Determining Non-Native Invasive Plant Propagule Pressure With Distance From Roads

Principal Investigators
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PROJECT SUMMARY

Plant communities around the world are being greatly altered by human development and the invasion of non-native species. Roads are often seen as the major vector for invasion. In this study we measured available soil moisture and emergence of surrogate weed seeds at set distances from a road. In addition propagule pressure, in terms of seed bank and seed rain, of non-native invasive species (NIS) smooth brome *(Bromus inermis)* and Canada thistle *(Cirsium arvense)* was recorded at the same distances from the road.

Our assumption was that available moisture decreases with distance from the road, thus providing improved establishment potential in closer proximity to the road. The results showed that the soil was at field capacity at all distances in the spring, after which the levels declined but more rapidly further from the road. Thus the sites adjacent to the road retained soil moisture for a longer period in the spring and after precipitation events. Surrogate weed seeds emergence did not differ with distance in the spring but was higher closer to the road in the fall; possibly reflecting the full soil profile in the spring providing adequate moisture at all distances compared with the declining moisture profile with distance from the road in the fall. Smooth brome seed rain decreased with distance from road, but no discernible pattern was observed for Canada thistle. Viable smooth brome seed from the seed bank also declined with distance from the road. Insufficient Canada thistle seed germinated to determine a pattern. Seed rain and the seed bank of smooth brome, and the seed rain of Canada thistle was positively correlated with the respective species' occurrence. More Canada thistle seed were recorded at distances of more than 1 m from the parent plant (28%) than smooth brome, which could be attributed to the wind-dispersed attributes of the seed. These data begin to improve our understanding how propagule pressure is influenced by distance from roads, which will benefit our understanding of non-native species colonization.

DISSEMINATION OF RESULTS

This work was presented at the Ecological Society of America Conference in Portland, Oregon in August 2004. It is also in the part of Charles Repath's Masters thesis and will be written into a journal manuscript within the next year.

BUDGET – AMOUNT SPENT IN DIFFERENT CATEGORIES

Grad. Student Salary and Benefits	2827.62
Supplies	1098.85
Travel	618.53
Indirect Costs (10% of above direct costs)	455.00
Total:	$5,000.00

METHODS

Twelve transects were established perpendicular to a road on the west side of Hebgen Lake in the Gallatin National Forest. As smooth brome was widely planted in this region to stabilize roadsides

no sites without smooth brome were found. Thus, six transects were established in an area where smooth brome spread into the grassland from the road and where Canada thistle was also present (treatment 0). The remaining six transects were established where smooth brome was only present immediately adjacent to the road and where Canada thistle was absent (treatment 1).

Seven sampling stations were installed along each transect at distances of 1.5, 3, 6, 12, 24, 48 and 96 m from the road. Transects were randomly divided so that soil moisture, surrogate weed seed emergence, seed rain and seed bank were studied along two transects each in both treatment areas. Site monitoring visits took place every 7-10 days from May through October of 2003, with additional work in September of 2004.

Sampling was completed in the National Forest near West Yellowstone and not Bighorn Canyon National Recreation Area (BCNRA) as suggested in the proposal. This was due to staffing changes at BCNRA which made it a less appropriate site than originally planned. The site at West Yellowstone met all of the requirements and had the additional advantage of being close to other project sites.

Available soil moisture

Soil moisture was recorded at the sampling stations by recording electrical conductivity in gypsum blocks throughout the sampling season. The gypsum blocks were buried at a depth of 15 cm.

Surrogate weed species emergence

Fifty seeds of surrogate weeds radish *(Raphanus sativa)* and spring wheat *(Triticum aestivum)* were sown in 0.7 m^2 wire rings near each of the sampling station. Two rings were used for radish and two for spring wheat seed.

Target species seed rain

Seed rain was measured using 0.06 m^2 area boards, and placed at 0-0.02 cm from the ground. Individual boards were placed at 1.5, 3, and 6 m, two boards were placed at 12 and 24 m, and three boards at 48 and 96 m from the road. Sheets of card covered in tanglefoot adhesive were tacked to the boards, which were changed every ten days throughout the experiment. Seeds of smooth brome and Canada thistle were identified and counted.

Target species seed bank

Soil cores were taken at the specific sampling distances to a depth of 10 cm; five cores at 1.5, 3 and 6 m and bulked into one sample for each distance, ten at 12, 24 and 48 m and bulked into two samples, fifteen cores will be taken at 96 m and bulked into three samples. The bulked samples were placed in 0.4 m^2 flats at placed in a greenhouse at controlled temperatures for 12 months. Germinated Canada thistle and smooth brome seedlings were recorded and removed at monthly intervals. At each point after seedlings were removed, the soil was disturbed and rewetted.

RESULTS

Available soil moisture

We evaluated if roadside runoff increased soil moisture in closer proximity to a road.
In spring the soil was at field capacity but declined to the permanent wilting point by late August at all sample distances from the road. However, the decline in soil moisture was slower in close proximity to the road. Overall, soil moisture decreased with distance from the road ($P = 0.001$) and was highest immediately adjacent to the road.

Surrogate weed species emergence

The emergence of surrogate weed seeds at the sample distances was recorded in spring and fall. In spring, there was no correlation between spring wheat or radish emergence with distance from the road ($P = 0.76$). Whereas, fall emergence of radish was significantly higher adjacent to the road than away from the road ($P = 0.005$). No spring wheat seed germinated.

Target species seed rain

Smooth brome seed rain decreased significantly with increasing distance from the road ($P = 0.001$, $R^2 = 0.20$) but Canada thistle seed rain did not ($P = 0.79$, $R^2 = 0.01$). With regard to decline with distance from target species occurrence the three Canada thistle patches were distributed along Transect 1, and the seed rain decreased with distance from these patches ($P = 0.04$, $R^2 = 0.30$). The same negative correlation was also observed for smooth brome. Very few seeds of smooth brome were observed outside of that species' occurrence area. Most of Canada thistle seed was observed within 1m of a parent plant but 28% of seed were located at greater distances. The greater dispersal rate of the Canada thistle seed was expected due to its wind-dispersed seed.

Target species seed bank

Smooth brome emergence from the seed bank decreased significantly with increasing distance from the road ($P = 0.001$, $R^2 = 0.17$; $n=98$). Only 4 Canada thistle seedlings emerged during the greenhouse seed bank study, preventing any data analysis.

CONCLUSION

Preliminary analysis of the field data suggests that periodicity of available soil moisture may be longer close to roads, providing the potential for increased seedling emergence. Propagule pressure of smooth brome decreased with distance from the road, also reflecting its pattern of occurrence. Less consistency was observed with Canada thistle, although the sample size was small.