Riparian Forest Associated With Tall-Grass Prairie: Species Composition and Distribution along the Missouri River of Central Nebraska

THOMAS L. FREEMAN[1], Department of Biology, Division of Arts and Sciences, College of St. Mary, Omaha, NE 68106, USA

[1] Present address: Department of Biology, University of Nebraska at Kearney, Kearney, NE 68849, USA

Abstract: Forest is often found between natural prairie remnants, or prairie restorations, and the river. These riparian habitats likely play important roles for control of erosion, maximizing diversity through "edge effect", providing nesting sites for birds and other cavity dwellers, and cover resources for animals. In addition, prairie-associated forests add to the recreational quality of many sites by providing shade, opportunities for game hunting and morel habitat for mushroom collectors. This study will present preliminary analysis of plant species and their distribution in forest adjacent to the Missouri river in Nebraska. Both belt- and distance- type methodology were utilized to characterize the woody vegetation, while line intercept methods were used for ground cover and other vegetation measurements.

Proceedings of the North American Prairie Conference 21: 63-68

Keywords: forest, tall grass, prairie, Missouri River, Nebraska.

Introduction

Many tree species associated with the Missouri River are adapted for colonization of the mineral soil produced by seasonal flooding. Because the flow of the Missouri has been carefully regulated for flood control, navigation and agricultural uses, the historic pattern of flooding has been greatly modified. This regulation of river flow has resulted in a parallel change in the distribution and composition of trees along the river. In general, flood-dependent species such as Cottonwood (*Populus deltoids*) and Willows (*Salix sp.*) have decreased while shade-tolerant species such as Mulberry (*Morus sp.*) and Ash (*Fraxinus sp.*) have increased in many riparian systems following control of river flow rates (Cooper et al. 1999). We studied the frequency and composition of trees in riparian forest of central Nebraska to characterize the current population and to establish foundation data sets for future studies.

Study Area

Data were collected in the public access areas at the Boyer Chute National Wildlife Refuge. The refuge is located approximately 10 miles north of Omaha, NE and is bound on the north and east by a bend in the Missouri River. The three study sites are confined to an island formed by a remnant of the Boyer River which connects with the north and south portions of the 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 entire study area is in the 10 year or less floodplain of the Missouri River (990-995 feet above sea level). Historically this area was heavily utilized for agriculture, but has been modified greatly since being made as a refuge in 1999 by the Army Corps of Engineers and the Fish and Wildlife Service. Significant projects have included prairie grass plantings, forest restoration and establishment of appropriate water movement through the chute (Boyer Chute Restoration Project, U.S. Fish and Wildlife Service).

Methods

Selection of sample sites

The study sites were selected as representative of larger patches of forest commonly found adjacent to the Missouri River. In addition, the study sites were required to have significant borders consisting of both river and prairie or prairie restoration. While thin strips of trees occur almost continuously along the bank of the Missouri River, these areas were excluded from this study.

Mapping

Map coordinates for the perimeter of the study area were obtained from a handheld GPS unit

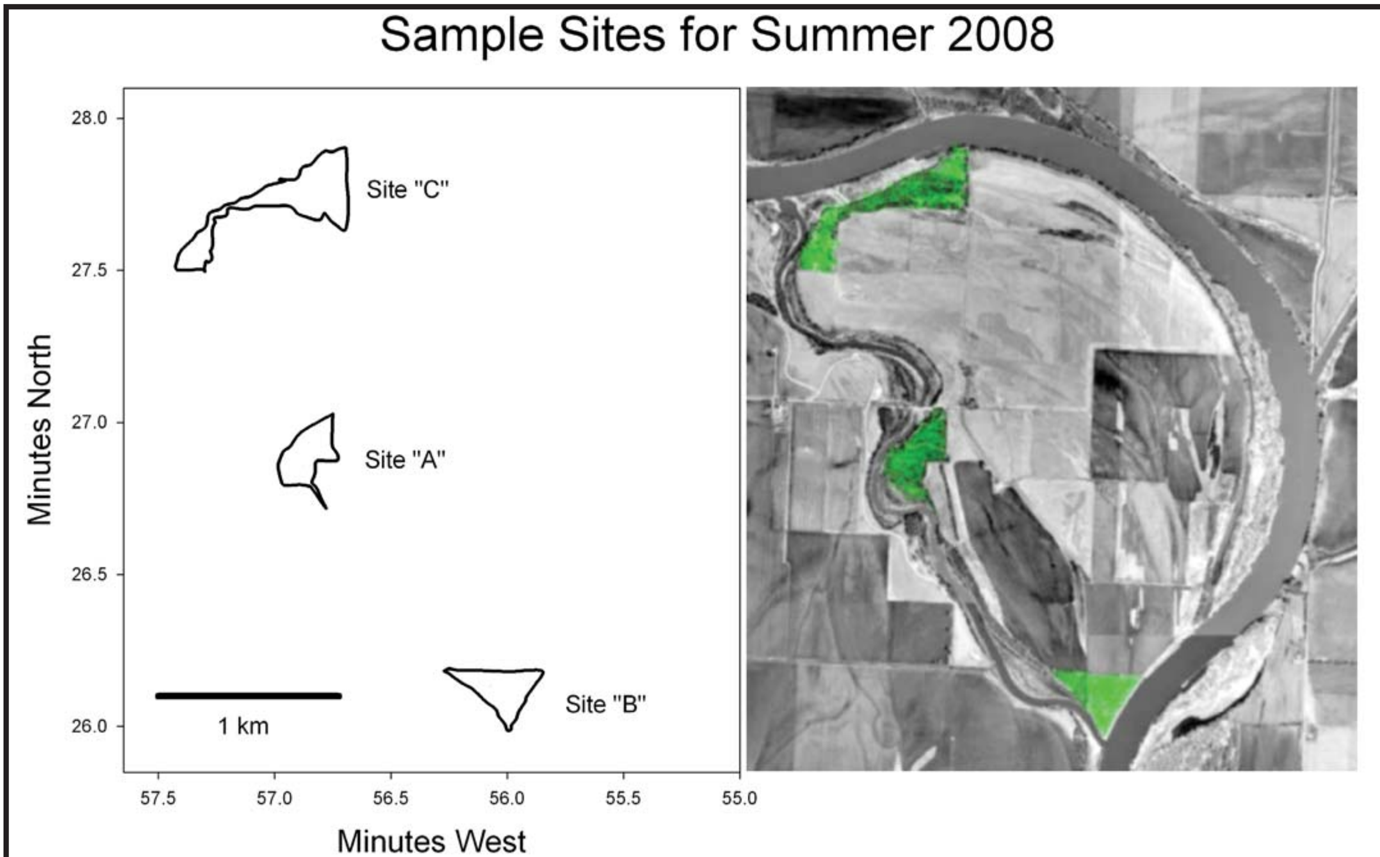

Figure 1. Map of study area. Coordinates for the perimeter of each site were obtained by handheld GPS, and the resulting data plotted. Geometric distortion of the GPS data was corrected by calibration to physical distances collected on site. Aerial photo, 1996, courtesy of the USGS.

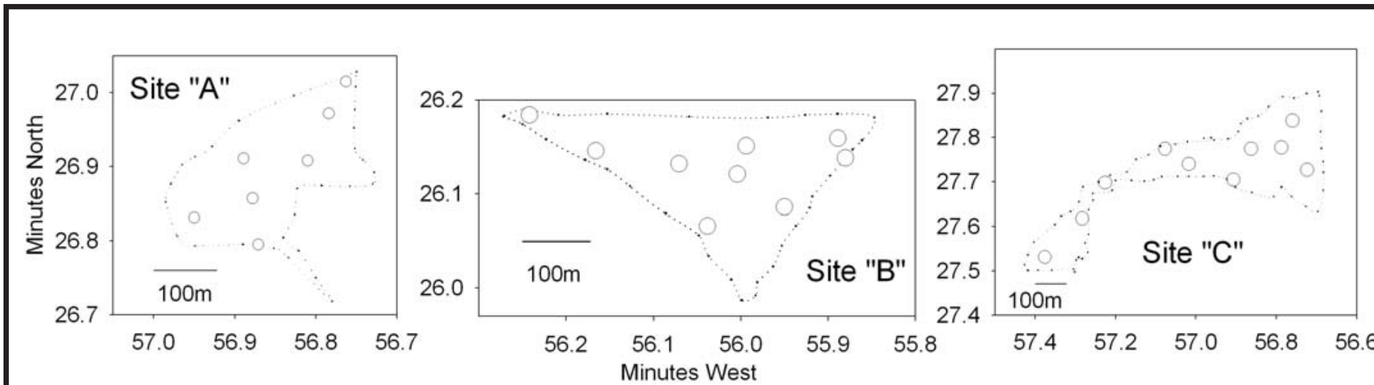

Figure 2. Location of sample sites in the study areas. Vegetation was sampled at the indicated locations utilizing 20m transects as described in Methods.

(Garmin®, eTrexH) with WAAS enabled and plotted with SigmaPlot 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). Satellite images (Google Earth) were used as aids during the study; however, only freely available USGS aerial photos are presented.

Vegetation measurements

Data were collected at 26 sites and consisted of point intercept, belt and distance methods (Figure 2). Point intercept data of plant species (Barth and Ratzlaff 2004, Ratzlaff and Barth 2007, Stubbendieck et. al. 1986, Stubbendieck et. al. 1989) were collected every meter along a 20m tape to a height of 1.5m. Belt data of woody plants >2.5cm in diameter at breast height (DBH) were collected along the same 20m tape at a width of 3m. In addition, a distance-type measurement was conducted by measuring the DBH of the 5 woody plants >2.5cm closest to the start of the 20m tape. Snags >2.5cm DBH were included in the vegetation measurements (Bonham 1989).

Digital estimation of cover

Digital photos were taken to evaluate their utility in estimating the density of cover with a Nikon Coolpix 950 camera. All photos were taken at the camera's widest angle (7mm focal length). Horizontal cover measurements were taken by photographing a 0.03 x 1.5 m board painted fluorescent orange at a distance of 2.5, 5, 10 and 20m. The cover was then measured by counting the red pixels using the NIH-ImageJ image analysis software.

Data analysis

Descriptive and mathematical significance of data were determined using the built-in statistical function of the Microsoft Excel office package.

Results and Discussion

Frequency of woody vegetation

Belt transects were utilized to quantify the frequency of woody stems >2.5cm DBH in the three study sites. As indicated in Table 1, ten species occurred at a rate of ≥32 stems per hectare. Species classified as other occurred in at least one transect and include American Elm (*Ulmus americana*), Siberian Elm (*Ulmus pumila*), Black Willow (*Salix nigra*), Tree-of-Heaven (*Ailanthus altissima*) and Virginia Creeper (*Parthenocissus quiquefolia*). While there is a temptation to characterize the plant community as Cottonwood (*Populus deltoids*) bottomland, Rough-leaved Dogwood (*Cornus drummondii*) greatly outnumbered all other species with a frequency exceeding all others combined. Snags (dead standing

Table 1. Frequency of woody stems greater than 2.5cm DBH. Values are the average of 26 belt transects (558 observations) and are normalized to stems per 1 hectare.

Common Name	Scientific Name	mean	std	MAX	MIN
Rough-leaved Dogwood	*Cornus drummondii*	1603	1860	5833	0
White Mulberry	*Morus alba*	327	325	1167	0
Cottonwood	*Populus deltoides*	167	620	3167	0
Red Mulberry	*Morus ruba*	154	383	1833	0
Green Ash	*Fraxinus pennsylvanica*	109	275	1333	0
Poison Ivy	*Toxicodendron radicans*	103	157	500	0
River-bank Grape	*Vitis riparia*	90	178	833	0
Hackberry	*Celtis occidentalis*	64	177	833	0
White Ash	*Fraxinus americana*	32	95	333	0
Box Elder	*Acer negundo*	32	67	167	0
other		45	89	333	0
snags		853	791	2500	0

Table 2. Ground cover. Values are the average of 26 point intercept transects (520 observations) and are normalized to frequency / 100 samples.

cover	mean	std	MAX	MIN
litter	38.65	16.22	80	10
leaf	11.92	12.89	40	0
bark	2.88	4.04	10	0
wood>2.5cm	7.69	6.20	15	0
wood<2.5cm	9.42	6.98	25	0
bare ground	27.88	19.86	70	0
other	1.54	4.19	15	0

wood >2.5cm DBH) were quite abundant averaging about 850 / hectare. Low frequency species which were encountered at the site, but did not occur in any transects, include Silver-leaf Maple (*Acer saccharinum*), Sycamore (*Platanus occidentalis*), Redbud (*Cercis canadensis*), American Linden (*Tilia*

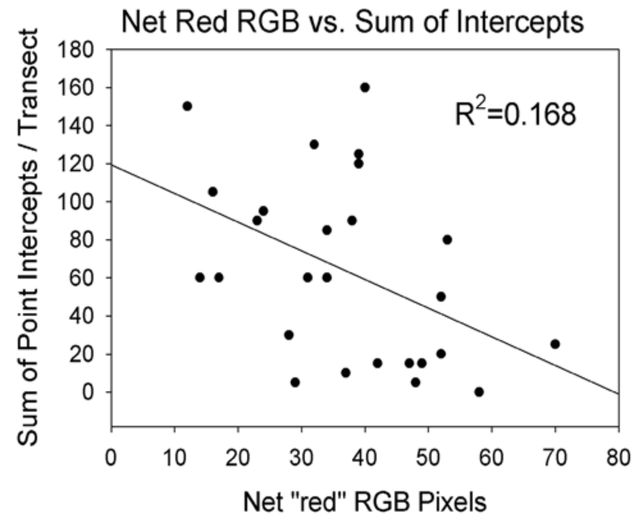

Figure 3. Estimation of horizontal cover density with digital photographs. The sum of point intercept data were compared to the number of "red" RGB pixel measured from photographs as described in methods.

Table 3. Point-intercept cover and species frequency to 1.5m height. Data were collected for each 1m segment over the length of a 20m tape to a height of 1.5m. The frequency rate, as a percent of all species intercepted, is represented by occurrence. The mean and standard deviations were for the number of hits per 100 samples.

Common Name	Scientific Name	frequency	mean	std	MAX	MIN
White Snakeroot	*Ageratina altissima*	40.4	25.8	32.6	100	0
Garlic Mustard	*Alliaria petiolata*	9.6	6.2	17.6	80	0
Wirestem Muhly	*Muhlenbergia frondosa*	6.9	4.4	10.1	40	0
Wooly Mullein	*Verbascum thapsus*	1.2	0.8	3.9	20	0
Downy Yellow Violet	*Viola pubescens*	2.4	1.5	3.1	10	0
Smooth Brome	*Bromus inermis*	9.3	6.0	21.1	95	0
Kentucky Bluegrass	*Poa pratensis*	2.4	1.5	6.1	30	0
Little Bluestem	*Schizachyrium scoparium*	1.5	1.0	4.9	25	0
Bluntleaf Bedstraw	*Galium obtusum*	1.5	1.0	2.5	10	0
Sedges	*Carex sp.*	2.1	1.3	3.6	15	0
Wood Sorrel	*Oxalis stricta*	0.3	0.2	1.0	5	0
Hemp	*Cannabis sativa*	0.3	0.2	1.0	5	0
Clearweed	*Pilea pumila*	0.3	0.2	1.0	5	0
Redroot Pigweed	*Amaranthus retroflexus*	0.6	0.4	1.4	5	0
Pennsylvania Pellitory	*Parietaria pensylvanica*	2.4	1.5	3.7	15	0
Labm's Quarters	*Chenopodium album*	0.6	0.4	1.4	5	0
forbs (not identified)		8.4	5.4	8.8	25	0
grass (not identified)		3.3	2.1	4.7	20	0
other		6.3	4.0	4.5	15	0

Table 4. Size distribution of trees. Trunk diameter at breast height (DBH) was use as a measure of tree size and as an indirect measure of age. All data are in centimeters.

Common Name	Scientific Name	mean	std	MAX	MIN
Rough-leaved Dogwood	*Cornus drummondii*	4.1	1.1	6.6	2.4
White Mulberry	*Morus alba*	16.9	16.3	82.8	2.4
Cottonwood	*Populus deltoides*	27.1	32.5	112.3	3.2
Red Mulberry	*Morus ruba*	9.7	8.1	27.6	3.8
Green Ash	*Fraxinus pennsylvanica*	16.7	9.8	34.6	4.5
Hackberry	*Celtis occidentalis*	9.5	5.0	19.8	3.9
White Ash	*Fraxinus americana*	11.8	8.3	20.8	3.2
Box Elder	*Acer negundo*	20.4	10.9	32.2	10.9
snags		7.2	7.9	51.8	2.4

americana), Honey Locust (*Gleditsia triacanthos*) and Red Cedar (*Juniperus virginiana*).

Ground cover and species occurrence

Point-intercept observations every meter for 20m were used to estimate cover at ground level and to estimate the frequency of vegetation occurring below 1.5m. Ground cover (Table 2) was extensive with bare ground occurring in only 27% of the observations; however, this value would be expected to increase as the summer progressed and low mass organic material decays (i.e. as leaf cover decays to bare ground). Generalized, partially decayed litter composed the majority of observations (about 38%), and downed wood (about 18%) of the observed points. Unexpectedly, very few live plants were intercepted at ground level and are included in the other classification at less than 2%. Vegetation below 1.5m was estimated by the point-intercept method as well. White Snakeroot (*Ageratina altissima*) was the dominant plant with a frequency of occurrence (False Nettle hits / all hits) above 40%. The next most abundant herbaceous species was the invasive Garlic Mustard (*Alliaria petiolata*). While Garlic Mustard was sampled in only three of the data collection sites, one site could be considered infested with about 80 intercepts per 100 measures (i.e. at least one hit 8 out of 10 times), and it is suspected that a large proportion of unidentified forbs encountered were the first year rosette stage of this species. It is anticipated that Garlic Mustard will increase in abundance and become the dominant under story plant as observed at other nearby sites. Future studies may be directed at measuring the rate of invasion. Due to canopy shade, very few of the sites contained significant amounts of grass, but when light permitted grass growth, Smooth Brome (*Bromus inermis*) and Wirestem Mulley (*Muhlenbergia frondosa*) dominated despite a good mixture of Little Bluestem (*Schizachyrium scoparium*), Sideoats Grama (*Bouteloua curtipendula*), Indian Grass (*Sorghastrum nutans*), Switchgrass (*Panicum virgatum*) and Big Bluestem (*Andropogon gerardii*) in the grass-dominated prairie restoration areas.

Cover estimation with digital images

Despite excellent correlations between cover and "red" RBG pixels in the laboratory setting, the use of digital photographs to estimate horizontal cover density were found to be unsatisfactory with only weak correlation (R^2=0.168) of point-intercept data with inverse of the "red" RGB pixels measured (Figure 3). This emphasizes the difference between laboratory and field studies, and the need for more sophisticated algorithms to detect pixel color for field studies.

Size distribution of trees

DBH was used as a measure of the size for all trees >2.5cm DBH encountered within the 26 belt transects included in the study (543 observations). The mean diameters of the dominant trees are summarized in Table 4. While Rough-leaved Dogwood was very abundant, all were universally small. White Mulberry (*Morus alba*) tended to be

2x the diameter of Red Mulberry (*Morus ruba*). Cottonwood displayed the largest mean diameter at 27.1cm, but these data were binomially distributed between very old trees (as large as 112cm DBH) and smaller trees located in forest restoration areas which were less than 10-20 years of age. Snags ranged from a small 2.5cm DBH to some isolated large specimens with diameters above 51cm.

Literature Cited

Barth R.E. and N.S. Ratzlaff. Field Guide to Wildflowers. 2004. Fontenelle Nature Association, Bellevue, NE.

Bonham, C.D. Measurements for Terrestrial Vegetation. 1989. John Wiley and Sons, New York. A guide to the more common trees found in the Eastern and Central U.S. The National Arbor Day Foundation. Nebraska City, NE 68410

Boyer Chute Restoration Project. U.S. Fish and Wildlife Service. http://www.fws.gov/ midwest/ BoyerChute /images.html

Cooper, D.J., D.M. Merritt, D.C. Andersen, and R.A. Chimner. 1999. Factors controlling the establishment of Fremont cottonwood seedlings on the Upper Green River, USA. Regul. Rivers: Res. Mgmt. 15: 419–440.

Ratzlaff, N.S. and R.E. Barth. Trees, Shrubs, Woody Vines, Grasses, Sedges and Rushes. 2007. Fontenelle Nature Association. Bellevue, NE.

Stubbendieck, J., J.T. Nichols and K.K. Roberts. 1986. Nebraska Range and Pasture Grasses (Including Grass-like Plants). University of Nebraska Press. Lincoln, NE.

Stubbendieck, J., J.T. Nichols and C.H. Butterfield. 1989. Nebraska Range and Pasture Forbs and Shrubs (Including Succulent Plants). University of Nebraska, Institute of Agriculture and Natural Resources. Lincoln, NE.