Demonstrating how trained, weed-eating cattle train herd mates as a tool to enhance weed management

Final Report to GLCI Colorado
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Project Summary

2009 project herd of cattle owned by Babe and Leo Hogan and Bill Hogan on the western edge of the Mayhoffer pasture.

This project's purpose was to demonstrate how ranchers can use a small group of cattle trained to eat weeds to train their entire herd quickly and efficiently. Using trained cattle to teach untrained animals means that ranchers could potentially have their whole herd trained within one grazing season. Ranchers and land managers then benefit from reduced weeds, and expenditures for controlling them. The amount of forage for ranchers is also increased by either turning weeds into forage in times of drought, or by potentially increasing populations of other plants that suffered from too much weed competition.

The plan was to use Babe and Leo Hogan's cows, previously trained through small grants projects with Boulder County Parks and Open Space to eat late-season diffuse knapweed and Dalmatian toadflax, to teach untrained cows belonging to Bill Hogan, also a Boulder County lessee. Animals were to be placed together in small training pastures so that untrained animals would have close contact with trained animals, could see them eat the target species, and would in turn begin eating them themselves. Once untrained animals were eating them in small pastures, we planned to return the newly trained animals to their home herd where they would train their remaining herd mates.

Weather, rancher resources, animals refusing to stay in fenced areas, and the plague that killed all the prairie dogs in the area all combined to disrupt these plans. As a result, we were unable to demonstrate conclusively how quickly animals learned from each other. However, we did gather very useful information on the high protein diet of forbs and weeds this herd chose in pasture. This information indicates that forbs are an important part of a pasture's makeup, providing both biodiversity and appropriate forage for cattle. Drawing on this information, we might reconsider the use of broadleaf herbicides on our target weeds since they impact not only the weeds, but the forbs as well.

Project Background

In spite of continued efforts to control invasive species, and the best efforts of herbicide companies to develop products for their management, weeds continue to spread nationwide at an average rate of 14% per year. In 2000, farmers and ranchers were already spending $5 billion to control pasture weeds, and an additional $1 billion was lost due to reduced grazing potential, reduced wildlife-related recreation, higher levels of soil erosion and reduced water quality (Pimental et al 2000). Researchers Rejmanek and Pitcairn noted in 2004 that when a weed is wide-spread "biological controls may be the only long-term effective way to suppress its abundance over the invaded area."

While we generally think of biological controls as species-specific insects, in this case, I think of biological controls as any herbivore attacking the plant. Studies on a variety of weeds indicate that grazing can be a successful tool for reducing weed populations. By training cattle to eat weeds, producers no longer have to import goats or sheep to a cattle operation, but can use the tool they have at hand, and they can reduce herbicide costs and the associated labor while increasing biodiversity.

Thanks to two decades of research at Utah State University, we know that animals choose what to eat based on what they learn from mother and herd mates, and from their own internal feedback from nutrients and toxins in plants (Provenza, 2003). This research, and associated animal behavior studies, also give us clues into the kind of environment required to get an animal to try a new food. Thus if a food is nutritious, and we can introduce it to an animal in a way that they will try it once, their own internal mechanisms will indicate that the food is good, and they will continue to eat it.

Based on this information, I developed the necessary steps to get a cow to try a new weed, with the idea that once they could eat the weeds in pasture, we would have a new tool to control advancing weed populations. Training takes about 8 to 10 hours in labor and costs about $200 in feeds from the local coop to train about 50 animals. I generally train from 25 to 50 animals at a time. This is a reasonable number to gather weeds for, though I have trained as many as 110 cow calf pairs. (For more on the training process visit my website at: http://www.livestockforlandscapes.com.)

Since 2004, I have trained cattle in California, Montana and Colorado to eat Canada, distaff, Italian and milk thistle, leafy spurge, spotted and diffuse knapweed, Dalmatian and yellow toadflax and black mustard. Trained animals subsequently added other weeds to their diets like Meadow and Missouri goldenrod, bull and musk thistle, wormwood sagewort and horehound. They gained weight at expected rates, suffered no health problems, bred back, continued to eat the weeds in subsequent years regardless of pasture size, and trained their calves to eat the weeds. We also found that their herd mates learned from them.

One of Babe and Leo Hogan's cows eating Canada thistle in 2008. While it is common for the Hogan cattle to graze Canada and Musk thistle, Kathy Voth is often requested to teach cattle in other places to eat these weeds.

Since the first year of training I have found that untrained animals in a herd learn from their trained herd mates to eat the target weeds. The first herd of 20 animals trained to eat Canada thistle, leafy spurge and spotted knapweed were put back into a herd of 60 animals once the first project was completed in mid-July. By mid-August, all animals in the herd were eating Canada thistle and spotted knapweed. (There was no leafy spurge in their pastures.) In Marin County California, 12 trained cows trained 120 to eat distaff and Italian thistle in 2007, and weed eating knowledge has since spread to the entire herd of approximately 400 animals. Today, the home-base for these cattle is almost devoid of Italian thistle. In 2008 in Montana, 8 heifers trained 20 pairs to eat Canada thistle, and steers on another ranch learned to eat this weed from 40 trained heifers in a pasture adjacent to them.

Because this idea is relatively new, ranchers are interested in seeing how it works for others before they adopt it themselves. They have also expressed concern that they may have to invest too much time in training because they have herds that are much larger than 50 animals. Thus, using the animals' ability to teach each other means that for minimal cost in time and labor a rancher could have an entire herd of weed managers in a very short time. Having a weed-eating herd can help ranchers in two ways. First it can reduce weeds and their expenditures on them. Second, it can increase the amount of forage available by either turning the weeds into forage in times of drought, or by potentially increasing populations of other plants that suffered from too much weed competition.

Project Plan

The plan for the project from the original proposal included:

1. Putting trained animals and new trainees together in a small trial pasture to become acquainted. We anticipated 3 days for this part of the process.

2. Moving the group to a second trial pasture where untrained animals could watch the trained animals eating the target weeds. Animals eating the target weed would be recorded in both the first and second pastures. This part of the process was to be an additional 5 days, so that animals would have had just over a week of training time together.

3. Moving the newly trained animals back to their home herd where they could teach their herd mates in a third trial pasture. Here we would observe and record which animals ate the target weed for an additional 4 days.

Factors Affecting the Project's Outcome

> ***Plans get you into things, but you got to work your way out.***
>
> ***~ Will Rogers***

Due to factors beyond our control, adjustments to the project plan were made early on.

Animal Numbers

First, it turned out Bill Hogan had only 30 animals available to be trainees for the project. Therefore it made more sense to simply include all of them in the first training phase. Working with our partners, Rob Alexander and Meaghan Huffman of Boulder County Parks and Open Space, we reasoned that we already know that animals learn from each other, and by reducing the complexity of the project we would have additional time for the animals to work together should anything not go according to plan.

On July 9, 2009, we built a trial pasture of approximately 4 acres in Boulder County's Mayhoffer pasture just south of Superior, Colorado. Two tanks fed by a spring provided water. On July 10, Bill Hogan herded 31 cow calf pairs to the pasture by 4 wheeler, and Babe Hogan and two cowboys on horseback brought in 38 cow calf pairs plus one bull. The two groups mixed immediately with no problems, demonstrating that the acquaintance period could be eliminated. They milled about the pasture and we observed trained animals eating dalmatian toadflax, and all animals eating musk and Canada thistle.

Fencing Issues

On July 11 we arrived to find that the herd had escaped from the trial pasture. We found them on the flats to the west of the trial pasture and had some success moving them using the truck, horn, and feed tubs that Babe and Leo's cows were trained to come to in 2008. Ultimately we could not put them in the pasture until Bill Hogan arrived on his 4-wheeler to herd them in. We reinforced the fence, repaired the floats feeding the water tanks, and observed cattle into the afternoon.

A rare picture of our project herd in the trial pasture.

We were not completely surprised that the herd did not respect the fence. Meaghan Huffman had been working with Bill Hogan's herd prior to beginning this project and she had been unable to keep them in an electric fence. When we

returned on July 12 to find that the cattle had again escaped, I decided that we would not put them back in the trial pasture, but that I would continue to observe them in the larger 300 acre portion of the Mayhoffer pasture available to them. My reasoning was:

1. They were staying together well as a group and not separating into their original herds so trainees would be near enough to trained animals to learn from them.
2. The eight heifers who trained the 20 pairs in Montana in 2008 were grazing in a very large pasture when training occurred so I believed that the size of the pasture would not prevent trainees from learning.
3. We had no better fencing materials available so improving the fence was not an option. Continuing to spend time putting them back into a trial pasture where they would not stay would waste time the cows could have spent grazing and learning together.

The two herds remained together for the rest of the project period, traveling together in the 500 acre pasture.

From July 12 through August 21 we observed the cattle in pasture which grew from 300 acres to 500 acres when the herd broke through an electric fence and accessed the southern part of the pasture that was normally inhabited by prairie dogs. To encourage them to spend more time in areas of our target weeds, we put salt blocks and a molasses-based supplement tub in a large patch of dalmatian toadflax. Progress on the two target weeds, dalmatian toadflax and diffuse knapweed was minimal. We found evidence that animals were grazing some of the weed, but were unable to observe if the new trainees were eating it. We found little evidence that diffuse knapweed was being grazed.

Unusually high quantities of forage

There was much more forage this year than last for the following reasons:

Precipitation

"A cool and very wet June 2009" is how the National Weather Service summarized the month preceding the start of this project. In fact, this was the second wettest June since records began in 1872 with 4.86 inches recorded at Denver International Airport, narrowly losing to the 4.96 inches of rain that fell in 1882. Normal precipitation is 1.56 inches. July was also cool and very wet, missing the top ten wettest July's on record by only .08 of an inch.

Boulder Precipitation Data in Inches From the Colorado Climate Center

Month	Actual	Normal
March	1.89	1.78
April	5.88	2.88
May	3.08	3.05
June	2.71	1.99
July	1.42	1.88

Naturally, all this rainfall from the second and eleventh wettest months on records supported a huge increase in vegetation. The contrast from the year before, when we experienced the hottest, driest July on record, was obvious to even the most inexperienced observer. The foothills remained green into the beginning of August, when they normally would have turned their usual golden color by mid-July. There were more, healthier grasses, though Rob Alexander of Boulder County Parks and Open Space observed that they still did not seem to have completely rebounded from previous years' droughts.

Plague

An additional 200 acres of vegetation was added to this mix when the prairie dogs that would normally have eaten it were killed by bubonic plague. The ghost town was grassless and covered in mustard skeletons, bindweed, sunflowers, musk thistle and more. From our accepted pasture paradigm, it looked so bad that I nicknamed it the "garbage area."

Normally I'm not concerned about the impact of healthy forage and pastures on cattle's willingness to eat targeted weeds because the weeds themselves are usually at least as nutritious as everything else available to them. Unfortunately, that was not the case this year. As I found from this project, the target weeds were significantly lower in nutritional value than the other forages the animals chose in pasture.

Almost no grass grew in the vacant prairie dog town, but the herd spent a great deal of time here because of the bindweed, prostrate pigweed, sunflowers, cutleaf nightshade and prickly lettuce that was found there.

Project Results

When you have lemons, make lemonade.
~ Kathy's Motto

We followed the herd in the 500 acre pasture for 14 days. As noted earlier, they grazed some dalmatian toadflax, and we found a few diffuse knapweed plants that had been bitten. But overall, the amount of grazing done on the two target weeds was negligible when compared to grazing in 2007 and 2008. I did observe one calf from the untrained herd eating both diffuse knapweed and dalmatian toadflax, so there is the potential that some learning on these weeds did take place.

As I followed the animals, what I noticed was that they generally avoided the grassier areas and preferred the "garbage area." Cows and calves moved purposefully to the large sunflower patches, grazing sunflower blossoms after their noon watering-break. When they had their fill of those, they searched for bindweed patches among the prairie dog holes or along fence lines, snipping off yucca fruits, musk thistle flowers, and taking prickly lettuce stalks to the ground as they ambled from patch to patch. When they'd come to a grassy area, they'd snatch a few mouthfuls, but they moved through them quickly to areas of prostrate pigweed, cutleaf nightshade, fetid marigold and Russian thistle. They ate wormwood sagewort, common ragweed, assorted chinopods, goldenrod, wild licorice, and more.

Since it appeared that the cows were not going to graze dalmatian toadflax or late-season diffuse knapweed, I decided to find out why they preferred the plants they were selecting over the target weeds and grasses. Since we know that nutrients increase palatability, my hypothesis was that they were choosing very nutritious foods. In fact, given the nature of their manure, I guessed that the plants they were selecting were generally high in protein.

I took 20 samples of plants that cattle were eating, collecting the parts of the plant that I observed they selected. I took them to Weld Laboratories in Greeley, Colorado and had them analyzed. The plants and their results are listed here in order of the preference the cattle displayed for them.

Loose stools like this one are indicative of a high protein diet.

	Results (on Dry Matter Basis)	
Sample ID	**Protein (%)**	**ADF (%)**
Bindweed (*Convolvulus arvensis)*	16.1	31.1
Prickly lettuce (*Lactuca serriola*)	17.3	22.0
Prostrate pigweed (*Amaranthus blitoides*)	20.1	26.5
Common Sunflower flowers (*Helianthus annuus*)	14.1	28.1
Cutleaf Nightshade (*Selenum triflorum*)	15.6	21.0
Broom-like ragwort (*Senecio spartioides*)	14.6	22.6
Netseed lambsquarters (*chenopodium berlandieri*)	15.2	24.4
Common ragweed (*Ambrosia Psiostachya*)	11.3	24.5
Musk Thistle flowers (*Carduus nutans*)	11.2	30.9
Chinese Lantern/Purple Groundcherry (*Quincula lobata*)	13.9	26.0
Wormwood Sagewort (*Oligosporus dracunculus*)	12.3	23.1
Wild Licorice (*Glycyrrhiza lepidota*)	15.2	24.1
Louisiana sage (*Artemisia ludoviciana*)	7.9	36.6
Plains milkweed (Asclepias Pumila)	12.3	20.9
Fetid Marigold (*Dyssodia papposa*)	18.4	16.6
Red Stem pigweed (*Chinopodium hostata*)	9.3	28.2
Unknown Sunflower	8.9	30.5
Velvet weed (*Gaura mollis/parviflora*)**	11.8	22.8
Wild Rose (*rosa arkansana*)*	6.8	32.0
Moth Mullein (*versbacum blattaria*)	8.5	39.2
* The sample for this plant contained more woody material than I observed cattle eating. It is possible that nutritional values would be different if only leaves had been analyzed.		

For comparison here are the nutritional values for the target weeds and the grasses in the pasture and for alfalfa:

	Results (on Dry Matter Basis)	
Sample ID	**Protein (%)**	**ADF (%)**
Dalmatian toadflax leaves (*Linaria dalmatica*)	6.7	15.8
Dalmatian toadflax stems (*Linaria dalmatica*)	6.1	36.3
Big Bluestem (*Andropogon gerardii Vitman*)	8.7	
Blue grama (*Bouteloua gracilis*)	7.9	
Smooth brome (*Bromus inermis*)	2.8	
Late-season diffuse knapweed (*Centaurea diffusa*)	8.0	
* Toadflax was tested at Weld Laboratories. Information on grasses and diffuse knapweed comes from “AllReference.com” (http://reference.allrefer.com/wildlife-plants-animals/plants/)		

Conclusions

Animals choose foods based on nutrition so grass may not always be the first, or best choice.
Based on the nutritional values of the plants the herd was selecting, it is clear that they were choosing forage that was higher in value than the target weeds. The results also explain why cattle were eating very little grass in pasture.


A well-grazed Wild Licorice plant.

The results of the nutrition analysis also explain why it was difficult to assess if or how 2007-2008 trainees were teaching the untrained animals to eat diffuse knapweed and dalmatian toadflax. Since animals were avoiding low-quality foods for high quality foods, it would be difficult to pass learning along on our target weeds.

This is important information for understanding how to manage cattle in pasture for weed control. In 2007 and 2008 trained cattle readily ate both late-season diffuse knapweed and dalmatian toadflax in pasture, probably because the drier climate in those years produced less vegetation. (July 2008 was the third driest and warmest month on record.) Available forage during those years was primarily grasses, the target weeds, horehound, wormwood sagewort, and Canada and musk thistle. Since the target weeds were equivalent to or better than the grasses in nutritional value the cattle grazed them. **Based on the difference between cattle response to the target weeds in 2007 and 2008 vs. 2009, we know that when we ask animals to manage weeds on our behalf, it is important that we keep in mind how they choose forages, and the relationship of our target weed's nutrition to other available forages.**

Learning to eat target weeds when animals are as young as possible may increase consumption.
Studies indicate that when young animals learn to eat a low-quality forage early in life, or when they learn to eat it from their mothers, they will continue to eat it even when they have free-choice of high-quality foods (Provenza et al 2003). Based on this, it is possible that the offspring that learned to eat the target weeds as calves with mother in 2008 may have been eating more of the target weeds than the animals we were following in the Mayhoffer pasture. Unfortunately, the offspring were not part of this project. **Following up on the foraging habits of trained cows' offspring will give us additional information for managing cattle as weed managers.**


Calves eating bindweed with Cow

Learning and social behavior may have increased the variety of forage selected in 2009.
We don't know if other herds were making the same kinds of diet choices in pasture this year. I also don't know if the forage choices of the project herd were unusual. When I describe what these cattle ate to experienced producers and land managers, they express surprise, leading me to believe that what I observed is unusual.

Research tells us that the more positive experiences an animal has with new things, the more likely it is to try additional new things (Cheney et al, Launchbaugh et al). The training process is designed specifically to provide positive experiences with new foods, so that trainees will be willing to try a target weed. Since 2005 I have observed that animals that have been through the training process choose many more unusual forages than what I taught them to eat. I have concluded that trainees' early experience encourages them to try new things.

It is possible that the 38 trainees in this case tried new forages based on their past positive experiences and that the untrained animals learned from them. To find out, I would need to follow other herds and see what they choose under similar circumstances.

Herbicides may be doing more damage than good to our forage base. Our traditional ideas about pasture and herbicides are that pastures should be primarily grass, and that herbicide damage to our pastures is nominal because they target only broad-leaf weeds and forbs. Two recent studies, along with this project, demonstrate that this assumption is false.

In their 2009 paper, "Control effort exacerbates invasive-species problem," Rinella et al summarized their sixteen year study. They found that "Aside from a transient increase in grass forage production, herbicide provided little benefit to the livestock producer or the ecosystem we studied. One of the primary objectives of spraying was to increase cattle forage by decreasing ***Euphorbia esula*** (leafy spurge) production, but paradoxically, two sources of evidence suggest that herbicide ultimately increased ***E. esula*** production." They note that their previous research showed that grasses and forbs compete with ***E. esula,*** and as herbicide leads to long-term suppression of several native forbs, it followed that reduced native-forb abundances would lead to increased production of the target weed. Thus, spraying was actually increasing their problem.

Fuhlendorf et al (2009) tested the assumption that applying herbicides extensively on rangelands to reduce forbs leads to an increase in grass production and ultimately to an improvement in livestock performance. What they found is that forbs were reduced by herbicide, but that grass cover varied more due to annual precipitation than the treatment. In addtion, they found that, "...livestock production was not altered either on an individual basis (gain/head) or on an area basis (gain/ha). Livestock production per area (gain/ha) might be increased if grass production after herbicide treatment could be predicted reliably. However, predicting grass production is notoriously difficult in rangeland ecosystems that have high inter-annual variation in precipitation. Reliable adjustments in stocking rate to harvest grass released from forb competition is unlikely and therefore fraught with risk."

Examples of what the project herd ate in pasture

Pigweed

Cutleaf Nightshade

Bindweed

Fetid Marigold

Given the variety of forbs/weeds the cattle in this project ate, the high nutritional value of the plants they chose compared to grasses, and the fact that research indicates that herbicides may exacerbate

our perceived problem while not providing any increase in weight gain for our livestock, I arrive at one question: If you can't beat them, why not eat them? In fact, forbs may be just as important a part of our forage base as grass. This project demonstrates that cattle with a broader view of what constitutes forage, can and will pick a diet heavy in forbs and light in grass. Five years of observing trainees indicates they also gain weight at expected rates, and in fact, in Marin County, California forb/weed eating cows gained more weight than their traditional grass-grazing herdmates. **By simply changing our minds about the role of forbs in a pasture based grazing system, we can solve weed problems and maintain or improve cattle productivity.**

This project provided unanticipated benefits to producers and land managers by providing a greater understanding of cattle behavior in pasture.
Though the project did not conclusively demonstrate how animals share diet selection knowledge in a management context, by altering the focus of the project I was able to gather useful information about what cattle can and will eat in pasture and the value of that forage as a nutrition source. Unforeseeable events, like weather and animal behavior, often make it difficult to guarantee outcomes of projects like this. By being flexible and paying attention to the animals themselves, I find that I can always modify projects in good-faith to produce a useful product.

Thank You!

Thanks to the Grazing Lands Conservation Initiative, Boulder County Parks and Open Space, and the City of Boulder for providing funding to make this project possible, to Babe and Leo Hogan and Bill Hogan for their willingness to try something new and letting me work with their cattle, to Rob Alexander and Meaghan Huffman for their support and hard work, to the BEHAVE team for their research promoting understanding of livestock behavior, to Leah Ashley for her assistance and enthusiasm, and to my parents, Orie and Donna Voth, and my husband, Peter Williams for their daily support of my work in Boulder. None of this would happen without you.

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Appendix A - Final Meeting: "Dinner and a Mooovie"

As of this writing the final meeting has not yet been held. Following are the details of the planned meeting. Final attendance numbers will be forwarded on September 25, 2009 to Darlene Jensen, Executive VP, Colorado Association of Conservation Districts.

The final meeting is scheduled for September 24, 2009 at the Boulder County Parks and Open Space Office Conference Room. The purpose of the meeting is to provide producers and NRCS, Extension, County and City staff with information on the project from 2007 to 2009, covering the training process, what we have learned from working with the project herds, and the implications for future management of cattle and weeds. I will take this opportunity to share what I saw cattle selecting this year and find out from participants what they have seen cattle select, and how this affects the way they might manage their pastures.

Invitees for the meeting were provided by project participants and include Boulder County and City of Boulder Open Space lessees, the County's advisory board, GLCI committee members, and others having expressed an interest in the project. The invitation list is attached, as is the invitation itself.

Final Meeting Invitees

Amber Brignue, City of Louisville - brignue@ci.louisville.co.us,
Steven Sauer, Boulder County Parks and Open Space - <ssauer@bouldercounty.org
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Mike Serrano 12245 Flagg Dr Lafayette 80026
Ron Sutherland 8230 N Foothills Hwy Boulder 80302

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Hank Hogan, 4965 Eldorado Springs Dr., Boulder, CO 80303
Ron Sutherland, 8230 N. Foothills Hwy., Boulder, CO 80302
Don Culver, Boulder Valley Farms, 7490 Clubhouse, Suite 201, Boulder, CO 80301
Leo and Albert Hogan, 1226 S. Cherryvale Road, Boulder, CO 80303
Robert Lover, 3700 Longhorn Road, Boulder, CO 80301
Lynn Shanahan, 1019 S. Foothills Hwy., Boulder, CO 80305
Richard Behrmann, 8110 Ouray Drive, Longmont, CO 80503
Andy Clyncke, 11328 Billings Ave., Lafayette, CO 80026
Dwayne Cushman, 1522 Taylor Mtn. Dr., Longmont, CO 80503
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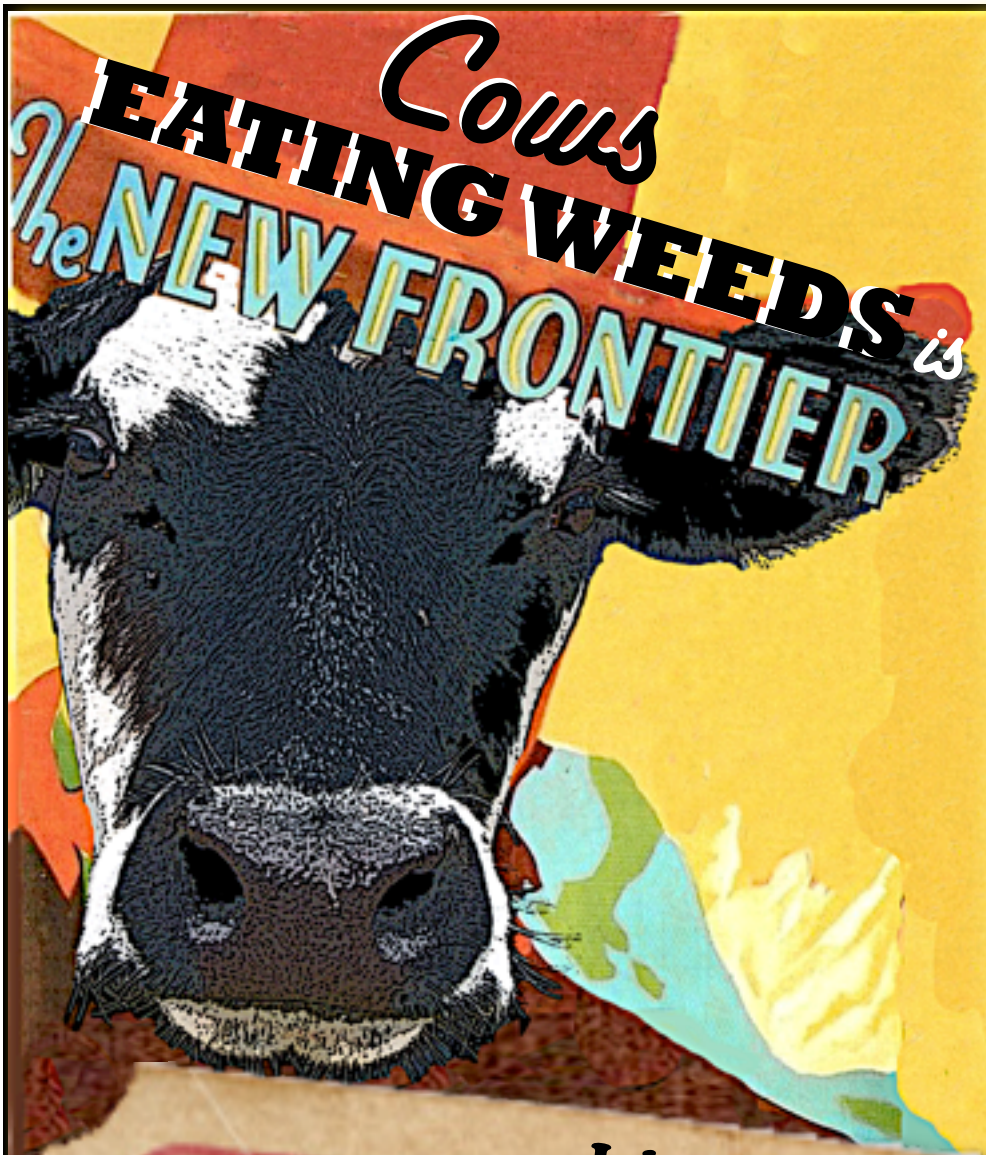
Cows EATING WEEDS is the NEW FRONTIER



2007 - Kathy Voth teaches 50 of Babe and Leo Hogan's heifers to eat late-season diffuse knapweed.

'08 and '09 - The trainees teach calves and herd mates and learn to eat Dalmatian toadflax.

Ranchers, Boulder County and the City of Boulder are all happy.

The cows are happy too, and add all kinds of new weeds to their diets, like wormwood, thistles, pigweed, ragweed and more....

We'll talk about what we learned at our wrap up meeting

Join us for Dinner and a Mooovie!

September 24, 2009, 6 to 8:30 p.m.
Boulder County Parks and Open Space
Conference Room
5201 St. Vrain Rd, Longmont, CO 80503

Kathy Voth will talk about training cows to eat weeds, results, what we've learned from working with cows as weed managers and show video of it all.

RSVP to save your dinner plate!
Leah Ashley, (970)402-1314 or
leashley@livestockforlandscapes.com

Brought to you by Livestock for Landscapes, Boulder County Parks & Open Space, City of Boulder and the Grazing Lands Conservation Initiative

TWO THUMBS UP! It'll change the way you think about weeds.
- Angus Cow