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WINDBREAK REMOVAL IN EASTERN NEBRASKA

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ABSTRACT

Higher prices for commodities (maize, soybean and wheat) have meant more tree removal in Eastern Nebraska. Casual window surveys each spring have shown new piles of woody vegetation pushed out to make room for an additional few acres of crop ground. During the summer of 2012 in an effort to document the removal, we undertook a more definite survey of windbreak removal for the period 2003 to 2010. Using digital imagery from the Nebraska Spatial GIS Database, we compared 12, one mile wide transects across the eastern third of Nebraska. Each section along each transect was observed manually and compared between the two study years. A total of 1,514 square miles (968,987 acres) were examined. The total number of field windbreaks dropped from 1,994 in 2003 to 1,852 in 2010, a loss of 142 windbreaks or a net loss of 7.12% of the windbreaks in the study area. The total length of the field windbreaks removed was 34.8 miles.

INTRODUCTION

Windbreaks, also known as shelterbelts, are defined as plantings of single or multiple rows of trees or shrubs established for environmental purposes (USDA-NRCS, 1997). Windbreaks in North America came into early prominence primarily as a filter/barrier tool to combat the Dust Bowl in the North American-Great Plains (Mize et al, 2008). Field windbreaks provide a wide variety of benefits in agriculture, ecology, society and economics. While benefits of field windbreaks have been documented for a long time (Brandle et al, 2009), less attention has been paid to changes in the distribution and abundance of windbreaks (Baltensperger, 1987). Casual observations have seen many instances of woody vegetation being removed to facilitate conversion to crop production. Recent increases in commodity prices are one possible reason for this conversion of non-crop acres to row-crop production. In the case of field windbreaks the question remains, how extensive is the removal? This study was initialed to investigate windbreak removal trends in eastern Nebraska.

MATERIAL AND METHODS

The Study Area

Based on the 1:24,000 scale quadrangle boundary data from the U.S. Geological Survey, a quadrangle was selected on the south state boundary as a benchmark (98°33'30.76"W 40°3'5.943"N). Additional quadrangles were selected south to north from this benchmark to the northern state border, skipping every two quadrangles. After reaching the last one, which is located at 98°34'19.946"W 42°55'43.191"N, 12 quadrangles were selected. In each of these 12 quadrangles, a 1-mile (1.61 kilometers) wide transect from the north quadrangle boundary to south was selected. These transects extend from longitudes between 98°32'15.954"W and 98°37'45.064"W on the west, and extend east to the state boundary. These areas were designated from Section A to Section L as shown in Figure 1, with a total of 262 quadrangles, and an area of 3921.4 square kilometers (968,987.6 acres).

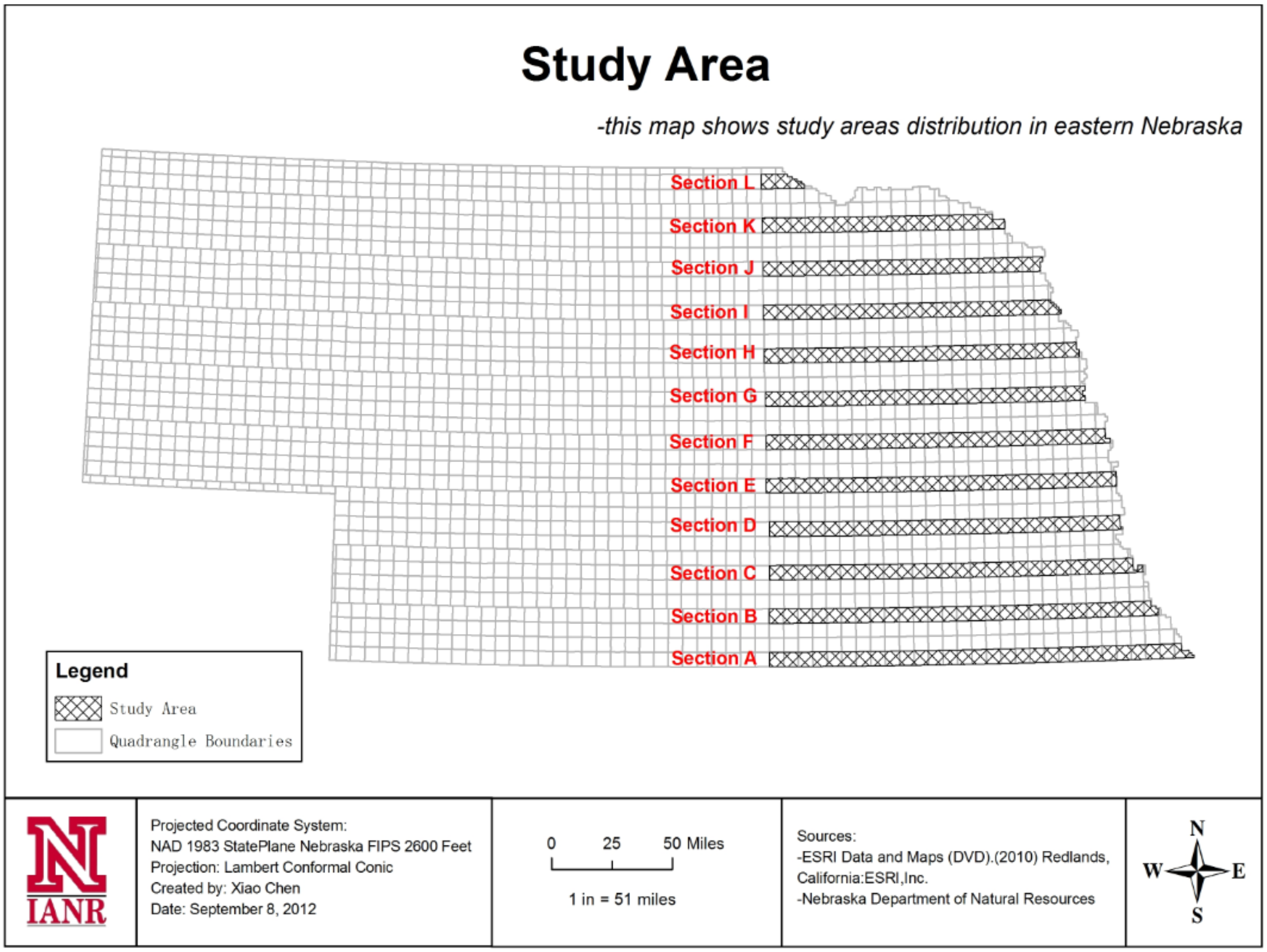

Figure 1. Windbreak removal study area in eastern Nebraska.

Data Processing

Using Geographical Information System (GIS) technology, a geodatabase was built to analyze changes in windbreak distributions in eastern Nebraska between 2003 and 2010. Digital 2003, 2010 imagery, and quadrangle vector data were all acquired from The Nebraska Department of Natural Resources Data Bank. The Nebraska Farm Service Agency (FSA) 2003 digital orthophoto was published by USDA FSA Aerial Photography Field Office (APFO) on 15 March 2004. The Nebraska FSA 2010 imagery was also published by APFO on 13 August 2010. Both 2003 and 2010 imagery are in 1 m ground sample distance (GSD) and are products of the National Agriculture Imagery Program, which acquires ortho imagery during the agricultural growing seasons in the continental U.S. The vector digital data by quadrangle were published by Nebraska Department of Natural Resources in January 1997. The quadrangle coverage was mathematically generated from latitude/longitude. It reflects the standard 7.5 minute USGS quadrangle.

Processing of 2003 images and 2010 images, and windbreak digitization, were completed in ArcMap 10.0 (ESRI, 2011). Data analysis was conducted in Microsoft Office Excel 2010.

There were thousands of separate images for each quadrangle in Nebraska that were combined into a single contiguous form. File geodatabase was utilized to accomplish this task. Under this geodatabase, a mosaic dataset was created and images were then loaded to merge into a single map. At last, this mosaic dataset was added to ArcMap as a layer for next step.

For 2010 images, each county has a separate file of satellite imagery with the same coordinate system in MrSID format, which is supported in ArcGIS. Therefore, images of counties in the study areas were added into ArcMap, and a group was created to manage their display.

After data preparation, windbreak digitization for 2003 image was necessary. The first step was to identify and extract windbreak features. The feature extraction step was conducted in ArcMap 10.0 manually using the Draw tool in Editor. Following extraction, data were converted to feature class and added to the 2010 imagery. Visual comparison of the 2003 and 2010 data sets allowed the determination of the change in the number and area of windbreaks removed during the period. Geometric calculation provided the length of each windbreak and, all data were imported to Excel spreadsheet for analysis.

RESULTS

Between the years 2003 and 2010 losses in both the number of windbreaks and the area of windbreaks were observed. From 2003 to 2010, the number of windbreaks dropped from 1,994 to 1,852 within the sampled transects, a loss of 142 windbreaks or a 7.1% net loss in the number of field windbreaks. The total length of windbreaks removed was 56.0 km (34.8 miles) or a loss of 7.8% of total windbreak length in the study area (see Figure 2). The sampled area represents approximately one-third of land area within the sampling region. If the sampled transects are representative of the entire area and if the removal rate is extrapolated to the entire sample region, windbreak loss would exceed 400 windbreak removals with a total length of over 150 km.

Windbreak removal rates were not uniform across the area ranging from a net gain in windbreaks in transect K in northeast Nebraska to over 20% loss for transect H in east central Nebraska (see Table 1).

Table 1. Rate of field windbreak loss (%) by transect in eastern Nebraska 2003 to 2010.

Transect	A	B	C	D	E	F	G	H	I	J	K	L
% loss	7.6	6.3	6.0	4.9	2.0	9.4	7.3	20.0	9.2	12.1	-2.4	0.0

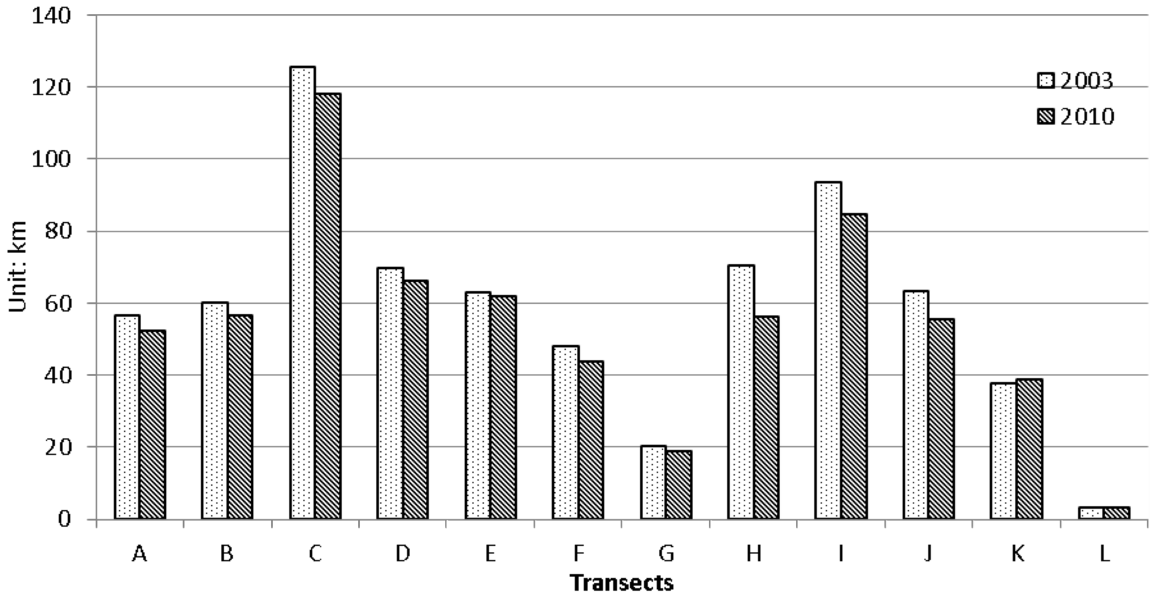

Figure 2. Kilometers of field windbreaks lost between 2003 and 2010 in eastern Nebraska by transect.

Field windbreaks are randomly distributed in the landscape. Using the 2010 inventory data, we calculated that for the sampled transects only 0.032 to 0.237% of the land area per square mile was devoted to field windbreak plantings (see Figure 3).

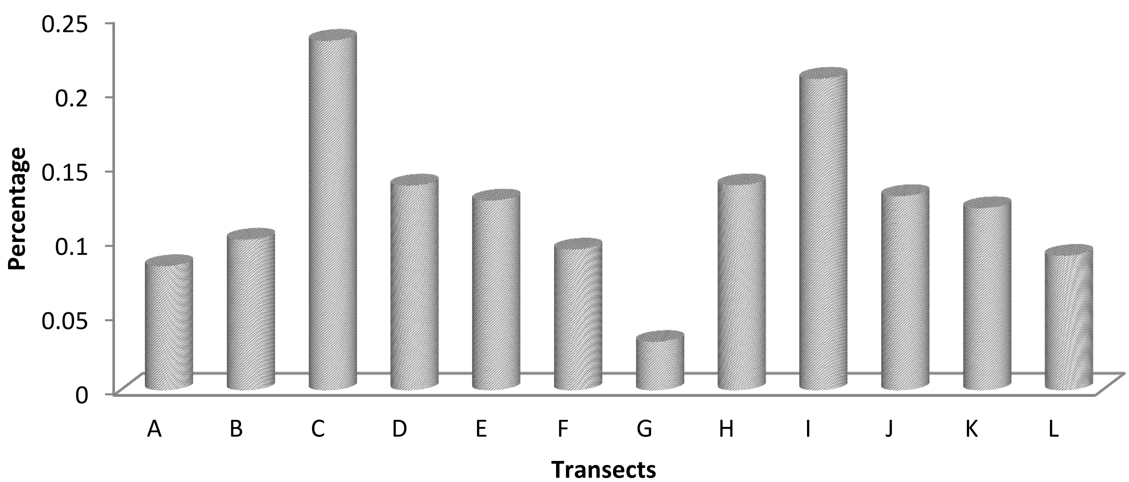

Figure 3. Windbreak density per square mile on sampled agricultural lands in eastern Nebraska, 2010.

Field windbreak protection typically extends for a distance of 10 to 15 times the height of the windbreak (H) to the leeward side and 2 to 5 H to the windward side. Most fields can be totally protected by planting 3 to 5% of the land to field windbreaks. At these densities, the investment in a field system is economically viable and increases the income flow to the producer (Helmers and Brandle 2005). Our analysis indicated that field windbreaks protect less than 1 percent of the cropland found in the study area. Given that adequate protection for a crop field requires that 3 to 5% of the land be planted to windbreaks the potential for additional field windbreak plantings in eastern Nebraska is high (Helmers and Brandle, 2005).

DISCUSSION AND CONCLUSIONS

Speculation as to the reasons for the increase in removal rates leads one to quickly assume that the huge run up in commodity prices (see Figure 4) over the last five years may have encouraged farmers to remove various types of tree plantings, including field windbreaks and riparian forest buffers.

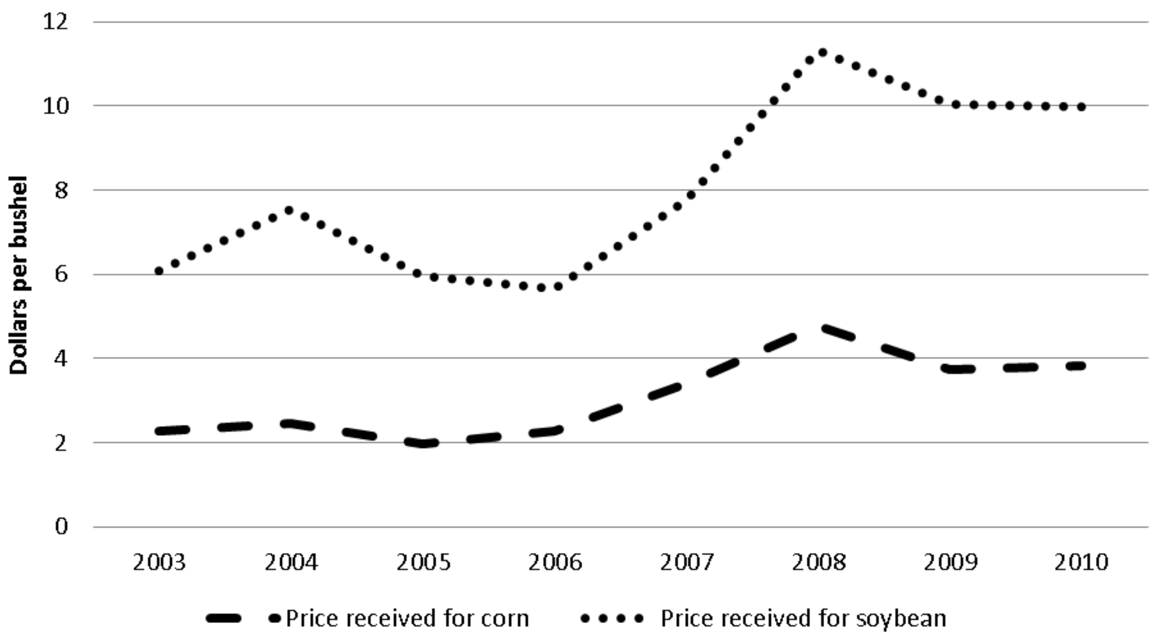

Figure 4. Commodity prices for corn and soybean for the period 2003 to 2010.
(http://www.nass.usda.gov/Charts_and_Maps/Agricultural_Prices/pricecn.asp)

Note that prices for both corn and soybean continued to rise in 2011 and 2012 adding additional pressure to land conversion from windbreaks to cropland. Closing prices as of June 4, 2013 in Lincoln, Nebraska were $6.98 for corn and $14.87 for soybeans.

Perhaps of greater concern is the belief that improvements in agricultural practices such as minimum tillage and no tillage have reduced the need for windbreaks for wind erosion control. To the contrary, while these practices are a positive control measure they lose effectiveness in a prolong drought. The introduction of GMO crops resistant to drought has also been cited as a reason to remove windbreaks as the need for water conservation is no longer a critical need. At this point in time the authors are inclined to believe that removal is being driven primarily by commodity price.

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