Horses & Invasive Plants
THE WESTERN USA STUDY

BY DR. STITH T. GOWER
PROFESSOR OF FOREST ECOSYSTEM ECOLOGY, DEPARTMENT OF FOREST & WILDLIFE ECOLOGY, UNIVERSITY OF WISCONSIN-MADISON

A study funded by the American Endurance Ride Conference (AERC) in the eastern USA showed that while horse hay and manure may contain a small number of seeds of invasive plants, the seeds do not successfully germinate on trails. In this new study—funded by AERC, Envirohorse, the Tanklage Foundation and the Dean Witter Foundation—a similar study was conducted in nine locations in the western USA. The western study is needed to better understand if horses introduce weeds in ecosystems that dramatically differ from ecosystems in the eastern USA.

No one likes weeds

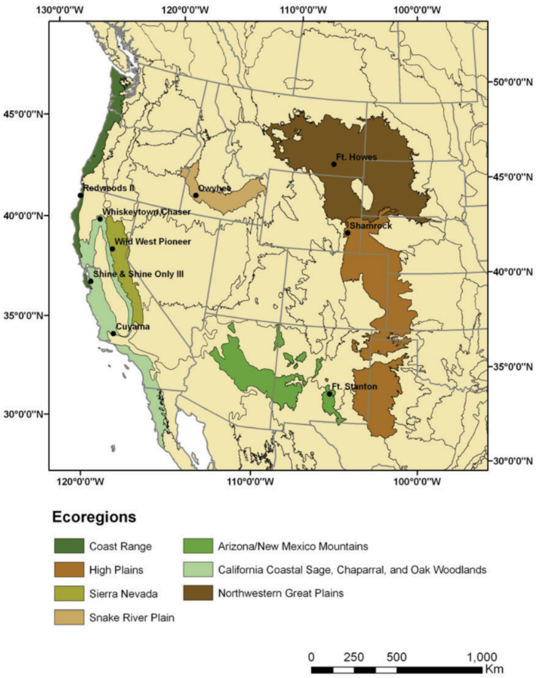
Weeds, also referred to as invasive, alien, or noxious plants, adversely affect the ecological and economic sustainability of native and managed ecosystems. Almost 500 invasive plants are now established in natural ecosystems in the USA. Invasive plants can displace rare plants in most any ecosystem, totally transform natural ecosystems (e.g., yellow star thistle in California grasslands), dramatically increase fire frequency, thereby threatening personal property and livestock (e.g., European cheatgrass in the shrub-steppe ecosystems in Utah and Idaho), and use precious ground water in arid ecosystems (e.g., salt cedar in southwest desert ecosystems).

Invasive plants compete with crop species in agriculture, pasture, and rangelands ecosystems and decrease yields and crop value. In the U.S. alone, the total cost of invasive plants in agriculture approaches $27 billion annually. Decreased productivity of forage crops totals an additional $1 billion annually. Moreover, some invasive plants are toxic to livestock and wild ungulates (e.g., leafy spurge and cattle). Many of the invasive plants were introduced for food, fiber, soil stabilization, or ornamental purposes.

However, the spread of invasive plants has dramatically increased in recent decades because of greater local to global transportation of people and commodities and disturbances (fire, road construction, etc.). Therefore, there is an urgent need to identify how invasive plants are introduced into ecosystems and thwart their spread.

Horses have been accused of spreading invasive plants through hay and manure. However, few studies have attempted to rigorously quantify whether these accusations are true. Campbell and Gibson (2001) reported 23 invasive plant species germinated and grew from horse manure samples in a greenhouse study, but only one invasive plant species became established in the trail plots in Illinois. Gower (2008) also noted that while non-native plants germinated and grew from hay and manure samples placed in the ideal conditions of pots, no non-native plants established on the horse trails at five sites in the eastern USA.

Figure 1. Location of the nine study sites and the associated ecosystem they represent.



The western horse-weed study

This study was intended to replicate the eastern USA study to determine if horses can introduce weeds in western USA ecosystems, which differ in climate, native vegetation, and invasive plant species. Specific objectives of this study were:

1. Assess the importance of different mechanisms by which horses may introduce non-native plant species.
2. Determine if invasive species introduced by horses germinate and colonize horse trails.

The study was conducted at nine locations that include a broad range of natural ecosystems (Figure 1):

- Cuyama Oaks XP, New Cuyama, CA (NCO)
- Shine & Shine Only III, San Jose, CA (SSO)
- Whiskeytown Chaser, Redding, CA (WTC)
- Wild West Pioneer, Nevada City, CA (WWP)
- Redwood Ride II, Orick, CA (RR2)
- Ft. Stanton II Pioneer, Ft. Stanton, NM (FSP)
- Shamrock Pioneer, Wheatland, WY (SRP)
- Ft. Howes, Ashland, MT (FTH)
- Owyhee Fandango, Oreana, ID (OWF)

Twenty rider/horse teams were randomly selected at each ride. The owner of each horse provided information on his/her home location so the travel time could be approximated. Information was also obtained on the horse's access to pasture versus dry paddock, and hay source. A representative sample(s) of hay, or hay substitute, were collected from each owner, each sample was thoroughly mixed, and the sample(s) was/were sub-sampled and placed in two labeled bags. I collected multiple hay samples from each source (i.e., alfalfa, timothy, oat hay, etc.) if riders brought several types of hay for their horses.

A manure sample (one to two piles depending on size) was collected from the horse trailer or in the temporary paddock where the horse resided, thoroughly mixed, divided into two sub-samples, and placed into two labeled bags. Hoof scrapings were collected from all four feet of the horse (except when horses had pads and no debris was present), combined, thoroughly mixed, and divided into two sub-samples. One sub-sample of each material was placed in a labeled bag and transported back to Madison, Wisconsin, for the germination study. The second sub-sample of each material from each horse was placed on the trail within 24 hours of sample collection.

Horses were also examined for seeds attached to their coat, mane or tail; however, no seeds were found on any of the horses at any of the nine rides.

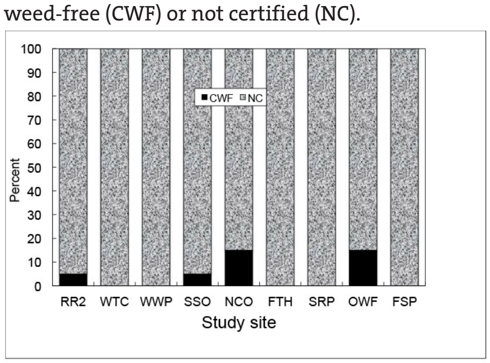
The hay, manure, and hoof debris sub-samples for the germination study were transported back to Madison, Wisconsin, and added to 15-liter plastic potting buckets filled with commercial potting soil. A second set of pots was only filled with commercial potting soils (no sample) and was randomly assigned as a control to each pot containing a sample. The paired pots were randomized and placed in a common garden that had similar environmental conditions. The pots were placed outside and watered twice per week with a complete Hogland's nutrient solution to ensure the germinating plants had adequate water and nutrients. Plants were grown to the end of the growing season and each germinated plant was identified by species and classified as native or non-native using the USDA Natural Resources Conservation Services state list (http://plants.usda.gov/java/noxiousdriver).

The second sub-sample of hay, manure, and hoof debris was placed in a 50 cm diameter plot located every meter along a transect at three random locations along a trail designated for horses. A control plot (no sample) was paired with each sample plot. The start and end point of each transect was marked with a large plastic stake driven flush to the ground so the transect could be re-located. Each plot was surveyed in 2009 and each germinated plant was identified by species and status (native or non-native).

Are there weed seeds in horse hay and manure?

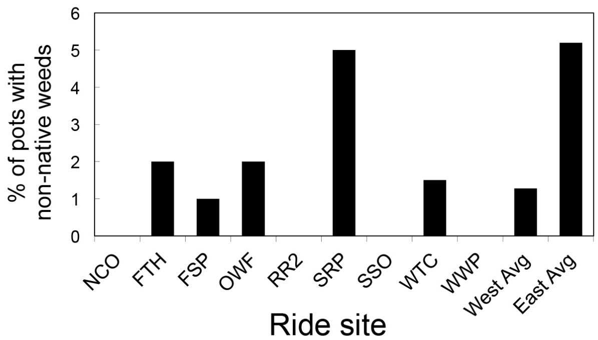
Three (15%) rider/horse teams at NCO and OWP rides, and one (5%) rider/horse teams at SSO and RR2 used certified weed-free hay, for an overall average of 4.4% for the 180 sampled horses at the nine rides (Figure 2).

Figure 2. Percent of total hay samples collected at each of the nine study sites that were certified weed-free (CWF) or not certified (NC).



No non-native plants grew in the pots containing manure and hoof scraping samples from the nine rides. Non-native plants grown in pots containing hay samples ranged from 0% for three sites (RR2, SSO, and NCO) to a maximum of 5% (SRP) for all 180 samples (Figure 3). The pot study demonstrated that hay is the primary source of non-native seeds, but averaged 1.4% of total plants germinated in pots for the nine study sites.

Figure 3. The percent of pots that weeds germinated from manure, hay, and hoof debris samples at each of nine western USA study sites, and the average for the western USA (this study) and eastern USA study (Gower 2008).



Common non-native plants inventoried in the pot study were yellow starthistle (*Centaurea solstitialis L.*), Canada thistle (*Cirsium arvense (L.) Scop.*), and musk thistle (*Carduus nutans L.*). Yellow starthistle originated from the Old World and probably arrived in California in the mid-1800s as a contaminant in alfalfa seed. Canada thistle is native to southeast Europe and Asia, and was likely introduced to the United States in the 1700s as a contaminant of crop seed. Musk thistle is a biennial plant that was introduced, by accident, from Europe in the 1800s. The seeds of all three species are animal- and wind-dispersed.

Although seeds of non-native invasive plant were present in hay samples, and germinated in the pots, the results from the trail plots were striking different. No non-native plants occurred in any plots on the trail that contained hay, manure, or hoof debris samples (data not shown). In other words, 0% of the three types of samples from 20 horses sampled at the nine sites, or 540 total samples, produced viable non-native plants on the trail. Two plots containing hay samples and one plot containing manure sample at FTH contained timothy (*Phleum pretense*) seedlings.

The results from this study corroborate the results of Campbell and Gibson (2001) who also found successful germination and establishment of invasive plants was significantly lower in the trail plots (one species) than greenhouse study (23 species). Gower (2008) also noted that while non-native plants germinate and grew in the ideal conditions of pots, no non-native plants established on the horse trails at five sites in the eastern USA. This study and other studies also observed that the presence of non-native species is greater immediately adjacent to the horse trail, but the presence of non-native plant species along the trail does not differ between horse trails and trails where horses are prohibited (Campbell and Gibson 2001).

Collectively these studies provide compelling evidence that horses are not an important source for the introduction of non-native plants.

Why horses are seen as villains

New roads and trails disturb the soil and provide exposed mineral soil that is required for most weed seeds to become established. Ironically, trails used very infrequently appear to be more susceptible to colonization by weeds than frequently used trails because the frequent traffic from hikers, horses, etc., damages the sensitive weed seedlings. In addition, any material (soil, rocks, sand, etc.) used to build trails may contain weed seeds. Finally, roads and trails increase the amount of light reaching the ground and as a result multiple strata of vegetation (e.g., grasses and forbs, shrubs, understory trees, overstory trees) exist at the edge of the trails.

Birds, an important source of spreading plant seeds, frequent these openings and multi-layered vegetation along the trail, and in the process excrete seeds in their feces. One study in the U.K. reported that birds prefer weed seeds over grain seed and berries.

Collectively, all these processes make it appear that horses are introducing weeds on the trails when, in fact, there are a myriad of processes responsible for observed vegetation composition along trails. For the reasons stated above, it is equally important that horse riders stay on marked trails and do not create new trails that may provide exposed mineral soil for weed seeds to become established.

Another source of confusion is weed classification systems. I adopted the USDA National Resource Conservation Service classification system because it provided a consistent database across all six states and it allowed me to compare the results of this study to the eastern USA study (Gower 2008). There are a myriad of textbooks on weedy and invasive plants that each use their own logic to classify a plant as a weed. Important commercial plant species used as forage for livestock and soil erosion control have been classified as weeds in horse-weed studies.

Interestingly, plants such as lespedeza, that Campbell and Gibson classified as exotic (following Mohlenbrock 1986), are not on the USDA NRCS noxious weed list for Illinois. Almost 60% of the individual plants classified as a weed in a pack horse study in Colorado were Kentucky bluegrass. The lack of consistent definitions and standard state or federal list creates unnecessary confusion in the scientific literature, which adversely affects management and policy decisions.

What can we do?

Trail riders must become stronger educational advocates for trails.

It is extremely important for trail riders help educate the public. The results of this study will be published in peer-reviewed scientific journals to provide credibility to the research. However, my 20-plus years of research has made one thing very clear: land managers do not have time to read scientific journals. Short, concise summaries in trade magazines, state natural resource magazines, etc., are excellent venues for this vital information. Every member should acquire copies of relevant articles and hand-deliver, e-mail or snail mail them to their local and state equine advocacy group(s), and state, federal and private trails coordinators/managers.

If we wish to maintain or improve trail use policy it is essential that we provide land managers and politicians with the necessary information to make sound ecological decisions. Here in Wisconsin, snowmobilers have access to gorgeous trails that I can only dream about riding. Why? Perhaps their well-organized and financially-supported advocacy user groups explain their success. I can only presume they work closely with private and state land managers to ensure access to trials.

Trail management is key

All of the horse-weed studies have shown that establishment of weeds on trails is almost nonexistent. However, a small fraction of hay and manure does contain weed seeds. Investing in waste manure and hay management facilities at trail heads would be a proactive management activity that would further decrease the small chance of weeds becoming established in horse camps and trail heads. Organizing annual work days to mechanically remove weeds would prevent any weeds in these high-use areas from reproducing and spreading, and build valuable relationship between trail riders and land managers. I even wonder if the trail master course should add weed control/eradication curriculum.

Conclusions

The 0% germination and establishment rate of weeds from hay, manure and hoof debris plots on the horse trails at the nine study sites illustrates the difficult physical and environmental conditions that seedlings experience during the critical germination and establishment phase.

Select relevant articles

Campbell, J.E., and D.J. Gibson. 2001. The effect of seeds of exotic species transported vie horse dung on vegetation along trail corridors. Plant Ecology 157:23-35.

Gower, ST. 2008. Are horses responsible for introducing non-native plants along forest trails in the eastern United States? Forest Ecology & Management 256:997-1003.

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