

Are invasive species in a western rangeland associated with stock ponds?

Anne M. Bartuszevige – Oregon State University, Department of Fisheries and Wildlife and Eastern Oregon Agricultural Research Center – Union Station, Union, OR
(Grant awarded 2006)

Proposal

I tested the hypothesis that there is a higher percent cover of exotic species near stock ponds and that the cover of exotic species decreases as the distance from the stock pond increases.

Vegetation sampling:

I randomly selected 25 ponds in the Zumwalt Prairie Preserve that met specific qualifications: 1. they were not located at the edge of a canyon, and 2. they were in an area surrounded by native grass, not within an old field that may have been seeded with nonnative grass species. At each pond, I sampled one downslope and two upslope transects, except at five ponds, where I sampled only one upslope transect due to time constraints. I elected to do two upslope transects because after visual inspection, it appeared there were vegetation differences on the two different slopes and I wanted to capture these apparent differences. I avoided the stream channel in the downslope transects to avoid the confounding factor of streamflow movement of seeds. I created the upslope transects to ascend uphill toward the upland portion of the prairie but not in the upstream direction thus the upslope transects were at some angle $> 30^\circ$ to the upstream stream channel. I sampled upslope transects in this manner because I was interested in movement of exotic plants into the prairie and not the dispersal of exotic plants within the stream corridor. Beginning at the edge of the pond and every 10 m thereafter along each transect, I estimated percent cover of vegetation of exotic species in 1 m² frames. Then I converted percent cover data to one of 8 cover class designations (0 = no cover, 1 = $< 1\%$, 2 = 1-5%, 3 = 5-25%, 4 = 25-50%, 5 = 50-75%, 6 = 75-95%, 7 = 95-99%, 8 = 99-100%) (Mitchell et al. 1988; McCune and Grace 2002). Transects were of indeterminate length: I ended each transect sampling when cover of exotic species was $< 5\%$ for three consecutive plots, or at 200 m, whichever came first.

Landscape sampling:

I obtained U.S. Geological Survey, Digital Ortho Quarter Quad (DOQQ) photos (2001) and Digital Elevation Model data for the Zumwalt Prairie Preserve for data collection. I collected data on aspect within a 200 m buffer of each pond using ArcGIS software (Environmental Systems Research Institute, Redlands, California, U.S.A.). I classified all upslope and downslope transects as north-facing (cool), south-facing (warm) or east/west facing (neutral).

Data analysis:

I asked the question if distance of total exotic plant cover differed in the upslope versus downslope direction and I analyzed species separately for those species for which sufficient data was available. These species included: *Poa* spp., *Bromus* spp., *Phleum pratense*, and *Ventenata dubia*. To determine if upslope and downslope distances differed, I used a one-way Wilcoxon signed-rank test. I used a two-sided Kruskal-Wallis test to determine if exotic plant spread was influenced by aspect.

Results

I identified 35 exotic species near stock ponds on the Zumwalt Prairie Preserve. The most commonly encountered species were exotic grasses: *Poa* species (*P. pratensis* and *P. compressa*) and *Bromus* species (mostly *B. tectorum* and *B. japonica*). Most species, especially forbs, were found at only a few plots. Exotic cover was always greatest at the edge of the stock ponds compared to plots further from the pond. In fact, cover at the edges of stock ponds was almost completely exotic, very few native species were found at the edge of the stock pond. Most

transects were <100 m in length (52 transects, 74%). Of the remaining transects only 4 (6%) were ended at 200 m because they had not yet reached < 5% exotic plant cover. Results of the Wilcoxon signed-rank test showed that exotic species spread further in the downslope (mean \pm 95% CI: 106 \pm 24.2 m, n = 25) direction than in the upslope (61.4 \pm 12.9 m, n = 45) direction ($Z = 2.52$, $df = 2$, $P = 0.006$, one-sided p-value; Figure 1). This pattern was reflected in the individual species analyses (*Bromus* spp: $Z = 2.25$, $df = 2$, $P = 0.012$; *Poa* spp: $Z = 2.77$, $df = 2$, $P = 0.003$; *P. pratense*: $Z = 2.91$, $df = 2$, $P = 0.002$; *V. dubia*: $Z = 1.34$, $df = 2$, $P = 0.09$; all p-values one-sided; Figure 2). In addition, downslope transects were more likely to have extreme values (Z test of equal proportions: $z = 2.82$, $P = 0.002$). For example, 10 of 25 downslope transects (40%) were greater than 100 m in length, compared to only 5 of 45 upslope transects (11.1%).

Aspect had no effect on exotic species spread in this system ($\chi^2 = 1.97$, $df = 2$, $P = 0.37$). This was also true for the individual species tested (*Bromus* spp: $\chi^2 = 1.12$, $df = 2$, $P = 0.57$, *Poa* spp: $\chi^2 = 3.28$, $df = 2$, $P = 0.19$; *P. pratense*: $\chi^2 = 0.82$, $df = 2$, $P = 0.66$; *V. dubia*: $\chi^2 = 2.03$, $df = 2$, $P = 0.36$; two-sided p-values)

Discussion

I found that exotic species, in general and five specific species spread further downslope from stock ponds than upslope which supports my original prediction. In addition, aspect was not related to spread of exotic plants from stock ponds. This could be explained by water movement, cattle behavior, or soil depth. First, seeds of exotic species may be spread downslope by water. While transect location was determined randomly, a special effort was made to avoid the immediate stream corridor for the downslope direction in order to avoid the process of stream flow dispersal of seeds. However, heavy rains in the spring flowing downhill may still carry seeds downslope via surface run-off.

Second, domestic livestock may influence exotic seed dispersal on the Zumwalt Prairie Preserve. Analyses of cow movement patterns have shown that cows spend a greater proportion of time near water sources during the hottest part of the day compared with availability in the environment (DeCurto et al. 2005). After drinking at stock ponds cows may rest and prefer to move in the downslope direction to conserve energy and keep cool. While resting, seeds may be dispersed by falling from fur or in fecal depositions.

Third, soils in the downslope direction are likely deeper, moister and/or more nutrient rich than those in the upslope direction. The upslope soil conditions may be too harsh for exotic species to establish in large numbers. Exotic species are often found on more nutrient rich soils (Safford and Harrison 2001). More investigation into the role of soil on exotic species establishment needs to be addressed.

I did not find a significant effect of aspect on exotic plant cover contrary to other studies (Pino et al. 2005; Caplan and Yeakley 2006). The nonsignificant effect of aspect could be an artifact of my site selection criteria. All ponds included in the study were on the upland portion of the prairie and therefore equally exposed to the sun.

Artificial water-points have attracted attention in rangelands because of the high levels of disturbance associated with them. Piospheres often develop around water-points in arid areas. The impacts of water-points in rangelands include piospheres, high nutrient levels near water, increased levels of exotic plants species, and soil compaction. All of these studies are observational in nature. No experiments with water-points have been conducted to understand the mechanisms by which exotic plants invade. High nutrient levels due to increases cow feces and urine may allow invasive plants to establish. In addition, the increased disturbance from hoof

action can also increase probability of exotic species spread. However, exotic species may be facilitated before presence of livestock through the disturbance of installing water points. Experiments are required to understand the mechanism(s) for exotic spread to water-points.

Long-term Goals

This project allowed me to more fully organize and prioritize avenues of research for a research program. My long-term goals are to investigate 1) mechanisms that facilitate exotic plant establishment at cattle attractants 2) how large native and domestic ungulates facilitate exotic spread through the rangeland landscape and 3) restoration priorities to prevent or slow the spread of exotic plant species. I am currently developing grants to address these goals.

Benefits of Seed Money

This seed grant was important because I was able to demonstrate that there are more exotic plant species at water-points on the Zumwalt Prairie. This study adds to a growing body of evidence that exotic and weedy plants are more abundant at water-points. This study also demonstrates that spread of exotic plants from water-points is not uniform. While aspect was not important for determining spread, slope position was. This study will aid land managers in understanding where priorities should be set for eradicating exotic plants. More specifically, this will aid The Nature Conservancy's northeast Oregon office in prioritizing management of exotic plants.

Advancing this Research

To advance the long-term goals of this research, partnerships with county, state, and federal management agencies would be beneficial. To understand mechanisms that facilitate exotic plant establishment, experimental manipulations will be required. When an agency begins to implement a policy of adding more off-stream water-points, an opportunity for a research partnership could be created. When mechanisms are established, more partnerships could be created to implement management and monitoring programs.

Publications

Bartuszevige, A.M. The influence of slope position and aspect on exotic plant species spread from stock ponds in a western U.S. rangeland. Target journal is *Rangeland Ecology and Management*

Literature Cited

- Caplan, J.S., and J.A. Yeakley. 2006. *Rubus armeniacus* (Himalayan blackberry) occurrence and growth in relation to soil and light conditions in western Oregon. *Northwest Science* 80:9-17.
- DelCurto, T., M. Porath, C.T. Parsons, and J.A. Morrison. 2005. Management strategies for sustainable beef cattle grazing on forested rangelands in the Pacific Northwest. *Rangeland Ecology and Management* 58:119-127.
- McCune, B., and J.B. Grace. 2002. *Analysis of Ecological Communities*. MjM software designs, Glenden Beach, OR.
- Mitchell, J.E., P.N.S. Bartling, R. O'Brien. 1988. Comparing cover-class macroplot data with direct estimates from small plots. *American Midland Naturalist* 120:70-78.
- Pino, J., X. Font, J. Carbó, M. Jové, and L. Pallarès. 2005. Large-scale correlates of alien plant invasion in Catalonia (NE of Spain). *Biological Conservation* 122:339-350.
- Safford, H.D., and S.P. Harrison. 2001. Grazing and substrate interact to affect native vs. exotic diversity in roadside grasslands. *Ecological Applications* 22:1112-1122.

Budget

Salaries and OPE

Employee Pay \$3209.85

OPE Employee Pay \$483.42

Other Expenses

Minor Equipment \$180.95

Professional Services \$360.00

Other Fees \$100.00

In-state Travel \$202.50

F&A Cost \$453.67

TOTAL \$4990.39