predictor of northern pintail presence and Populated Rangelands could be the best predictor of a reduction of northern pintai abundance.

Northern Pintail (*Anas acuta*)

http://www.animalspot.net/wp-content/uploads/2012/05/Northern-Pintail.jpg

Mallard (*Anas platyrhynchos)*

http://upload.wikimedia.org/wikipedia/commons/b/b7/Female_mallard_nest_-_natures_pics_edit2.jpg

Table 1. Anthrome Classes present in buffers and Description.

Class	Description
Urban	Dense build environments with very high populations.
Mixed Settlements	Suburbs, towns and rural settlements with high but fragmented populations.
Residential Rainfed Croplands	Rainfed croplands with substantial human populations.
Populated Croplands	Croplands with significant human populations, a mix of irrigated and rainfed crops.
Remote Croplands	Croplands without significant populations.
Populated Rangelands	Rangelands with significant human populations.
Remote Rangelands	Rangelands without significant human populations.
Remote Woodlands	Forest regions with minor land use without significant population.
Wild Woodlands	Forests and savanna.

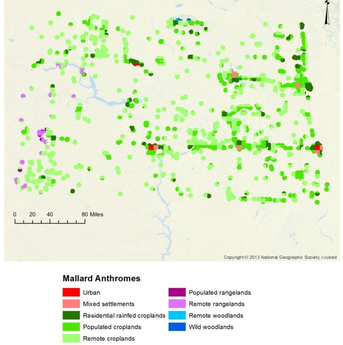

Figure 4

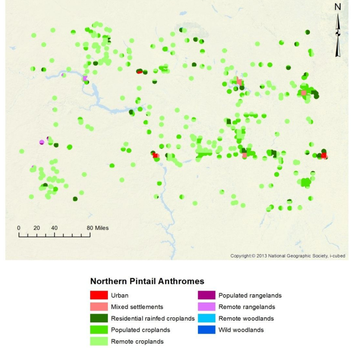

Figure 5

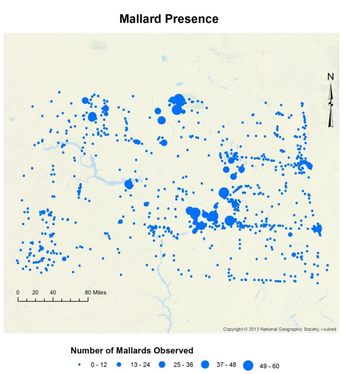

Figure 6

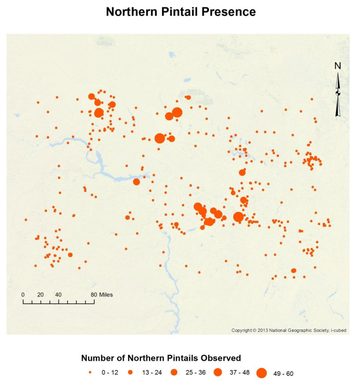

Figure 7

Results and Discussion

Both mallard anthrome presence and northern pintail anthrome presence seems to correlate with overall anthrome coverage in North Dakota. The most abundant anthrome in North Dakota is Remote Croplands followed by Populated Croplands (Fig 2, Fig 4, and Fig 5). Overall, 9211 mallards and 4469 northern pintails were observed. There is a lot more connectivity between mallard anthrome buffers than there is between northern pintail anthrome buffers. This could be explained by the difference in the number of overall observations. Mallard and northern pintail presence is shown in figures 6 and 7.

Through comparing the anthrome habitats and the duck presence, we found that it is possible to predict mallard abundance using anthromes (Fig 1). Remote Croplands, Remote Woodlands, and Wild Woodlands were significantly effective at predicting mallard presence (P < 2e-16, P < 2e-16, P = 1.04e-14). Urban, Mixed Settlements, and Remote Croplands were significantly effective at predicting a reduction in mallard abundance (P = 4.85e-13, P = 1.51e-06, P = 0.000192). It was not possible to predict northern pintail abundance using anthromes because the standard error was so large (Fig 3). This was probably due to the smaller sample size.

Through this study, we can see the power of observing ecological communities in the context of human land use. The fact that we can predict the presence of mallards in the context of anthromes shows how strong our impact on ecological communities is. We can see through this study that relatively low populated areas are better predictors of dabbling duck abundance. It also shows us which anthromes we need to protect and expand. According to this study, it would be most beneficial to protect or expand Wild Woodlands, Populated Rangelands, and Remtote Croplands to increase habitat for mallards.

Future Research

Future research should focus on using anthromes as predictors of endangered or threatened bird species presence. It is more accurate to determine which anthromes endangered species can live in because we are including human activity as a function of the habitat. The protection of endangered and threatened species must be in the context of human activities, especially in populated regions such as the USA.

Future research should also lower the resolution of the anthromes. For global trends, the anthrome data used in this study is appropriate. For smaller scaled research that focuses on local areas, a finer resolution would be more usefull. It is also important in terms of conservation as micro-anthromes may be important predictors of species presence.

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VII. References

Ellis E, Goldewijk K, Siebert S, Lightman D, Ramankitty N. 2010. Anthropogenic transformation of the biomes, 1700 to 2000. Global Ecol Biogeogr. 19:589-606.

Ellis E, Ramankutty N. (2008) Putting people in the map: anthropogenic biomes of the world. *Frontiers in Ecology and the Environment.* 6:439–447.

Kareiva P, Watts S, McDonald R, Boucher T. (2007) Domesticated nature: shaping landscapes and ecosystems for human welfare. *Science.* 316:1866–1869.

Klett A, Shaffer T, Johnson D. 1988. Duck Nest Success in the Prairie Pothole Region. J Wild Manage. 52(3): 431-440.

Sanderson W, Jaiteh M, Levy M, Redford K, Wannebo A, Woolmer G. (2002) The human footprint and the last of the wild. *BioScience.* 52:891–904.

Sloan C. 1972. Ground-water hydrology of prairie potholes in North Dakota. Department of Interior for the development of the Missouri River basin.

Smith G, Stoudt J, Gollop J. 1964. Prairie pothole and marshers. Waterfowl tomorrow: U.S. Bur. Sport Fisheries and Wildlife. 451-460.

US Fish & Wildlife Service. "Federal Duck Stamp Office: What Are Duck Stamps?" *8 Mar. 2013. Web. 10 Apr. 2013. <http://www.fws.gov/duckstamps/Info/Stamps/stampinfo.htm>.*

Walker J, Rotella J, Schmidt J, Loesch C, Reynolds R, Lindberg M, Ringelman J, Stephens S. 2013. Distribution of Duck Broods Relative to Habitat Characteristics in the Prairie Pothole Region. J Wildl Manage. 77(2):392-404.