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Local Ecology Research Papers

Patterns of Reed Canary Grass (Phalaris arundinacea L.) Distribution in Relation to Soil Moisture

Mark R. Glineburg
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Abstract

Reed canary grass is an invasive wetland species that is capable of aggressively taking over entire plant communities. Understanding growth patterns and success factors of reed canary grass may help to someday eradicate this problem. This study was undertaken to determine if soil moisture is a factor in reed canary grass success. Data was collected from three sites in southern Minnesota: Skoglund Pond on St. Olaf College campus, Heath Creek, and a pond from the Carleton College Arboretum. At each site, reed canary grass percent coverage was determined and soil samples were taken within the successful growing area of the reed canary grass, at the outer perimeter of the growing area, and outside the growing area. Soil moisture analysis showed a significant difference in percent soil moisture and location. Mean percent soil moisture was highest within the reed canary grass growing area, lower at the outer edge of the growing area, and lowest outside of the growing area. Reed canary percent coverage results express that there are other factors beside proximity to water source that effect growth success. Overall, the result of this study suggests that the presence of reed canary grass is dependent on soil moisture.

Introduction

Reed canary grass (*Phalaris arundinacea* L.) is an invasive species that is found in pasture or wetlands on every major landmass except Antarctica and Greenland (Morrison and Molofsky 1998). It is native to the United States and Canada but is now more widespread because of agricultural introduction (Barnes 1999). Historically, reed canary grass has been used as a forage and hay crop in marshes and floodplains, as well as for sediment stabilization of shorelines and ditch banks (Barnes 1999). In the eleven states that lack noxious weed laws, reed canary grass continues to be planted on roadsides to prevent erosion (U.S Department of Transportation 2002). The introduction of this plant has become a serious problem because it has escaped domestication and is capability of aggressively taking over whole plant communities (Morrison and Molofsky 1998).

The large and detrimental success of reed canary grass is due to its good distribution of growth from the spring to summer, flood and drought tolerance, and ability to persist in spite of heavy grazing (Barnes 1999). Because of the rapid growth of reed canary grass it may cause declines of other wetland species within several years following its introduction (Barnes 1999). Volker and Smith (1965) found that eleven species disappeared from a wetland in Iowa, after the introduction of reed canary grass (*Phalaris arundinacea* L.). They also found that, the seed bank of a soil from an Illinois wetland has become completely dominated by reed canary since it was planted for hay in the 1940's. According to the Cofrin center for biodiversity, at University of Wisconsin Green bay, reed canary grass is perhaps the worst invasive species in Wisconsin, to date.

St. Olaf college campus naturalists have been concerned about the abundance of reed canary grass in the restored natural wetlands. Its aggressive nature has made it an undesirable weed that threatens the success of other species. Lauren Lucas (2003) found a decrease in species diversity related to the presence of reed canary grass on the St. Olaf campus. The south side of the Skoglund pond had more reed canary grass and lower species diversity then the north side. Action has been taken on the St. Olaf natural lands to control this problem. But, it can take five or six seasons of to deplete the seed bank and control efforts are not completely effective. Thus, understanding growth patterns and success factors of reed canary grass is necessary to help someday eradicate this problem.

In depth knowledge of this invasive species is one of the first steps to completely eradicating this problem and restoring wetlands to the natural state. With this in mind, his study was undertaken to determine if reed canary grass success is related to soil moisture. The percent coverage of reed canary grass and percent soil moisture were studied at three sites in southern Minnesota. It was hypothesized that percent coverage of reed canary grass would be highest at distances nearest the water and decrease as it got further from the water. Further it was hypothesized that reed canary growth would be dependent on soil moisture.

Methods

The growth patterns of reed canary grass and soil moisture were studied at three locations in Southern Minnesota: the Skoglund Pond on St. Olaf College campus, a pond at the Carleton College Arboretum, and Heath Creek.

At each location, six transects measuring a width of 2 meters and the length from the waters edge outward to the end of the reed canary growth, were measured and marked off. Three transects were evenly spaced out along the edge of the water. Within each transect, 2 meter by 5 meter plots were created every 5 meters to assess the percent coverage of reed canary grass.

Soil samples were collected using a tube soil sampler to study the moisture in the soil. A total of 18 samples were collected form each site, three from each transect. At each transect a sample was collected from the soil next to the waters edge (point 1), from the end of the reed canary growth line (point 2), and at point 3 which was outward from point 2 at a distance equal to that of point 1 to point 2. The soil samples were weighed after collection and weighed once again after a drying period of 24-48 hours at 105° C. The percent soil moisture was calculated from the difference in mass.

The percent coverage data was analyzed using the Stata Statistical Software (2003) to run regression and analysis of variance test. Analysis of variance test were also used to analyze the soil moisture data.

Results

Two way analysis of variance found a significant difference between percent soil moisture between sites (p-value=0.0039) and between soil sample location, (p-value=0.000) with no significant interaction (p-value=0.9477) (Table 1). Mean percent soil moisture for each site was significantly highest within the growing area of reed canary grass (Table 1). Total soil moisture for within the growing area was 44.8 percent. This is significantly higher then 22.6 percent soil moisture at the end of the growing area and 20.1 percent soil moisture outside the growing area.

Reed canary grass percent coverage from the Skoglund pond and Heath Creek resulted in the highest mean percentage being nearest the water (Table 2 & 3). Regression graphs of the percent coverage in relation to distance from water, for both Skoglund Pond and Heath Creek, found a trend that express a negative correlation between distance from water and percent coverage (Figure 1 & 2).

Analysis of variance for reed canary grass percent coverage results from a pond at the Carleton Arboretum, showed no significant correlation between percent coverage and distance from water (Table 4). However, the regression graph of the percent coverage in relation to distance from water expressed a significant positive correlation between distance from water and percent coverage (Figure 3).

Discussion

Results expressed that the presence of water in soil is necessary for reed canary growth. Soil moisture results found significant differences between the percent soil moisture within the growing area of reed canary grass, at the edge of the growing area, and outside of the growing area. At every site, reed canary growth had ceased when soil moisture levels where down around 20 percent. Reed canary was not found growing in dry soil. Red canary grass is a wetland species, thus it is logical that its growth would be positively correlated to soil moisture.

Morrison and Molofsky (1998) performed a study examining the factors of reed canary grass becoming established in a new location. They measured a wide array of environmental and physical factors and found only three determining factors. These were plot, amount of vegetative cover, and the interaction of clone with vegetative cover. Soil moisture was found to have no affect on biomass production. In the Morrison and Molofsky study, they transplanted *Phalaris arundinacea* into a pasture that contained variable soil moisture and examined the biomass production. They noted that the summer of 1996 was extremely wet and as a result, percent soil moistures varied from only 27.7 percent to 47.2 percent. The soil moisture of the pasture was consistently suitable for the reed canary grass to successfully grow.

Morrison and Molofsky's results showed no soil moisture affects on biomass production because the tested soil moistures were all within the successful growing range. I found reed canary grass to successful grow at soil moisture between 20.4 to 49.9 percent. Morrison and Molofsky low of 27.7 percent was well within the found growing range.

Reed canary grass percent coverage results showed a trend at two of the three sites expressing a negative correlation between distance from water and percent coverage. The greater the distance from the water source the lower percent coverage. This correlation, however interesting, was not found to be significant. Also, the third site expressed the opposite, positive correlation between distance from water and percent coverage. Thus other factors beside distance from a water source must play a role in reed canary percent coverage. At every site it was noted that reed canary coverage became less under the canopies of trees. In some occasions reed canary growth ceased under tree coverage. Shade created by overhead trees may create light levels too low for reed canary success. Further, it was observed that reed canary growth lines never extended into dense forests. It became evident that the presence of tall woody species negatively effected reed canary growth.

Morrison and Molofsky (1998) found that reed canary grass tolerates a wide range of environmental conditions and can occupy habitats where other species perform badly, but it grows poorly in dense vegetation. Reed canary grass was found to be most successful when vegetative cover was sparse. Like most invasive species, reed canary is opportunistic and positively responds to disturbed or sparsely populated areas. These findings by Morrison and Molosky express why reed canary was not found to grow in dense forests.

Overall this study resulted in two trends of reed canary growth, one being significant. As hypothesized, reed canary growth was found to be significantly dependent on soil moisture. Soil moisture below 20.4 percent was found to be too low for reed canary growth. It was hypothesized that percent coverage of reed canary grass would decline as the distance from a water source increased. This negative correlation was found at two of the three sites. The data was insignificant expressing that other factors may contribute to reed canary success, including the presence of light and vegetative cover. This study has given some insight into the factors of growth success of this aggressive and undesirable invasive species, but more knowledge is necessary. Reed canary grass is capable of dystroying beautiful lands by taking over whole plants communities. Continual investigation of reed canary growth dynamics is essential to eradicate this pest and restore lands to their natural beauty.

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Table 1. Percent soil moistures for Location 1 (beginning of growth area), Location 2 (end of growth area), and Location 3 (outside of the growth area) for all three sites.

Site	Location 1	Location 2	Location 3	Total
Skoglund	42.6667	20.4333	19.2167	27.4389
Carleton	49.9167	26.1333	23.56	33.7706
Heath	41.9333	21.2667	18.0167	27.0722
Total	44.8389	22.6111	20.0706	29.3453

P-value Between Sites	0.0039
P-value Between Location	0
P-value Interaction	0.9477

Table 2. Mean percent coverage, standard deviations and frequencies for distance 1 (0-10 meters), distance 2 (10-20 meters), distance 3 (20-30 meters), and distance 4 (30-greater then 30 meters) from Skoglund Pond.

Distance	Mean	Std. Dev.	Freq.
1	50.2083	30.1598	12
2	19.5833	35.0149	6
3	40	38.7298	4
4	1	0	1
Total	38.3043	34.2732	23

P-value	0.4454

Table 3. Mean percent coverage, standard deviations and frequencies for distance 1 (0-10 meters), distance 2 (10-20 meters), distance 3 (20-30 meters), and distance 4 (30-greater then 30 meters) from Heath Creek.

Distance	Mean	Std. Dev.	Freq.
1	19.5455	9.34199	11
2	16.5	10.5475	5
Total	18.5938	9.48546	16

P-value	0.5698

Table 4. Mean percent coverage, standard deviations and frequencies for distance from a pond at the Carleton College Arboretum. Distance 1= 0-10 meters, distance 2= 10-20 meters distance 3= 20-30 meters etc.

Distance	Mean	Std. Dev.	Freq.
1	68.75	38.4427	12
2	52	26.5832	10
3	71.25	38.13809	10
4	76.45	32.68405	10
5	74.28571	35.6404	7
6	91.25	11.81454	4
7	100	0	2
8	100	0	2
9	100	0	2
10	100	0	2
11	95	0	2
12	95	0	2
13	95	0	2
14	95	0	2
15	95	0	2
16	95	0	2
17	82.5	17.67767	2
18	40	0	1
Total	77	30.8734	76

P-value	0.3479

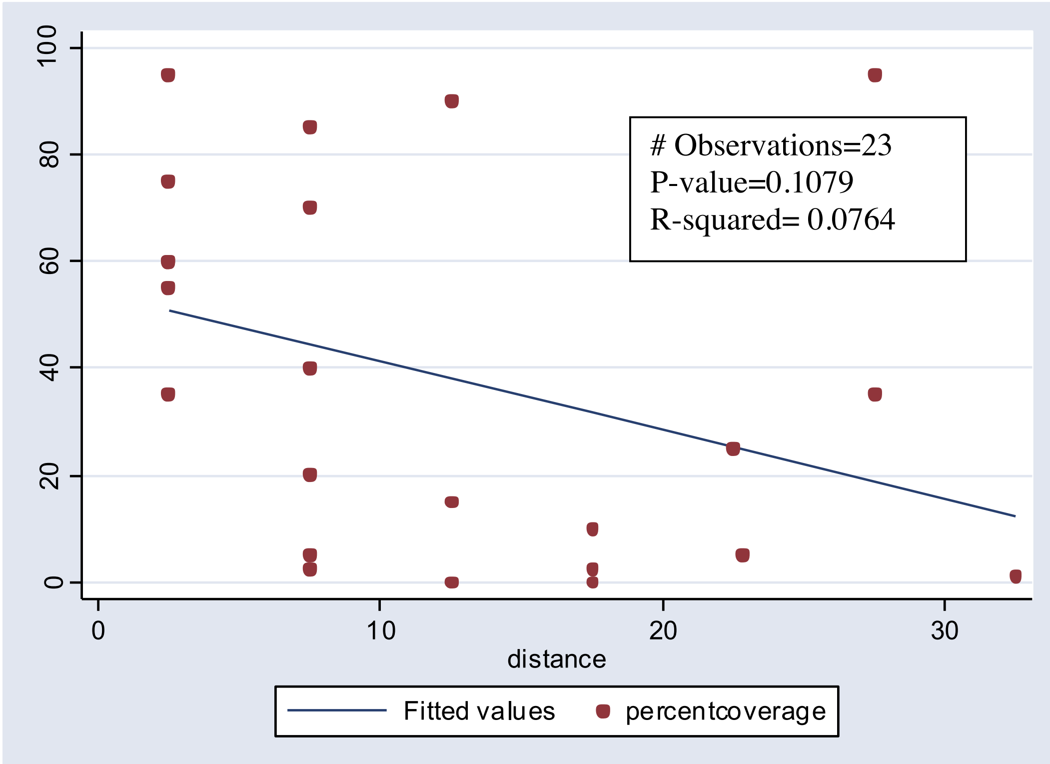

Figure 1. Linear regression of distance from water in relation to reed canary grass percent coverage, at the Skoglund Pond.

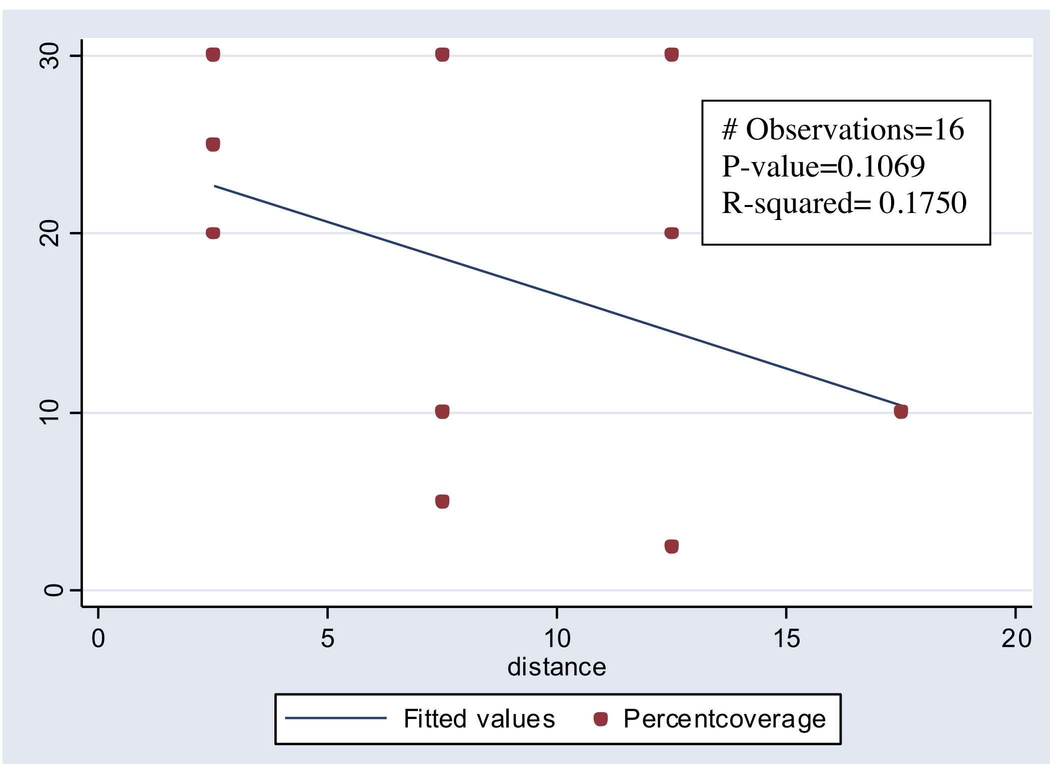

Figure 2. Linear regression of distance from water in relation to reed canary grass percent coverage, at Heath Creek.

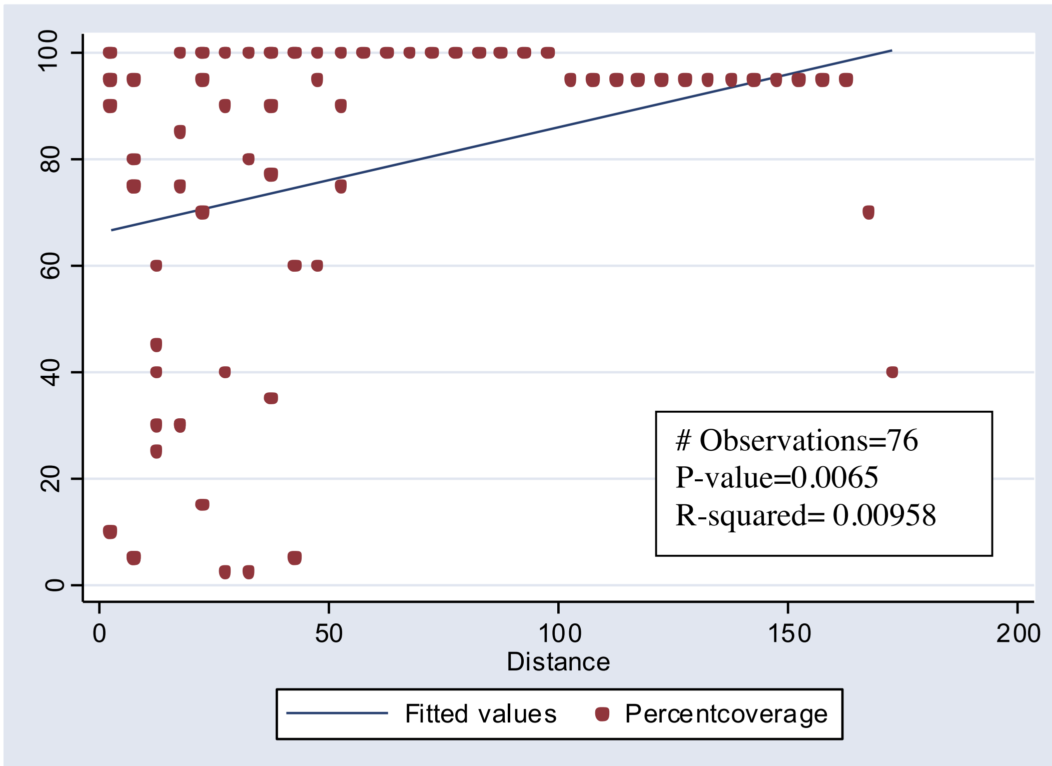

Figure 3. Linear regression of distance (meters) from water in relation to reed canary grass percent coverage, at a pond from the Carleton College Arboretum.