

NWIPC Targeted Grazing 2009 – Canada and Bull Thistle

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Abstract

In 2008, 10 heifers were trained to include field scabious (*Knautia arvensis*) in their diet to explore the feasibility of using cattle grazing as an invasive plant management tool. Field trials continued in 2009 with local ranching partner Bar K Ranch who provided heifers (15) and animal husbandry expertise for the project. The project animals were trained to eat invasive thistle using methods developed during the 2008 trial. Project animals were introduced to Canada (*Cirsium arvense*) and bull thistle (*Cirsium vulgare*), two species usually avoided by cattle while grazing in pasture. The training process started with feeding hand-cut invasive plants mixed with other feeds while the animals were fenced in a training corral. After several days of training the animals were moved to a field pasture where their use of thistles and the remaining pasture was assessed to determine the efficacy of using trained cattle as weed managers. While in corral the project animals showed similar responses to the 2008 animals however, the results in pasture differed greatly. The trained cattle avoided the target invasive plants in pasture. There was very limited grazing on Canada thistle flowerheads and no observations of feeding on bull thistle. Other palatable forage species (grasses) present in the training pasture were also avoided. Post field season nutritional analysis of the thistles found that the thistles in the pasture had high Ca:P ratios which reduced their palatability. While in pasture the trained cattle likely fed on species that were more palatable than the target thistles. Future trials will need to consider the nutritional quality of the surrounding vegetation as well as the quality of the target invasive plants.

Background

In 2008, Northwest Invasive Plant Council (NWIPC) Board of Directors initiated a targeted grazing project within the field scabious containment area around the Saik'uz First Nation reserve lands in the Vanderhoof area, "Targeted Grazing of Field scabious (*Knautia arvensis*) in Vanderhoof, BC". This project involved locating a cattle rancher to provide the subject animals, background research into the biology and toxicity of field scabious, developing training and project methodologies, field site assessments, field scabious forage analysis, daily feeding and monitoring of research animals, data collection and analysis and the preparation and presentation of the study results at the Invasive Plant Council of BC Invasive Plant research forum in October 2008. The project resulted in 10 beef heifers that ate field scabious (which they previously avoided) while grazing in pasture. Field trial results showed that field scabious was grazed to a similar stubble height as the surrounding grasses. The field trial was conducted before

field scabious bloomed. Follow up monitoring showed that grazed plants developed re-growth within one week after grazing and were producing flowerheads within one month after grazing. Nutritional analysis (forage testing) of field scabious revealed young and pre-bloom plants are nutritionally comparable to alfalfa hay and so provides adequate nutrition for normal weight gain in heifers. The project also increased awareness of the use of cultural controls for invasive plant management, in support of the NWIPC and the Saik'uz, who manage large infestations of field scabious without the use of herbicides. The trial demonstrated the potential for cattle ranchers to reduce herbicide use and other invasive plant costs while increasing the use of infested areas of their own pastures. Other benefits of the trial include trained cattle who remember their training the following year and continue to graze the target invasive plants (Voth 2008), as well as, the trained cattle demonstrating to their calves and untrained herdsmates that the target invasive plant is an acceptable plant to graze (Voth 2008). The 2008 trial received technical support from NWIPC members and the Ministry of Agriculture and Lands. Rod and Darleen McLeod provided 11 heifers for the project and volunteered numerous hours of operational support. The project was financially supported solely by NWIPC.

To build upon the previous year successes a project was developed in 2009 between NWIPC and the Bar K Ranch (Prince George, BC) targeting invasive thistles. Bar K Ranch provided 15 heifers and one bull to the project as well as technical expertise and operational support. The trial at Bar K Ranch was more independent than the trial performed in 2008. Taylor Grafton from Bar K Ranch performed the majority of the training feeding duties, unlike 2008 when Amy Barnes from NWIPC conducted all the feedings.

Methods

Cattle choose to eat particular foods based on feedback from their digestive system. The type of feedback an animal receives from ingesting a particular plant influences the chances of the animal selecting to eat it in the future. Avoidance of a specific plant species can be the result of a “bad” response from the animal’s digestive system. To avoid “bad” responses, cattle avoid eating unfamiliar food (Provenza 2003 in Voth 2008).

The general training procedure was adapted from Kathy Voth’s work on training cattle to be invasive plant managers (www.livestockforlandscapes.com). The first step was to research the target invasive species to ensure there would be no negative health effects from feeding it to cattle. Some of the trial animals from each study year were intended for the beef market at the end of the season and they needed to gain weight at a rate comparable to animals feeding on their typical pasture vegetation. A literature review did not find any reported toxins in either thistle species or any reported or suspected negative health effects on cattle that consumed Canada or bull thistle (or any other closely related species).

The Bar K Ranch loaned 15, 1.5-year-old replacement heifers and one bull for the trial. Female animals are preferred because if they remain in the herd they will have calves, and calves learn what to eat from their mothers. Calves will learn to graze the target invasive plants their mother was introduced to in the trial.

A training program was developed to create the necessary positive experience of learning to eat the unfamiliar target invasive species. Training started July 6 2009. The project animals were separated from the main herd and placed in corral with free access to unlimited hay and water. At no point during the study were the animals denied food to force them to eat the target invasive plants.

The training program started with introducing new types of prepared cattle feed to accustom the project animals to a new feeding routine and new types of feed. Every morning for four days, the project animals were fed a ration of familiar barley feed mixed with a ration of unfamiliar commercial cattle feed. The unfamiliar cattle feed included alfalfa pellets, whole rolled corn, whole oats and beet pulp pellets (beet pellets were soaked in water before feeding, see Figure 1). The one part familiar barley ration was mixed with the one part unfamiliar commercial feed in buckets and in the corral (see Figures 2 and 3). Next, Canada and bull thistle were added to one of the now familiar commercial cattle feeds (one part Canada thistle, one part bull thistle and one part commercial cattle feed, see Figures 1 and 2).



Figure 1 One part hydrated beet pulp pellets with one part familiar whole barley ration.



Figure 2 Now familiar alfalfa pellets with equal parts Canada and Bull thistle ration.

Thistles were hand-cut from fields near the coral. Cutting enough thistles for 16 animals every day was not practical for our rancher so large quantities were cut in advance and stored in the shade and fed for two or three days.

Animals had one feeding of just thistles in preparation for turning the participant animals out to pasture,

The project animals were moved to a training pasture close to the corral on July 21, 2009. The training pasture was 1.3 ha in size and composed of mixed vegetation. The pasture was composed of approximately 10% Canada thistle, 8% bull thistle, 14% grasses, 15 % hemp nettle, 17% clover species, 20% pigweed, 7 % plantain, and 9% other species (including dandelion and oxeye daisy). Visual observations were conducted in accordance with the US Bureau of Land Management Technical Reference 1734-3 Utilization Studies and Residual Measurements, 1999.



Figure 3 Participant cows trying a new commercial feed while in corral.

After four days, no feeding on thistle was observed; the concern was that the animals had too much space and no “pressure to try the new thistle/forage. The training pasture was made smaller while still maintaining adequate forage for all the animals. The project animals spent five days in the smaller pasture before the fence was removed July 30, 2009.

Observations

The 2009 project animals behaved in a similar fashion to the project animals from 2008 while in corral. When feeding in corral, the animals eventually became curious enough to come over to the feeding tubs and “check out” what was inside. Initially all the animals avoided eating any new feed and would sort the new feed out from the familiar ration irrespective of commercial cattle feed or invasive plant material. After some time (generally 1 to 1.5 hours) the project animals would begin to feed on the new food item of the day.

Not all animals ate large amounts of the new food ration however all animals were observed trying new feed. Some participant animals would feed enthusiastically on the new food ration, while others would quickly lose interest and move onto other food sources (hay, ground cover in corral) or other activities (rest and chew cud). Occasionally a mature bull thistle plant was left uneaten while all Canada thistle had been consumed by the next day’s feeding. In 2008, no field scabious plants were uneaten by the next feeding.

Visual assessments of the training pastures following grazing revealed that the participant animals occasionally ate a few flower heads off Canada thistle. Canada thistle use was not extensive or consistent (see Figures 4-6). No feeding was observed on bull thistle plants.

Feeding was uniform throughout the pasture. The heaviest concentration of grazing occurred next to the entrance gate to the pasture where the vegetation was clipped extremely short (see Figure 5).



Figure 4. Selected Canada thistle flower heads eaten by trained cattle.



Figure 5. Bull thistle plant without signs of grazing, located in heavy use area near gate.



Figure 6. Training pasture looking west towards the gate, many areas of the training pasture showed little signs of use.

Other areas of the training pasture contained palatable grasses and herbs that were only lightly grazed (see Figure 6).

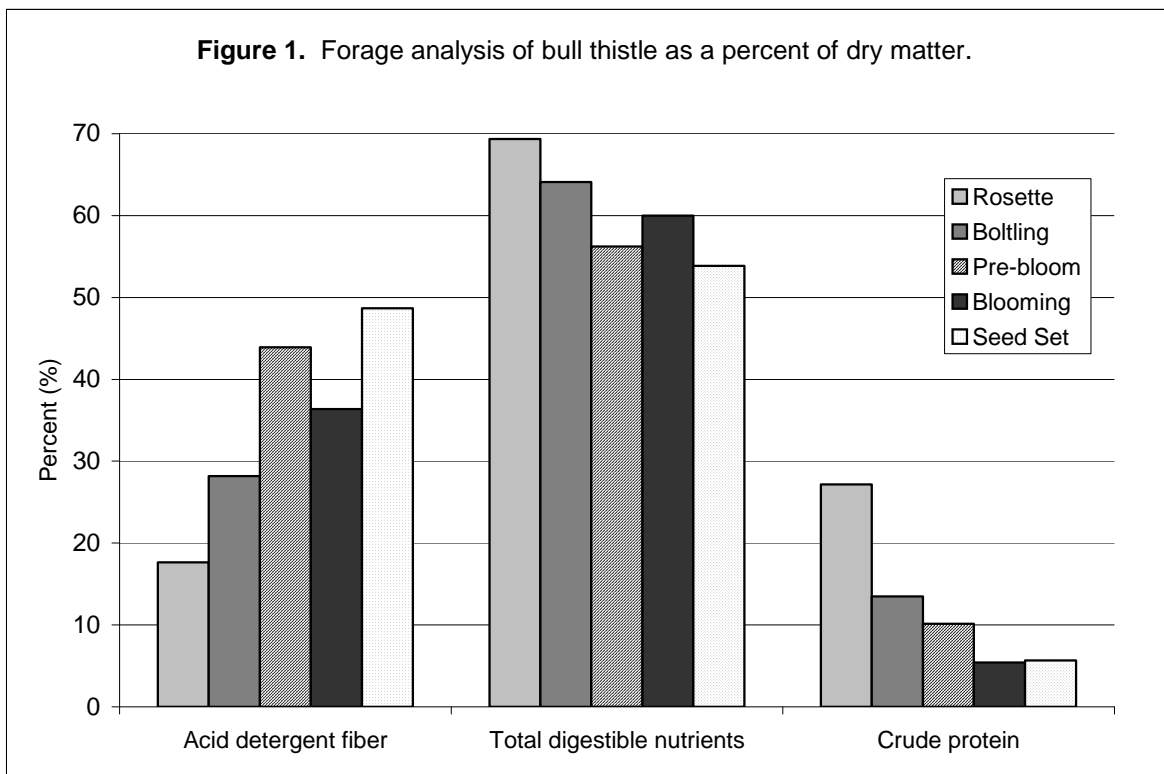
Nutritional Analysis Results

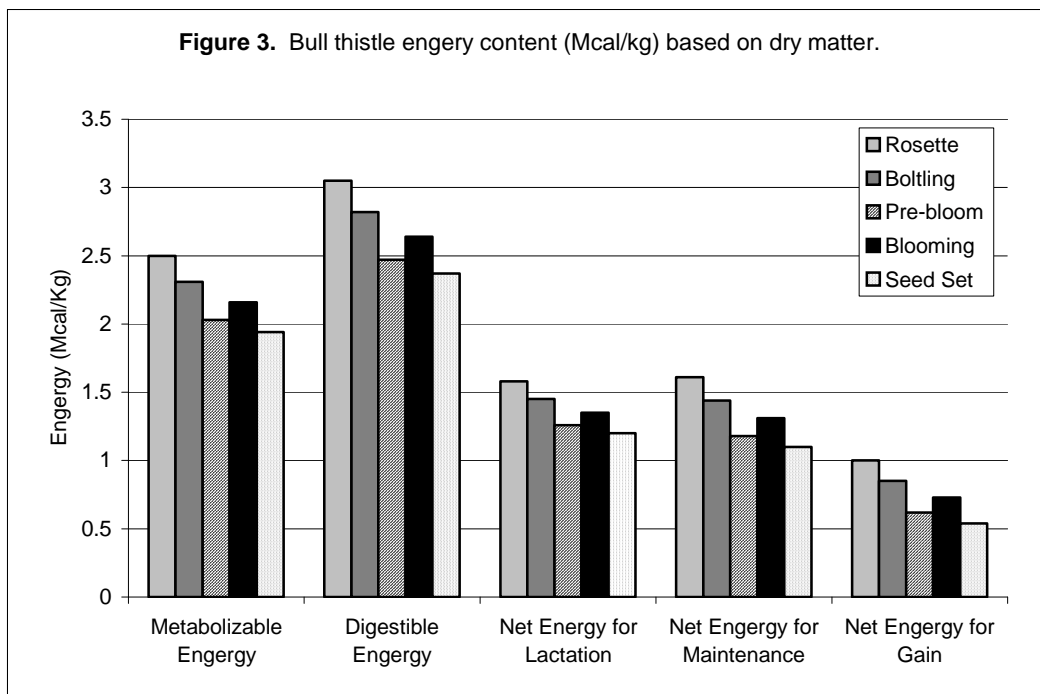
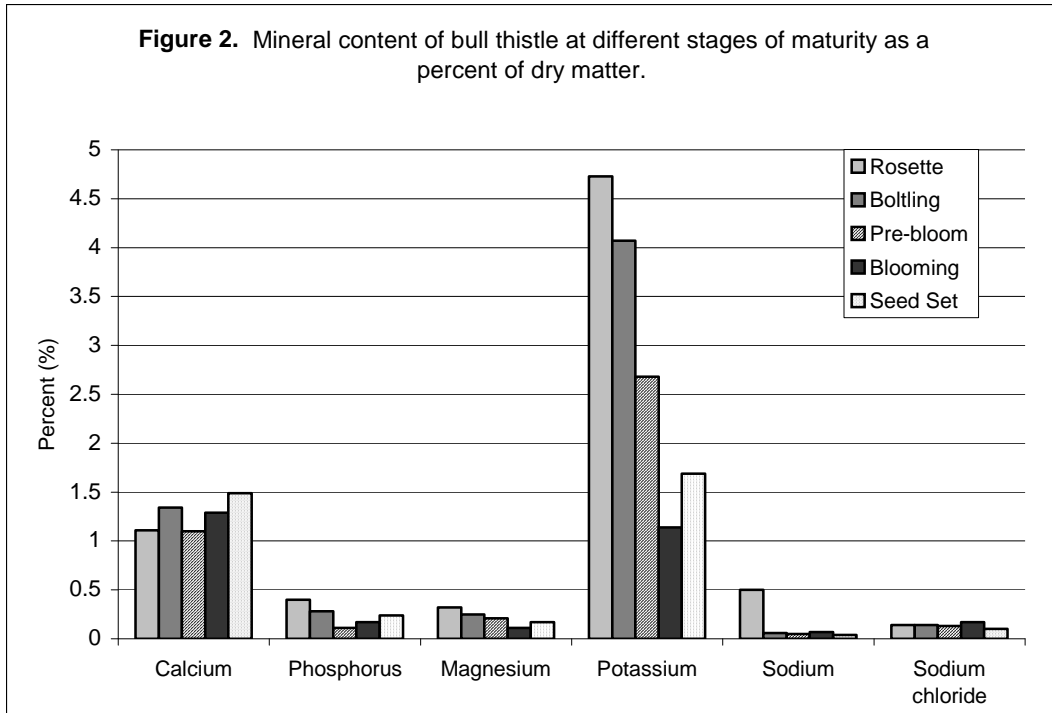
Bull thistle (*Cirsium vulgare*) samples were collected from the Bar – K Ranch throughout the duration of the target grazing trial (see Table 1.).

Table 1. Bull thistle life stages and sample collection dates

10-Jun	12-Jul	22-Jul	09-Sep	09-Sep
Rosette	Bolting	Pre-bloom	Flowering	Seed set

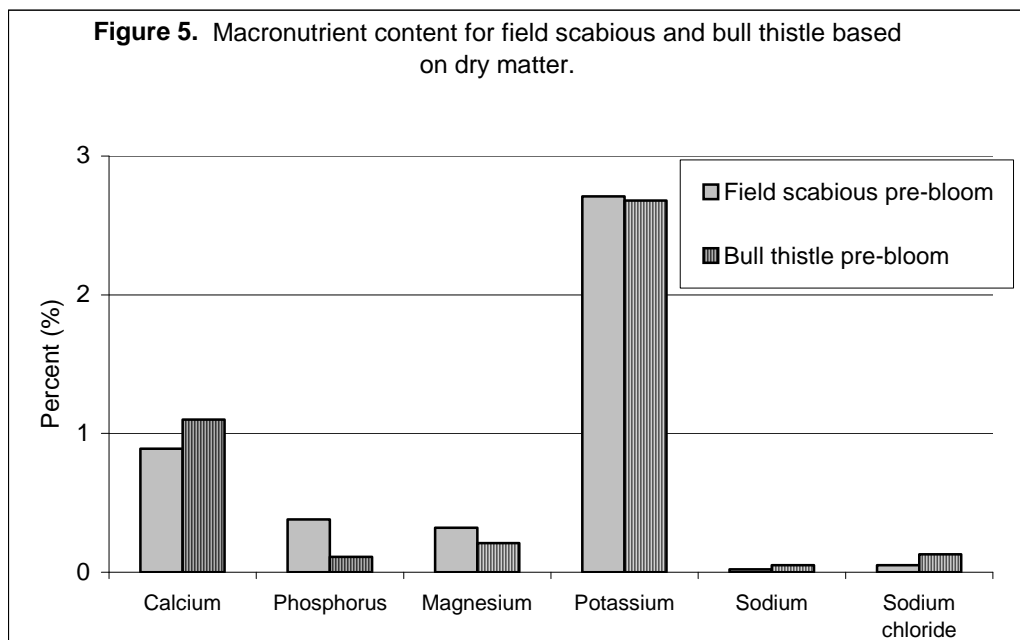
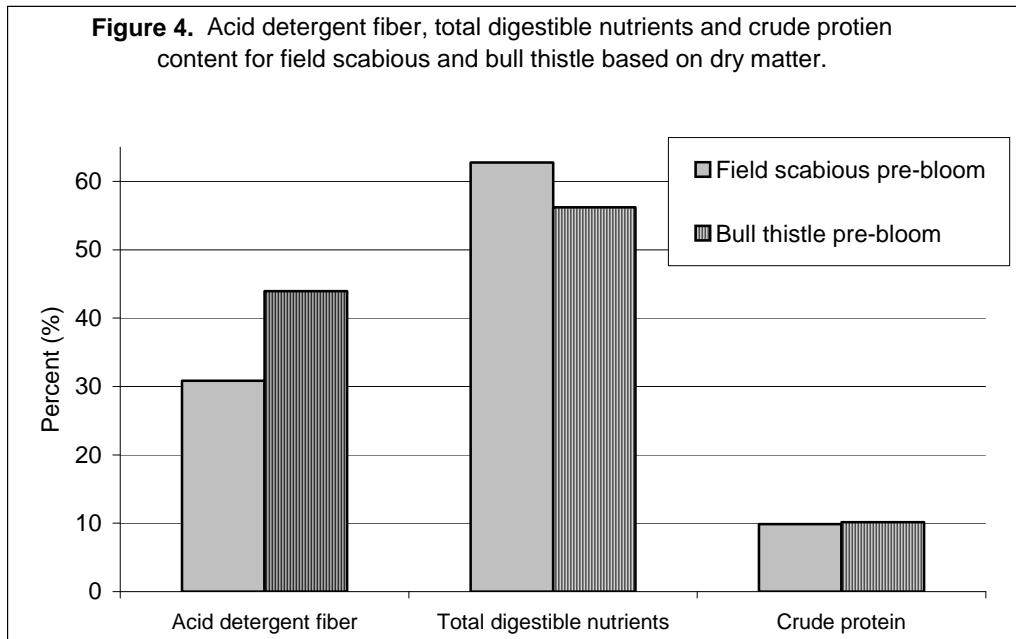
Whole plants, excluding the roots, were harvested then stored frozen until samples could be sent for analysis. Samples were analyzed (Forage package 1) by Central Testing Laboratory Ltd. (Winnipeg, MB) in November 2009, the results are summarized in Figures 1 though 3.





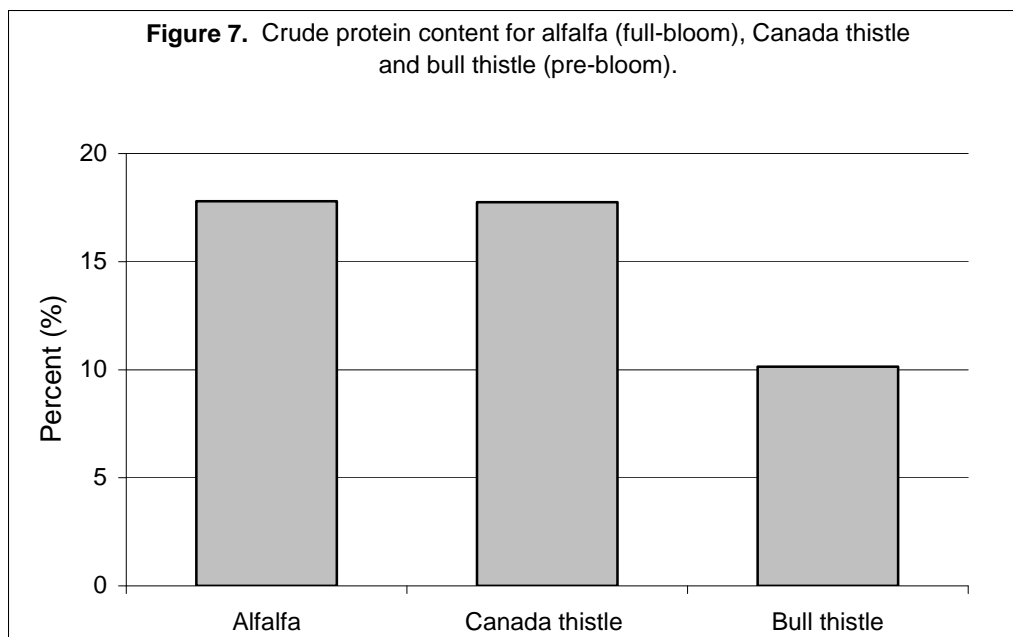
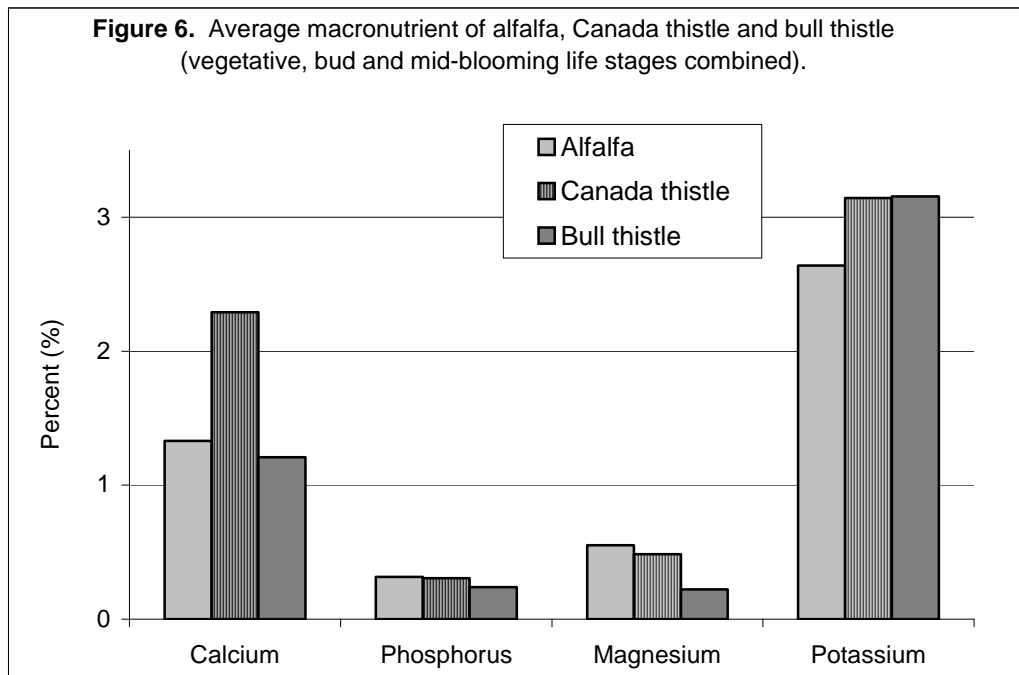
This is the same forage analysis package that was carried out on field scabious (*Knautia arvensis*) in 2008. The methods used for analysis by Central Testing Lab are reported in Appendix A.

Both thistles and field scabious followed the same trend of decreasing energy content with plant maturity. However field scabious energy values were always slightly than bull thistle values at each life cycle stage. The forage and macronutrient concentrations in pre-bloom bull thistle and pre-bloom field scabious plants can be found in Figures 4 and 5.



The nutritional values for Canada thistle (*Crisium arvensis*) were reported in Marten et al. (1987). Data was collected for two years (crops) and values were averaged over the entire life cycle of the plant. Figure 4, displays nutritional

values for Canada thistle and alfalfa (from Marten et al.) and bull thistle (from 2009 analysis).



Marten et al. did not report acid detergent fiber (ADF) for any of the species tested so a direct comparison of fiber content was not possible however, neutral detergent fiber values for Canada thistle did increase with plant maturity.

Discussion

The forage quality of both thistles and field scabious declined with plant maturation that is typical of many weeds and cultivated forages (Marten et al. 1986). All weeds tested met the crude protein (CP) requirements for pregnant, replacement beef heifers (8.8 % CP) at the pre-bloom stage. However, bull thistle and field scabious at 10.1% CP each fell short of meeting the requirements for mature beef cows or first-calf beef heifers that require 10.5% CP (Abaye et al. 2009).

Acid Detergent Fiber (ADF) is a measure of the cellulose and lignin components of the plant cell wall and a measure of neutral detergent fiber (NDF) includes the parts of the cell wall captured in ADF plus any hemicellulose present. ADF is often used as an indicator of digestibility and NDF as an indicator of dry matter intake (Abaye et al. 2009; Schroeder 1994). Bull thistle had a much higher concentration of ADF compared to field scabious that may have resulted in lower palatability. Lower palatability may have played a role in the avoidance of bull thistle seen during the grazing trial.

High calcium-phosphorus (Ca:P) ratios (those greater than 7:1) have been implicated in conditions like milk fever, impaired feed conversion, and inferior breeding performance (Abaye et al. 2009). Both Canada thistle (8:1, Marten et al. 1986) and bull thistle (10.0:1) have higher than acceptable calcium-phosphorus ratios at the pre-bloom stage. This ratio was lower in other life stages (2.3:1 to 7.6:1). The Ca:P also was much lower in field scabious at pre-bloom state with a value of 2.3:1 and a range of 2.3:1 to 4.6:1. Feedback from a cow's digestive system affects palatability (Voth 2008), and the elevated calcium-phosphorus levels in both thistles may have resulted in "bad" signals from their digestive systems. These "bad" signals could reduce the thistles palatability and reduce the cow's intake.

The deduction that trained cattle graze plants with higher palatability (regardless of training) is supported by field trials and nutritional analysis conducted by Kathy Voth in 2009. Cattle previously trained to eat Dalmatian toadflax (*Linaria dalmatica*) and diffuse knapweed (*Centaurea diffusa*) were placed in a herd with untrained cattle to observe how the untrained animals learned to eat weeds from the trained animals. Unexpectedly, intake levels of the target weeds were very low and the intake levels of other weed species were high. The cattle were preferentially consuming "other" weeds over the target weeds and pasture grasses. Voth's study showed that the animals were choosing plants with protein content higher than either target weed species, or the available grass species.

Conclusions

When selecting target weeds for the 2009 Targeted Grazing trial it was assumed that if a weed had no recorded detrimental compounds, its forage value would be high enough to be included in a cow's diet after training. However this year's trial animals avoided the target weeds while in pasture. It is possible that the animals were choosing higher quality forage than what they were presented with in the corral-training phase of the trial.

Future observations of the 2009 herd may show that the animals will choose thistles in their grazing habits when the thistle are young (to avoid the high calcium-phosphorus ratios of the older plants) and when other forage options have low protein values.

Future targeted grazing studies will have to consider the nutritive value of the target plants and also the nutritive value of the other available vegetation.



References

Abaye, A.O., G. Scaglia, C. Teutsch, and P. Raines. 2009. The nutritive value of common pasture weeds and their relation to livestock nutrient requirements. Virginia Cooperative Extension; Publication 415-150. Available at: <http://pubs.ext.vt.edu/418/418-150/418-150.pdf>

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Appendix A: Methods of Analysis

Methods of analysis reported by Central Testing Laboratory Ltd.

Acid Detergent Fiber (%)	ANKOM 08-16-06
Crude Protein (%)	Modification of Leco Version 2.2
Mineral	Modification of AOAC 968.08, 935.13A
Moisture (%)	Moisture Analyzed AOAC 930.15
Moisture (%)	Moisture Received AOAC 922.02

Analytical Tests Used

ANKOM Technology Method 9 08-16-06 Neutral Detergent Fiber in Feeds Filter Bag Technique (from "ANKOM Technology Method 9 08-16-06" http://www.ankom.com/09_procedures/NDF_081606_A2000.pdf, accessed Jan. 7, 2010)

"This method determines Neutral Detergent Fiber, which is the residue remaining after digesting in a detergent solution. The fiber residues are predominantly hemicelluloses, cellulose, and lignin. This method is applicable to grains, feeds, forages and all fiber-bearing material."

Modification of Leco Version 2.2 AKA Protein (Crude) in Animal Feed (from "Protein (Crude) in Animal Feed AOAC 990.3" Official Methods of Analysis of AOAC INTERNATIONAL (OMA), 18th Edition, <http://www.eoma.aoac.org/> Accessed January 7, 2010)

Crude protein is tested first through the combustion analysis method for solid animal feeds containing 0.2-20% N.

Mineral (from “Minerals in Animal Feed and Pet Food AOAC 968.08” and “Calcium in Animal Feed AOAC 935.13” Official Methods of Analysis of AOAC INTERNATIONAL (OMA), 18th Edition, <http://www.eoma.aoac.org/> Accessed January 7, 2010)

The first test quantifies copper, iron, manganese, zinc, and calcium through the atomic absorption spectrophotometric method. The test for calcium uses the wet ash titration method.

Moisture (from “Loss on Drying (Moisture) for Feeds (at 135°C for 2 Hours)/Dry Matter on Oven Drying for Feeds (at 135°C for 2 Hours) 930.15” Official Methods of Analysis of AOAC INTERNATIONAL (OMA), 18th Edition, <http://www.eoma.aoac.org/> Accessed January 7, 2010)

This quantitative test measures dry matter and moisture using the “Loss on Drying” technique.

Moisture (from “Plants 922.02” Official Methods of Analysis of AOAC INTERNATIONAL (OMA), 18th Edition, <http://www.eoma.aoac.org/> Accessed January 7, 2010)

This method refers to sample preparation for plants.