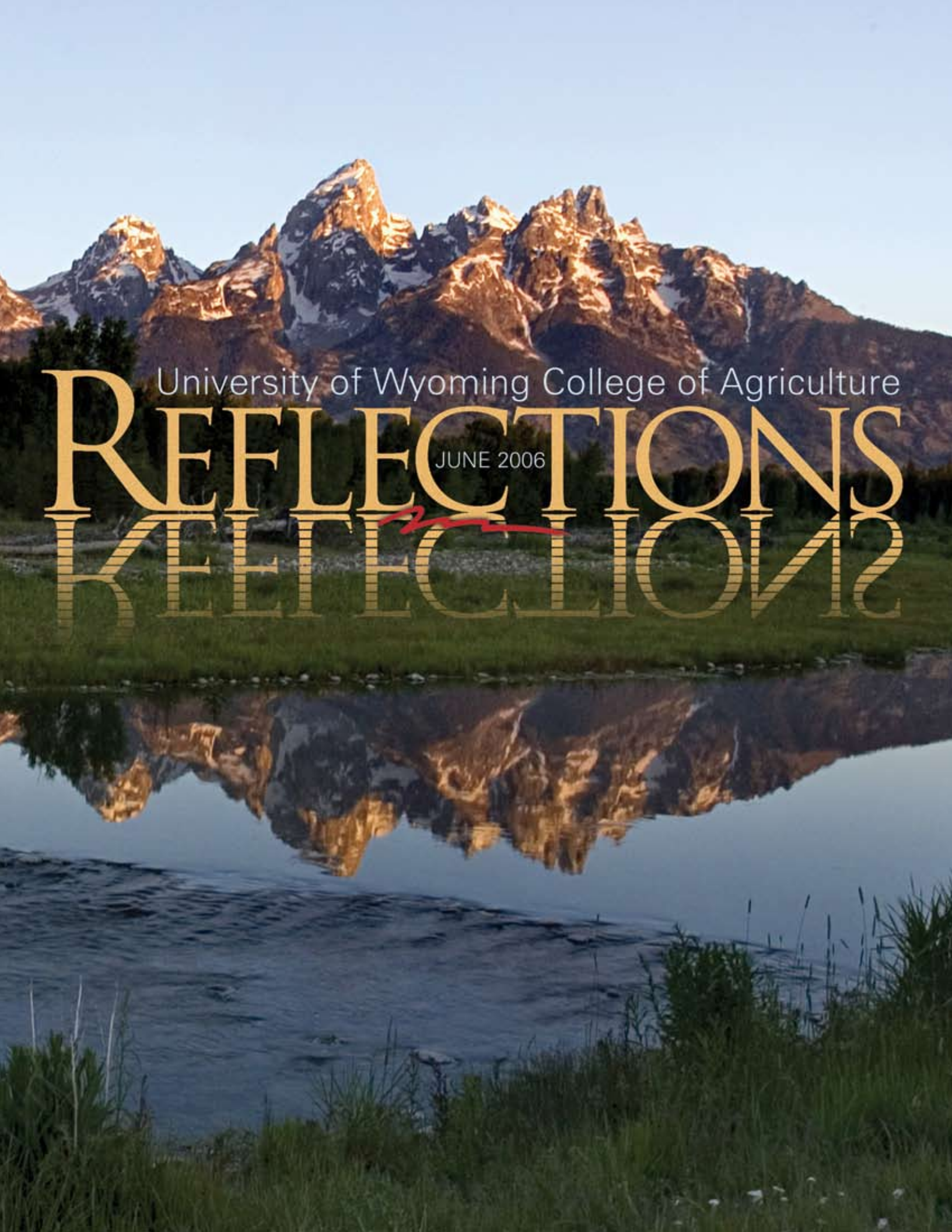

University of Wyoming College of Agriculture
REFLECTIONS
JUNE 2006

"It is the function of creative men to perceive the relations between thoughts, or things, or forms of expression that may seem utterly different, and to be able to combine them into some new forms – the power to connect the seemingly unconnected."

William Plomer,
1903 – 1973

"Form Follows Function" is the theme of this year's *Reflections* magazine.

In the College of Agriculture, the form of the tripartite mission of instruction, research, and extension/outreach follows an identified function to serve the educational information needs of students, Wyoming citizens, and the global scientific community. The college's research and outreach programs are issue-oriented and focus on agricultural sustainability and profitability, natural resource management, and family and community resources.

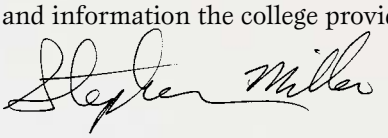
With eight undergraduate and 20 graduate degree programs, the college's array of educational opportunities is impressive and takes on many forms and functions. The choices include options ranging from production agriculture to human nutrition to molecular biology to rangeland ecology and watershed management. Check it out yourself by contacting any of the departments listed inside the back cover.

This issue of *Reflections* contains articles on such topics as invasive weeds, human nutrition, sainfoin, garbanzo beans, rabies, an elk die-off, and seed predation. It again illustrates the diversity of projects underway in the College of Agriculture to meet the information needs of our stakeholders. These efforts are conducted in laboratories, on private farms and ranches, or at three research and extension centers located around the state. The newest center near Lingle is designed to integrate crop/livestock/natural resources into sustainable production systems. With personnel in every county, the College of Agriculture is working to provide research and outreach outcomes that are responsive to the needs of our stakeholders.

Faculty members in the College of Agriculture were again very successful in obtaining extramural funding to support the tripartite mission of the college. External grant awards this past year totaled more than $10 million and ranked the college second throughout the entire university. Due to our small faculty numbers relative to other colleges, dollars per faculty member was tops in the university.

The next time you visit our campus, stop by the College of Agriculture to witness faculty and student efforts firsthand. See how the form of the college's tripartite mission of instruction, research, and extension/outreach follows an identified function to serve our stakeholder needs. To learn more about the college and its functions, please visit our Web site at www.uwyo.edu/UWAG.

We hope you enjoy this issue of *Reflections* and the assortment of opportunities and information the college provides.



Stephen D. Miller
Associate Dean and Director
College of Agriculture, Agricultural Experiment Station

form follows

Still glides the stream, and shall for ever glide;

The Wyoming Agricultural Experiment Station (AES) team at the University of Wyoming's College of Agriculture coordinates the publication of *Reflections* with the Office of Communications and Technology. AES staff members include, from left, Kathleen Bertoncelj, senior office associate; Stephen D. Miller, director; Gail Lamb, senior accounting associate; Joleen Pantier, accounting associate; and Jeani Walker, student office assistant.

function

The form remains, the function never dies.

William Wordsworth, 1770 – 1850

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TWO YEARS LATER

What killed the Red Rim elk?

Merl Raisbeck
Professor

Rebecca Dailey
Graduate student

Donald Montgomery
Associate Professor

Roger Siemion
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Laboratory Technician I,

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College of Agriculture,
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Like many investigations into a killer, there are oftentimes more questions that result than answers.

The discovery two years ago of a recumbent cow elk on the Daley Wildlife Habitat Management Area in the Red Rim area southwest of Rawlins signaled the beginning of the largest spontaneous elk mortality in Wyoming history.

Within six weeks, an estimated 350 animals, mostly cows and calves, became paralyzed and died of either starvation or predation (Figure 1). Faculty and staff members from the Wyoming State Veterinary Laboratory in the College of Agriculture worked with Wyoming Game and Fish Department personnel for several weeks before ultimately identifying the causative agent as *Xanthoparmelia chlorochroa* (Figure 2), a free-living lichen common to many parts of the state.

This simple answer generated many more questions. For example: How did such a common forage species poison such a huge number of animals? Is there any way of predicting (and hopefully preventing) poisoning under any given set of circumstances in the future? Is it safe to run cattle or sheep on lichen-infested areas? Is it safe to eat game animals that have been eating lichen?

Figure 1. Cow elk stricken by lichen on the Daley Wildlife Habitat Management Area February, 2004. This particular animal had been down for two days at the time the picture was taken. Although she couldn't rise, she remained alert and hungry and had eaten everything she could reach. She was given the alfalfa, left, to see if she would recover given time and food.

Figure 2. *Xanthoparmelia chlorochroa* collected from the Red Rim area southwest of Rawlins. The lichen is relatively small (the specimen pictured is about the size of a quarter) and non-descript, but those looking closely can find it growing practically in every desert and many montane areas of the state.

No single experiment could possibly answer all of these questions. There was, however, one line of investigation central to all the others: "What is (are) the actual toxin(s) in *X. chlorochroa*?"

Seventy five years ago, Professor O. A. Beath investigated livestock poisoning by a southeastern Wyoming lichen he identified as *Parmelia molliuscula*. We believe Beath's *P. molliuscula* was actually *X. chlorochroa*. Beath suggested the toxic principle was usnic acid (Figures 3a and 3b), a "lichen substance" or secondary metabolite that has been used in folk medicine for centuries.

Although Beath never proved his claim, there is indirect evidence that both supports and refutes his hypothesis. Shortly after we demonstrated the lichen was toxic to elk, we identified usnic acid in samples of toxic lichen collected on the Red Rim. This wasn't terribly surprising as the presence of usnic acid is one of the taxonomic criteria that defines *X. chlorochroa*; however, the mere presence of a substance does not prove it's a toxin. Usnic acid poisoning in other mammals does not result in signs even vaguely similar to those seen in the Red Rim elk. Maybe ruminants respond differently to usnic acid than dogs, cats, mice, and people do – or maybe there's something else we need to be worrying about in *X. chlorochroa*.

We decided to find out.

The basic experimental design was very simple: feed sheep (as a surrogate for elk) purified usnic acid and see if it produced clinical signs and lesions similar to what was seen in the Red Rim elk. Sheep were chosen as an experimental model for elk as they are smaller (requiring less dosages of the expensive usnic acid), their physiology is better understood (i.e. there is less question about what is "normal"), and, most importantly, they could be handled frequently without triggering "capture myopathy," a stress-induced condition of wild cervids that very closely resembles the signs and lesions of *X. chlorochroa* poisoning. Old-timers who ranched in southern Wyoming during the Dust Bowl years indicated sheep developed the same clinical signs as the Red Rim elk when they ate lichen. Just to be sure, we fed lichen collected on the Red Rim to a couple of ewes. Although they were not as severely affected, they exhibited exactly the same signs as the elk.

The next step was to determine how much usnic acid to use. We had a pretty good idea of the concentration of usnic acid in Red Rim lichen from analyses we'd done during the crisis (Figure 4), and these numbers were later confirmed by John Roach, a research chemist with the U.S. Food and Drug Administration in College Park, Maryland. Unfortunately, usnic acid occurs in two different chemical forms, or enantiomers, which are quite different biologically. An enantiomer is either of a pair of chemical compounds that are mirror images to each other but are not identical. Rebecca Dailey of Cheyenne, a graduate student in the Department of Veterinary Sciences, worked two months determining how to differentiate enantiomers in lichen. Her research demonstrated the usnic acid in toxic lichen from the Red Rim area was the " + " isomer, so that form of acid was used.

Sheep were fed usnic acid, starting with a dose calculated from the concentration in the toxic lichen that produced recumbency in elk fed Red Rim lichen. The intent was to feed increasing amounts of usnic acid until the sheep showed clinical or sub-clinical signs of poisoning, then run a comprehensive battery of tests to determine 1) if the syndrome was the same as seen in the Red Rim elk in 2004 and 2) the mechanism of action of the toxin. However, even after the dose of usnic acid was increased to several times that contained in the Red Rim lichen, there were no clinical effects. Finally, dosing with more than 700 milligrams/kilogram/day for five days produced poisoning.

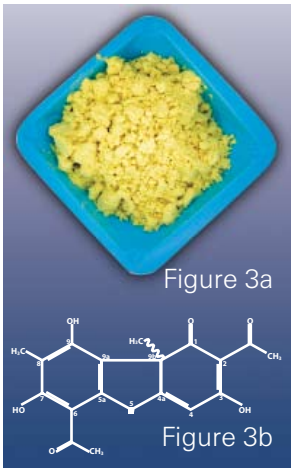
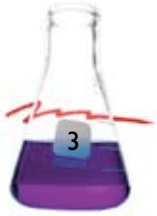


Figure 3a. Usnic acid is extracted from a number of different lichens in Asia for use as an antibacterial and preservative agent in a variety of consumer products in Europe.

Figure 3b. Molecular structure of usnic acid. The enantiomers differ by the orientation of the methyl group. All that is presently known about the toxic properties of usnic acid comes from a few old experiments in laboratory animals and accidental poisonings in people.

The clinical signs of usnic acid poisoning are very different from those of lichen intoxication. In the latter, animals become progressively more ataxic and weaker over a one- to two-day period, eventually either becoming recumbent or recovering. With usnic acid, animals are asymptomatic until they drop dead without any premonitory signs. Usnic acid produced marked blood chemistry changes that suggested ongoing damage to kidney and skeletal muscle. Lichen poisoning results in blood chemistries that suggest muscle damage but nowhere near the magnitude seen with usnic acid, nor is there any evidence of damage to other organs, such as kidneys.



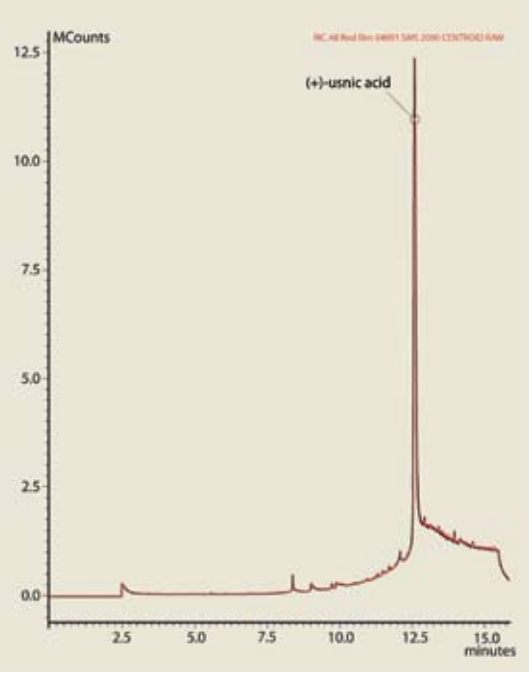


Figure 4. Gas chromatographic trace of lichen sample collected in February 2004. Usnic acid is the large peak on the right. This methodology does not differentiate between enantiomers so this peak represents the total amount of usnic acid present in the sample. Note also the many smaller peaks to the left of the usnic acid peak. At present, these compounds have not been identified but represent a small fraction of the possible synergists in the lichen.

Post-mortem examination of usnic acid-treated animals revealed massive necrosis of the muscles of locomotion (Figure 5). A similar lesion was seen in some of the lichen-poisoned elk but only in those that had been recumbent for two to three days. Most lichen-poisoned elk exhibited only mild or no muscle damage, at least as far as could be determined microscopically. Since elk are prone to stress-induced muscle damage, we believe the mild muscle lesions in the elk represent the primary effect of the lichen, and the massive damage seen in a few is more likely the result of struggling to rise after they'd gone down.

At present, it appears usnic acid is only part of the story behind the Red Rim die-off. The amount of usnic acid in lichen from the Red Rim was several-fold less than doses that caused absolutely no measurable effects in this experiment. The amount of lichen it would take to yield a toxic dose of usnic acid is more than even a starving animal can eat in a day. The clinical signs and blood chemistry profiles of usnic acid poisoning are significantly different than those associated with the lichen. Even allowing for interspecies and individual-to-individual variation between animals, it does not appear there was enough usnic acid in the Red Rim lichen to cause poisoning by itself. On the other hand, although the lesions caused by usnic acid are quite different *quantitatively*, they are similar *qualitatively*. It is probable that usnic acid acted in synergy with some other, as yet unidentified, toxin in *X. chlorochroa* to cause the specific syndrome seen in the field.

There are a number of questions we hope to investigate soon. A common misconception, often promoted by the mass media, is that merely identifying a given compound in a toxic foodstuff somehow proves it is poisonous. Plants contain thousands, if not millions, of different compounds, most of which are innocuous or even beneficial. Other compounds, harmless by themselves, may act synergistically to become quite toxic in combination. One question we hope to address is the identity of this missing link. This is important to more than just Wyoming's livestock and wildlife – *Xanthoparmelia* species are marketed as everything from herbal 'Viagra' to weight loss supplements on the Web.

We have received funding from the Wyoming Wildlife/Livestock Disease Partnership to characterize the pathology of *X. chlorochroa* poisoning. Understanding what the plant does in various organs will likely give us some clues as to what other toxin(s) is (are) present in the lichen. This study will hopefully also reveal subtle lesions that will allow us to differentiate lichen poisoning from other forms of paralysis and muscle necrosis in future field cases.

Figure 5. Muscle from an usnic acid-treated sheep. Note the extensive calcification (arrow) and pale, necrotic appearing muscle (just above ruler). The ewe behaved normally until the morning she died despite the apparent damage to the muscle.

Cent$ible Nutrition

Making sense to change lives for the better

Mary Kay Wardlaw, Food Stamp Nutrition Education Specialist and Director,

Department of Family and Consumer Sciences

"I am saving about $90 on my food bill. My husband and I are on a fixed income and I have specific dietary needs, and now we are both eating better for less money. The money we save every month we have spent on paint for the house, clothing, and other things we could not afford before."

"Helping families eat better for less." That is the mission of the Cent$ible Nutrition Program (CNP) in Wyoming.

The CNP provides families and individuals having limited financial resources with education in basic nutrition, food-resource management, meal planning, food preparation, food safety, and sanitation.

CNP is funded from the U.S. Department of Agriculture's (USDA) Food Stamp Nutrition Education (FSNE) and the Expanded Food and Nutrition Education Program (EFNEP).

The Wyoming Department of Family Services contracts with the University of Wyoming to deliver the CNP. A variety of assessment tools track the positive impacts of the program.

History

Wyoming EFNEP in 1969 began providing nutrition education to families with limited resources in three counties. In 1997, funding for the FSNE program from the USDA Food and Nutrition Service allowed expansion to 11 counties. Additional FSNE funding in 2000 allowed statewide delivery of the program. The name Cent$ible Nutrition Program was adopted to include FSNE and EFNEP funding while creating a seamless nutrition education effort for participants at the local level.

The program operates on a $3.5 million annual budget with nearly half of that amount from matching in-kind support. This in-kind match comes from counties, tribal governments, the University of Wyoming, and other collaborating public agencies.

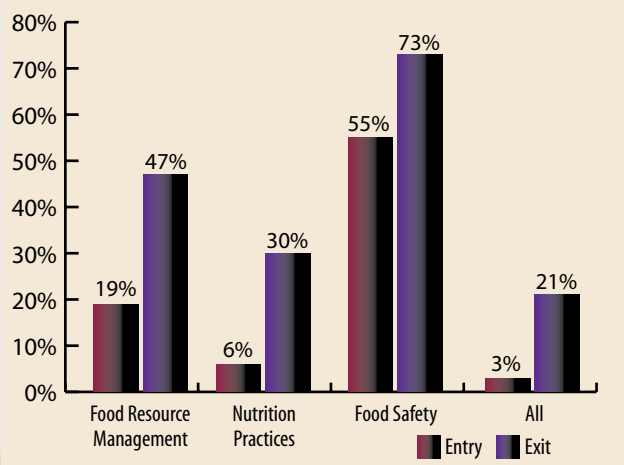
Currently, 30 nutrition educators teach the program. Many recently completed CNP certification by participating in an on-line training curriculum developed by Louisiana State University. County-based educators are responsible for recruitment, documentation of impacts and local matching funds, and teaching the curriculum. Classes enable participants to develop new skills and gain knowledge to:

- Improve nutritional and physical well-being of the total family.
- Increase knowledge of the essentials of human nutrition and physical activity.
- Increase the ability to select and buy food that satisfies nutritional needs.
- Improve skills in food production, preparation, storage, safety, sanitation, and mealtime practices.
- Increase the ability to manage food budgets and related resources such as food stamps.

A typical CNP class includes hands-on learning with participants helping to prepare and sample recipes from the CNP cookbook. Classes are not only participatory, they incorporate a dialogue approach to learning that draws on participants' experiences and applies the information into their own lives. CNP promotes healthy lifestyle changes for improved nutrition and food safety while saving money. Small changes over a lifetime are more sustainable and more effective.

This past program year, CNP educators graduated 1,717 adults in the program with an average of 8.3 lessons per participant. A graduate is a participant who completes at least five lessons.

Of the adult participants, 79 percent were at or below 125 percent of poverty and more than 90 percent below 185 percent of poverty, as defined by federal guidelines. Nearly one in five participants enrolled in one or more food assistance programs as a result of participation in CNP. Most participants, 68 percent, were female. Of those enrolled, 93 percent received group instruction and 6 percent one-on-one lessons, while 1 percent participated in home-study lessons. Of enrolled adults, 23 percent were minorities, with 8 percent American Indian and 12 percent Hispanic.



Behavior change in food resource management, nutrition practices, and food safety.

Impact Documentation

Adult participants in CNP programs complete a survey and 24-hour diet recall at entry and exit. The survey assesses a variety of nutrition, food resource management, and food safety practices. The survey and diet recall are used to customize programs for individuals and to assess impacts of the program.

Data is entered into the Evaluation/Reporting System (ERS), a program designed by the EFNEP program to measure nutrition education impacts. ERS includes a variety of reports useful for management purposes, diagnostic assessments of participant needs, and summary data for state and national assessment of the program's impact. Documentation about the program can be found at www.csrees.usda.gov/nea/food/efnep/ers/ers4.html.

The nutrient content information was drawn primarily from the database used by the USDA for the Nationwide Food Consumption Survey, with additional items on the nutrient content of foods from the USDA's Agriculture Handbook 8. Foods were assigned food group servings based on a paper that translated the Food Guide Pyramid recommendations into measurable quantities.

Adult Impacts

The entry and exit diet recalls provide comparative data on consumption of foods from five food groups: breads and cereals, fruits, vegetables, dairy, and meat or meat alternatives. Of the 1,717 graduates, 1,602 or 93 percent showed positive changes in any food group. For example, graduates reported eating 1.2 fruits per day at entry and 1.9 fruits per day at exit. This is an improvement of more than one-half serving per day and is near the recommendation of at least two per day.

An additional food group, called "other," includes foods high in fat, sugar, and calories and generally low in nutrients. One "other serving" is approximately equivalent to 35 calories or one

teaspoon of fat or two teaspoons of sugar. For most participants, an improvement is noted with a decrease in the number of other servings from entry to exit. CNP participants reported an average of 23.3 servings at entry and 16.5 servings at exit. This reflects an average reduction of 238 calories from high-fat and high-sugar foods. This finding is reinforced by the measurement of actual grams of fat consumed, which decreased from 90.3 to 75.7 per day.

The ERS program computes a nutrient adequacy ratio (NAR). This is based on nutrient intake divided by the Recommended Dietary Allowance for the nutrient with the limit of 1 or 100 percent. Six nutrients are measured: protein, iron, calcium, vitamin A, vitamin C, and vitamin $B_{6.}$ The mean combined NAR for the six nutrients increased from 0.76 to 0.82 for program graduates. The goal for a "perfect" diet would be an NAR of 1. This increase represents a 6-percent improvement for those six nutrients combined. This is a significant change that can lead to improved health in the long term.

Final reports of graduates revealed:

A participant learns from Cent$ible Nutrition Program educator Helen Gregorio how to use the new USDA MyPyramid to plan "cent$ible" menus that include a variety of colorful foods from the five food groups. (Photo by Karen Hruby)

- 89 percent of graduates showed improvement in one or more nutrition practices
- 83 percent of graduates showed improvement in one or more food resource management practices, and
- 59 percent of graduates showed improvement in one or more food-safety practices.
- 58 percent more often planned meals in advance, and 63 percent more often used the "Nutrition Facts" on food labels to make food choices compared to when they first enrolled in the program.

Graduates reported saving an average of $43.50 per month on their families' food dollars this past year while still providing their families nutritious food.

In addition to the enrolled participants, CNP educators shared nutrition information with 19,580 adults in one-time educational settings in the past program year, which ended in September, 2005. Evaluating one-time contact with adults involves a post-lesson measurement of intended behavior change, and 79 percent reported intent to improve health-related behavior.

Educators also provide programming for youths from families having limited incomes. Nearly 6,800 young people in Wyoming participated in a series of lessons, and an additional 7,300 youths participated in one-time educational programs last year.

The CNP affects families throughout Wyoming by giving them a hand up, not a hand out, during challenging financial times. With the program's history and consistent delivery, future research – qualitative and quantitative – on long-term impacts should yield significant data about how people have improved their lives.

What's

for dinner?

Rodents and rabbits partake in jointed goatgrass seed buffet in wheat/fallow fields

Gustavo Sbatella
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Temporary Associate
Research Scientist

David Wilson
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Department of Plant Sciences

Stephen Miller
Associate Dean and Director,

Wyoming Agricultural Experiment Station

Producers eyeing their wheat and fallow systems may notice mice and rabbits as only secondary to their field's landscape. Research now indicates they could be allies in combating jointed goatgrass.

Jointed goatgrass is a troublesome winter annual grass that continues to increase in winter wheat/fallow systems of the Central Great Plains and Pacific Northwest.

Producers incur losses through yield reduction, competition, and grain contamination that results in dockage. More than five million acres of winter wheat in the western United States are infested with this weed. Jointed goatgrass control in a wheat and fallow rotation is particularly difficult because most herbicides that are effective on jointed goatgrass also injure wheat because the two species are closely related. To implement effective management practices, factors affecting seed numbers and seed viability must be investigated.

Weeds have the potential to produce a large number of seeds, and jointed goatgrass is no exception. One plant can produce up to 1,800 viable seeds. Since jointed goatgrass is primarily dispersed by seeds, its fate in agricultural fields will determine the size of the future population.

Many weed-control practices are aimed at reducing the number of seeds in the soil. Deep tillage is a tool farmers frequently use to reduce jointed goatgrass seed populations near the surface; however, tillage decreases moisture, which can lead to erosion, especially in dry years. Profound changes in the amount of seeds on the surface can also be expected under no-till systems and organically grown fields compared to conventionally managed fields.

As growers shift from intensive tillage to no-till production systems, seeds on the surface will increase. Will this increase predation of the seed by insects, birds, and small mammals?

Although seed predators alone are unlikely to be effective biological agents, they may be able to stress weed populations sufficiently to reduce seed banks when combined with other management techniques.

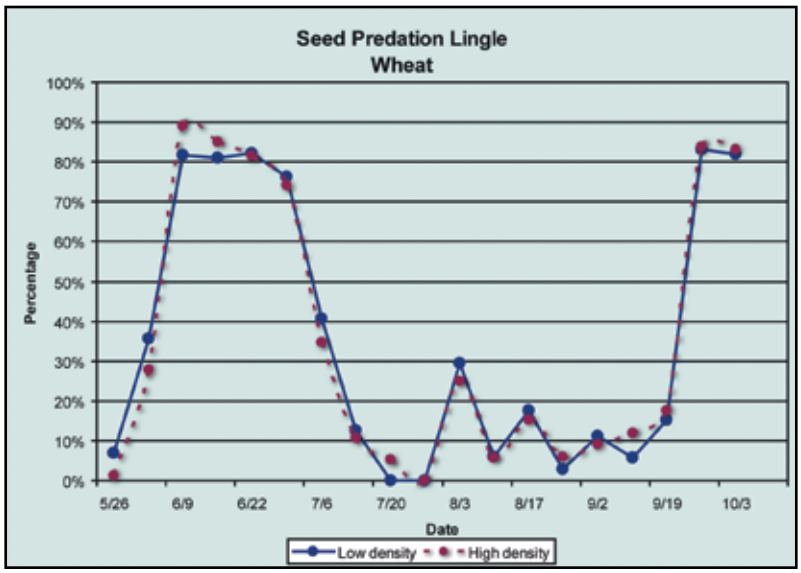


Figure 1: Seed predation in wheat. Lingle, Wyoming

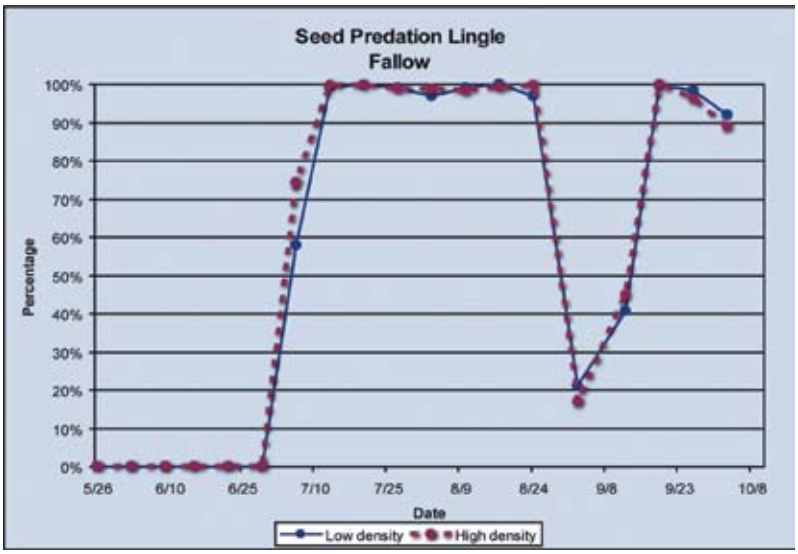


Figure 2: Seed predation in fallow. Lingle, Wyoming

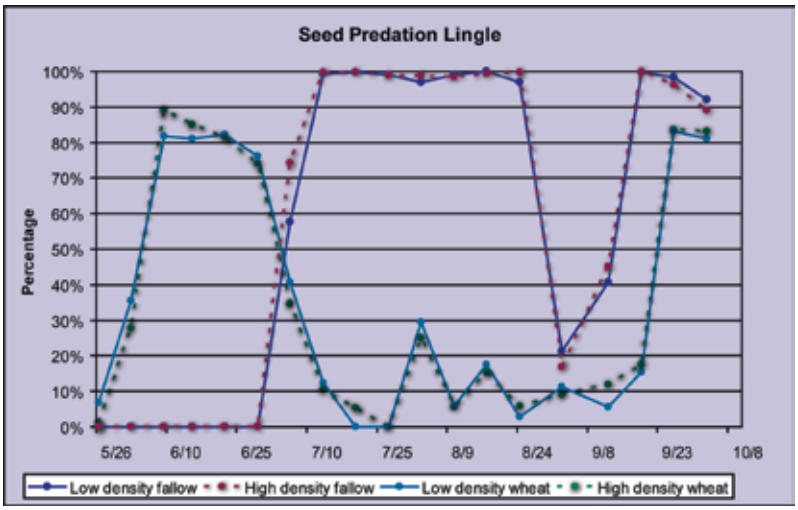


Figure 3: Seed predation in wheat-fallow. Lingle, Wyoming.

Wooden exclosures covered with aluminum screens in wheat shelter special seed-bearing cards to prevent predation and quantify the effects of the environment.

In preliminary studies conducted in southeastern Wyoming and western Nebraska, significant seed predation by small rodents was reported. Field studies were established at the University of Wyoming Sustainable Agriculture Research and Extension Center near Lingle to determine jointed goatgrass seed predation in wheat and fallow systems. This research was supported by the National Jointed Goatgrass Research Program.

Jointed goatgrass seeds were placed on 3-inch by 3½-inch sandpaper cards and offered to predators in both fallow and wheat strips. Wooden exclosures covered with aluminum screens were placed over one set of cards to quantify the effects of the environment on predation cards and prevent predation.

The study was initiated May 26, 2005, and continued to October 3, 2005. Predation cards were replaced weekly. Two factors were evaluated – background seed density and distance from field edge. Motion sensitive, infrared cameras were used to identify predators.

Seed predators may be able to stress weed populations sufficiently to reduce seed banks when combined with other management techniques.

Neither distance from field margin or jointed goatgrass seed density influenced predation, which was observed in both the wheat and fallow strips, although seed predation patterns differed between the two strips. Seed predation started in week two on the wheat strip (Figure 1) and reached levels close to 80 percent the following four weeks. A steady decrease occurred from weeks six through nine until wheat was harvested. Decline in seed predation during the six- to nine-week period probably resulted from loss of favorable habitat. The wheat crop was losing leaves, the canopy became more open, and rodents were more exposed to their enemies. At the same time, wheat grains became available, resulting in an alternative food source.

Jointed goatgrass seeds were placed on 3-inch by 3½-inch sandpaper cards and placed in fallow and wheat strips.

After the wheat was harvested, seed removal fluctuated from 0 to 30 percent. Feces found on the predation cards suggested that mice were the main predators when wheat was on the field, while rabbits predominated after harvest.

There was no seed predation the first six weeks in the fallow strip (Figure 2). The soil surface at the beginning of the study was covered by dead Russian thistle. When seed removal was observed, vegetation coverage had grown 12 inches tall. Seed predation levels near 100 percent remained fairly constant from weeks eight to 14. To establish the importance of vegetative coverage, all plots were mowed, and seed removal decreased to 20 percent after the disturbance.

Two weeks later, predation returned to the same levels before mowing. These results suggest that rodents were more affected by the disturbance created by mowing than to the change in soil coverage.

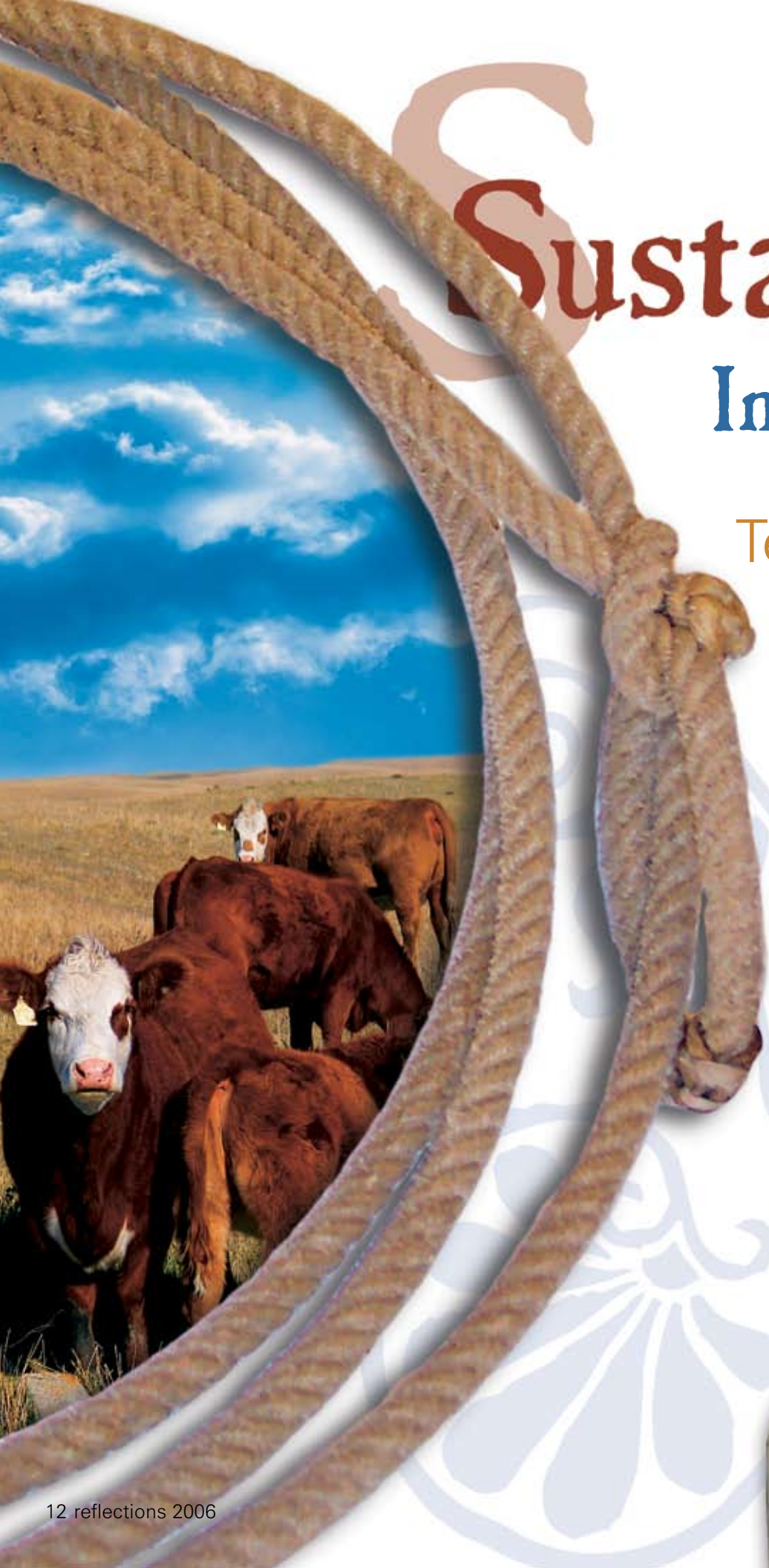
The overlap of the wheat and fallow graphs (Figure 3) suggest predation shifted between strips. The dramatic changes caused by the wheat harvest combined with increased vegetation coverage in the fallow are possible explanations for this behavior.

Rabbits were the predominant predator of jointed goatgrass seeds following wheat harvest. Motion sensitive, infrared cameras identified predators.

Studies on seed predation by insects indicate predation usually occurs for a short period. In contrast, this study indicates that jointed goatgrass seeds can remain part of a rodent's diet for an extended period.

This study confirmed mice and rabbits as predators of jointed goatgrass seeds and that such seeds can be part of the rodent's diet for long periods. Further, the methodology developed proved useful in quantifying seed removal. Future research should focus on how vegetation cover affects seed predation and levels of seed removal when other food sources are readily available.

Doctoral student Gustavo Sbatella places jointed goatgrass seeds on sandpaper cards.



Sustainable Improving the

Techniques can lasso risks attempting to fence in producers

Michael A. Smith
Professor
James W. Waggoner Jr.
Associate Professor,
Department of
Renewable Resources

Ranching:
chances of staying in business

While cattle prices may be at historic highs, the cattle price cycles of the last century suggest prices will decrease, economists point out. Meanwhile, operation costs continue to increase, squeezing potential profitability.

A clear understanding of objectives and costs of alternative management systems can be used to minimize capital, operating, and labor expenses in most operations. Ranching can be made easier for both the cattle and rancher without adversely affecting profitability.

Sustainability is maintaining or improving profits, reducing vulnerability to risks such as unpredictable weather or markets, and maintaining or improving the quality of the resource base and environment.

Several research projects over the last decade address major issues in sustaining a ranching operation. Perspectives on sustainable ranching derived from those efforts and experience with Wyoming ranches are offered here.

Rethinking the structure of a ranching operation, when the only certainty is an uncertain future, is easier when not struggling to stay in business. Alternatives to current practices can be evaluated and tested, and objectives for the family and ranch can be considered.

A ranch, even those with substantive agronomic enterprises, is in the business of producing forage and converting that resource to a marketable product through cattle.

Profitability would appear to follow how efficiently that forage is converted to a marketable product. All the latest breeding, animal health, and management technology can be considered and perhaps adopted if the practice meets the operators' objectives for profit,

risk, and quality of the resource; however, there are several practices that may improve the environment for considering new technologies.

Reducing production costs and adding flexibility to a ranch operation are the most likely paths to greater income stability and reducing risks due to lower prices. There is a lesser likelihood producers can increase production and gross income more than they can reduce costs. The relative magnitude of impacts to costs and returns favors cost-reduction practices compared to commonly available income-generating practices.

Here are management strategies that, taken alone or as a whole, should favorably address one or all of the elements of sustainability. All these practices, unconventional as they may seem to some, have been favorably tested by a few producers in Wyoming, and published research is available to support others

Many Wyoming ranchers calve in winter or very early spring, but a later calving season matches the period of higher nutrient demand by the cow to the period of greater availability of nutrients from grazing lands. This practice can greatly reduce feed costs by letting grazing supply the high-quality feeds needed during late pregnancy and lactation while reducing the quantity and quality required in winter during mid-pregnancy.

A later calving season matches the period of higher nutrient demand by the cow to the period of greater availability of nutrients from grazing lands. This practice can greatly reduce feed costs.

Winter feed has been recognized as the greatest cost in most cattle operations. An adequate, quality diet may be available solely from rangeland or stockpiled forages on tame pastures, those lands primarily consisting of non-native plant species or domesticated cultivars of native species. Compensation for smaller weanling calves may be obtained through delayed sale combined with the normally higher unit price of smaller calves or retaining calves through yearling age. Weights of long-yearling cattle, those between 19 months and 2 years of age, have not been significantly affected by birth dates of either March or June. Later calving generally increases the percent of cows exposed that wean calves and reduces the death losses associated with dystocia (difficult or slow labor) and enteritis (inflammation of the intestinal tract).

Providing water in winter for cattle may be a concern; however, the amounts required are smaller, and Canadian cattlemen provide assurance that cattle will eat enough snow to be healthy during mid-pregnancy. More winter grazing, especially on rangeland, tends to maximize grass yields and associated environmental benefits because the plants are dormant.

Winter feeding of energy or protein may be minimized. Shrubs in many plant communities may provide a protein source. Short-term winter nutrient deficit may not be detrimental to animal production if time for recovery of body condition before calving is allowed. Providing some nutrient supplement may be advantageous. Liquid feed tubs and dehydrated molasses-based blocks have been shown to significantly shift cattle use to areas otherwise infrequently grazed.

Having a plan for drought is a critical risk-reduction strategy. A culling plan may be required. When stocker cattle are normally retained, they may be sold earlier when prices are more favorable and before the forage shortage has occurred. Early weaning reduces cow-nutrient requirements. Culling priorities should be developed for what cows are to be sold if a forage shortage is looming. Forage yield in the upcoming season can be predicted by spring precipitation across Wyoming and much of the northern plains/intermountain area where cool-season grasses dominate the forage base. This provides the opportunity to implement any destocking before prices typically fall.

Drought that causes reservoirs, springs, or streams to go dry may limit forage supplies. Hauling water or installing shallow buried or unburied pipelines are widely used solutions. Alternative forage sources are difficult to find in the middle of a forage-supply shortage. Early recognition of impending shortages may provide the opportunity to find reasonably priced additional grazing.

Irrigated crops or other improved forages, both annual and perennial, can be harvested through grazing animals at much less cost than mechanical harvesting. When to use these forage sources most effectively depends on the type of operation and other forage supplies. Retained yearlings will gain over a longer period of the summer if grazed on normally higher quality irrigated forages. Where snow cover is normally low, native rangelands may provide adequate winter grazing and allow use of higher quality pastures in summer when a cow's nutrient requirements are greater. Standing or windrowed forages on tame (including irrigated) pasture can provide low-cost forages to be grazed even in snowy country.

Optimizing the grazing animal to fit the environment must be considered. Smaller cows optimize the

use of variable quality forage supplies in a dry climate to produce proportionally greater calf yields than larger cows. Smaller cows can be more selective for higher quality dietary items among variable quality forages and require a lesser amount.

Heifer development is challenging. If low-cost forages are used to form the basis for heifer growth, then age of first breeding may be moved later to allow more growth. Range-raised, forage-adapted, smaller bulls more closely match a range herd they are bought to service. Forage-adapted, smaller bulls maintain better on rangelands and travel to or with a cow herd. Smaller bulls should result in less dystocia in females and heifers. Smaller cattle should finish in the feedlot earlier at sizes yielding meat cuts more in tune with contemporary consumer tastes.

Marketing provides an opportunity to improve gross returns to a ranch operation and receive benefits from investment in breeding to improve carcass qualities. Retaining ownership of yearling cattle offers the opportunity to convert more of the forage resource into a marketed product and minimizes the forage required for maintenance of the cow herd.

Even if retained ownership were revenue neutral, the increased flexibility associated with being able to market non-breeding animals earlier in response to expected forage shortages would be valuable. Net returns to an operation may be improved by only buying or retaining replacements when prices are lower and the net present value greater.

Recent observations indicate that producers entering into niche marketing (such as with organically grown or "natural" animals or marketing into a branded product line) may more reliably capitalize on breeding programs emphasizing carcass quality or other ranch management approaches that are not routinely rewarded in typical marketing.

Grazing management for cattle might be summed up in three general principles. These include maintaining forage available for adequate animal production and soil surface protection through monitoring residual forage, improving distribution of grazing over the landscape to harvest more of the forage resource, and avoiding repeated same-season use of the same area, especially in spring.

Animals perform better if they can minimize searching for adequate amounts or quality forage even if this may mean leaving more residual forage than is needed for soil-surface protection from wind or water erosion. Monitoring of residual forage amounts allows a manager to optimize the use of rangeland resources by the timely moving of cattle within or between pastures. Spring use, when most grasses, forbs, and shrubs are growing, has the greatest potential to adversely affect the growth potential of plants. Summer use tends to concentrate grazing animals on riparian areas. Fall or winter use minimizes impact on grasses and forbs but may result in higher use of shrubs.

Grazing systems without fences may not be feasible everywhere but, where fencing can be minimized, a large expense in capital and maintenance costs can be avoided. More intensive grazing management generally means that more water for livestock has to be provided regardless of the development of pastures. Regulating the availability of water to grazing animals to specific times and locations would accomplish the same movement pattern as accomplished with pastures assuming that all water could be regulated.

Herding using low-stress methods can be used to optimize the effectiveness of off-stream water sources for a grazing system or minimize use on riparian zones. Low-stress livestock handling refers to an approach to herding and handling animals that minimizes stress and labor through application of animal behavior principles. One or a few people can move many hundreds of cattle with proper training of both people and cattle.

Science, education rabies cases

Two decades of tracking rabies

Kenneth Mills, Professor; Kenji Sato, Assistant Professor; and Amy Boerger-Fields, Laboratory Technician; Department of Veterinary Sciences

Mentioning rabies almost always elicits a response from people because of its near 100-percent fatality rate in humans.

Worldwide, thousands of people die of rabies annually, yet in the United States, death occurs at a very low rate. The number of rabies-related deaths in the U.S. has declined from more than 100 annually in the early 1900s to one or two per year in the 1990s, according to the Wyoming Department of Health. This is because modern-day prevention and treatment programs have proven nearly 100-percent successful.

We were unable to find records of the last human rabies fatality in Wyoming, and the state health department has no confirmed case on record.

The lack of human fatalities is interesting since there are two large wildlife population pools that are infected.

Why are there no human fatalities?

It is a direct result of state and local laws governing rabies vaccination of pets along with reliable and effective surveillance by the Wyoming State Veterinary Laboratory (WSVL). Rabies has changed over the last few decades from a disease of dogs, cats, and domestic species to a wildlife disease.

There are two general rabies cycles. Bat rabies circulates in bat populations and, on rare occasions, infects many other species. The second, and larger pool, is terrestrial rabies, which circulates in different species in different parts of the United States (Figure 1).

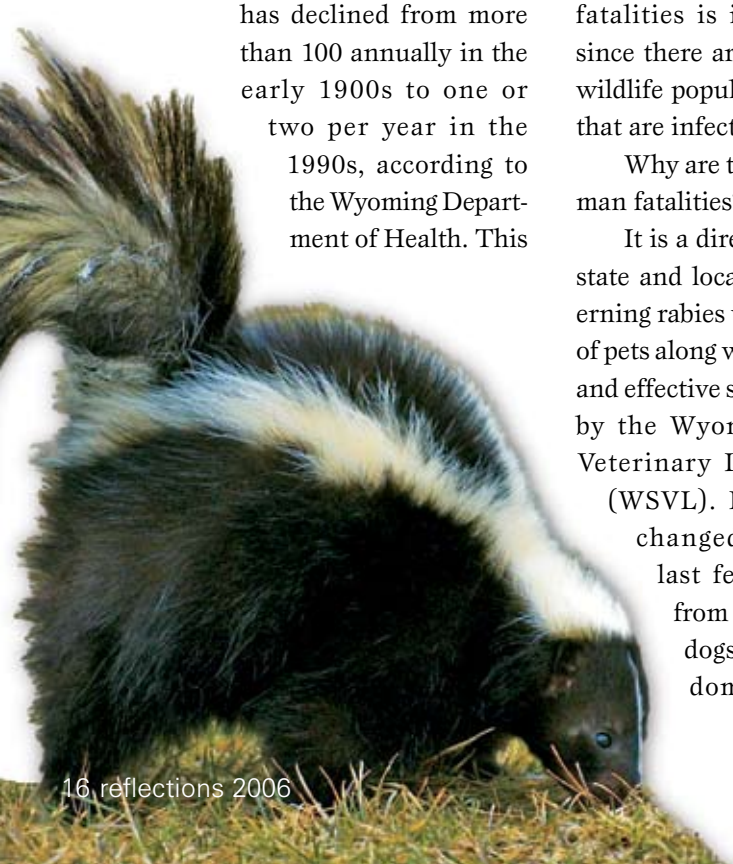
We know there are different cycles because laboratory techniques distinguish viral strains coming from various species. An example is a relative simple molecular test allowing veterinary diagnosticians to identify whether rabies virus infecting a horse originated in a bat or a skunk.

Wyoming geography offers a unique opportunity to study the dynamics of rabies over time and its spread into previously free areas. This article focuses on terrestrial rabies because rabid bats can show up almost anywhere.

Tracking the distribution of rabies in time and space within Wyoming means tracking the location of infected skunks.

Anytime a significant level of rabies occurs in skunk populations, there is the potential for spillover into domestic species and for human exposure. Luckily, most people avoid skunks so there are not many direct exposures. Yet, Wyoming citizens are occasionally attacked by rabid skunks, and there was one case in which Wyoming children were attacked by a rabid skunk while sleeping in a tent.

Most people consider dogs and cats when they think of rabies, but researchers the past two decades have identified more horses and cattle that tested positive than cats and dogs.



keeps human at bay

The spread of terrestrial rabies in Wyoming tends to be along river drainages and other riparian areas, which provide the best skunk habitat in Wyoming. The virus itself has nothing to do with water. Wyoming is a headwaters state. Figure 2 is a depiction of the major drainages and shows where rabid skunks are most likely to be found; therefore, drainages flowing north out of Wyoming into Montana and eventually into the Missouri River are likely to have rabid skunks because those states have rabies circulating in their skunks.

Drainages in western Wyoming, such as the Snake or the Green rivers, lead to states where there is no rabies virus present in the skunk populations. The four maps seen in figures 3 through 6 show areas where terrestrial rabies have been found the past two decades. WSVL researchers diagnosed the first case in Johnson County in 1984. Rabies over the next four years spread throughout northeastern Wyoming. Infected skunks in the 1990s began to be identified in the Big Horn Basin and, in the late 1990s, cases were detected in the Riverton-Lander area. In late 2000 and early 2001, researchers were surprised and a little alarmed to find infected skunks in the Farson area in southwestern Wyoming. This suggested a new focus of rabies-infected skunks might be establishing itself in the upper Green River Basin that might eventually spread into the Colorado River Basin.

Good, continuous skunk habitat is not prevalent in the area between Lander and Farson, which are separated by the Wind River Mountains. Continued surveillance of skunks in the Farson area failed to detect any more cases, and it appears the outbreak

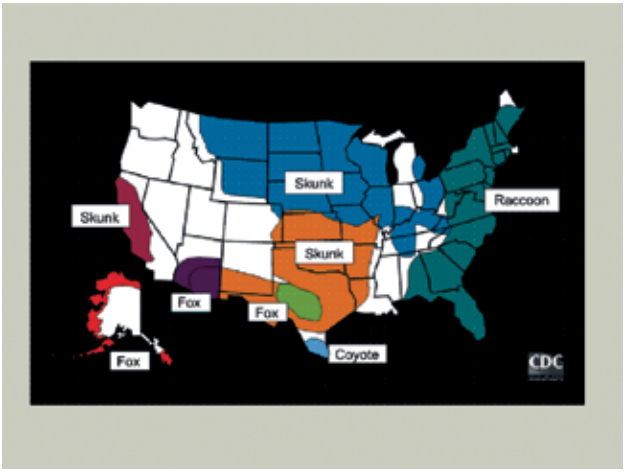


Figure 1. Distribution of major terrestrial reservoirs of rabies in the United States.

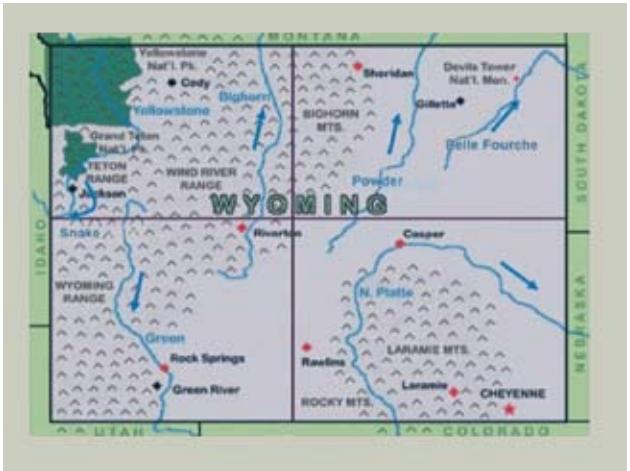


Figure 2. Drainages of major rivers in Wyoming.

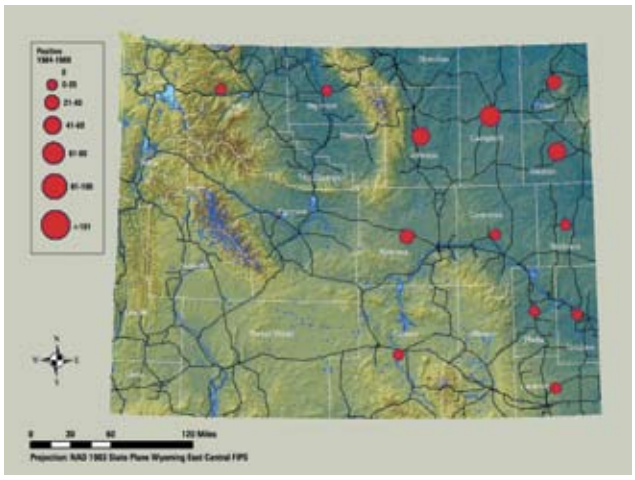


Figure 3. Rabies positives (terrestrial) 1984–1988.

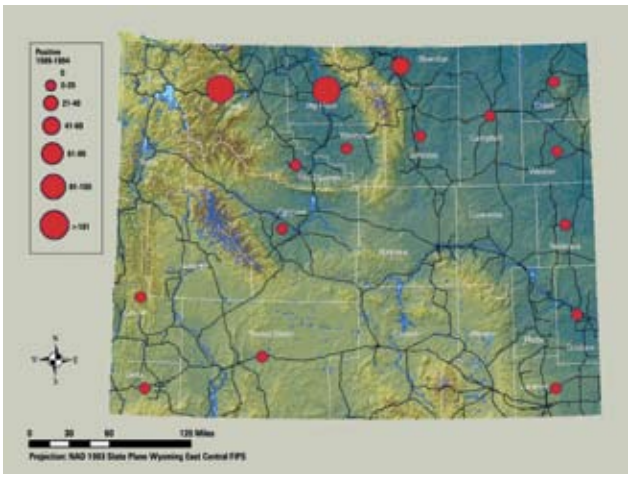


Figure 4. Rabies positives (terrestrial) 1989–1994.

has faded. It is generally assumed that, once rabies is established in a skunk population, it persists at a level that follows a cyclic pattern depending on the number of skunks.

Rabies appears to be a permanent ecological feature among skunks in northeastern Wyoming. In other areas like Farson, Lander, Riverton, and the Big Horn Basin, the disease has, for reasons not fully understood, disappeared. Figure 6 shows the last few years where there has been a general decline in cases statewide.

Interesting cases:

Rabies in the schoolyard:

The greatest number of human exposures occurred in 1992 in northeastern Wyoming after a young dog was taken to a grade school for show-and-tell. This occurred several weeks after the unvaccinated animal had been in a fight with a skunk. Rabies symptoms can take seven days to several months to manifest themselves. The animal began to show signs of rabies shortly after the school visit, and rabies was confirmed by the WSVL. About 100 received post-exposure treatment for rabies. The animal was too young to receive rabies vaccine, but it should have been euthanized once a known exposure to a wild animal had taken place. It is important to realize that the Centers for Disease Control and Prevention recommends an unvaccinated pet exposed to a rabid animal or a wild animal that can't be tested be euthanized. The key point here is to keep pets vaccinated!

Rabid horses:

There were two very different cases of rabies in horses near Sheridan. In one case in 1997, a miniature horse became aggressive and chased other animals. It showed no impairment of locomotion, demonstrated no fear, and even chased bulls on the ranch. The animal was euthanized, submitted to the WSVL and tested positive for rabies. A second, and very different, case in 1999 involved a horse that was becoming lame and, while being examined by a veterinarian, stumbled and sat down like a dog. It was not aggressive and appeared bright and alert. Luckily, the veterinarian had worked at the WSVL and remembered a comment about associating dog-sitting behavior in horses with a possible diagnosis of rabies.

The horse was put down, and its brain was submitted along with a piece of spinal cord from the lumbar region (lower back). The brain was negative, but the spinal cord was positive for rabies. These two cases demonstrate several important points. There is no typical presentation of rabies in animals.

Our laboratory advises veterinarians and animal owners who live in the rabies endemic parts of the state to first test and rule out rabies in any animal showing neurological disease. The two horses were most likely exposed in very different areas of the body. The miniature horse was probably bitten on the face since the virus went directly to the brain. By contrast, the dog-sitting horse was probably infected by a bite on a rear leg so that the initial infection was in the spinal cord. Rabies virus spreads through the nervous system by traveling along nerves.

Rabies in unexpected places:

In 1991, there were three known positive skunks in the Star Valley in extreme western Wyoming. Skunk rabies had never been seen there. A similar situation with

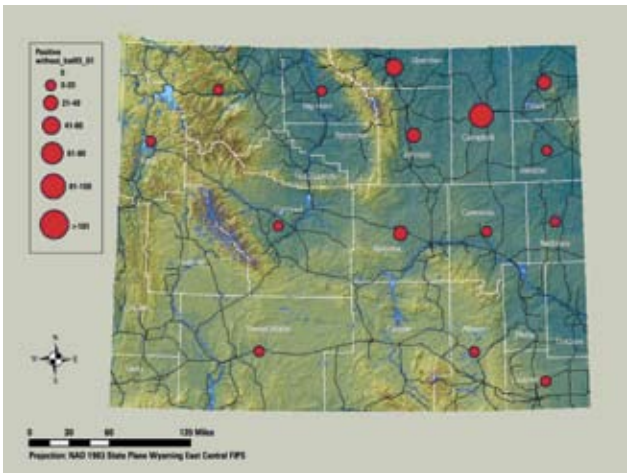


Figure 5. Rabies positives (terrestrial) 1995–2001.

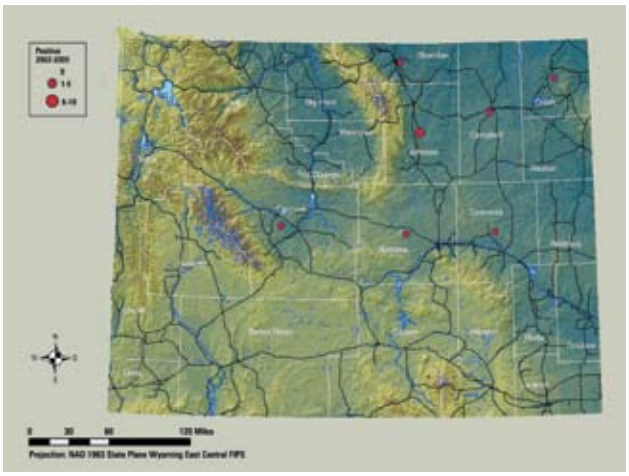


Figure 6. Rabies positives (terrestrial) 2002–2005.

one positive skunk from Teton County occurred in 2000. Typing of the viruses showed they were the bat origin virus and not the skunk virus. Presumably, a bat had bitten a skunk. Fortunately, this example of transfer of bat rabies to skunks did not result in the establishment of an outbreak of rabies in a new area. It was once thought the bat virus could not establish a continuing cycle in skunks. Unfortunately, this was proven wrong a couple years ago in Flagstaff, Arizona, when that exact process occurred; therefore, even if an area has not had skunk rabies, it is not immune from having rabies-infected skunks.

Dealing with rabies in Wyoming involves multiple agencies. The WSVL performs all the rabies testing and provides results and data to other agencies. Rabies examinations, except for the surveillance samples, are performed free as a service to the state.

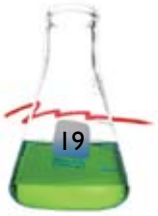
The Wyoming Department of Agriculture, through the Animal Damage Management Board, provides money for an active surveillance program.

The state health department is responsible for all issues involving human exposures.

The U.S. Department of Agriculture's Wildlife Services is the collector of animals from most Wyoming counties for submission to the WSVL as part of the surveillance. The Wyoming Highway Patrol (WHP) also plays a role. When someone is bitten by a potentially rabid animal and his or her physician wants to start treatment (such a program costs from $1,200 to $1,500), WHP troopers have relayed animal heads to the laboratory for testing the same day.

Predicting the skunk rabies situation in Wyoming is at present more art than science. The key variable is the size of the skunk population. Good habitat and the right climate conditions will produce lots of skunks causing the easy spread of the virus from one animal to another. Because the state has an active surveillance program, researchers hope to determine the first few cases in an area and then use public education to reduce the number of human and animal exposures.

The ingredients that have kept rabies out of the human population in Wyoming are the active monitoring of skunk populations, the veterinarians and wildlife biologists who are alert to neurological signs in animals, and a proactive education program by the Wyoming Department of Health – a good diagnostic program.



Department of Veterinary Sciences Professor Ken Mills, and bacteriology and rabies section leader with the Wyoming State Veterinary Laboratory, uses a fluorescent microscope to visualize virus or bacterial infected tissues by directly labeling them with a specific antibody that has a fluorescent tag.

Triple-threat approach SWATS

Sarah Tyrer
Graduate Student

Brian Mealor
Graduate Student

Ann Hild
Associate Professor,

Department of Renewable Resources

Wyoming can be a difficult place for a plant to survive, especially if the surrounding community is dominated by an exotic invader.

Invasive plant species may act as ecosystem transformers by altering nutrient cycling, erosion, fire regimes, and soil chemistry. In Wyoming, one invader of rangelands is Russian knapweed, a perennial that forms dense colonies.

Native to Eurasia, Russian knapweed was probably introduced in North America in the late 1890s, and it now occupies millions of acres of western North American rangelands. Its success is attributed, at least in part, to characteristics such as extensive root growth, vegetative reproduction, lack of North American predators, an ability to produce chemicals that inhibit the growth of neighboring plants, and possible soil nutrient alteration.

Brian Mealor collects native grasses from old Russian knapweed invasions to determine if plants from long-term invasions were better competitors than those from non-invaded areas.

Department of Renewable Resources graduate students Sarah Tyrer and Brian Mealor, under the direction of Associate Professor Ann Hild, use an approach integrating molecular genomics, greenhouse experiments, and field research to examine how Russian knapweed invasions affect native plant communities and find native plants capable of competing against Russian knapweed. Tough native competition would aid in the struggle against knapweed's expansion into rangelands where chemical or mechanical control may be difficult.

The team's goal is to understand if native grasses develop the ability to co-exist and compete with Russian knapweed and if native forbs and shrubs can survive in soils where knapweed has been.

Because Russian knapweed and soil surrounding the weed may contain chemicals that negatively affect the growth of other plants, Tyrer examined how native forb and shrub seedlings emerged and grew in soils after knapweed was removed. In a greenhouse study, she examined two native forbs and two native shrubs using soils from Russian knapweed invasions and adjacent non-invaded areas. Soils were collected at two rangeland sites near Greybull and Riverton and one abandoned pasture near Greeley, Colorado.

All four species were able to germinate and establish in soils from knapweed invasions, and plant growth was greater in soils from the invasion. Soil chemical testing indicated higher nutrient levels in soils from

by researchers Russian knapweed

Russian knapweed dominates a field near the Laramie Regional Airport.

inside the invasion at the Greybull and Riverton sites, suggesting Russian knapweed positively alters soil nutrient properties.

Because soil nutrients and forb and shrub growth were greater in soils from the invasion, it appears that in areas where Russian knapweed has been removed, soil properties should not limit the emergence and establishment of native forbs and shrubs.

If knapweed changes so many ground rules, can native grasses adapt to life inside invasions?

Mealor's goals were to collect native grasses from old Russian knapweed invasions and determine if they differed genetically from grasses in neighboring, non-invaded areas. He also examined how well those grasses compete with Russian knapweed. He collected native grasses from invaded sites in Wyoming, Colorado, and Idaho to assess whether native plant populations have the ability to adjust to invasive-dominated communities (one measure of their resilience).

Mealor conducted DNA fingerprinting analyses to search for signs of selection between populations of grasses inside and outside of knapweed invasions and found that the weed may exert selective pressure on native grass populations. He also planted seeds from the native grass alkali sacaton with Russian knapweed to determine if plants from long-term invasions were better competitors than those from non-invaded areas. Preliminary results suggest that sacaton from invaded areas is less affected by knapweed competition and may suppress knapweed growth more than sacaton from non-invaded areas.

Although Russian knapweed is highly competitive, our studies indicate there may be native species that can compete with Russian knapweed. Planting native grasses that out-compete Russian knapweed may provide land managers another means by which to better control this weed.

The struggle to control Russian knapweed is an uphill battle for land managers, but competitive native plants may prove an important ally.

Sarah Tyrer examines how native forb and shrub seedlings emerge and grow in soils after Russian knapweed is removed.

Botany Professor Steve Miller, director of the Nucleic Acid Exploration Facility, holds a package containing 16 glass capillaries used in the new genetic analyzers in the College of Agriculture. Individual gel samples move down the separate capillaries in the new machines and about 300 to 400 samples can be processed per day.

NEW GENETIC sequencer revs up research at the College of Agriculture

Steven L. Miller, Senior Editor, Office of Agricultural Communications and Technology

Genetic sequencers in the Nucleic Acid Exploration Facility (NAEF) and installed in the College of Agriculture will enable faster testing and provide a world-class preparation and training facility.

Funded by $380,000 from the National Science Foundation's Experimental Program to Stimulate Competitive Research, the machines can process 400 to 600 samples a day. Nucleic acid molecules store genetic information. The basic nucleotides are the same for every organism – the difference is in the sequencing or order. The machines determine the sequence of nucleotides in the DNA from different organisms and much more. Researchers can look at what characteristics a particular organism has and how they are passed from one generation to the next, but they can also do much more. Researchers can examine crime scenes, how similar organisms are to other organisms, the genetic structure of populations, or the macroeveolutionary forces that affect a population of organisms. College departments traded space to house the facility. There are two rooms – one for the sequencing facility and the other for the preparation/training laboratory.

Current research supported by the NAEF at the University of Wyoming includes:

1) What is the genetic relationship between Wyoming's only federally listed endangered plant species, *Penstemon haydenii* (blowout beardtongue), and isolated populations of the same species in Nebraska?
2) What historic and biogeographic factors might explain why black bear populations across Wyoming have diverged more than Canadian populations separated by almost 10 times the geographic distance?
3) How has an introduced fish, genus *Catostomus* (sucker), impacted the genetic structure of native fishes in western Wyoming?
4) How did the radiation of trees following the last glaciation affect the genetic structure of obligate root symbiotic fungi? Mychorrhizae are fungi that form a symbiotic relationship with the roots of living trees. They provide protection from root pathogenic bacteria and fungi and function in water and nutrients uptake for the tree in exchange for photosynthate from the tree.
5) Should the three currently recognized species of rosy-finches (genus *Leucosticte*) in North America be considered a single morphologically diverse species?
6) Have river otters in Yellowstone Lake declined since the introduction of lake trout?

The facility improves the research infrastructure at UW and may enable more grants and projects to be funded because of the availability of the sequencing facility. Students, whether graduate or advanced undergraduates, will be able to be trained at UW.

DID SOMEBODY SAY GAR-BAA

Can crop believed mentioned in

"As black beans or pulse come pattering down on to a threshing-floor from the broad winnowing-shovel..."
~ The Iliad by Homer

Andrew Kniss
Research Scientist

Ryan Rapp
Temporary Research Assistant

Jim Krall
Professor,
Department of Plant Sciences

Stephen D. Miller
Associate Dean and Director,
Agricultural Experiment Station

Garbanzo beans, more commonly known as chickpeas, are a common item on many salad bars in fine restaurants.

Chickpeas are an excellent source of low-purine proteins (particularly helpful for those who suffer from gout). They can be used in stews or as a coffee substitute and provide the main ingredient for common dishes in the Middle East such as hummus, a smooth, thick mixture used as a dip, and falafel, ground spiced chickpeas shaped into balls and fried.

Consumers can find chickpeas in the canned goods section of a grocery store and sometimes as roasted items in the snack aisle.

Garbanzo beans may also soon be growing in southeastern Wyoming fields.

Major world producers of chickpeas are India, Pakistan, Turkey, and Canada. In 2001, India accounted for 60 percent of world production. Canada exports much of its chickpea crop to major importing countries including Spain, India, and Pakistan. Eighty percent of U.S. production is also exported.

AAAA-NZO?

Homer's *Iliad* successfully sail in Wyoming?

First domesticated in present-day Turkey, chickpeas being used as a food source may date back 7,500 years. Mention of the crop has been found on Egyptian papyrus scroll texts dating to approximately 1,500 to 1,100 B.C. Chickpeas are thought to be the pulse mentioned in Homer's *Iliad*.

So why, after several thousand years, is this crop finally making its way to Wyoming?

Several appealing agronomic traits have led University of Wyoming College of Agriculture researchers to investigate whether chickpeas can be successfully grown in southeast Wyoming.

Pulse crops are legumes and are capable of fixing their own nitrogen. This means less farmer-applied fertilizer requirements and more "natural" nitrogen present in the soil for subsequent crops in a rotation such as wheat. Under optimal conditions, chickpeas can produce up to 80 pounds of nitrogen per acre.

Two types of chickpeas are recognized and are named kabuli and desi. The pods of both typically contain one to three seeds. Kabuli types are larger and are usually what one sees on a salad bar and in grocery stores. Most of the chickpeas grown in the U.S. are kabuli, but kabuli only accounts for 15 percent of the world chickpea production. The desi types are smaller and can have a red to brown color in addition to the more typical beige.

Although not commonly used in American kitchens, chickpeas are the world's third most important pulse crop (after dry beans and peas), and they account for 15 percent of world pulse production. Some experts believe the Roman politician Cicero derived his name from *Cicer,* the Latin word for chickpea (due to an unfortunate ancestor who had a growth on his nose that looked like a chickpea). The specific name, *C. arietinum*, is thought to be derived from Aries the ram, because the shape of the seed resembles a ram's head.

Chickpeas are also quite efficient water consumers. After harvest, chickpeas leave behind more water in the soil than wheat, making them a good rotational crop. Chickpeas have a greater rooting depth and show a higher response to additional water than other pulse crops. In years of good soil mositure, the yield potential will be greater.

Chickpeas can also tolerate light frosts in the spring – a good trait for any crop in Wyoming.

Management of a chickpea crop can be compared to growing dry beans, a crop familiar to many Wyoming growers. Chickpeas can be planted and harvested using dry bean equipment with minor modifications. The main difference is the planting date; in southeast Wyoming, chickpeas should be planted in late April to early May, much earlier than the dry bean crop.

One of the challenges when adding a new crop to any rotation is weed management. Controlling weeds is a critical factor in chickpea production because heavy infestations can reduce yields by 100 percent. Few herbicide options are available for chickpea production, leading researchers to look at more unconventional ways of dealing with weeds.

Chickpeas have one more interesting trait growers in Australia have exploited to achieve non-chemical weed control. The leaf surface of the chickpea plant secretes several acids, which, in India, are sometimes collected and used medicinally or as a vinegar. In Australia, the acid is left on the leaves to make chickpea plants unpalatable to sheep. Consequently, sheep can roam through a field munching on weeds while leaving the crop relatively undisturbed. The sheep are then removed from the fields before flowering begins so the chickpeas can recover and produce acceptable yields.

Research was initiated in Wyoming to determine if this same system would work under its climate and weed spectrum. Results from a dry land site in 2003 looked

quite promising as the sheep seemed to prefer the weeds to the chickpeas; however, drought conditions and a hail storm prevented the collection of any yield data.

In 2004, the grazing study was repeated on dry land and irrigated ground with mixed results. Under dry land conditions, the sheep once again spent most of their time grazing on the weeds.

The irrigated plot provided much different results. The predominant weed specie in the irrigated trial was common lambsquarters, which has a relatively high feed value but is unpalatable to sheep. Rather than eating the weeds, the sheep seemed content to travel down the rows of chickpeas, leaving the lambsquarters untouched. Any chickpeas left behind were soon choked out by the overwhelming weed pressure.

In addition to grazing studies, more than 40 different herbicide treatments were evaluated for weed control in 2003. Only those showing promise were used in 2004 and 2005. Several treatments provided consistent weed control across all three years of research. In particular, Spartan® herbicide tank-mixed with either Prowl®, Outlook®, or Dual Magnum® applied pre-emergence seemed to provide season-long weed control. No promising post-emergence herbicide options were identified.

Another factor that aids in weed control is narrow row spacing. Since no post-emergence herbicide is available, it is important to get a good stand of weed-free chickpeas early in the season. The larger the spacing between crop rows, the more time the crop will take to shade out the ground between rows, allowing weeds to emerge and grow uninhibited.

The best stands of chickpeas are achieved when the space between rows is no more than 12 inches. This narrow row spacing also aids in harvesting the chickpea crop as it will help keep plants upright, allowing direct cutting with a combine rather than cutting and windrowing prior to harvest. Although grazing chickpeas for weed control may not always be a viable option in Wyoming, acceptable weed control may be obtained through a combination of herbicides and planting practices.

Pre-emergence herbicides provided season-long weed control. No post-emergence herbicides were successful.

Markets are available for chickpeas near southeast Wyoming, and they are being successfully produced and marketed in western Nebraska. Under irrigated conditions, yields of 1,800 to 2,400-pounds per acre have been demonstrated in Goshen County. This could translate to a net economic return of up to $70 per acre at a selling price of $17 per cwt, compared to a typical irrigated dry bean crop that will provide net returns of $16 to $38 per acre. And there is nothing baaaa-ad about that.

Sustainable Agriculture Research and Extension Center

anything but business as usual

Jim Freeburn, Director, Sustainable Agriculture Research and Extension Center

SAREC's combination of irrigated and dry land cropland will provide research applicable to growers in diverse Wyoming.

The University of Wyoming College of Agriculture's new Sustainable Agriculture Research and Extension Center (SAREC) near Lingle is a work in progress with potential for tremendous research opportunities.

SAREC is not "business as usual" for the college and the Wyoming Agricultural Experiment Station (AES). The emphasis on systems or holistic research will benefit Wyoming producers and will also provide a unique opportunity for researchers to work on large-scale, long-term projects.

The most unique aspect of the southeast Wyoming center is the emphasis on integrated research systems. A management committee of farmer-rancher representatives and UW faculty members developed the control research system for SAREC. The emphasis on systems research will foster collaborative relationships among researchers and result in unique and positive research results that will benefit Wyoming agricultural producers. The integrated system is reflective of southeast Wyoming.

"This facility is designed to serve the people of southeast Wyoming and to provide them with current, relevant, cutting-edge information on integrated crop and livestock systems," says Stephen D. Miller, associate dean and director of the Wyoming AES.

"With the current push for biofuels research in the state, this will allow ag economics, animal, plant, and renewable resources faculty members to work together to develop these new crops."

SAREC's size and assets offer multiple research opportunities in one location. SAREC has 1,522 acres of dry land cropland, 349 acres of irrigated cropland, 1,880 acres of rangeland, 19 acres of irrigated organic cropland, and 40 acres of dry land organic cropland.

Construction at SAREC is setting the stage for many research opportunities. At least five different projects were

Integrating research systems is a focus of SAREC throughout its 3,800 acres of crop and rangeland.

The 5,700-square-foot office building at SAREC will have two meeting rooms, seed and plant processing laboratories, and 10 offices.

under construction earlier this year. A new 5,700-plus square-foot building is the cornerstone of the facilities and includes 10 offices, a research preparation room, and a seed laboratory.

The office building will also have two meeting rooms – one with a capacity of 65 for community education and another for small groups of up to 15.

Also under construction is a livestock research building, a shop, a hazardous materials facility, and a feedlot.

The livestock facility will have an office and a small laboratory along with a processing area for taking research data from cattle and sheep. The shop will be used to support research efforts at SAREC and will enable UW employees to complete work on plot equipment and more.

The hazardous materials facility will store pesticides and fuels and will meet or exceed all federal standards.

Construction on the feedlot began earlier this year. It will feature 28 pens designed by Natural Resources Conservation Service personnel to demonstrate how it can be a model for environmental stewardship and safety.

Eight of the pens are designed for multiple species and may be used for cattle or sheep, and other animals. The remaining pens are for cattle only with a capacity of more than 400 head.

Information about SAREC can be accessed at www.uwyo.edu/uw-expstn/Centers/SAREC.asp

SAREC facilities provide tremendous opportunities for crop and livestock research in one location.

SAREC's dry land, irrigation, range, and cropland options offer great potential to harvest data

A number of projects are underway or planned at the new Sustainable Agriculture Research and Extension Center.

The irrigated portion of the farm is comprised of a lateral move sprinkler, two center pivots, and gravity irrigation. Small plots can be planted under the lateral sprinkler. These projects include plant pathology work in potatoes, sugar beets, and dry beans; and weed research in corn, small grains, sugar beets, and dry beans.

There is also research involving alternative crops, biofuels, and alternative forages. One of the two center pivots has been designated to be used as irrigated pasture, of which one-third was drilled to permanent vegetation consisting of a mix of alfalfa, Regar meadow brome, and orchard grass.

One large-scale project on the irrigated farm includes looking at iron deficiency in grain sorghum on land that had been leveled. Many soil samples were taken, along with leaf samples, to analyze the extent of the deficiencies in hopes of solving the problem.

Dry land projects include weed control in sunflowers, winter wheat, and millet, along with variety trials in alternative crops, oil seeds, and medics.

Large-scale work is underway with no-till wheat-fallow rotations and a four-year crop rotation of wheat, millet, sunflowers, and fallow.

On the rangeland, a modeling project is analyzing available water, timing of moisture, and temperature to help predict how much forage will be produced in a certain growing season given the amount of moisture and timing.

Root system of the sainfoin plant showing severe galling due to multiple parasitism by the northern root-knot nematode. The northern root-knot nematode was first reported as a parasite of sainfoin in the United States by the authors in 1986.

'shoshone' sainfoin shuns northern root-knot NEMATODE

Researchers develop, release variety adapted to dry land and irrigated conditions

Fred Gray, Professor, Department of Plant Sciences, University of Wyoming; David Wofford, Professor, University of Florida, Gainesville; David Koch, Professor Emeritus, Department of Plant Sciences, UW; Toshiro Shigaki, Research Associate, Baylor College of Medicine, Houston, Texas; Ronald Delaney, Professor Emeritus, Department of Plant Sciences, UW; Alan Gray, Director, Powell Research and Extension Center, UW; Mark Majerus, Research Scientist, Natural Resources Conservation Service, Bridger Plant Materials Center, Bridger, Montana; Dennis Cash, Animal and Range Sciences Department, Montana State University; David Wichman, Central Agricultural Research Center, Montana State University, Moccasin, Montana; Katherine Keeney, Senior Office Assistant, Department of Plant Sciences, UW.

'Shoshone,' a new variety of sainfoin jointly released by the universities of Wyoming and Montana and the federal Natural Resources Conservation Service, is well-adapted to both dry land and irrigated conditions in Wyoming and Montana.

It should also adapt nicely to other areas in the northern Rocky Mountains and possibly in the northern Great Plains.

'Shoshone' was released in January 2005 by the University of Wyoming's Agricultural Experiment Station (AES), headquartered in Laramie, the University of Montana AES in Bozeman, Montana, and the U.S. Department of Agriculture's NRCS Bridger Plant Materials Center near Bridger, Montana. It will be available to producers in July. The variety was named 'Shoshone' in honor of Chief Washakie of the Eastern Shoshone Tribe.

Breeder seed, which was produced in 1994, was planted at the UW Powell Research and Extension (R&E) Center in 2003. Foundation seed was first harvested in 2004, and certified seed obtained from the foundation was first produced in 2005.

Sainfoin – also known as holy grass or holy hay – is a deep-rooted perennial herb with stout, erect stems arising from a crown. Shoots from the plant

Sainfoin plant showing symptoms of die-back caused by severe parasitism of roots by the northern root-knot nematode.

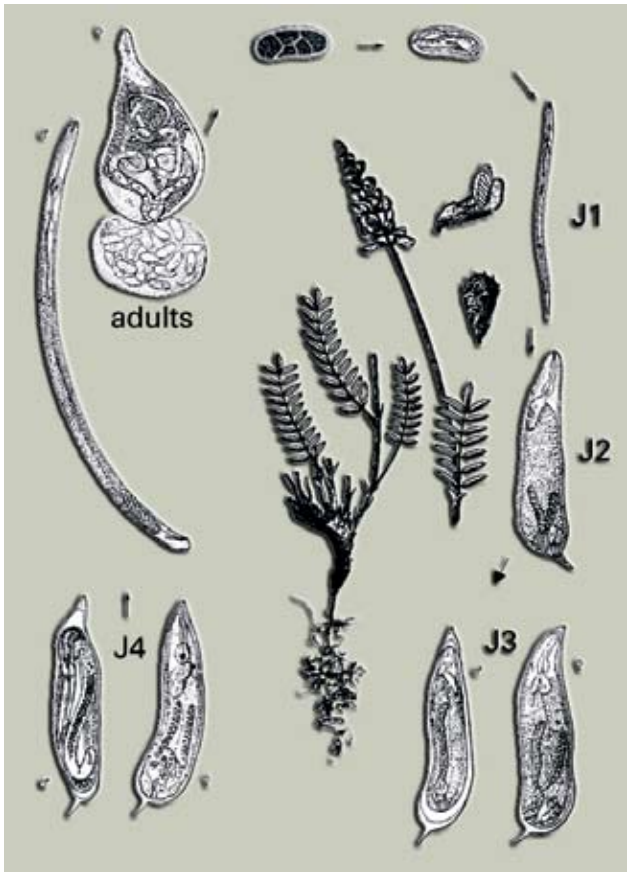
are highly nutritious and extremely palatable as feed for all types of livestock and wildlife.

Leaves are pinnate with 13 to 21 leaflets per stem. Flowers are borne on an erect raceme and are pink to rose in color. Seeds are kidney-shaped and produced in a bean-shaped spiny pod, which aids in dissemination. Unlike alfalfa, seeds remain in the pods when harvested.

Sainfoin has been cultivated in Europe for more than 450 years. A member of the Fabaceae (Leguminosae) plant family, sainfoin traces back to regions around the Mediterranean, Black and Caspian seas, and north into Russia.

Onobrychis viciifolia was first introduced into the northern Great Plains of the United States in Montana and North Dakota in the 1960s. Seed from Turkey was planted, and selections were made for adaptability to the region followed by forage-yield and animal-feeding trials. Similar plantings and selections were also made in Canada. From these introductions, varieties of sainfoin released include Eski in 1964 and Remont in 1971 by Montana State University, Melrose in 1972 and Nova in 1980 by Agriculture and Agri-Food Canada, and Renumex in 1979 by New Mexico State University.

When consumed, fresh sainfoin, unlike alfalfa, which is in the same plant family, does not cause gas formation and bloating, which can lead to death in ruminant animals. It can be hayed for winter feed or grazed during the growing season. In addition, sainfoin can be used for wildlife habitat restoration, as a component in "food plots" to attract wildlife, and as a legume component in Conservation Reserve Program plantings. Beekeepers indicate honey yields with sainfoin are much greater than with alfalfa.



Life cycle of *Meloidogyne hapla* on sainfoin showing the adult male and female, eggs, and four juvenile stages (J1-J4). When temperatures are favorable, this endoparasitic nematode can produce up to 350 eggs and may complete up to three cycles during the growing season in Wyoming. Drawing by C. S. Papp.

Since sainfoin matures earlier than alfalfa, it provides early spring forage for animals. At similar stages of maturity, sainfoin has slightly lower crude protein but higher digestible nutrients compared to alfalfa. Like other legume plants, sainfoin fixes atmospheric nitrogen and provides extra nitrogen for non-leguminous companion forage species.

In 1981, an experiment was established in Laramie at the UW livestock facilities to compare the performance of Ladak alfalfa and Remont sainfoin. After four years, during which time plots were harvested twice each year, forage yields were 10.7 tons per acre for sainfoin and 9.9 tons per acre for alfalfa. Plant stands remained good for both forage species.

In the spring of 1981, a sainfoin variety trial was established at the former UW Torrington R&E Center. Unlike the trial at Laramie, severe stand decline occurred by the following summer. Roots of stunted plants were heavily galled by the northern root-knot nematode, *Meloidogyne hapla*, a root parasite common to much of the United States. Overall stand reduction in sain-

foin entries by the spring of 1983 was 91.5 percent. All six entries appeared to be equally susceptible to the nematode.

Roots of an alfalfa variety included as a comparative check had only a low level of galling, which did not adversely affect plant stands. After the stunted and chlorotic sainfoin plants were removed, the remaining, healthy-appearing plants were allowed to intercross with native pollinators; however, before this could be accomplished, a 10-foot high fence had to be erected to prevent deer predation. Seed was produced from the open pollination of the 176 surviving plants in the summer of 1984.

Breeder seed field of 'Shoshone' sainfoin at the former University of Wyoming's Archer Research and Extension Center.

Seed of 'Shoshone' sainfoin showing a single shelled seed and several unshelled seeds. Note the occasional spines, which aid in dissemination from attachment to furry animals such as sheep and goats. Photo by R. Spence.

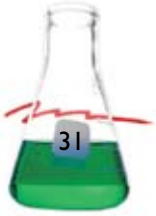
From the seed collected, several experiments were conducted in the UW Research Greenhouse in Laramie to evaluate reaction to this root parasite.

The experimental seed line expressed a higher level of tolerance to *M. hapla* than Remont sainfoin. This was expressed by higher shoot and root weights and lower plant mortality. An exhaustive search for resistance to *M. hapla* in the world collection of *O. viciifolia*, as well as in collections of other species of *Onobrychis*, proved futile, indicating a possible lack of co-evolution.

Breeder seed of the experimental sainfoin line was produced at the former UW Archer R&E Center near Cheyenne in 1994. This seed was used to establish eight field trials in Wyoming and Montana under both dry land and irrigated conditions. Forage yields were collected for four or more years at each site. All plots were harvested twice each year. Results from these trials showed the Wyoming experiment line had yields equal to or slightly better than Remont when planted alone or when intercropped with a forage grass species. Plant stands remained good in both entries in all experiments indicating good winter hardiness.

In a separate trial near Bozeman, Montana, having 16 entries, including alfalfa, cicer milkvetch, birdsfoot trefoil, and sainfoin, the Wyoming experimental line ranked second in total forage yield after four harvest years. No damaging insect or disease, other than the northern root-knot nematode, was observed on the sainfoin line during the eight years of field testing.

Sainfoin requires a different strain of rhizobia than alfalfa, which is commercially available. Seed of Shoshone will be available for purchase this July from the Wyoming Seed Certification Service (http://www.wyseedcert.com) at the Powell R&E Center.



Lambs feeding on sainfoin plants in a grass-legume pasture.

Darrell Freeman
Graduate Research Associate

Angel Ferrero-Serrano
Graduate Assistant

Ann Hild
Associate Professor

Tim Collier
Assistant Professor

Scott Miller
Assistant Professor,
Department of Renewable Resources

Biocontrol & spatial technology in the fight against weeds

Scientists use Mother Nature and high tech as weed warrior tools

Herbicides are often the best tool landowners have to control weed infestations. Use of chemicals, however, may not be appropriate along waterways that supply drinking water or where protection of rare and valuable plant species is a goal.

What can be done to control troublesome weeds when the use of chemicals is not an option?

Researchers in the College of Agriculture's Department of Renewable Resources are working on solutions for the control of Canada thistle, a designated noxious weed in Wyoming. At least 200,000 acres across Wyoming are infested with this perennial, broad-leaved weed originally from Eurasia. This weed is unpalatable to most livestock, competes with desirable plant species for water and nutrients, and forms thick patches that are difficult to eradicate.

One potential control strategy involves the use of a stem-boring weevil (*Ceutorhynchus litura*) that may reduce weed numbers to acceptable levels. Angel Ferrero-Serrano, a master's student

under the guidance of Assistant Professor Tim Collier and Associate Professor Ann Hild, is conducting an experiment to determine the effectiveness of the weevil in controlling Canada thistle. Ferrero-Serrano is testing the weevil's effect on the weed alone and in combination with two range grasses – needle-and-thread and alkali sacaton. Competition between the grass and the thistle appears to increase stress from stem-boring activities of the weevil and leads to greater thistle mortality.

Knowledge gained from this experiment will assist in revegetation projects that would fail if aggressive weeds like Canada thistle were not controlled. Use of biocontrol agents like the weevil will allow restoration practitioners to incorporate grasses and forbs, mimicking natural plant populations. Herbicides used to control Canada thistle, which would kill forbs and other broadleaved plants, would be unnecessary.

Canada thistle is also a big problem in the native tallgrass prairies in North Dakota, particularly the Tewaukon National Wildlife Refuge (NWR), where use of herbicides is restricted. UW researchers are using Geographic Information Systems (GIS) technology to understand why the weed heavily infests some sites and is not a problem in other, similar-looking areas. They hope to relate the spatial patterns of weed infestations with underlying soils, slope, hydrology, and management actions such as prescribed fire, haying, and grazing. For example, Canada thistle seems to readily infest rich, loamy soils, but the seasonal timing and frequency of prescribed fires influences the density and spread of the weed. The analysis should reveal how the history of management inputs and other factors, such as slope and aspect, determine to what degree thistle infests a given area. Department of Renewable Resources researchers plan to develop a decision-support system for use by the managers of the Tewaukon NWR, which is managed by the U.S. Fish and Wildlife Service. The system will help prioritize weed-control efforts as well as assist in the planning for the effects of future burns, hay leases, and grazing plans.

Canada thistle infestation in a North Dakota tallgrass prairie site. Photo by Darrell Freeman.

A stem-boring weevil, *Ceutorhynchus litura*, is a biocontrol method being studied in strategies against Canada thistle.

Noxious weeds cost landowners and managers billions of dollars annually in the United States. Biocontrol organisms such as the stem-boring weevil provide a direct tool to target Canada thistle infestations.

Noxious weeds cost landowners and managers billions of dollars annually in the United States. Although herbicides are often the best tool for controlling weed infestations, non-chemical methods are sometimes needed. Biocontrol organisms such as the stem-boring weevil provide a direct tool to target Canada thistle infestations. GIS and spatial technologies offer a broad-scale approach to prioritizing weed-control efforts. Both tools may increase our ability to address weed problems in Wyoming and elsewhere.

'THINK BIG' think agriculture

Pepper Jo Six, Recruitment Coordinator, and Kelly Wiseman, Staff Assistant, Office of Academic and Student Programs

"Think Big" – This is the theme of the Office of Academic and Student Programs when educating the public about the University of Wyoming College of Agriculture.

The college is a mix of traditional and non-traditional opportunities and programs. The college has eight diverse programs including rangeland ecology and watershed management, molecular biology, microbiology, family and consumer sciences, agricultural business, animal and veterinary sciences, agricultural communications, and agroecology. Students have a wide range of career opportunities available upon graduation, including financial advisers, public relations professionals, crop consultants, microbiologists, and nutritionists.

Research opportunities for undergraduates sets the college apart from many institutions. Approximately 40 undergraduate students are employed annually in our research labs giving students the opportunity to gain valuable practical experience. All degree programs offer invaluable research, study abroad, and internship experience in the student's area of interest. The Beyond the Classroom program learning experiences include study-abroad programs in France, field trips offered through the Department of Renewable Resources, opportunities to work with faculty members on research projects, and educational experiences through the National Western Livestock Leadership Internship.

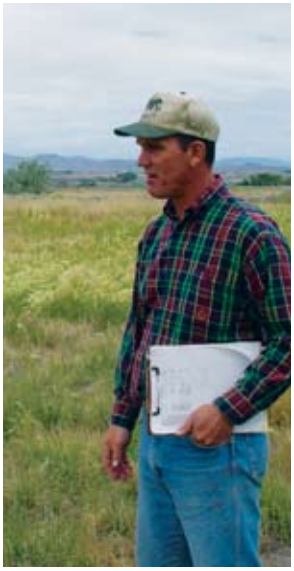
Undergraduate students work directly with faculty members on a variety of laboratory and field research projects. In 2005, the college brought in more than $10 million in research grants with projects ranging from improving the water supply and lives of people in Africa to the study of nematodes as a model to further understand human diseases. Many of our research projects are interdisciplinary, giving students an even greater learning experience.

College of Agriculture undergraduate and graduate students have opportunities for many types of field research.

The college is small but mighty in student support. The college awards approximately 180 scholarships annually totaling $250,000. Scholarship donors and recipients are recognized each fall at the college's annual Brand of Excellence scholarship banquet.

The diversity of our college student population continues to be an important theme. Female students make up 56 percent of the College of Agriculture student body. Out-of-state student numbers continue to grow, and the college is bucking the national trend with significant increases in enrollment. Enrollment has increased from 784 in 2002 to 876 for the 2005-2006 year.

Associate Dean and Director of Academic and Student Programs Jim Wangberg is teaching a new course titled "Agriculture: Rooted in Diversity." The course development was a collab-



The more than $10 million in research grants received by the College of Agriculture in 2005 was used to fund research ranging from improving water supplies to using caterpillars to produce "humanized" proteins.

orative effort between a team of UW faculty members and has been offered two previous semesters as a topics course.

The class features a series of guest lecturers speaking on a variety of diversity topics. Students complete a research project, ending the semester with a presentation of their final projects and a public reception. Past topics have included Mexican sheepherders in Wyoming, black cowboys, and women in agriculture. Funded by grants from the UW President's Advisory Council on Minorities' and Women's Affairs, the Wyoming Council for the Humanities, and the UW American Heritage Center, the course fulfills two core general education requirements.

The college offers a variety of activities and services to help students get the most from their college experience. A personal counselor on staff helps students build academic skills, develop career paths, and adjust to the campus environment.

The college has a fully equipped student computer lab and student lounge. There are more than 20 college clubs, teams, honoraries, and organizations to engage students in campus life. Ag Council, representing all of the college's student clubs, meets and organizes college-wide activities throughout the year.

UW graduates, current students, or friends of UW can become involved in recruiting by using UW's On Deck Student Referral Program. By following this link, http://www.uwyo.edu/admissions/on_deck/, prospective students can be referred to the UW Admissions Office.

The goal is to actively seek and recruit students who will make a positive impact on campus. The Academic and Student Programs Web site is http://www.uwyo.edu/AGPROGRAMS.

Reflections

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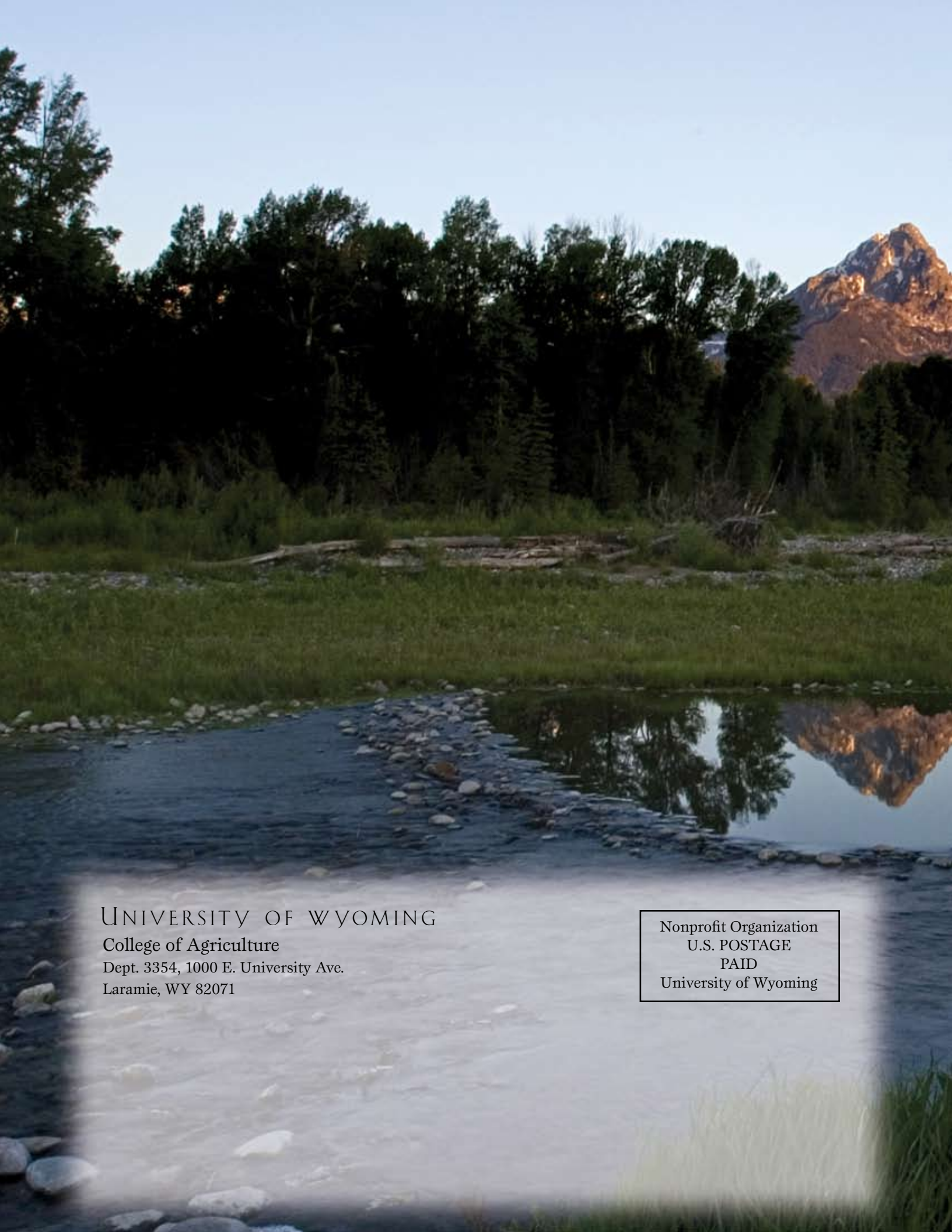

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