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Fred Pollnac, Tim Seipel, Charles Reopath, and Lisa Rew.

Effects of Abiotic and Biotic Factors on the Occurrence and Establishment on Non-Indigenous Plant Species

Roadways are known vectors for dispersal of non-indigenous plant species (NIS) and several studies have shown that NIS tend to be more abundant along roadsides than in interior habitats. Knowledge of the relative roles that abiotic and biotic factors play in this phenomenon would facilitate the creation NIS population spread models and would aid in prioritization of control efforts. We hypothesize that NIS abundance along the roadside will decrease with increased elevation. We also hypothesize that NIS emergence will decrease as distance from road increases. Two studies were initiated in the Greater Yellowstone Ecosystem to investigate these hypotheses. In each study, 100 m transects were established perpendicular to surveyed roadways. The first study examined the effects of an elevation gradient (1,800 m – 3,300 m) on NIS abundance on three roads. The second study examined the effects of native species cover and distance from a roadway on NIS cover and surrogate NIS emergence. Data were analyzed using generalized linear models. NIS abundance decreased with increased elevation ($p < 0.05$) and distance from the road ($p < 0.001$) in the first study. Similarly, NIS abundance decreased with distance from road ($p < 0.001$) and also with increasing native cover ($p < 0.001$) at the second site. Despite equal planting densities, surrogate NIS emergence decreased with distance from road during the fall ($p < 0.01$), but there was no significant trend for the spring. The combined results of these studies lend support to previously observed patterns of NIS abundance declining away from roadways. The observed decline of roadside NIS abundance with increased elevation in the first study, and the observed decline of surrogate NIS emergence away from a road suggests that abiotic factors play an important role in the establishment of NIS, and highlights the need for additional studies concentrating on the effects of environment on NIS establishment.



Effects of Abiotic and Biotic Factors on the Occurrence and Establishment of Non-Indigenous Plant Species



Fred Pollnac, Tim Seipel, Charles Repath, and Lisa Rew, Montana State University, Bozeman, Montana, United States of America

Introduction

Non-indigenous plant species (NIS) are a common focal point in the management of natural areas. A better understanding of how NIS are introduced to new areas, coupled with knowledge of how local population dynamics are influenced by biotic and abiotic factors, would improve the efficiency of management by helping to prevent new invasions and prioritize management of extant populations. NIS can be introduced into natural areas in a variety of ways. Although the dispersal of plant species propagules to areas where they are not indigenous does occur via natural events, most recent introductions have been due to human activities¹.

Several factors affect the likelihood of NIS establishment in a given area. Disturbance is generally thought to increase establishment². In particular, environmental conditions along roadsides are altered in many respects which may increase the likelihood of NIS establishment^{3,4}. On the other hand, factors such as poor soil conditions², large amounts of plant litter, shading⁵, and more general stressful climatic conditions^{7,8} seem to decrease the likelihood of seedling establishment for NIS.

The goal of this study was to explore some of the abiotic and biotic factors which may affect NIS establishment and spread in the Greater Yellowstone Ecosystem. Specifically, distance from road, elevation, and native plant cover/richness were examined.

Objectives/Methods:

Objective 1

Question: How does distance from a road affect the emergence of a surrogate NIS and native plant cover/richness?

Methods:

- Four 100 m transects were placed randomly and perpendicular to a forest service road.
- One 1/10 m² ring was placed on each side of the transect and sown with 50 *Raphanus sativa* seeds at distances of 1.5 m, 3 m, 6 m, 12 m, 24 m, 48 m, and 96 m away from the road.

• *Raphanus sativa* emergence, native cover, and non-native cover were recorded within each ring.

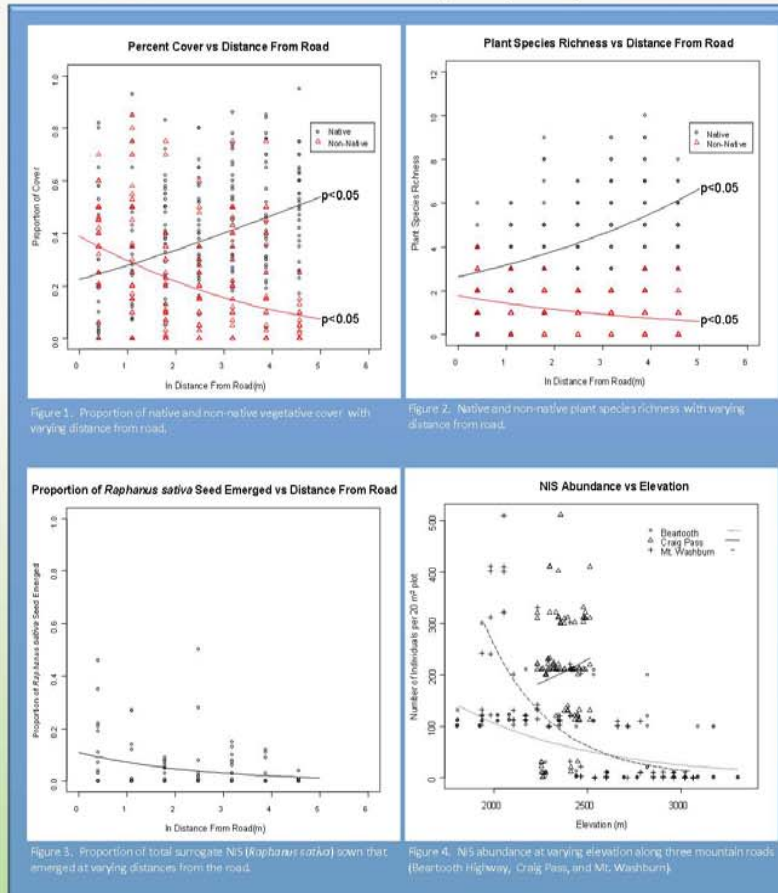
Objective 2

Question: How does elevation affect the presence and abundance of NIS?

Methods:

- Three roads which proceed up an elevation gradient were selected.
- Each road was stratified by elevation for a total of twenty 100 m transects spaced evenly along the elevation gradient and placed perpendicular to the road.
- NIS abundance was recorded along each transect.

Results of Generalized Linear Model (GLM) Analysis



Conclusions:

- NIS cover and species richness decrease with increased distance from roads, while native species show the opposite trend.
- Surrogate NIS emergence decreased with increased distance from road.
- NIS are generally less abundant at higher altitudes.

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Figure 5. Sampling ring used for Objective 1.



Figure 6. Sampling transects along the Beartooth Highway for Objective 2.



Figure 7. Current research to quantify the potential of vehicles to transport NIS propagules.

Current and Future Research:

- More detailed examination of the influence of biotic and abiotic factors on NIS emergence, fitness, and spread
- Quantification of vehicular transport of NIS