MONITORING THE ANNUAL INCREASE OF GARLIC MUSTARD IN EASTERN NEBRASKA

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Abstract: Introduced from Europe to North America in the mid-1800s, garlic mustard (Alliaria petiolata) has demonstrated an effectiveness at invading the understory of many wooded sites. The increase in garlic mustard was monitored at the Boyer Chute National Wildlife Refuge located in eastern Nebraska in wooded plots adjacent to existing prairie and prairie restoration projects. Permanent transect locations were established and line-intercept data collected each summer from 2008 to 2010. Data indicate a rapid increase in the number of transects intersecting garlic mustard as well as a dramatic increase in frequency each year. These studies emphasize the rate of colonization as a significant challenge when attempting to control garlic mustard.

INTRODUCTION

Garlic mustard has steadily invaded the understory of North American forests, but the dynamics of the long-term invasion by this species have not been thoroughly studied (Lankau 2009). Invasion by garlic mustard has been correlated with changes in soil bacteria composition (Burke 2010), with inhibition of arbuscular mycorrhizal fungi (Barto 2010) and with complex alteration of plant communities (Pardini 2009). The purpose of this study was to monitor and quantitatively measure the invasion of garlic mustard into forested areas of eastern Nebraska.

METHODS

STUDY SITE

Data was collected at the Boyer Chute National Wildlife Refuge, and special use permits were obtained from the U.S. Fish and Wildlife service for all activities. Three heavily wooded study sites were selected on an island formed by a remnant of the Boyer River which connects with the north and south portions of a bend in the Missouri River (Figure 1). The refuge consists of at least 3,121 acres and is currently expanding to a planned 9,912 acres with holdings in both Iowa and Nebraska. The study site is in the ten-year or less floodplain of the Missouri River (990-995 feet above sea level). Historically the area was heavily utilized for agriculture, but has been modified greatly since refuge establishment in 1999 by the Army Corps of Engineers and the Fish and Wildlife Service (Boyer Chute Restoration Project).

MAPPING

Map coordinates for the perimeter of the study area were obtained using a hand-held GPS unit (Garmin, eTrexH) with WAAS enabled. The resulting GIS data was plotted using QtiPlot graphical software. Geometric distortion of data was corrected by correlation of latitude and longitude to surface distances measured on site (0.052±0.003 minutes / 100m north-south; 0.077±0.003 minutes / 100m east-west).

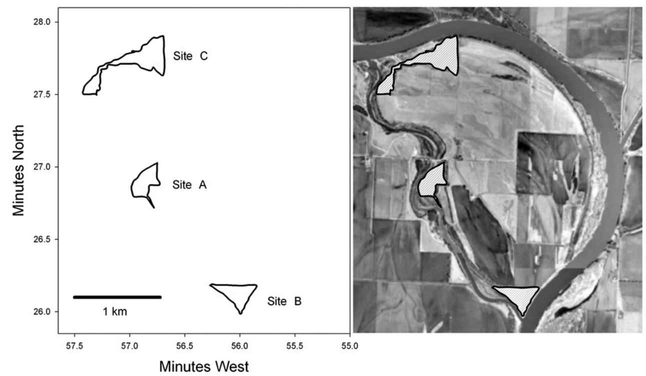

Figure 1. Boyer Chute study sites. Boundaries of study sites were mapped by walking the perimeter and determining GPS coordinates every 100 to 200 meters. Correlation of GPS coordinates to physical distances was accomplished with on-site measurements as described in Materials and Methods. Aerial photograph of the study site, composed of an island bordered on the north and east by a bend of the Missouri River and the chute of the Boyer River on the west and south.

VEGETATION MEASUREMENTS

Twenty-seven permanent sample sites were established in 2007, and data were collected at those sites in the summers of 2008, 2009, and 2010 in late June and July. Sites were located from previously established GPS coordinates, and point intercept data were collected. Data for each site consisted of a single 20-meter point intercept transect with intercepts measured every meter to a height of 1.5 m utilizing standard methodology (Bonham 1989).

DATA ANALYSIS

Descriptive and mathematical significance of data were determined using the OpenOffice spreadsheet software and OOoStat Statistics Macros version 0.5. Data were analyzed by one-way ANOVA with statistical significance set at $p<0.05$.

RESULTS AND DISCUSSION

Garlic mustard increased in geographic distribution and frequency in the wooded areas of Boyer Chute National Wildlife Refuge between 2008 and 2010. Sampling locations containing garlic mustard increased from 3 to 9 to 12 locations in 2008, 2009, and 2010, respectively (Figure 2). Garlic mustard was intersected at a frequency of 47, 109, and 225 intercepts / 1000 samples in 2008, 2009, and 2010, respectively (Figure 3). Because there was no apparent Corps of Engineers activity between 2005 and 2009, the movement of garlic mustard was likely not due to construction projects on the refuge. The increase in garlic mustard was significant ($p<0.05$) as evaluated by one-way ANOVA and can be crudely estimated as a doubling of frequency each year. For comparison, white snakeroot was intersected 133, 113, and 81/1000 samples in 2008,

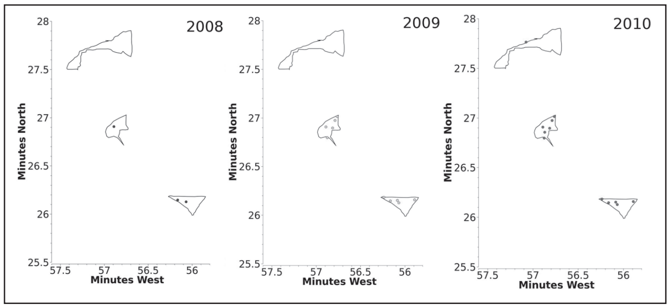

Figure 2. Location of sample sites containing garlic mustard. Map of study sites illustrating the location of transects intersecting garlic mustard in the summers of 2008, 2009, and 2010.

2009, and 2010, respectively, but the difference between years was not statistically significant despite a strong downward trend in frequency (Figure 3). Given the observed rate of garlic mustard increase, it is anticipated that garlic mustard will continue to increase at the study site.

While long-term data will be required for modeling, some gross predictions can be made for the movement of garlic mustard within the study site. As seen in Figure 2, garlic mustard has on average appeared at 3-6 new locations per year, which would imply that 100% of the 27 permanent transects would possess at least one garlic mustard intersection in 2-4 years, which would correspond to sometime between the years 2012

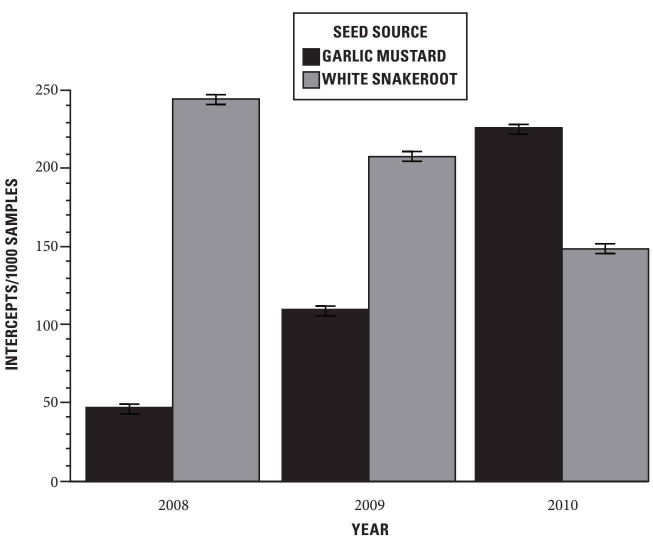

Figure 3. Garlic mustard frequency. Frequency of garlic mustard (white) and white snakeroot (gray) during summers of 2008 to 2010. Data were normalized to 1000 point intercept measurements, and bars represent the mean of intercept data collected for the indicated year. Error bars span one standard deviation. Data evaluated by one-way ANOVA. Garlic mustard significantly different between groups ($p<0.05$), while white snakeroot failed to demonstrate statistical significance ($p<0.60$).

and 2014. Approximating the change in garlic mustard frequency by line intercepts is more problematic and difficult to anticipate with sparse data, but the maximum garlic mustard frequency in a single transect which was judged to be maximally infested with garlic mustard in 2010 was measured at 34 intersections over 20 point intercept measurements, which would correspond to approximately 1,700 garlic mustard intersections per 1,000 measurements. If a crude estimate of a doubling in garlic mustard frequency per season is accepted from the data presented in Figure 3, then the maximum frequency of garlic mustard will be reached on the study site in approximately four years, or the summer of 2014, which is in reasonable agreement with the prediction that all permanent transects could contain measurable garlic mustard between 2012 and 2014. While these predictions are based on limited data, only three seasons, they do emphasize the rapidity in which garlic mustard is likely to invade the area. Plans for the future of this investigation are to continue to monitor the study site for garlic mustard in an effort to produce robust models of garlic mustard invasion.

ACKNOWLEDGMENTS

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