Cows Eating Weeds

Heifer Grazing Spotted Knapweed

Methodologies to Determine the Long-Term Effectiveness of the 2004 Cattle Behavior Modification Project and for Training of Additional Cattle at Grant-Kohrs Ranch NHS
with
Information on Managing Cattle for Weed Control.

February 2009

Kathy Voth
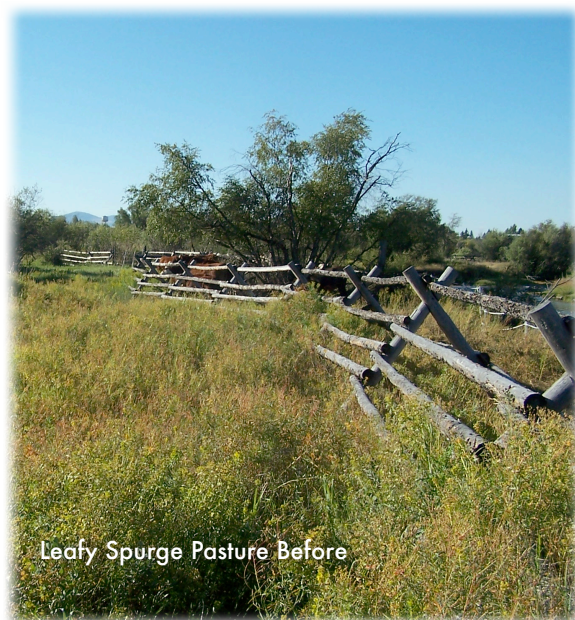Utah State University and
Livestock for Landscapes, LLC
kvoth@livestockforlandscapes.com
http://www.livestockforlandscapes.com
with Leah Ashley, Research Associate

Leafy Spurge Pasture Before

Leafy Spurge Pasture After

Summary

In 2004 I developed a process to teach cattle to eat weeds as part of a cooperative project with Grant-Kohrs Ranch National Historic Site and Utah State University.   Cows learned to eat Canada thistle, leafy spurge and spotted knapweed. They successfully grazed all three weeds in pasture and taught their calves to include the weeds in their diets.

The purpose of this project is to provide techniques for determining whether trained animals are still grazing the weed in pasture and to find out if their untrained herd mates have learned from them. Further, if untrained animals have not learned the behaviors, it provides a tool for ensuring that trained animals teach the untrained ones. Finally, Idiscuss suggestions for managing the Grant-Kohrs herd for targeted grazing to improve weed management results.

To aid those who were not a part of the original project or who might follow in the future, I provide background to the original 2004-2005 project and the training process. I also provide insights into the training process based on the work that I have done in California, Colorado and Montana from 2006 to 2008.

2004 -2005 Pilot Project Background

The primary purpose of the 2004-2005 project was to pilot the use of behavior management of livestock for reducing weeds and restoring natural landscapes. The project was based on a growing body of research indicating that behavior of livestock is flexible and that it can be effectively modified and managed to:

1) enhance and maintain biodiversity of rangelands,
2) restore pastures and rangelands dominated by invasive species and
3) improve wildlife habitat.

Pilot Project Partners

Grant-Kohrs Ranch National Historic Site

Utah State University

Perkins & R BAR N Ranches

City of Deer Lodge

Rocky Mountain Cooperative Ecosystems Studies Unit

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Based on this research, I developed a training process to over-come animals' natural fear of new foods to get them to try nutritious weeds and to ensure that they grazed it in pasture.

I created the seven-step process detailed in Appendix A and used it to teach a herd of 19 yearling heifers and one steer to eat leafy spurge, Canada thistle, and spotted knapweed. The training process began in February, and concluded with introducing them to the target weeds in dry lot in June of 2004. Once the animals were eating the weeds well in dry lot they were moved to trial pastures for observation.

The first trial pens were in unirrigated pasture. They included grass, alfalfa, knapweed and Canada thistle and included enough forage for one day each. In both pastures cows immediately begin to eat knapweed.

They ate buds and stripped stems even though plants were no longer young or tender. Many knapweed plants were grazed to the ground while some grasses went untouched.

Since the herd was willing to eat the weeds in small pastures where there was "gentle pressure" to eat them, they were moved to larger pens, containing enough forage for 4 to 5 days. The herd topped most of the knapweed plants in this pasture and also ate Canada thistle. The animals continued to graze knap-weed and Canada thistle in a number of large trial pastures. They also tried other plants they had not been trained to eat including musk thistle, field bindweed, and sulfur cinquefoil. Since the cattle had demonstrated that they would eat weeds and would continue to eat them in large pastures, they were rejoined with the larger Grant-Kohrs herd. While observation time after their returned to the herd was limited, it was apparent that the cattle continued to eat weeds
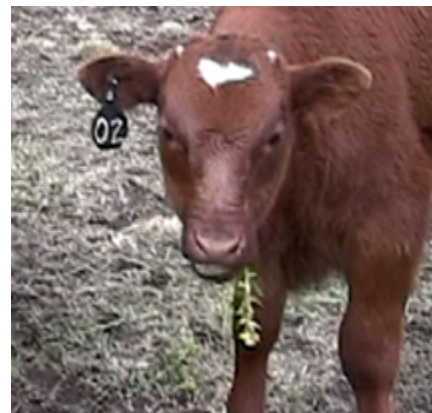
All trainees but one had a calf in 2005 and all calves learned to eat weeds from their mothers. During this second year of the project, thanks to a limited lifting of the riparian area use restrictions, we were able to test the cattle's willingness to graze leafy spurge in pasture. They successfully grazed leafy spurge in one large pasture in June and in two smaller pastures in August. They also continued to eat Canada thistle and spotted knapweed. They also grazed brush, wild rose, and Canada goldenrod.

One of the most important insights into animal behavior provided by this project was "how" the animals ate leafy spurge. I found that they stripped stems of their leaves and flowers, rather than grazing them to the ground. To the right is an example of a leafy spurge stem that had been stripped of its leaves.

2006 - 2008 Training Insights

In 2006, I refined the original training steps while teaching two groups of 30 cows each and one group of 5 cows to eat distaff and Italian thistle in Marin County, California. In 2007 I taught cattle to eat milk and sow thistle in California and trained cows in Boulder County, Colorado to eat late-season diffuse knapweed. Projects in 2008 included training 40 heifers at Vandenberg Air Force Base to eat black mustard, 320 cows and 38 bison to eat Canada thistle in southern Montana and 48 cows and their calves to eat Dalmatian toadflax in Boulder County, Colorado. This on-the-ground experience has provided the following insights into the training process and animal behavior:

Cows can be trained to eat a new weed in as little as 5 days.
     The initial phase of the training involves helping animals overcome their fear of new foods. By feeding unfamiliar but nutritious foods morning and afternoon for four days, cattle acclimate to the idea that when "feeding time" arrives, it is likely to be something good even if it looks strange. They demonstrate their willingness by running to the feed tubs or feeding site and quickly trying whatever they are served. This behavior carries over to the fifth day when weeds are cut and placed in the tubs.

Molasses is not required for training

We ran a research experiment called "Is Molasses the Silver Bullet?" to see if it was the training process or the molasses that encouraged cows to try weeds. We compared how much of the weed trained cows ate on the first day it was put in their tubs, to how much untrained cows ate. Trained cows ate 81 oz and untrained cows ate 2 oz, demonstrating that it was the process and not the molasses that was important. We have since trained cows to eat Dalmatian toadflax without molasses.

Some weeds require more time than others for animals to learn to graze them in pasture

One of the reasons for using trial pastures for training is that research shows that animals must learn new techniques for harvesting different plants in pasture. My observations in the field over the last 5 grazing seasons indicate that plants with less leaf mass and stemmier growth patterns seem to be more easily harvested by novice weed eaters. Thus animals seem to learn more rapidly how to eat late-season diffuse knapweed, spotted knapweed and Dalmatian toadflax. Leafy species, such as thistles, (Canada, musk, distaff, Italian and bull thistle) seem to require more unfamiliar grazing techniques. Animals working on these plants begin by harvesting tops and larger, lower leaves before ultimately learning to graze the entire plant.

By far the most difficult weed has been leafy spurge. Grant-Kohrs trainees solved the problem of grazing it by stripping stems of leaves and flowers. Other graziers have reported that their cattle graze tops of the plant or bit off the entire plant. Further work on this weed will be important in managing it for the future.

Cattle trained to eat one weed try others on their own

In 2005 I observed that the Grant-Kohrs trainees were eating many plants they would not normally have eaten including willow, wild rose, other varieties of brush, musk thistle, and Canada goldenrod. I have since observed other trained animals expanding their diets beyond what I had taught them to eat. Trainees in Marin County, California added bull thistle, sow thistle, poison oak, and coyote bush to their diets. Trainees in Boulder County added Canada thistle and musk thistle. It seems that cattle who have gone through the training process have a more "open mind" about what may constitute food.

Cattle continue to eat weeds years after training

Cattle trained to eat distaff and Italian thistle in Marin County California in 2006 are still eating weeds in 2008. In Boulder, Colorado, a herd trained to eat Canada thistle in 2007 continues to eat weeds. Research supports the idea that animals will continue to eat a familiar food for the rest of their lives.

Cows learn from each other

It is not surprising that calves learn from their mothers. This behavior is noted by both research (Mirza et al 1990 and 1992) and anecdotal evidence. Research also reveals that herd mates learn from each other (Thorhallsdottir et al 1990, Biquand et el, 1992, Ralphs et al, 1994, Ralphs 1997).

Just as importantly, I have also observed this knowledge transfer at work in various projects. In California in 2007 twelve trained cows taught 120 untrained animals of varying ages to eat distaff

and Italian thistle. The rancher that houses the trained herd when they are not at work reports that his entire herd now eats Italian thistle in pasture. In Montana in the summer of 2008, 20 cow-calf pairs at the Woodson Ranch learned to eat Canada thistle from 8 trained heifers, and a herd of steers at Horse Creek Hay and Cattle began eating Canada thistle after simply grazing in a pasture next to a herd of 40 trained heifers. In both Montana examples, animals were grazing at will in large pastures and were eating significant amounts of the target weed. In the Woodson pasture 80% of the thistle was grazed to the same level as the grass. Of the remaining 20% of the plants, tops and flowers had been removed.   Results were similar at Horse Creek Hay and Cattle (unpublished data Voth 2008).

Methodologies

Grant-Kohrs Ranch National Historic Site (GRKO) would like to answer these questions to determine if the pilot project continues to have an impact:

1) Are the 2004 trainees continuing to eat the target weeds (Canada thistle, leafy spurge and spotted knapweed)?;

2) Do their offspring eat them?; and

3) Have untrained animals learned to eat the target weeds from their trained herd mates? If not, how can their training be enhanced?

The "observation recipes" included here can be used to answer these questions. These methodologies are based on what I have learned about the training process and the behavior of trained animals over the last 5 grazing seasons, and on research regarding potential success of targeted grazing for weed control.

Observation Timing

Choosing the time of year to do these observations is based on the growth stage of the target weeds. The "right" time for grazing includes these elements:

1) The weed is nutritious and susceptible to damage by grazing.

As shown in the picture below, nutritional values of plants change over time, generally dropping as the plant matures. Susceptibility to grazing also changes during the growing season, with most plants suffering the most damage during bolting stage and just before and at seed set (Launchbaugh 2006).

Changes in Plant Palatability and Susceptibility to Grazing Over a Growing Season
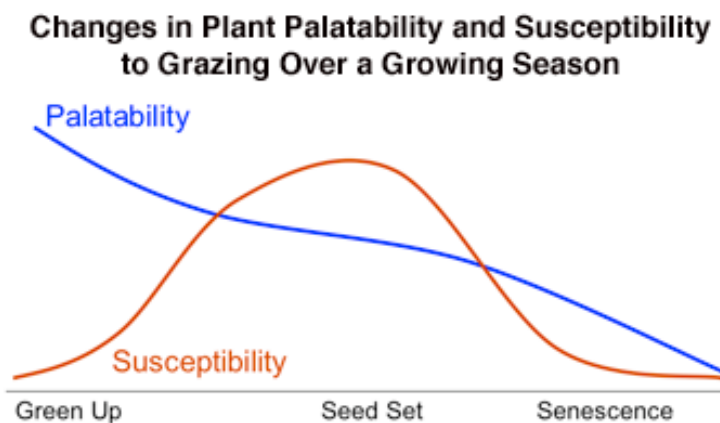
2) Preferred species will not be harmed by targeted grazing.

Of course, different species are at these stages at different times during the growing season, and weather and precipitation can change this timing from year to year. This makes choosing the right timing to address all three target weeds problematic. In this case, a good time for grazing the target weeds will be when the plants look like this:

Leafy Spurge

This plant goes to flower quite early, but is still palatable into August as demonstrated by cattle at Grant-Kohrs grazing it in 2005. Grant-Kohrs Ranch 2004 trainees have eaten the weed when it looks like this. It will be about knee high and many of the stems will be in flower.

When GRKO trainees grazed this plant in the Stuart annex pasture, we found that about 80% of all plants were grazed to some degree. You can compare other forages remaining with the amount of leafy spurge consumed by looking at the before and after pictures in Appendix D.

The pasture where the herd grazed in June is separated from the Clark Fork River by a jackleg fence. In August they grazed in a two-day pasture on the west side of the fence next to the river and in a day-long pasture on the east side of the fence.

Spotted Knapweed

This plant begins to come up in late spring as small rosettes. Again, its growth rate depends on temperature and moisture. The pictures at right show a Grant-Kohrs trainee in July of 2004 grazing spotted knapweed just before bloom in the Upper Taylor pasture. The picture at far right is an example of the height and appearance of the weed in pasture during this time.

Based on past experience cattle will eat it readily at this stage, and as mentioned previously have grazed plants to the ground. In 2004 and 2005 GRKO trainees in pasture grazed all spotted knapweed plants to some degree. Pictures in Appendix D indicate what we can expect from cattle grazing this weed. Grasses in these pasture were grazed to about 4 to 5 inches in height.

Canada thistle

This plant begins to come up in late spring as small rosettes. By late June it could be about knee high depending, of course, on temperatures and moisture. The picture on the far right shows a Grant-Kohrs Ranch trainee in July of 2004 with the Canada thistle plant she is grazing in the Upper Taylor pasture.
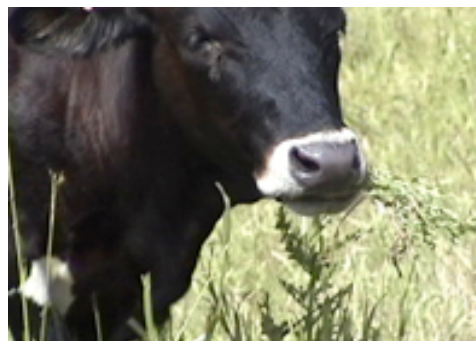
Based on previous experience it is likely that plants will be in this stage from late June through July. It seems that Canada thistle begins to go to seed in mid-to-late August in this area of Montana. While trained cattle and bison have demonstrated that they will continue to eat it at this stage, little weed control is being accomplished. Previous experience also indicates that cattle will continue to eat both spotted knapweed and leafy spurge through August.

When GRKO trainees grazed this plant in pasture, they ate every plant. In one pasture, where the thistle was just beginning to come up, I watched the heifer named Maggie graze down all the grass around the four inch plants and then come back and neatly bite off each remaining thistle.

Based on observations of GRKO trainees and cattle I worked with during the summer of 2008 in the Madison and Ruby Valleys, I would expect cattle to graze about 90% of plants to the ground level with the grasses in the pasture, and to have topped or eaten the ends off the remaining 10% of thistles in the pasture.

Observation Pasture Locations, Sizes and Contents

In choosing where you'll put your observation pastures consider the following:

1) They include all three target weeds. The Stuart Annex Pasture used in 2005 is a likely location unless subsequent weed management efforts have eliminated the target weeds in this area. In general the pastures should include about 30 to 40% weeds. Pictures in Appendix D can be used as examples of appropriate vegetation in pastures.

2) They provide a variety of forages for the cattle. Variety is important because it allows animals to mix foods to offset potential effects of toxins in plants and allows individuals to meet their own dietary needs.

3) They provide enough forage for about a day to a day and a half of forage. Based on past experience, a pasture about an acre in size will provide enough forage for observing the original trainees and their offspring (28 animals). The pasture for the 38 remaining untrained animals should be about an acre and a half in size. Pastures of this size are small enough to allow for efficient observation of the animals.

Animals to Be Observed

According to Range Technician Dawn Kidwell there are 11 animals remaining from the original herd of trainees and 14 of their offspring. These animals will be the first observed in pasture to see if the trainees continue to eat weeds and if the offspring graze them as well.

As of this writing the rest of the herd is made up of 38 untrained animals of varying ages. These are the animals that will be observed in the second pasture to see if they graze the three target weeds. Based on research mentioned earlier, and on observations of animals having learned from each other, I would expect these animals to have learned to eat weeds from their herd mates.

Collecting Data

For this project data collection is relatively easy. You will collect information on the impact of cattle on observation pastures with repeat photography, along with data on which cattle are eating weeds using the data collection sheet in Appendix C.

Repeat photography
      1) Take before and after pictures of the pasture from four different locations. Specific instructions for repeat photography are included as Appendix B.

2) Take before and after pictures of three plants from each target species in three different locations in the pasture. Mark them by pounding a nail with a washer into the ground so you can find the specific plant after the observation period to take an "after" photo. These photos will provide information on "how" the animals are eating the weeds.

How animals graze a particular weed is important in subsequently determining how best to manage them to control it. Past experience indicates that novice weed-eaters tend to begin by harvesting tops and larger bottom leaves of plants. As they become more accustomed to harvesting a weed, they eat more and more of each individual plant. In 2005, the pilot project trainees appeared to favor stripping leaves and flowers from leafy spurge. With Canada thistle and spotted knapweed they ultimately ate most plants level with adjacent forage, or to the ground. Example pictures can be seen in appendix D.

Other grazing habits may become apparent as you observe the cattle in pasture. As noted in the original project, if we maintain the expectation that weeds be grazed in the same way as "normal" forage, we may be disappointed and not give the cattle the credit they deserve.

Data Collection Sheet (Appendix C)

Once cattle are in their observation pastures, use the data collection form to record which animal is eating which weed. The data collection sheet includes a column for weeds other than the targets that the animals might eat. Record observations of animals grazing with slash marks (卌). Best observation times are early morning and late afternoon when animals are most likely to be grazing.

The purpose of the in-pasture observations is to see if animals are or are not eating weeds. If it is difficult to count the number of times an animal eats a weed, keeping notes of which animals seem to be eating larger quantities is adequate. These notes might be useful later when making culling decisions.

Observer Qualifications

To gather the best information in the most efficient manner I recommend that your observer be enthusiastic about the project and committed to spending the time necessary to observe the cows and gather good data. To reduce the potential for human influence on the grazing animals it will help if the person doing observations is quiet and calm so the animals are equally quiet and calm.

If the observer is new to the herd, it might help them to get to know the animals better if they prepare their own "flash cards" to identify them. I have made flash cards by taking photos of the animals and writing identifying marks or numbers on the backs of the pictures to help me recognize specific individuals. Then when I'm in pasture I can more quickly identify which animal is eating which plant.

Observation Recipes

1) Are the 2004 trainees and their offspring continuing to eat the target weeds?

Ingredients

14 original remaining trainees
14 offspring
1 acre electric fenced pasture (as described in "Observation Pastures" section) with water
1 - 2 observation days

Directions

1. Take "before" pictures of pasture and target weeds based on Appendix B instructions.
2. Place cattle in observation pasture and observe for 1-2 days.
3. Use observation data collection form (Appendix C) to record individuals grazing target weeds.
4. When observation period is completed, take after photos of pasture and target weeds.

2) Did untrained cattle learn from their trained herd mates?

Ingredients

38 untrained cattle (herd remainder)
1.5 acre electric fenced pasture (as described in "Observation Pastures" section) with water
1 - 2 observation days

Directions

1. Take "before" pictures of pasture and target weeds based on Appendix B instructions.
2. Place cattle in observation pasture and observe for 1-2 days.
3. Use observation data collection form (Appendix C) to record individuals grazing target weeds.
4. When observation period is completed, take after photos of pasture and target weeds.

Using Trained Cows to Teach Untrained Herd Mates

In all cases where animals have learned to expand their diets from their herd mates, proximity has been the key. As noted earlier, 12 trained cows in a Marin County, California project trained 120 untrained animals to eat weeds when they shared small pastures as part of a management intensive grazing program. Such tight proximity, however, does not seem to be required. The eight heifers on the Woodson Ranch trained 20 cow-calf pairs to eat Canada thistle while sharing a very large pasture and the steers who learned from trained heifers in Sheridan, Montana did not even share a pasture, but only an electric fence line.

While we don't have all the information we need to determine exactly how closely trainees need to work with untrained animals to learn, it seems clear that by putting them in close proximity we have our best chance at transmitting knowledge and of observing it. Based on that, we provide the following protocol for using your 14 trained cows to teach their 38 untrained herd mates if they have not already learned.

3) Using trained cattle to teach untrained herd mates.

Ingredients
All trained and untrained animals
2 to 4, contiguous, 1.5 acre electric fenced pastures (as described in "Observation Pastures" section) with water
1 - 2 observation days

Directions
1. Take "before" pictures of pasture and target weeds based on Appendix B instructions.
2. Place cattle in the first of the two pastures. Once forage is grazed to about 50% move the herd to the adjacent training pasture for one day.
3. Observe untrained animals to see if they are beginning to eat the target weed using the observation data collection form.
4. Continue moving herd through training pastures until untrained animals are eating the target weeds.

The purpose of the 2 to 4 acre contiguous pastures is to provide several "classrooms" where trained and untrained animals can graze together. Since we don't know precisely how long the training might take, having a series of pastures allows us to adjust how long the animals are together to give the untrained cattle as much time as they need to learn.

To make the process most efficient for staff, simply place the animals together and leave them to work in their first training pasture. It is important that neither the forage nor the untrained animals be stressed, so when they have grazed forage in the first pasture to about 50% move them to the next pasture even if all the weeds have not been eaten. Remember that the animals are practicing a new grazing technique, so look for even small changes in the target weeds. Plant tops may be bent over from "gumming" by the practicing cows, or stems may be broken but not snapped off because the cow didn't yet have the necessary skills to break it off and put it in her mouth.

Once your herd is in the second training pasture, observe the untrained animals to see what they are eating. If they are not even trying the weed, leave them in pasture slightly beyond 50% reduction in forage. When it is time to move them to the next pasture, reduce it's size by about 1/2 to provide a sense of scarcity. Note that you are only giving them the appearance of scarcity because they will be moved in time to have plenty of forage. Again, you don't want to stress the plants or starve your animals.

It is more likely that the animals will be eating the weed by the time they move to the second pasture, even if they don't yet have strong skills at harvesting it. Depending on staff time available you can continue to move the animals through their four training pastures, giving untrained animals more time to practice in close proximity with experienced weed-eaters, or you can return them to their regular pastures.

Managing Cattle to Meet Weed Management Goals

Once animals are grazing a target weed, our goals for that weed along with the time and money we have will determine how we manage our animals' grazing.

"Timing" and "Intensity" of grazing are our primary tools for managing vegetation. Timing of grazing means choosing the time of year when the target weed is most susceptible to damage from grazing and preferred species are least susceptible. As the picture below notes, a plant's palatability and susceptibility to grazing changes over the growing season with both palatability and susceptibility to control decreasing after seed set (Launchbaugh 2006). Since palatability is based on the nutritional value, it is obvious that we will have best luck with grazing when the plant's nutritional value is higher. Since seeds may also be spread in the manure of grazing animals, it also makes sense that we avoid grazing after seed set. Thus by paying attention to the growth stage of the target weed, we can pick a time before seed set to graze for maximum impact.

Changes in Plant Palatability and Susceptibility to Grazing Over a Growing Season

Palatability

Susceptibility

Green Up   Seed Set   Senescence
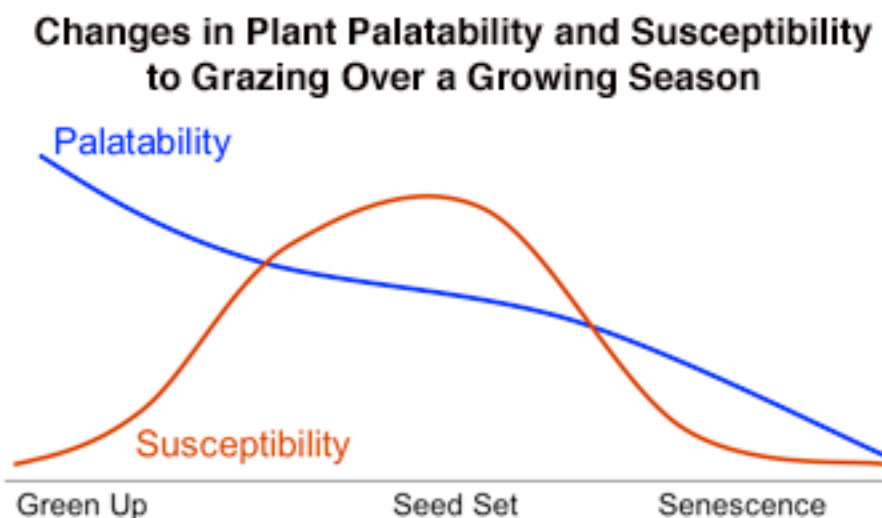
Intensity describes the frequency, or how often a weed is grazed, and the stocking density used when targeting a weed. We know that grazing a plant more than once during a grazing season can reduce its vigor and its population over time. Intensity of grazing is also increased when using a higher number of animals (a heavier stocking density), resulting in higher impact on the target weed. Some suggestions about timing and intensity are included by species below.

Even with proper timing and intensity, eradication of an invasive species is unlikely based on our past experience. In spite of concerted efforts over the last 50 years, weed populations continue to grow at about 14% per year. However, our historic experience with reductions in native grasses throughout the west, along with more recent targeted weed grazing research indicates that a plant can be severely reduced with grazing. How rapidly and to what degree we want to reduce a weed's population will determine how we manage our animals.

If speed and near eradication is the goal, we must spend a great deal of time and money managing our livestock. Since herbivores do not eat every part of every plant unless they are confined or forage is limited, and because rapidly reducing an invasive species population requires that every target plant be consumed, the closer we want to come to eradication, the more time and money we will need to spend on managing our grazing animals. Animals must be focused in smaller pastures, we

must move them to new pastures to prevent damage to preferred species, and then move them back again to hit regrowth of the target weed.

Under such a management intensive grazing system, the balance required between protecting preferred species and adequately injuring the target weed is difficult to achieve and requires daily and even hourly attention to changes in the pastures being grazed. Thus a prescription is not possible. Rather, the manager must be adaptable, and be prepared to practice both the art and science of grazing management.

Given those difficulties most targeted grazing managers prefer to take a slower approach towards reduction of weed populations, making a longer-term commitment to the process. One of the benefits of taking one's time is that material and labor costs are reduced. Another benefit is that potential damage to preferred species is easy to prevent and easier to recover from if a mistake is made.

Following are suggestions by species for developing a targeted grazing program to address the three weeds cattle were trained to eat based in part on a review of the literature presented by University of Idaho's Rangeland Ecology and Management Department (http://www.cnr.uidaho.edu/rx-grazing/Forbs). Because these species can all be found together in some Grant-Kohrs pastures, an overall suggestion for grazing management follows.

Leafy Spurge (Euphorbia esula)

Researchers recommend that 95% of top growth be removed. After the first treatment, regrowth should be regrazed. Grazing can occur in the growing and flowering stages. Work with sheep indicates that animals first learning to eat leafy spurge may prefer younger plants. As noted earlier, trained animals at Grant-Kohrs Ranch National Historic Site stripped leaves and flowers from plants in both June and August, so it is possible that grazing can be accomplished throughout the summer.

Potential Effectiveness

Grazing by sheep and goats has been very effective at reducing biomass on an annual basis when leafy spurge is grazed to a moderate to severe level of utilization. Thus, we should be able to expect similar results from cattle that have been trained or have learned from herd mates to eat the weed.

Researchers note that grazing effectiveness can appear to be low after the first year because plants might produce a flush of new growth the spring of the following year. The pictures on the next page from a grazing project in the Deer Lodge Valley in Montana, show that after four years of consecutive grazing, this high density infestation of leafy spurge was suppressed (Launchbaugh 2007).

In moist or riparian areas, leafy spurge appears to be more resilient, requiring more grazing frequency to suppress it. This is important to note since much of the leafy spurge on Grant-Kohrs Ranch National Historic Site occurs in riparian areas.

This is the infestation of leafy spurge in Deer Lodge Valley, Montana when herders first began using sheep to control it in 2001.

After the following year, spurge in the foreground has been replaced by grasses. Some spurge is still visible in at the base of the near hills and on the slope of the hill on the far left.

This is the pasture after four years of grazing by sheep. Leafy spurge is no longer visible.

Spotted Knapweed (Centaurea maculosa)

Since spotted knapweed is a biennial or short-lived perennial, the grazing objective for this plant is to prevent or reduce seed production. To choose the right time for grazing, I consider both potential impacts to the plant and the needs of the grazing animals.

A 2008 clipping study (Benzl) found that clipping during bolting stage reduced viable seeds by nearly 90% compared with no clipping, and that removing 100% of flowers at full bloom reduced seed viability by 100%. Unfortunately there is a great deal of difference between clipping and grazing. The clipper will always remove 100% of the flowers regardless of plant palatability. The cow, on the other hand, will never remove 100% of the flowers. She will also reduce the overall quantity she eats of the weed, and will eat more of the native grasses, because the nutritional value/palatability of the weed decreases when it is in flower.

The 2007 Launchbaugh study below indicates that target weed palatability is maximized, while impact on other species is minimized during July. Animals choose more of the target weed, and less of the grass during this month than the months of June and July. This coincides with what I observed in 2004 when the herd first grazed in trial pasture. Cattle in pasture grazed every knapweed plant to some degree, but all tops were bitten off. It is also what we would expect based on crude protein values of pre-flowering spotted knapweed (as much as 18%) and flowering knapweed (6.6 percent). Keep in mind that cattle require a minimum of 8% protein to function adequately.

Relative Proportion Removed
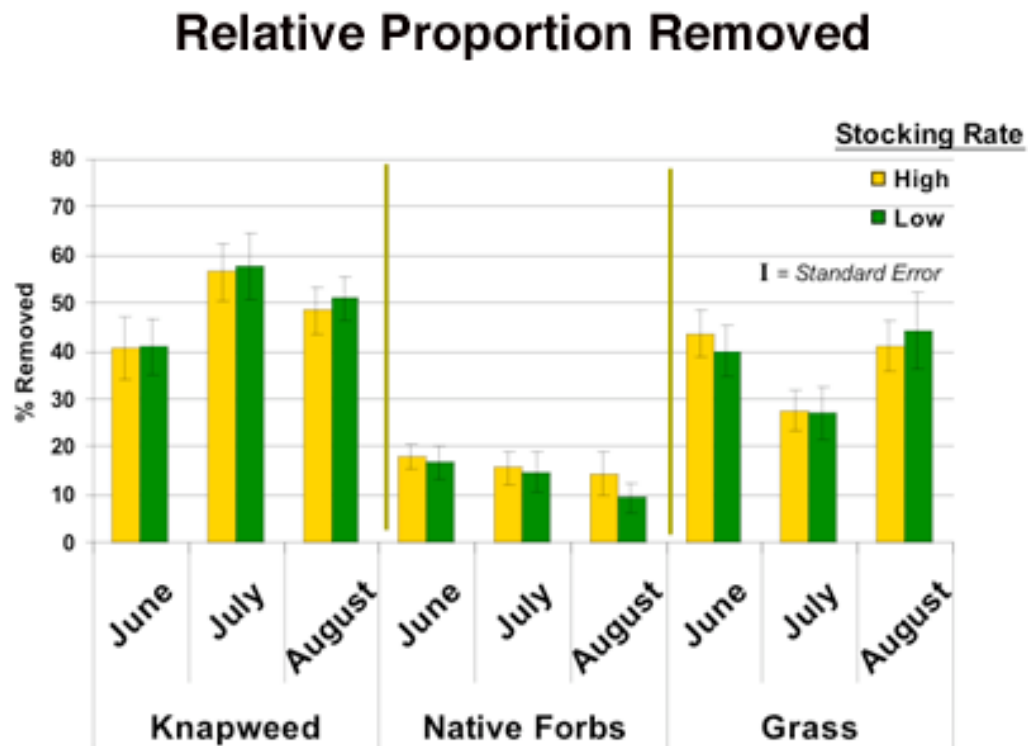
Based on this information, I weigh the probability of reducing viable seeds by nearly 90% based on my animals' willingness to eat all bolting plants, versus the lesser likelihood of achieving 100% seed reduction when asking my animals to graze a plant that does not meet their nutritional needs. I keep in mind impacts on desirable species as indicated by additional research. This leads to my preference for grazing in late June and July.

Management Cautions: That is not to say that grazing at this time doesn't have it's challenges. While our first year of grazing in trial pastures in 2004 indicated that grazing the grasses to 4 to 5 inches produced no negative effects, changes in precipitation can and will affect grass response. Thus, it is critical for range managers to take this into consideration when deciding timing and duration of grazing in any area.

Canada Thistle (Cirsium arvense)

Canada thistle is a perennial plant that has a vigorous and spreading root system making it more difficult to control whether with grazing or herbicide. Our objective in grazing this plant is to reduce its vigor by grazing it early and often.

Researchers suggest beginning grazing when rosettes first appear, but since these are quite low to the ground, livestock may have difficulty removing rosettes. Our work at Grant-Kohrs Ranch and at 6 different ranches in the Ruby and Madison Valleys in 2008 demonstrated that trained cattle will graze this plant throughout the grazing season, that they will eat stemmier plants with equal gusto, and that they will graze it to the same height as the grass in the pasture. Ranchers in other areas have indicated that this kind of repeated grazing has eradicated Canada thistle from their pastures (Dennis Neal pers com).

Thus, animals should be moved from a pasture when necessary to protect preferred species, and returning to regraze new Canada thistle sprouts if grazing will not harm preferred species.

Suggestions for Cattle Management for Weed Management Goals.

Timing

Based on what we know about the three target weeds, focusing on grazing them in June and July when they are bolting and just before seed set will provide the most impact. This timing has been shown to reduce the number of flowers on spotted knapweed plants, as shown below (Launch-baugh 2007). It is also the time of year when the target weeds are at their most palatable.
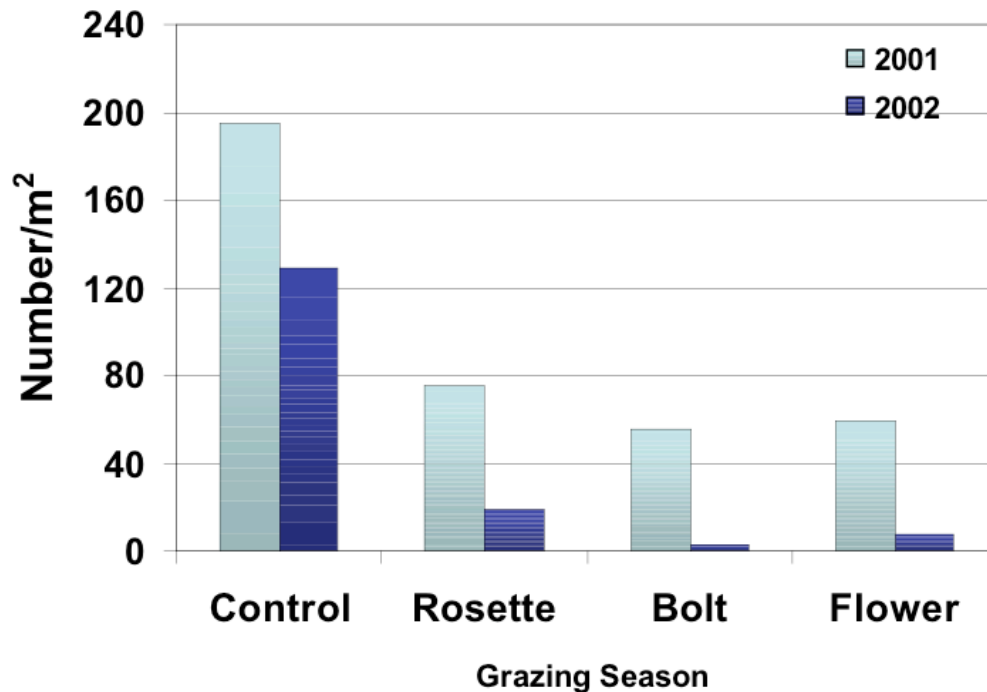
Intensity

To really reduce weed populations using grazing, everything points to using high stocking densities and grazing plants more than once in a growing season. In Chapter 7 of "Targeted Grazing: A Natural approach to Vegetation Management and Landscape Enhancement, Bret Olson and Karen Launchbaugh provide the following suggestions for managing animals to achieve weed reduction goals:

> "The number of days to graze in a year depends on the characteristics of the target weed and the surrounding vegetation. The general goal is to graze at a frequency and intensity that will be most detrimental to the weed and most beneficial to the surrounding desirable vegetation. Exactly how this goal is accomplished will depend on the situation and the skill and knowledge of the person making grazing management decisions. The most common grazing strategies involve concentrating animals in relatively small areas for a few days and then moving them onto another area when defoliation objectives are met. In many cases, grazing prescriptions will involve returning to an area that was grazed earlier in the season to graze the regrowth of the target plant, preferably when desired species are dormant.

> "The number of years of grazing required for weed control varies, but will nearly always involve several consecutive years. The initial two to five years will focus on weed suppression based on the response of the target weed and surrounding plant community. After the target plant has been reduced to an acceptable level, grazing may be applied at a lower rate (fewer animals) and/or less frequent level for landscape maintenance. Targeted grazing is not a one-time and then walk-away tool – it is a long-term landscape enhancement commitment."

Given that the GRKO cattle herd will be reduced to less than 70 animals in the near future, treating areas with the target weeds at the intensity required will be difficult. Perhaps one of the most important contributions GRKO can make in advancing the use of cattle as weed managers would be as a demonstration ranch, using the small herd to target small pastures, and tracking animal performance and vegetation changes over time. Through on-going coordination with me as I gather new information, management of the herd could be adapted to improve impacts on weeds.

In this case, staff would pick a demonstration area and define goals for the vegetation in it. These goals could include reduction in target weed populations, increases in preferred vegetation, etc. The herd would then be used to meet those goals.

For example, if the goal was to reduce spotted knapweed populations the herd would be placed in the demonstration area in late June to early July when the knapweed is bolting, but not yet flowering. Animals would be moved when grasses were grazed to 4 to 5 inches in height to prevent long-term damage to them. Animals would return to regraze knapweed in late August or September when plants have had a chance to resprout or even bloom. Progress can be tracked over time using repeat photography and monitoring of plant densities in the demonstration area. Animals would be managed similarly for Canada thistle and leafy spurge reduction.

For more on the ins and outs of intensive grazing management, consult the book "Holistic Management Handbook: Healthy Land, Healthy Profits" by Jody Butterfiled, Sam Bingham and Allan Savory. Savory is known for his theories on intensive management, and though these theories have not yet been proven useful in arid areas, they seem to function well in areas, like the Deer Lodge Valley, that were traditionally grazed by large ungulates. (The book is available in paperback from Amazon.com for $24.75.)

Given that GRKO is considering leasing grazing on the ranch, another good demonstration opportunity would be using trained GRKO cattle to train lessee cattle before they begin grazing. Assuming that the leased areas would not be as intensively managed, comparisons in changes in weed populations could be made between intensively managed demonstration pastures and the leased pastures.

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Appendix A - Training Process

Step 1 - Know Your Plants

What We Did

We found that each of our target weeds were comparable to alfalfa in nutritional value so we were fairly certain that the animals would eat them if the toxins were not too strong. Canada thistle contains nitrates that can cause death in high quantities. Molasses and corn help the animal process nitrate into protein. Leafy spurge contains ingenol esters with unknown effects. Diarrhea was the primary concern, though we were also told to beware of blistering on mouths and excessive saliva-tion. We saw no evidence of any negative effects associated with leafy spurge. Spotted knapweed contains sesquiterpene lactones/cnicin. No negative effects were listed for this weed.

Why

Research indicates that animals choose what to eat based on feedback from nutrients and toxins in plants. Nutrients tend to increase consumption and toxins tend to decrease it. If your target weed has good nutritional value, once your animal has tried it, she'll probably like it.

Toxins are secondary compounds that plants manufacture to protect themselves from grazing. All plants contain toxins, including the fruits and vegetables we eat every day. Research demon-strates that animals can learn to mix foods to offset the effects of toxins in foods. In some cases sci-entists have also discovered supplements that bind toxins so the animal suffers no ill effects.

Pointers

Keep in mind nutrient and toxin levels change depending on the season, precipitation, and soils. Your animal's ability to tolerate nutrients and toxins also changes depending on its nutritional state and the other types of forages in the pasture. Being able to mix forages allows animals to offset ef-fects of toxins. Therefore, to increase your chances for success don't place your animals in solid stands of your target weeds unless you intend to provide them some sort of supplement to offset potential effects of toxins.

Timing your grazing is very important. Many plants re-sprout or bud out at lower levels if they are grazed once. Repeated grazing may be required to control the plant, or you may choose to use a combination of grazing and herbicides if you want to eliminate the plant.

Step 2 - Choose Your Animal

What We Did

We chose 19 heifers, all less than a year old, to increase the chances they would try new foods and so they would teach their calves what to eat. This represents about 1/3 of the current herd at Grant-Kohrs Ranch. In 2005 we observed these cows with the calves and found that they were passing on the new diet habits.

Why

Research demonstrates that younger animals are more likely to try new foods. Young animals learn from their mothers what to eat and this learning is longest lasting. Animals also learn from each other.

Pointers

We began with a small number of animals because we were trying something new and wanted to give ourselves the best shot at success. When deciding how many animals you will work with, you might also consider the amount of time you have for picking weeds and preparing foods. Keep in mind that first impressions count and bad ones will last forever.

Step 3 - Reduce Fear of New Things

What We Did

Over the winter, while animals were in dry lot, we spent a week or two feeding them a wide variety of nutritious food in assorted textures, shapes and sizes. We served the foods in black tubs so they would associate "good foods" with anything we placed in the tubs. Cows ate alfalfa pellets, rolled corn, oats and barley, range cubes, beet pulp pellets and a molasses-based supplement in a black tub.

Refined Process

This is the area where the biggest change was made. Rather than spending the winter feeding unfamiliar foods it is much easier and the animals learn faster if they are fed unfamiliar nutritious foods morning and afternoon for four days, followed by the weeds on the afternoon of the fifth day.

Why

Research demonstrates that animals are "neophobic" or afraid of new things and places. (This may be one of the reasons they don't naturally eat weeds.) They will try new foods a little at a time and decide whether or not to increase consumption based on feedback from the nutrient and toxins in the food.

Research also indicates that the more foods an animal has had positive experiences with, the more likely it is to try something new.

Pointers

Keep in mind that first impressions count and bad ones will last forever. So be sure your animals don't overeat any of these nutritious foods. Too much of a good thing can cause illness and your animals could become a bit more cautious about trying new foods. This process doesn't have to take a long time. You'll know you're ready to go on to the next step when your animals are noticeably interested in the black tubs.

Step 4 - Keep Animals in Good Condition

What We Did

We fed our heifers from 21 to 25 pounds of hay per day. The weeds we fed were simply a "snack."

Why

The nutritional state of an animal affects how it reacts to nutrients and toxins in plants and its willingness to eat them. Processing toxins requires more protein, so starving animals are less capable of eliminating toxins from their systems.

Pointers

An animal may be better able to tolerate toxins in a weed at different times during the day, depending on what it has already eaten. If you're not having the success you anticipated, experiment with feeding at different times of the day after the animal has had a chance to eat other foods.

Step 5 - Make the Unfamiliar Seem Familiar

What We Did

We used a liquid, molasses-based supplement and pre-mixed corn, oats and barley (COB) as familiar flavors to encourage the animals to try the weeds and to offset the effects of nitrates in Canada thistle. We picked weeds in the morning, put them in tubs, threw in a couple handfuls of COB and sprayed everything with a very light coating of the liquid molasses supplement. Once the liquid had dried we served it to the animals. We did this for 4 to 6 days with each weed.

> **Refined Process**
>
> Projects completed in 2006 - 2008 have demonstrated that molasses is not critical to the training process. By going through Step 3, animals become willing to try whatever they are fed. Using Step 3, we have even trained animals to eat a weed without using molasses.

Why

According to research, animals are more likely to try something new if it is associated with a familiar flavor. Animals try new foods in small quantities and increase consumption if they feel no ill effects. They decrease consumption if the flavor of the food changes suddenly.

Pointers

These aren't the only flavors available to you. Goat and sheep producers using their animals on weeds sometimes spray saltwater on plants to encourage animals to try them. One rancher used this technique with his cows during a drought when only weeds were available. Don't be discouraged if your animals don't chow down the first day. Give your animals the time to try the new food and adjust to it. Once they're eating, resist the urge to push them to eat large quantities. Eating too much may cause them to feel sick and then they may never eat the weed in pasture.

Step 6 - Field Test Your Animals

What We Did

We initially placed our project herd in pens with just enough forage for one day. The idea was to provide enough pressure to ensure they didn't eat the best and leave the rest. They began eating thistle and knapweed immediately. After the third day we put them in larger pens with enough forage for 4 to 5 days so that we could monitor consumption for purposes of reporting success or failure.

Why

Research indicates that if an animal can meet its needs by eating only preferred forages, it will. When preferred forages make up less than 40% of its diet, the animal will learn to mix foods with toxins to meet its needs. In the field, researchers found that pens containing just enough forage for one day ensure that animals will eat the target plants.

Pointers

If your animals are eating the weed well in dry lot, they may continue to do so in the field, so you may be able to skip placing them in "one-day" pens. I will be doing additional work in this area in the future.

> **Refined Process**
>
> Projects completed in 2006 - 2008 indicate that the one-day pastures are important to helping animals focus on learning techniques for harvesting a new plant on their own.

Step 7 - Observe and Adapt

Why

Because most weed management technology has focused on herbicides there is very little information about weed response to grazing or on the amount of pressure required to encourage animals to include them in their diet on a continuous basis. Therefore those trying this new grazing technique will have to pay attention to their animals' responses and habit. Observation of plant response will tell the grazier how many times a plant must be grazed in order to prevent it going to seed and at what times of year grazing works best. If you make changes to animal management, make only one change at a time so you can more easily track what is and is not a successful modification. Keep notes and take plenty of pictures. Be on the lookout for changes in animal health.

Why

If you make changes to animal management, make only one change at a time so you can more easily track what is and is not a successful modification. Keep notes and take plenty of pictures. Be on the lookout for changes in animal health.

Appendix B - Repeat Photography Instructions

To create before and after photographs that really describe what you observed on the ground you need to repeat the direction, height and composition of the picture. Here are some tips to get the best shots possible.

1. Choose a spot from which to take the picture.
     If you can, mark it with a stake, or if you can use existing fence posts to shoot from, that will help. For example, you might decide to take a picture facing west with your back resting against a particular fence post. Note where you took the picture from in the repeat photo form found on the next page.

2. Maintain the same focus and height for the camera
     This is easiest if the same person takes both before and after pictures, wearing the same shoes. Zooming in makes it hard to repeat, so taking pictures with the camera at its widest view is easiest.

3. Incorporate landmarks in your photos.
     As you look through your camera's viewfinder, check to be sure the frame includes a horizon line. Include rock outcrops, mountain slopes, or other geologic features in the picture so that when you take your "after" pictures you'll be able to match these features up again.

4. Add any observations you have of what you see in the pasture or of what you see the cattle doing.

5. Print your "before" photos for reference when you go out to take after photos.

Photos of Changes in Weeds

For this project we are also tracking changes in the target weeds. Mark the weeds you photograph for the "before" photos by pounding a nail with a large washer into the ground near the plant. The nail and washer can be used to mark not only the plant but to mark where you put your foot so that you can relocate the position you had when you took the original photo. Use the same pointers found above to provide a frame of reference for your plant and to add information about the location from which you took the picture, and any observations you have of the pasture, the plants, or what the cattle are doing.

Repeat Photo Data Sheet For Pastures

Date: _____**Data Collector:** _____

Pasture Name/Number: _____

Circle One: Trained Herd   Untrained Herd   Trained Animals Teaching Untrained Animals

Photo 1 Location: _____

_____

Field Observations: _____

_____

Photo 2 Location: _____

_____

Field Observations: _____

_____

Photo 3 Location: _____

_____

Field Observations: _____

_____

Photo 4 Location: _____

_____

Field Observations: _____

_____

Repeat Photo Data Sheet For Target Weeds

Date: _____**Data Collector:** _____

Pasture Name/Number: _____

Circle One: **Trained Herd**   **Untrained Herd**   **Trained Animals Teaching Untrained Animals**

Circle One: **Canada Thistle**   **Leafy Spurge**   **Spotted Knapweed**

Photo 1 Location: _____

_____

Field Observations: _____

_____

Photo 2 Location: _____

_____

Field Observations: _____

_____

Photo 3 Location: _____

_____

Field Observations: _____

_____

Photo 4 Location: _____

_____

Field Observations: _____

_____

Appendix C - Data Collection Form

Date: _____ **Pasture:** _____ **Collector:** _____

Tag #/Name	Leafy Spurge	Canada Thistle	Spotted Knapweed	Observations

Appendix D - Pasture and Grazed Weed Example Pictures

To help you select pastures with a good mix of forages, here are examples of pastures grazed at Grant-Kohrs Ranch National Historic Site in 2004 and 2005.

Target weeds are mixed in with all the forage you see here.

This is an example of a large spotted knapweed patch in this same pasture. Note that spotted knapweed tends to grow in drier areas and this is the drier end of the pasture.

Christina in SW Knapweed patch pen 4

Here is another pasture showing a mixture of grass and spotted knapweed.

Canada thistle was also mixed in with the grasses and spotted knapweed in this photo.

This is a long narrow pasture set up to test cattle on leafy spurge in August of 2005. Though the pasture was small it had a large patch of leafy spurge (foreground) as well as belly-high grass, Canada golden rod, and the other two target weeds as shown in the picture below.

Again, these pictures provide examples of where pastures and the mix of weeds with other forages. This picture shows grasses, canada thistle and spotted knapweed at the drier end of the pasture. The lower end of the pasture had little knapweed, but more grass as shown in the picture below.

Here are some examples of the varying degrees to which cattle graze spotted knapweed in pasture.

The ends were bitten off of this plant and leaves stripped from most stems.

Stems were grazed to about six inches from the ground on this plant.

This plant was grazed to about ten inches from the ground.

Here are examples of how cattle graze Canada thistle in pasture showing the progression from trimming tops to eating all but the stem of the plant.