The effect of grazing and roads in the spread of invasive species

UNDERC West

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Abstract

Invasive plants can cause serious ecological and economic problems so it is important to know how vectors of dispersal aid the dispersal process. This study took place in Charlo, Montana and focused on seven common invasives in the area: spotted knapweed, butter-and-eggs, sulfur cinquefoil, tall tumble mustard, cheat grass, St. John's Wort, and yellow sweet clover. By looking at grazing by cattle and nearness to roads, I quantified the power of both of these factors as potential vectors separately and in combination. Disturbance caused by grazing cattle was found to have no significant impact on the abundance of invasives. However, invasives were found to be in higher abundance closer to roads and less abundant further from roads suggesting roads act as a vector for their dispersal. These factors in combination were found to have no greater impact when considered together than when considered separately. These findings could aid in potential land management strategies in the future.

Introduction

An invasive species can be defined as "an introduced species that has overcome dispersal barriers to produce established self-perpetuating populations far from the initial introduction" (Prentis et al, 2008). Invasive species overcome dispersal barriers by a number of means, one of the most common being the intentional or unintentional introduction of a species into a given area by human activity (Prentis et al, 2008). While the original aim of intentionally introduced species is to benefit an area, these species can often have unintended negative impacts.

Numerous invasives have become prevalent throughout Montana. This study focused on seven species that are common in the Mission Valley area and cause the greatest amount of trouble both economically and ecologically throughout Montana. The species of focus included cheat grass (*Bromus tectorum*), spotted knapweed

(Centaurea maculosa), St. John's Wort (*Hypericum perforatum*), yellow sweet clover (*Melilotus officinalis*), butter-and-eggs *(Linaria vulgaris),* sulfur cinquefoil (*Potentilla recta*), and tall tumble mustard (*Sisymbrium altissimus).* Cheat grass was originally introduced in the hopes that it would aid in soil stabilization and reduce erosion but in reality it has become a major problem for ranchers (Belovsky and Belovsky). Cheat grass seeds desiccate quickly and become sharp. These sharp seeds burrow into the mouth of grazing animals, often causing infection (Belovsky and Belovsky). Yellow sweet clover can cause hemorrhaging in the stomach of cattle, once again causing an economic impact for ranchers (Belovsky and Belovsky). Spotted knapweed and St. John's Wort both release toxins into the surrounding soil, preventing other plants from being able to grow (Belovsky and Belovsky) and other species such as butter-and-eggs, tall tumble mustard, and sulfur cinquefoil cause a problem simply by out-competing native species.

Invasive species are managed in a variety of ways. The most common and effective treatment option is spraying a chemical that will directly target the invasive species (DiTomaso, 2000). While this treatment option has the highest success rate it can also be extremely expensive. This cost may not be feasible for many individuals as well as groups such as government organizations and Native American tribes that are responsible for managing large areas of land. Another management strategy is the use of bio-controls. For example, the National Bison Range near Charlo, Montana utilizes beetles to help combat St. Johns Wort, yellow toadflax, and spotted knapweed. While this strategy will not get rid of invasives entirely, if adequate amounts of bio-controls are applied to an area this method can help decrease the abundance of invasive plants and therefore minimize the competitive pressure they exhibit on native species. In order to properly manage land and make the land as productive as possible while using the least amount of funds it is necessary to understand the lifecycle of each particular invasive as well as dispersal methods and vectors that could intensify the rate of dispersal.

Once introduced into an area invasive species can be spread further through different vectors. Roads have been shown to act as “preferential migration corridors” for the spread of invasive species and “can act as starting points for plant invasions into adjacent habitats” (Von der Lippe and Kowarik, 2007). Seeds have been shown to adhere to cars temporarily (Von der Lippe and Kowarik, 2007). If the car continues to progress before the seed detaches, the seed has the potential to disperse further than would be possible by natural dispersal methods (Tyser and Worley, 1992). This process can lead to accelerated dispersal of plants, which can alter species composition in that area (Von der Lippe and Kowarik, 2007).

Another mode of dispersal for invasives can be through animals. Seeds have been shown to adhere to fur and if the animal grazes on the plant, the seeds can pass through the digestive system and be deposited in a new location (Constible et al, 2005, Vignolio and Osvaldo, 2010). Although grazing has been shown to significantly impact the prevalence of invasives, cattle ranching is a large part of the economy in western Montana (Vignolio and Osvaldo, 2010). In addition to private ranches, groups also utilize their land for animal grazing. The Confederated Salish and Kootenai tribe of western Montana lease out parts of their land to cattle ranchers to generate additional revenue for the tribe. Although these groups are not participating in ranching directly, they are still increasing the grazing pressure in the area by allowing their land to be ranched by others. Thus grazing needs to be taken into consideration when determining an effective management strategy to prevent the further spread of invasive species.

In this experiment I investigated roads and grazing as potential vectors for the dispersal of invasives and determined if these factors in combination have a greater impact on the spread of invasives than they do individually. Roads have been shown in previous studies to act as vectors in the dispersal of invasive species (Von der Lippe and Kowarik, 2007) so it is predicted that the prevalence of invasive species will be highest near the road and decrease as the distance from the road increases. Also, it has been suggested that the grazed areas surveyed will show a significantly higher abundance of invasives than the non-grazed areas (Vignolio and Osvaldo, 2010) so I anticipated finding a higher prevalence of invasives throughout the grazed sites when compared to ungrazed cites. When taking into consideration grazing and distanced to the road in combination I expect the combination of both factors to have a greater impact on the prevalence of invasives than either pressure alone. For example, I anticipate finding the highest invasive abundance near roads in cattle grazed plots and the lowest abundance far from the road in the ungrazed plots. By comparing these two factors I hope to provide information that could aid conservation efforts in the future that aim to minimize the spread of harmful invasive species.

Methods

Forty sites were surveyed throughout the Ninepipes region in Charlo, Montana. Twenty sites were grazed by cattle and twenty sites were ungrazed. Every site was either Salish/Kootenai tribal land or federally managed by the National Bison Range. All sites were along publicly accessible and frequently traveled roads. Sites were chosen based on the grazing history of each individual plot as well as management history. Areas that were actively seeded, sprayed, or bio-controlled were avoided. Ungrazed land was defined as any land that has not been grazed in the past five years. Grazed land was defined as any land that has been grazed in the past two years and has a history of being grazed.

At each site a 100m transect was placed perpendicular to the road. Transect starting locations were chosen at random. Starting at the road, every ten meters a one meter by one meter quadrant was placed next to the transect. The presence or absence of an invasive species within the quadrant was noted as well as the percent cover of that species throughout the entire quadrant. There were a total of 11 quadrant measurements per transect.

Once the data was collected it was analyzed to determine significance. To test the effect of the road on all of the invasives of focus collectively, the total abundance of invasives was calculated. A regression was then used to determine if there was a relationship between prevalence of invasives and the distance from the road. To compare grazed and ungrazed plots the average of invasive abundance across each plot was determined for each treatment type and was analyzed using a t-test. An

ANCOVA was also used to take distance from the road and grazing into account together to see if there was a relationship between the two factors. In addition to the consideration of the total values, the individual values for each invasive species were considered. The same process and tests were run on the individual species data.

Results

Grazing

The average percent cover at each plot was calculated allowing the treatment to be considered and not the distance from road. A t-test was used to determine if there was a difference between grazed and ungrazed plots. The t-test showed there was not a significant difference between the overall abundance of invasives in grazed and ungrazed plots (t=0.270710577, df=35.4, p=0.788183970) (Figure 1).

Roads

The total percent cover of all of the invasives at each distance at each site was calculated and a linear regression was run. The linear regression showed distance was a significant factor (p=0.006) but was only marginally negatively correlated with invasive abundance (coefficient=-0.001).

Grazing and Roads

An ANCOVA was run to determine if there was an interaction between grazing and distance from road. The interaction term between treatment (grazing) and distance from road was insignificant (F=0.147, p=0.701) (Figure 2).

Individual Species

In addition to the data being analyzed together, each species was analyzed separately in the same manner as above. When conducting a t-test to consider effect of grazing, cheat grass (p=0.868872975), spotted knapweed (p=0.943153658), St. John's Wort (p=0.577655075), butter-and-eggs (p=0.73015912), sulfur cinquefoil (p=0.510154950), sweet yellow clover (p=0.827) and tall tumble mustard (p=0.23619037) were all found to have an insignificant difference between grazed and ungrazed locations. When conducting a regression to consider the impact of distance from roads cheat grass (F=0.143613113, p=0.704898821), spotted knapweed (F=3.190392912, p=0.0747639), St. John's Wort (F=2.508591065, p=0.113948695), sweet yellow clover (F=3.283006669, p=0.070685351), butter-and-eggs (F=1.743937508, p=0.187329923), sulfur cinquefoil (F=2.602849362, p=0.107391835), and tall tumble mustard (F=0.869988806, p=0.351472274) were all found to be insignificant. An ANCOVA was run and of the focus species five showed an insignificant interaction between distance from road and treatment (cheat grass, F=0.176866935, p=0.674286417)(spotted knapweed, F=0.306325339, p=0.580226956)(sweet yellow clover, F=0.748017802, p=0.387579045)(butter-and-eggs, F=0.966314710, p=0.326144919)(tall tumble mustard, F=0.581121247, p=0.446284414). However, two species did have a significant interaction term of less than 0.15 (St. John's Wort, F=2.502863688, p=0.114362776) (sulfur cinquefoil, F=2.615563132, p=0.106541378). The interaction term was removed and the test was run again. The p-value for distance when considering St. John's Wort was p=0.1139 which is significant in an ANCOVA. Sulfur cinquefoil had a similar result with the p-value being p=0.107456 which is once again significant.

Discussion

Roads

This finding is in line with my hypothesis as well as the findings of previous studies. For the total invasive presence, nearness to roads was shown to have a significant impact on the prevalence of invasives. This finding should be taken into consideration by landowners when determining an appropriate invasive management strategy for their land.

Grazing

For the total average percent cover the t-test showed there was no significant difference between grazed and ungrazed sites. This is contrary to the findings I have found in other literature and is thus contrary to what I expected to find. This result could be due to a number of factors. The majority of my grazed site locations were Salish/Kootenai land. I enquired as to the management history of the sites and was told that a bio-control was released five years ago in some of my sites. However, I was assured that this bio-control was not released in high enough densities to make a significant impact of the invasive community in the area and therefore I should proceed with my experiment. Although this organization did not find the release of this bio-control effective in decreasing the abundance of invasive species it is still possible this release did have some impact, thus slightly reducing the prevalence of invasives in these areas and thus biasing my results.

Grazing and Roads

The ANCOVA showed an insignificant interaction term between treatment (grazing) and distance. This was contrary to what I expected to find. This could be caused not necessarily by a lack of interaction but a slight bias in some of the grazed sites as discussed above. Additional research should be done in this area.

Individual Species

The same statistics were conducted for each individual species as well as the total values. When considering individual species, all t-tests to measure difference between treatments were found to be insignificant as well as the regression conducted to determine a potential relationship between distance and abundance. Both of these findings are contrary to what I expected to find based on previous studies. The regression values were contrary to the results found for the total calculated values. This could be caused by to low of an infestation rate of any one species to be shown as significant but when considering all seven invasives together does in fact have a significant relationship. When ANCOVAs were conducted for each individual species, five of the seven species had and insignificant interaction term. However, sulfur cinquefoil and St. John's Wort both had significant interaction terms of less than 0.15. However, when considered without the interaction term both species had significant p-values (<0.15) for distance, which would support the hypothesis that distance from roads has a significant impact on the abundance of invasive species.

Conclusions

Although some findings were contrary to what was expected, these results could still be used when determining a management strategy. Roads were found to have a greater impact on the spread of invasives so it is possible that targeting the area near the road when spraying over a larger proportion of the land could have a greater impact than simply spraying the entirety of one particular field whether it had been grazed or not. Additional research should be conducted in this area.

In future studies this experiment could be improved in a number of ways. A larger sample size would give a better representation of the overall landscape and multiple transects per site could give a better representation of species composition in each specific area. In addition, a way to continuously measure the presence of invasives along the transect would be helpful. Often invasives would bunch in areas that were not within the eleven one-meter quadrants and therefore the presence of these invasives would not appear in the data. Also, it was noted that invasives tend to be present along of near fence lines. An additional measurement at the fence (normally 5m) could give a better representation of the invasive presence. Despite conflicting results, these results could still be beneficial even though additional research is needed to clarify this topic.

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Figures and Tables

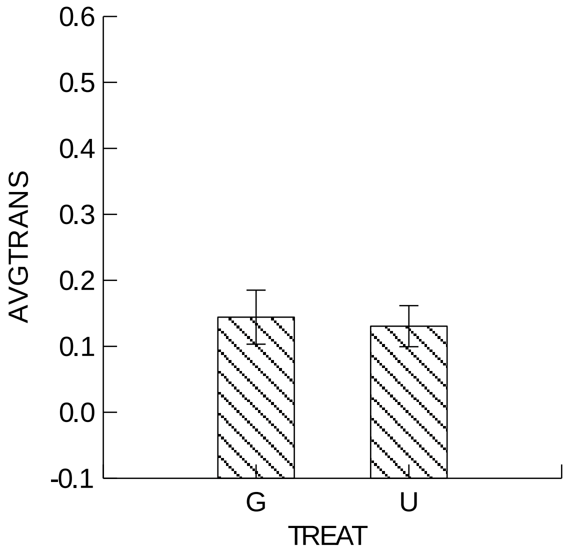

Figure 1. Average cover in grazed and ungrazed plots

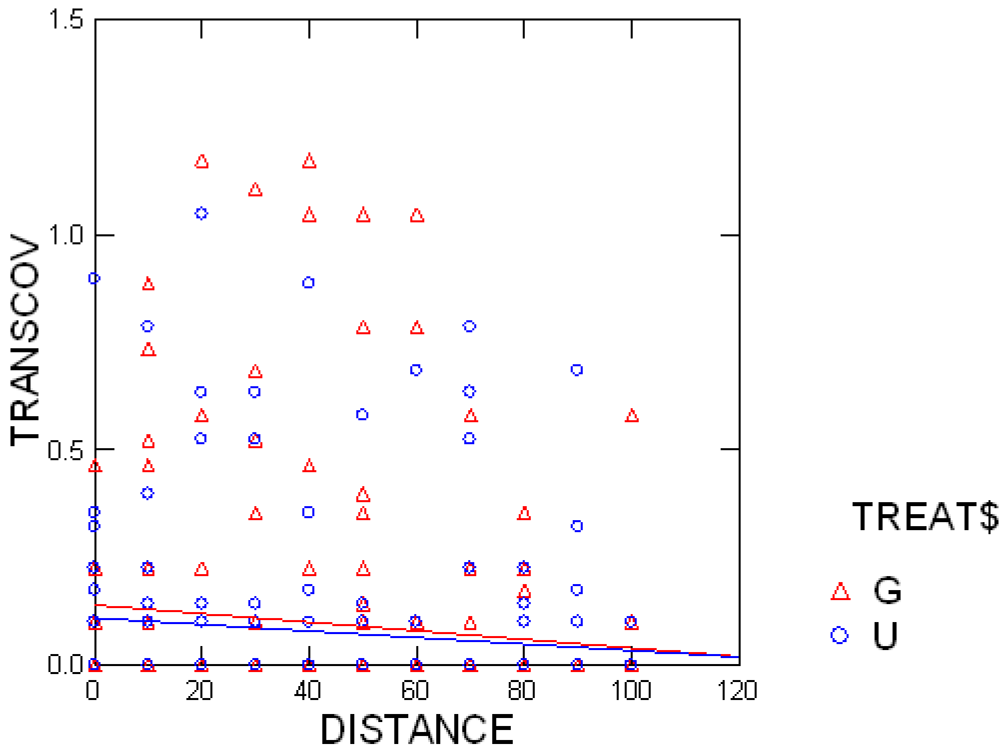

Figure 2. Interaction between distance from road and the percent cover