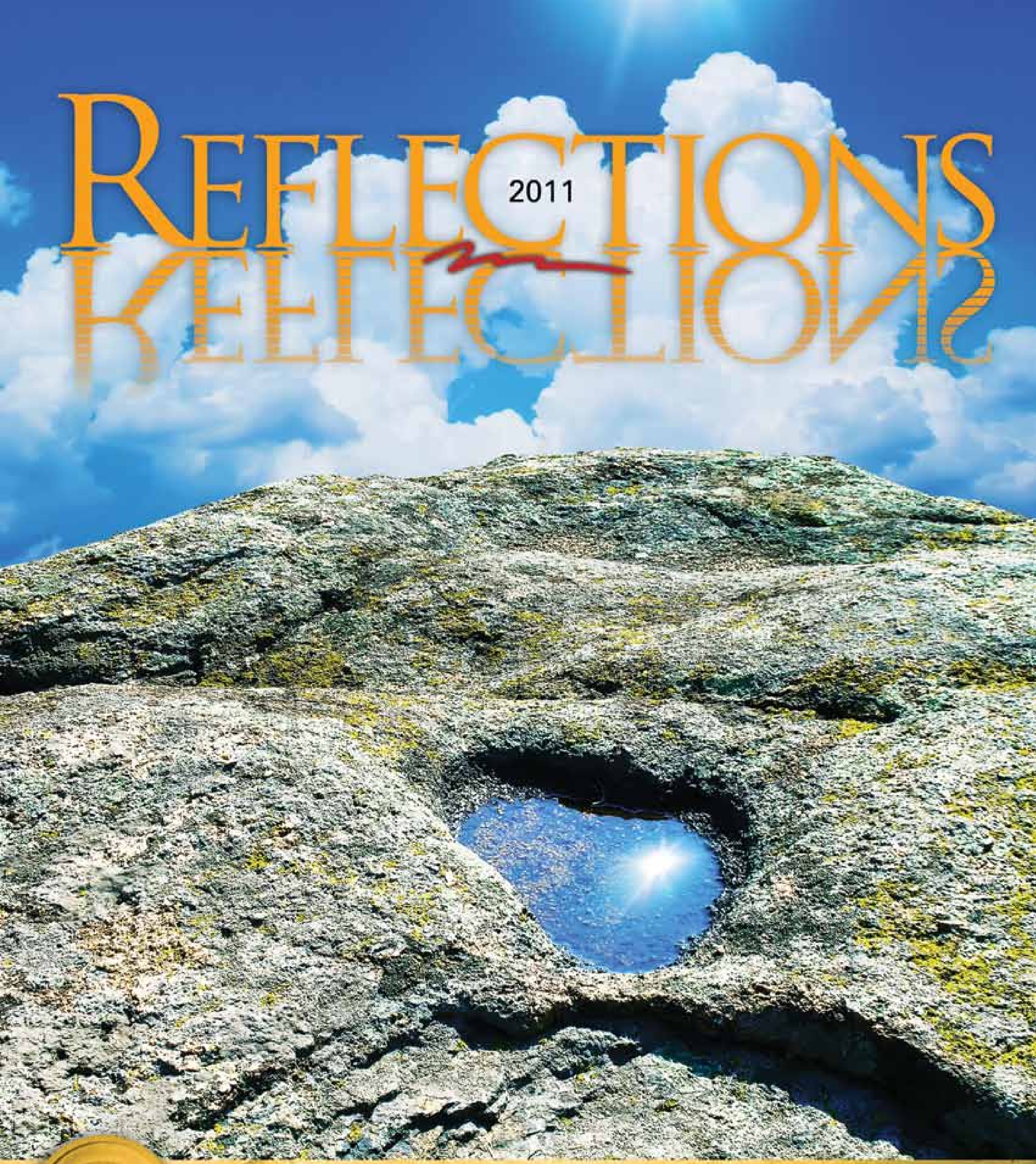
REFLECTIONS

2011



UNIVERSITY OF WYOMING

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

This is the foundation of all. We are not to imagine or suppose, but to discover, what nature does or may be made to do.

–Francis Bacon

FOUND

This year's "Foundations" theme for *Reflections* is only fitting. The unique vision of our great nation's forefathers led to the passage of the Morrill Act of 1862, which served as the foundation for eventual establishment of our state's land-grant university.

The University of Wyoming was founded in 1886 when Wyoming was still a territory. In 1891, the state took advantage of another visionary act of Congress, the Hatch Act of 1887, and founded the Wyoming Agricultural Experiment Station (AES). Now in their 125th and 120th year respectively, the University of Wyoming (more specifically the College of Agriculture and Natural Resources) and Wyoming AES continue to embrace the foundational spirit of the Morrill Act and Hatch Act.

Their founding enabled practical education based on research by scientists in our college and at research and extension centers throughout Wyoming. The fascinating stories in this issue of *Reflections* demonstrate how members of the college continue to use science-based knowledge as the foundation of education. The inscription carved into the building in which the Wyoming AES office is located sums up the collective nature of these stories perfectly, "For the maintenance of a perfect and efficient agriculture and the improvement of the rural home and rural life." This issue of *Reflections* also highlights several reasons for the inscription on the College of Agriculture Building outside of the entrance to the dean's office, which states the foundation of agriculture is not rooted in the soil but rather the vision and attainment of all.

This issue of *Reflections* is dedicated to the former directors who were instrumental in providing a solid foundation for the current status of the Wyoming AES: the late Al Gale and the retired Colin Kaltenbach, Jim Jacobs, and Steve Miller. The Wyoming AES is forever indebted to their collective service that spanned the previous three decades. Thank you!

I sincerely hope you enjoy this issue of *Reflections*. Please feel free to share your comments, suggestions, thoughts, and questions by contacting me at (307) 766-3667 or brethess@uwyo.edu.

Best regards,

Bret W. Hess
Associate Dean for Research and Director of the
Wyoming Agricultural Experiment Station

Associate Dean Bret Hess

About the Agricultural Experiment Station

Associate Dean and AES Director Bret Hess in these videos explains:

- The mission of the Wyoming Agricultural Experiment Station http://bit.ly/lusD4i
- Why the formats of the Powell Research and Extension Center field day and the Laramie R&E Center Greenhouse tours have been changed http://bit.ly/lDErhC
- Why directors of the R&E centers are requiring scientists conducting research at the centers write for the public brief, easily understood bulletins about their research http://bit.ly/jAZnrM
- Why the seed cleaning equipment has been moved from the Sheridan R&E Center to the Powell R&E Center. http://bit.ly/lkdLZc

research • extension • teaching

ATIONS

College of Agriculture and Natural Resources

FEATURED OFFICE

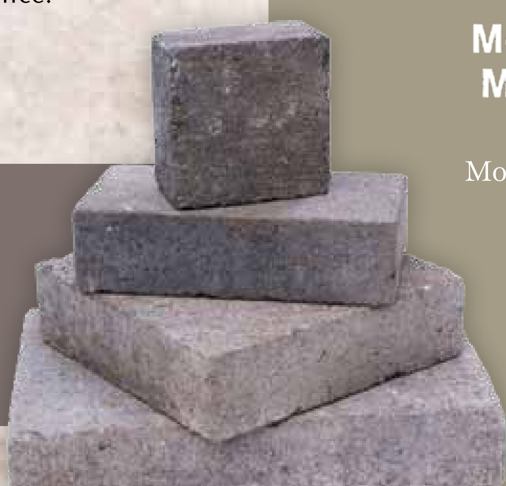
Members of the Administrative Business Office are, from left, Shirley Augustin, senior accounting associate, Lanny Hansen, accounting associate, Gail Lamb, senior accounting associate, Jacque Cook, executive business manager, Mindy Braman, senior accounting associate, and Sandy DeCora, accountant.

ADMINISTRATIVE BUSINESS OFFICE

The hardworking members of the College of Agriculture and Natural Resources Administrative Business Office handle all the day-to-day activities for the administrative and non-academic units in the college, including the Agricultural Experiment Station, the Dean's Office, and the UW Cooperative Extension Service. In addition, all personnel documentation flows through the office.

GO TO

http://multimedia.uwyo.edu/UWAG_STREAM/reflections2011/index.html for additional photographs not used in this edition and to interact with the online e-magazine.



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is published by the University of Wyoming College of Agriculture and Natural Resources.

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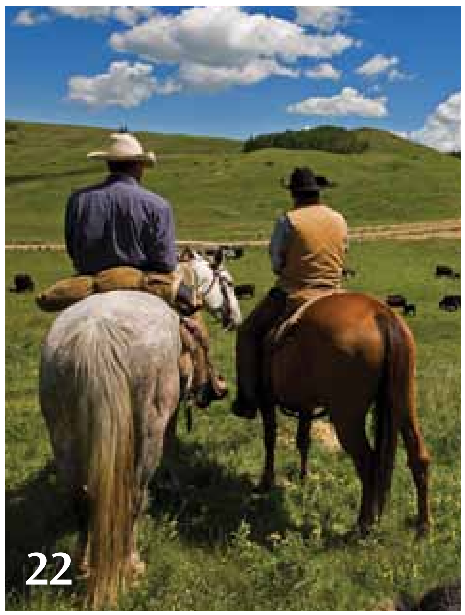

Selected as the
Reflections 2011 top story

UW scientists conduct chronic wasting disease research in two Wyoming deer populations

The helicopter crew delivers the first two deer of the day.

Dave Edmunds
Ph.D. Student

Melia Devivo
Ph.D. Student

Todd Cornish
Associate Professor
Department of Veterinary Sciences

Chronic wasting disease originally was discovered in Colorado and Wyoming but is found in free-ranging populations of deer, elk, and moose in 13 states and two Canadian provinces.

It's a cold, snowy morning in February 2010 and, in the distance, the *whop-whop-whop* of helicopter blades cuts through the silence.

As the helicopter breaks the horizon, we assess the package carried beneath. The neatly delivered cargo consists of two live white-tailed deer (*Odocoileus virginianus*) in bags, captured using a net-gun shot from the helicopter, and then flown to a staging area. There, two graduate students and a skilled team of helping hands from the Wyoming Game and Fish Department, Wyoming State Veterinary Laboratory, and University of Wyoming prepare to work on the deer. Deer are chronic wasting disease (CWD) and pregnancy tested and marked with collars and ear tags.

This capture season marked the end of one study and the beginning of another. The first study investigated effects of CWD on population sustainability and behavior related to disease spread of free-ranging, white-tailed deer in an endemic, or persistently affected, area of Wyoming. The new study will examine the effects of CWD in a mule deer (*Odocoileus hemionus*) population within a similar area of Wyoming. White-tailed deer were captured near Glenrock, and mule deer were captured near Douglas, both in Converse County, which is a hot spot for CWD.

Not a Virus or Bacteria - It's a Prion

CWD is a 100-percent fatal disease of white-tailed deer, mule deer, elk (*Cervus elaphus nelsoni*), and moose (*Alces alces*) for which there is no vaccine or treatment. This disease is in the same family that cause bovine spongiform encephalopathy (BSE) or "mad cow" disease in cattle, scrapie in sheep and goats, and Creutzfeldt-Jakob disease (CJD) in humans. All of these diseases are caused by a similar infectious agent called a prion (pree-on). Disease-associated prions (PrP^{CWD}) are the abnormal form of a normal cellular prion protein (PrP^{C}). The PrP^{CWD} are spread through direct contact among animals and indirectly through environments contaminated by animals that shed PrP^{CWD} within their saliva, urine, feces, and by decaying carcasses.

A mule deer recently processed sports a Global Positioning System (GPS) collar and identification ear tags. These GPS collars record the locations, ambient temperatures, and daily activity levels of the deer.

The disease originally was discovered in Colorado and Wyoming but is found in free-ranging populations of deer, elk, and moose in 13 states and two Canadian provinces. CWD management strategies have been ineffective at limiting the geographic spread or lowering the prevalence of CWD in these populations. Wildlife professionals are investigating the basic ecology of this disease ideally to develop more effective management tools. Important questions that remain unanswered include what effect the disease has on population growth and sustainability and how CWD is spread geographically and between animals.

Research within Wyoming's CWD Endemic Area

Two graduate students in the Department of Veterinary Sciences, Dave Edmunds and Melia Devivo, are attempting to answer these questions. Edmunds is wrapping up a seven-year study during which he captured and radio-collared 175 white-tailed deer. Devivo recently began a five-year study and, in February 2010, captured and radio-collared 40 adult female mule deer.

The objectives of both studies are to monitor CWD-positive and CWD-negative deer using radio-telemetry and Global Positioning System (GPS) collars throughout their lifespans and compare these two groups based on survival, home range size, habitat use, migration patterns, dispersal rates, daily activity patterns, reproductive success, and genetic susceptibility.

Previous research has demonstrated some deer may be genetically resistant to or survive longer with the disease, and we are investigating the role of this in both species. Ultimately, we will determine the role of CWD in population sustainability and the mechanisms of geographic spread within and among free-ranging deer populations.

To accomplish our goals, deer were captured every winter and were tested for CWD by examining a biopsy of their tonsils by using a pathology assay known as immunohistochemistry. A blood sample was collected from each deer for pregnancy testing and to test for genetic susceptibility to the disease. Deer were ear-tagged and radio-collared before release. We recapture surviving deer annually to retest for CWD and retrieve GPS data from collars, including where they have been, when they were active, and air temperatures. Additional deer were captured and enrolled into the study to restore our sample size as deer die throughout the year. We tracked deer throughout the year using radio telemetry and GPS technology.

Dave Edmunds collects a tonsil biopsy for chronic wasting disease testing from an anesthetized white-tailed deer. Inset, tonsil biopsies are collected using surgical forceps.

Results and Implications

Overall CWD prevalence (percent of the deer that tested positive for CWD) in white-tailed deer near Glenrock was 28 percent with a higher prevalence in females (34 percent) than males (22 percent). This result was interesting as other studies suggest a higher prevalence in bucks than does in other areas of the country. First-year results on the mule deer study indicate a 25-percent CWD prevalence in female mule deer near Douglas, which is lower than the prevalence (45 percent) of hunter-harvested deer that consist mostly of bucks from the same area. This suggests that, unlike white-tailed deer, CWD is less common in female mule deer in this area.

Surprisingly, pregnancy was not significantly affected by CWD in white-tailed deer with 95 percent of CWD-negative deer and 92 percent of CWD-positive deer pregnant. Similarly, CWD does not appear to significantly affect pregnancy in mule deer with 82 percent of CWD-positive and 100 percent of CWD-negative females pregnant out of 40 deer. We are unsure if CWD-positive does go on to successfully raise their fawns, but this is a behavior we hope to answer.

Important questions that remain unanswered include what effect the disease has on population growth and sustainability and how CWD is spread geographically and between animals.

Fieldwork Not for Faint-hearted

Tracking deer encompassed the vast majority of the work and put Edmunds and Devivo into some very interesting, yet exciting, situations. Most deer do not politely stand next to the road to be observed and no matter what the weather conditions, deer still needed to be found. More than one truck had to be chained up or dug out of deep mud or snowdrifts that turned out to be packed harder than they appeared. Arduous hikes through a variety of terrain and weather to find a missing or dead deer (which were taken to the Wyoming State Veterinary Laboratory to determine cause of death) are often incorporated into an already long day of tracking. While tracking deer may sound unpleasant to some, these are the experiences that make field work so interesting, hard, and educational, Edmunds and Devivo say.

Melia Devivo and Dave Edmunds discuss their research in these videos:

How deer are tested for chronic wasting disease in UW study
http://bit.ly/jZ5fcs

UW chronic wasting disease study examines Converse County deer
http://bit.ly/kcyufH

Why UW Ph.D. student Melia Devivo pursuing chronic wasting disease mysteries
http://bit.ly/jNELCm

How and why radio collars are used in University of Wyoming chronic wasting disease study
http://bit.ly/l3XSx2

UW Ph.D. student Dave Edmunds explains why he pursued chronic wasting disease research
http://bit.ly/m2sMKd

Our preliminary analysis indicates genetic susceptibility does affect survival time. Deer that carry the resistant genotype survived significantly longer with CWD than deer that carry the non-resistant genotype (25 months compared to 8 months). It is interesting to speculate the resistant deer that survive longer and produce more fawns may affect the composition of future populations by selecting for this genotype and mitigate low annual survival of CWD-positive deer; we need future data to support this idea.

All white-tailed deer, despite genotype, were equally susceptible to CWD infection. We also are interested in determining if the same holds true for mule deer. Genotyping mule deer in our study will examine this relationship between genotype and survival of CWD-infected deer.

Interestingly, migration and dispersal rates were lower in CWD-positive white-tailed deer (21 percent and 4 percent, respectively) than CWD-negative deer (39 percent and 20 percent) indicating infected deer were more sedentary. The fact that sick deer do not want to leave their home partially explains locally high CWD concentrations within endemic areas and the relatively slow geographic spread of CWD.

Preliminary results indicate mountain lions (*Puma concolor*) are effective predators of CWD-positive mule deer. Sick deer are less aware of their surroundings and are easy targets for mountain lions.

Mountain lions may play a key role in limiting the amount of infectious prions in the environment and, thus, CWD prevalence, by removing positive animals and consuming carcasses.

What the Future Holds

As the white-tailed deer study concludes, answers to our remaining questions will be revealed. We are using data collected in the field to build population models to determine effects of CWD on this white-tailed deer population and other techniques to examine differences in behavior. The mule deer study is in its early stages but promises exciting, new information regarding CWD and its influence on free-ranging mule deer populations. These studies not only enhance our knowledge of this disease but also will provide vital information for the management of sustainable deer populations within the CWD endemic area of Wyoming and other states and provinces affected by CWD.

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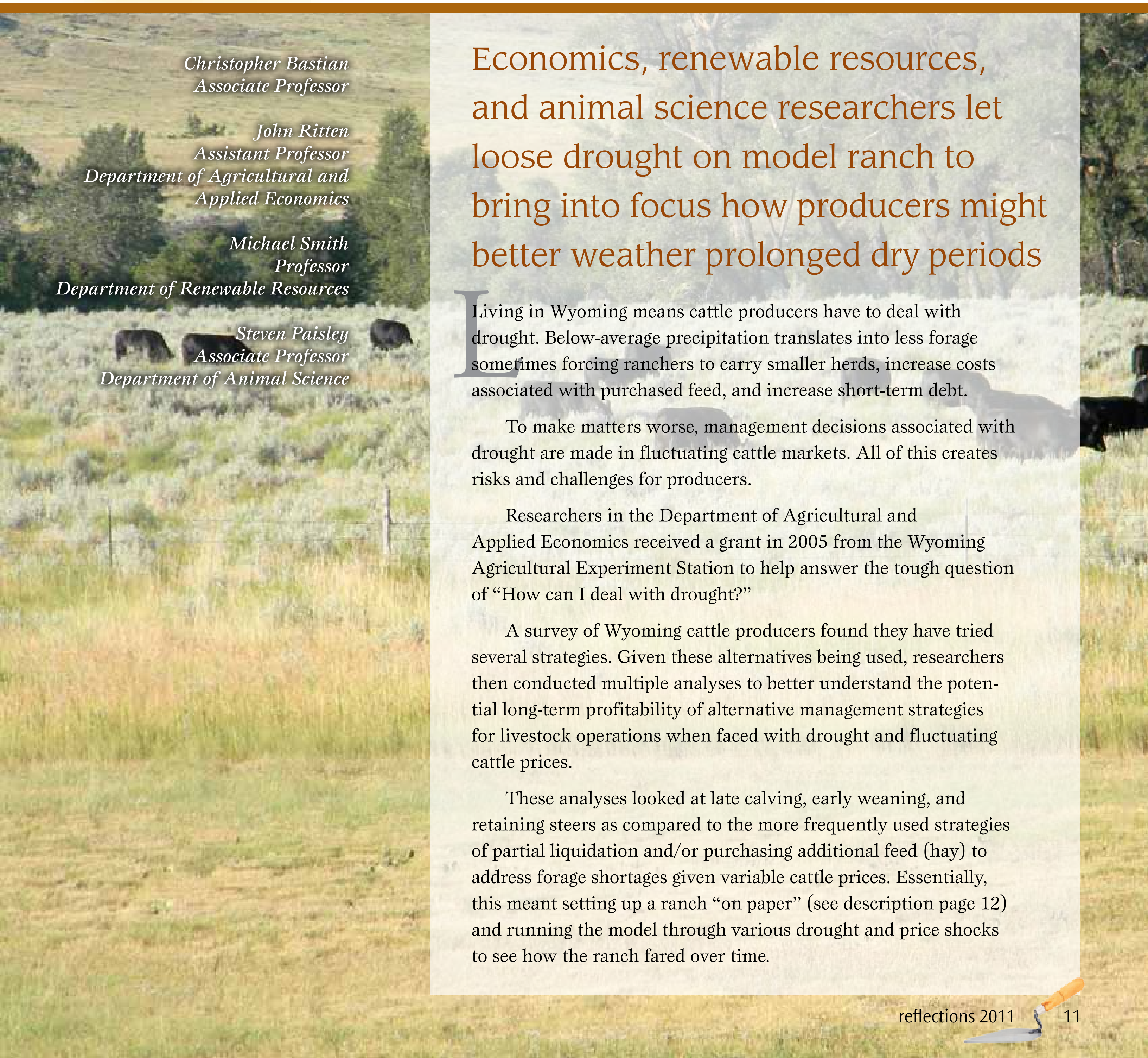
Selected as the *Reflections* 2011 second-place story

DEALING WITH DROUGHT



Christopher Bastian
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John Ritten
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Michael Smith
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Department of Renewable Resources

Steven Paisley
Associate Professor
Department of Animal Science

Economics, renewable resources, and animal science researchers let loose drought on model ranch to bring into focus how producers might better weather prolonged dry periods

Living in Wyoming means cattle producers have to deal with drought. Below-average precipitation translates into less forage sometimes forcing ranchers to carry smaller herds, increase costs associated with purchased feed, and increase short-term debt.

To make matters worse, management decisions associated with drought are made in fluctuating cattle markets. All of this creates risks and challenges for producers.

Researchers in the Department of Agricultural and Applied Economics received a grant in 2005 from the Wyoming Agricultural Experiment Station to help answer the tough question of "How can I deal with drought?"

A survey of Wyoming cattle producers found they have tried several strategies. Given these alternatives being used, researchers then conducted multiple analyses to better understand the potential long-term profitability of alternative management strategies for livestock operations when faced with drought and fluctuating cattle prices.

These analyses looked at late calving, early weaning, and retaining steers as compared to the more frequently used strategies of partial liquidation and/or purchasing additional feed (hay) to address forage shortages given variable cattle prices. Essentially, this meant setting up a ranch "on paper" (see description page 12) and running the model through various drought and price shocks to see how the ranch fared over time.

This study's model ranch

The "paper ranch" created for this research is based on a 600-cow ranch in central Wyoming and compares the alternative strategies across a data series of 86 years of precipitation and 27 different cattle price cycle scenarios. The ranch raises alfalfa and meadow hay for winter needs but can purchase more if necessary. The ranch has state and Bureau of Land Management grazing leases in addition to grazing from deeded land, and calves are normally sold in the fall after weaning.

How research came about

This research developed from asking producers in Wyoming how they dealt with drought. Associate Professor Christopher Bastian discusses how the research developed in this video

http://bit.ly/lB4TOf

Table 1. Range and Distribution of Net Discounted Returns over Entire 86-Year Horizon

	Late calving	Late calving additional benefits	Early wean	Retain steers	Summer feeding	Base
Minimum	$1,382,708	$1,556,828	$1,241,704	$1,440,733	$977,329	$885,562
Average	$1,532,248	$1,712,451	$1,415,089	$1,591,260	$1,105,798	$1,034,335
Maximum	$1,640,996	$1,826,303	$1,542,872	$1,683,501	$1,189,350	$1,121,476
Standard Deviation	$80,402	$83,309	$81,951	$65,694	$62,143	$66,743

Table 2. Range and Distribution of Net Discounted Returns over 5-Year Drought

	Late calving	Late calving additional benefits	Early wean	Retain steers	Summer feeding	Base
Minimum	$48,911	$68,465	$31,713	$90,100	$24,580	$18,248
Average	$167,625	$190,960	$153,680	$187,490	$106,344	$106,764
Maximum	$275,338	$302,349	$301,088	$287,245	$184,798	$192,630
Standard Deviation	$68,032	$71,640	$71,592	$51,200	$48,130	$51,247

The base scenario allows partial herd liquidation as a drought mitigation strategy (labeled as *Base* in Table 1 and Table 2), and the model ranch was allowed to choose the most profitable herd size given available forage and cattle prices. The option to purchase additional hay (*Summer feeding*) allowed the ranch to feed hay in summer months when most feed requirements are traditionally met through grazing. The option to wean calves early and take them to market earlier than normal to reduce forage needs in the summer (*Early wean*) assumes the producer is free to wean as many calves as needed to bring herd requirements in line with available forage on August 1 (as opposed to October 15 in the *Base* model). The animals are taken to market at lighter weights due to early weaning.

Later Calving Dates

The strategy that utilizes later calving dates (*Late calving*) pushes calving dates to June 1 (as opposed to April 15 in the base model) but maintains the October 15 weaning date and the November 1 sale date. As expected, calves born later are sold at lighter weights than traditionally born calves (e.g., steers were modeled at 390 pounds for the late-calving scenario versus 440 pounds in the base model). Weights for late-season calves are not assumed to be drastically different from earlier-born calves, as some research has found that, in Wyoming, later-born calves usually experience heavier birthweights than early-season calves.

The lighter expected weaning weights do not necessarily mean a producer should overlook this option. Research reported in 2007 indicated lighter weaning weights for later calving seasons but mentioned that the reduced costs from late calving can increase overall profitability.

Late-Calving Scenarios

To address these potential cost savings, we evaluated two late-calving scenarios. The base late-calving scenario (*Late calving*) only alters calving dates, weaning/sale weights, and the prices associated with lighter sale weights. The other late-calving scenario (*Late calving additional benefits*) models additional benefits based on other research that may or may not be realized by individual producers trying this strategy. These additional benefits include increased breed back, a reduction in calf death loss by 50 percent, a reduction in yearly cow costs (due to less calving difficulties and labor costs), less supplementation needs, and a reduction in yearly fixed costs. The reduction in fixed costs represents cost savings associated with less required buildings for calving, given most calving would take place out-of-doors.

While not all of these additional benefits may be experienced by all producers (for example, it is unlikely an operation would eliminate existing barn space due to reduced calving inside), the analysis included all benefits to understand the potential impact of a best-case scenario associated with a conversion to late calving. It should be noted, however, the model

Economists changed calving and weaning times and summer feeding options while inflicting drought on their model ranch.

assumes the transition has already occurred, and none of the conversion costs (transition breeding stock, updating grazing strategies, etc.) have been included.

Retaining Weaned Steers Scenario

The final scenario analyzed retaining all weaned steers (*Retain steers*) over winter with the goal of selling yearling steers the following November. To accommodate the reduced forage supply associated with drought, this scenario gave producers the option to sell some short yearlings May 1 to reduce herd forage requirements if needed. It is assumed that transition to a cow-yearling operation has already occurred, and neither the initial loss of revenues associated with a foregone steer calf crop nor any costs associated with the conversion are in this analysis.

In addition to overall profitability, special attention was given to how each scenario performed across different lengths of drought periods. All of the comparisons are made across the sum of net returns over the period and scenario analyzed.

Scenario Results

As seen in Table 1, the profitability over the 86-year horizon varied across management scenarios. Allowing for summer feeding did improve overall average profitability over the long run when compared to just partial liquidation. However, this alternative was the least profitable when compared to the remaining management options. If all of the additional benefits are included with the late-calving option, this scenario outperformed all others over the planning horizon on average. However, if the only change is lighter calves at sales date, ignoring all other potential benefits, the scenario that retained all steer calves over the winter with the option to sell in early summer or fall outperformed the late-calving strategy. The option to wean calves early and send them to market when forage resources became scarce in midsummer performed worse than either late calving or retaining steers yet outperformed both summer feeding and only partial liquidation as management strategies.

These results are generally the same across a five-year drought as well (Table 2). Variability in profits (as seen in the minimum, maximum, and standard deviation figures) is higher for the late calving with additional benefits compared to retaining steers. Thus, producers may want to consider the risk of income variability with late calving in their decisions.

All this suggests cattle producers may be able to make changes to their cow-calf operations and better deal with long-lasting droughts.

Generally, retaining ownership of steer calves over the winter, with the option to sell if forage supplies become scarce, outperforms both partial liquidation and summer feeding, and it results in less profit variability than late calving or early weaning with only slightly less profits compared to the late calving with additional benefits across most of the scenarios analyzed.

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A well-trodden path

Amy Nagel
Research Associate
Department of Agricultural and Applied Economics

Collaboration and exchanges between Wyoming and Greater Mongolia

Forty to 50 degrees north of the equator, the climate is dry – maybe 12 inches of precipitation a year – and windy.

These endless plains, covered with grasses and shrubs, often under a crust of windblown snow, are classified as cold, semi-arid steppe. Cattle and sheep graze on public lands, still herded by horseback.

This could describe familiar rangelands in much of Wyoming – and just as easily the vast grasslands of Greater Mongolia. Similarities in topography, climate, and agricultural practices between the High Northern Plains in the U.S. and the Mongolian steppe provide an interesting basis for collaboration in research, teaching, and learning.

Teaches Ag Course

In May, 2010, I traveled to Hohhot, Inner Mongolia, in northern China to teach an introductory course in agricultural economics at the Inner Mongolia Agricultural University (IMAU).

Hohhot (pronounced just as it looks) is a "town" by Chinese standards, and I was not expecting a population similar to metro Denver. My first impression was waking to a buzz of traffic: yellow and green taxi cabs; old Soviet-style trucks and zippy new private cars; motorized and pedal-powered bikes, often topped with hefty loads; brash, brave pedestrians; even a few mules and donkeys joined the fray, hauling fruits and vegetables into the city and trash and recycling out.

Neon signs duplicating Chinese characters in Mongolian script were the only indication of the region I was in. But, outside this sea of concrete, the grasslands of the Mongolian Steppe that encompass Hohhot and Inner Mongolia extend beyond political boundaries. Greater Mongolia is a geographic, ecological, and ancient cultural region, crossed by the modern borders of China, Mongolia, and Russia.

(Photo by IMAU Student)

Amy Nagler, with impromptu hand signals, and students from the Inner Mongolia Agricultural University tour a temple in Hohhot, Inner Mongolia. Buddhist temples were quiet, welcoming, contemplative spaces within the bustle of the city with both Tibetan and Indian influences, says Nagler.

Past and Future Collaborations and Exchanges

Although I did not go to Inner Mongolia as part of an organized exchange program, I was surprised to find I was only the latest visitor on a well-worn path between the College of Agriculture and Natural Resources and Greater Mongolia.

Probably the most experienced traveler, venturing from Wyoming to Inner Mongolia and Mongolia on more than a dozen trips since 1984, is Steve Williams, professor of soil microbiology in the Department of Renewable Resources. Williams has crossed this sizeable region many times, dodging camels and sheep and never refusing a beverage of fermented mare's milk, or *airag*, to study land reclamation and restoration in fragile grassland ecosystems stressed by mining, overgrazing, and inappropriate plow agriculture.

Like Wyoming, Mongolia has huge mineral and energy resources. The Tavan Tolgoi (Five Hills) coal deposit in the Gobi Desert rivals Wyoming's Powder River Basin as the richest coal field on the planet. Untapped reserves of uranium, gold, silver, tungsten, phosphate, molybdenum, and copper lay beneath the thin, delicate topsoil. To preserve the still abundant wildlife and their habitats that overlay these potential riches, mine and reclamation planning before disturbance are imperative.

Williams is both an expert and an advocate for conservation and planned development in Mongolia (see page 19).

An official Memorandum of Understanding between IMAU and the UW College of Agriculture existed in the 1990s. Although now out-of-date, collaborations and exchanges continue between these universities.

This past October, two emissaries from IMAU visited as guests of the Department of Animal Science. Ecology Professor Zhao Mengli and Professor Jin Ye, dean of the College of

Food Science and Engineering, toured agriculture in Wyoming and Nebraska, spoke on grassland resources, livestock production, and traditional food processing in Inner Mongolia at the animal science seminar, and met with College of Agriculture and Natural Resources Dean Frank Galey regarding further collaborations and exchanges.

Trips are planned for several teachers and students from the college to travel to Mongolia this summer. This June and July, 30 youth from Wyoming and other Western states traveled to Mongolia accompanied by 4-H specialists Kim Reaman and Warren Crawford, Rachel Mealor, extension range specialist in the Department of Renewable Resources, and Brian Mealor, assistant professor and extension weed specialist in the Department of Plant Sciences.

They collaborated with the Mongolian 4-H Youth Organization, a Non-Governmental Organization in Mongolia, and learned about the environment and culture in Mongolia.

(Photo by Amy Nagler)

One of the milking facilities at the China Mengniu Dairy outside Hohhot, Inner Mongolia.

(Photo by Amy Nagler)

Neon signs and night traffic on a rainy spring night in downtown Hohhot, Inner Mongolia.

Experiences and Impressions Teaching in Hohhot

The students I taught in Hohhot were the best part of my experience in China. They were sometimes shy but so motivated to practice English they would whisper answers to my questions and constantly used cell phone apps to translate unfamiliar words. I had a great time touring the city and meeting up for a few “Snow Deer” beers with my students.

In class, students appreciated new vocabulary and enjoyed seeing pictures of American farms and ranches. They were especially interested in agricultural markets, food systems, and agricultural policy. Questions and discussions always came back to the topic of food supplies to meet the needs of growing and shifting populations in China and around the world.

“What new technologies could increase production of food crops?”

“How do market institutions and incentives relate to food availability?”

These students saw their future roles as agricultural economists in a serious, important light.

Agriculture surrounding the growing urban center of Hohhot city was also undergoing rapid changes. A dairy I toured, China Mengniu Dairy Company Limited, was a marvel of modern production and vertical integration. It housed 11,000 Australian Holsteins in industrial facilities. It was one of two huge dairy corporations outside of Hohhot. While the dairy is privately owned, the Chinese government is its primary shareholder.

The countryside surrounding Hohhot was a patchwork of small produce farms. Plastic row cover lay in strips ready for spring planting. Greenhouses made of brick and plastic were used to grow food crops and orchids for export. Beyond this, in villages where many of my students grew up, their families continued to raise sheep and goats and cultivated home gardens.

Recycled water bottles hauled by tricycle in Hohhot, Inner Mongolia.

(Photo by Amy Nagler)

As China's economy develops and its growing population shifts from rural to urban areas, how these diverse food systems will be managed to meet ever-changing food demands will be in the hands of the students in my class. They take this responsibility with an earnest enthusiasm and are eager to make new connections with collaborators in the West.

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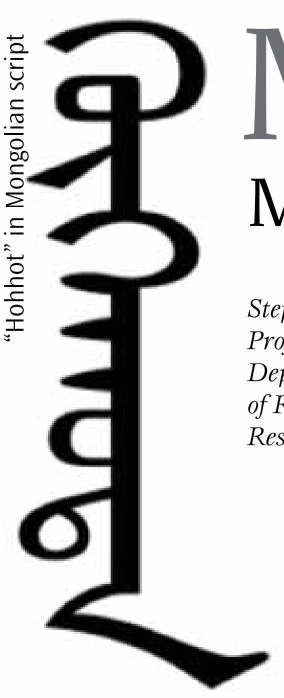
Inner and Outer Mongolia

Inner Mongolia is one of five autonomous regions in China, each home to a minority ethnic group. Most Americans are familiar with Tibet – the other three are Xinjiang Uyghur, Ningxia Hui, and Guanxi Zhuang. Inner Mongolia extends along China's borders with Mongolia and Russia. Mongolian people comprise about 17 percent of the population in this region of China. Hohhot, the capital city, is the second-largest city in Inner Mongolia with an urban population of nearly 2 million.

Mongolia (sometimes referred to as Outer Mongolia) is a sovereign nation bounded by China on the south and Russia to the north. The modern democratic government in Mongolia was formed in 1990. Ulaanbaatar, the capital of Mongolia, is a growing city of more than 1 million people.



“Hohhot” in Mongolian script

MONGOLIA:

Minerals, mining, mitigation and coal

Stephen Williams
Professor
Department of Renewable Resources

We had been traveling all day across central Mongolia.

First, we went north of the capital, Ulaanbaatar, nearly to the growing city of Darhan and then west to Erdenet (and its huge, ancient copper mine) and then on to Saikan Soum.

The country is an immense repetition of mountain, valley, steppe; mountain, valley, steppe; redundant.

But boring?

No!

We dodged camels and sheep on the highways and roads; crossed swollen rivers, sometimes via bridge and sometimes without. Early in the day, we laughed when the GPS lady tried to take us across a bridge that had washed out. Late in the day, we cursed her when she tried to take us through a solid granite wall.

We reached Saikan Soum and checked into the only hotel. I passed through three heavy, insulated doors just to reach the passage to my room. They were reminders the weather can be fierce here in central Asia during winter. The floors were uneven, the steps each a different height – leftovers of the Russians who controlled this country before democracy came in 1990.

It seems like all of the Russian buildings of that era were constructed too quickly with little thought to comfort but still made of concrete and brick that would last a thousand years.

Mineral extraction in central Mongolia

There is an argument they have the opportunity to get it right in terms of government, conservation, and organization – to get it right in a way not commonly seen anywhere.

The next morning, we went to the home of our contact. We had breakfast with some fermented mare’s milk as a beverage and then departed for the mine site. We took the same route we had taken before except we went 14 kilometers to the mine.

Mine Land Reclamation

This was a mine that had been closed and reclaimed. Soil from a nearby road building project had been salvaged and spread over the contoured mine overburden. Native grasses and forbs had been planted on the surface and now, two months later, a beautiful cover of grass, forbs and, yes, some weeds, covered, albeit not completely, the now nearly forgotten coal mine. Stranger still, the reclamation effort had been initiated and completed by a foreign company whose only motive seemed to be to change the reclamation paradigm in Mongolia.

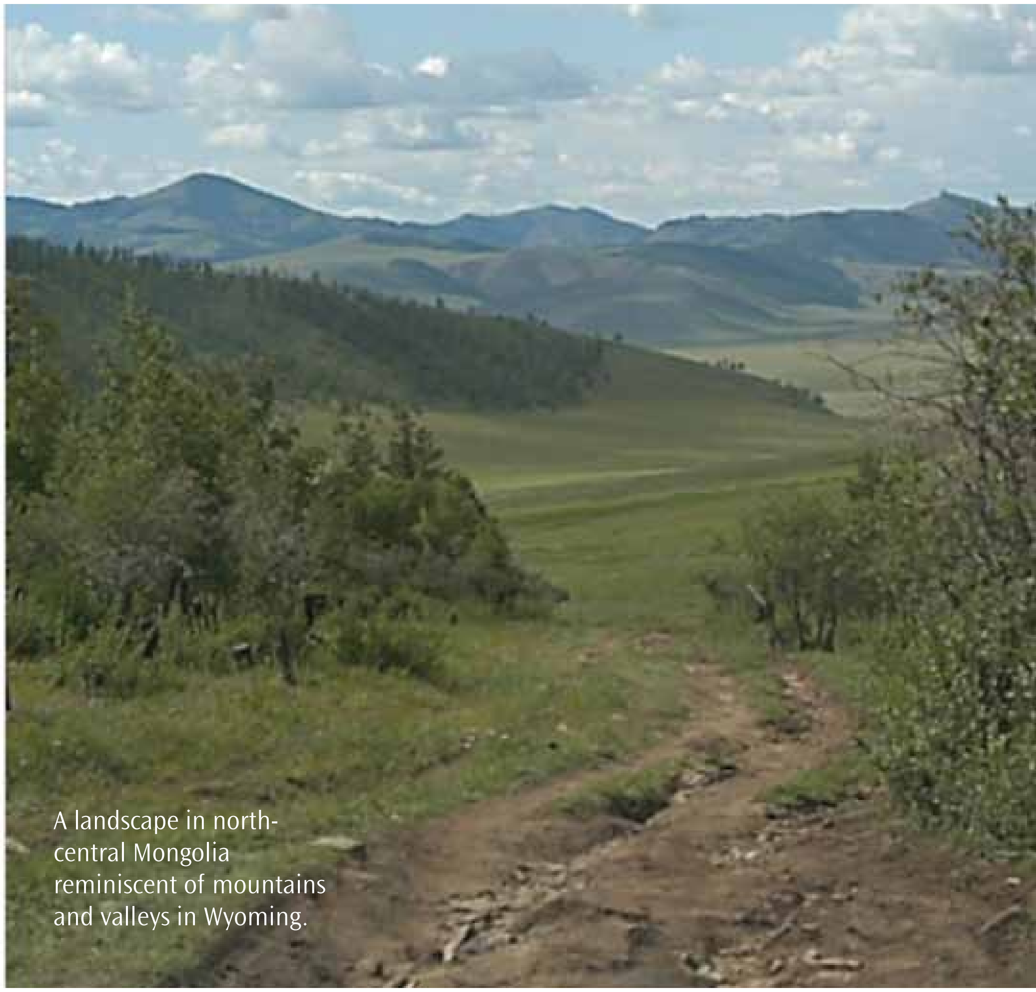
(Photo by Steve Williams)

A camp of traditional gers, or yurts, beside mine tailings in Mongolia.

In previous visits to Mongolia, I had seen sites that, post-mining, were little more than moonscapes.

My home state is Wyoming, an energy-rich zone that, if we were a foreign country, provides more energy to the United States than any other country – more than Saudi Arabia, more than Kuwait. It provides more than 11 percent of the energy used by the rest of the USA. But Wyoming pales next to the energy and mineral potential of Mongolia. This country, more than six times the size of Wyoming, has energy and mineral reserves that are just now being realized, and international and domestic companies are fighting over the opportunity to exploit these resources. Uranium, gold, silver, tungsten, phosphate, copper by the boat load and then there is also coal.

(Photo by Steve Williams)



A landscape in north-central Mongolia reminiscent of mountains and valleys in Wyoming.

Mineral, Energy Resource Development

Days later, I was in a meeting where the discussion was wildlife and wildlife habitat preservation in Mongolia in the face of energy and mineral development.

Mongolia is attempting to logically design development of its mineral and energy resource and preserve its vast land and wildlife heritage. It is a tough job for a fledgling democracy beset on every side by hunger for its resources.

During the meeting, there had been discussion of preservation as well as reclamation after mining. I even stuck my neck out and made a short presentation on reclamation urging minimization of disturbance, preservation of topsoil to aid in reclamation, and development of a seed industry specializing in reclamation species. I also emphasized mine and reclamation planning before disturbance – a controversial topic in Mongolia.

There was a lull in the discussion. A substantial man across the room made his way to the microphone. He made it clear he represented the mining industry. He also made it clear that, if the mining industry had to deal with reclamation after disturbance, it would eat into their profits so drastically they would be bankrupt. As the interpreter translated his words, I could see faces of concern around the table, a few people taken aback and apparent reconsideration.

Me, I found it a lesson in history and not without irony.

Wyoming History

I remember representatives of some development companies making similar statements some 35 years ago as the United States was about to pass the Surface Mine Control and Reclamation Act (SMCRA, 1977). Since its passage in the USA, surface mining companies have not only mined millions of tons of product and paid billions of dollars in taxes and to clean up mines abandoned before 1977, but they have also reclaimed tens of thousands of acres of disturbed areas and have simultaneously made billions of dollars in profits.

Not everyone is happy, and our situation in the USA is not without issues. But, it works to a considerable extent.

Mineral, Energy Future

Mongolia has changed a lot in the last 10 years. They are now on the verge of mineral and energy wealth that could fuel their economy and bring them into the modern world in an unambiguous manner. But, the

unscrupulous nip at Mongolian heels and attempt to line the pockets of the decision makers to get their ways. However, Mongolia has untold wealth, a small population, and huge land mass and a conservation ethic born of survival on the steppe for thousands of years.

There is an argument they have the opportunity to get it right in terms of government, conservation, and organization – to get it right in a way not commonly seen anywhere.

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SMITTEN EARLY

Genghis Khan died in 1227, but he still continues to conquer.

That happened to Professor Steve Williams when, in high school, he read a biography of Khan. Smitten, he then read "everything I could get my hands on about the Mongolians," says Williams.

Williams has traveled to there about a dozen times; the first with seven students. "Many of the students have gone on to careers that have involved China or other international places," he says.

The initial trips were thought to provide technical expertise to Mongolian peoples in China, Mongolia, or Russia.

"We soon learned we were learning more from them than they from us," he says. "That has continued."

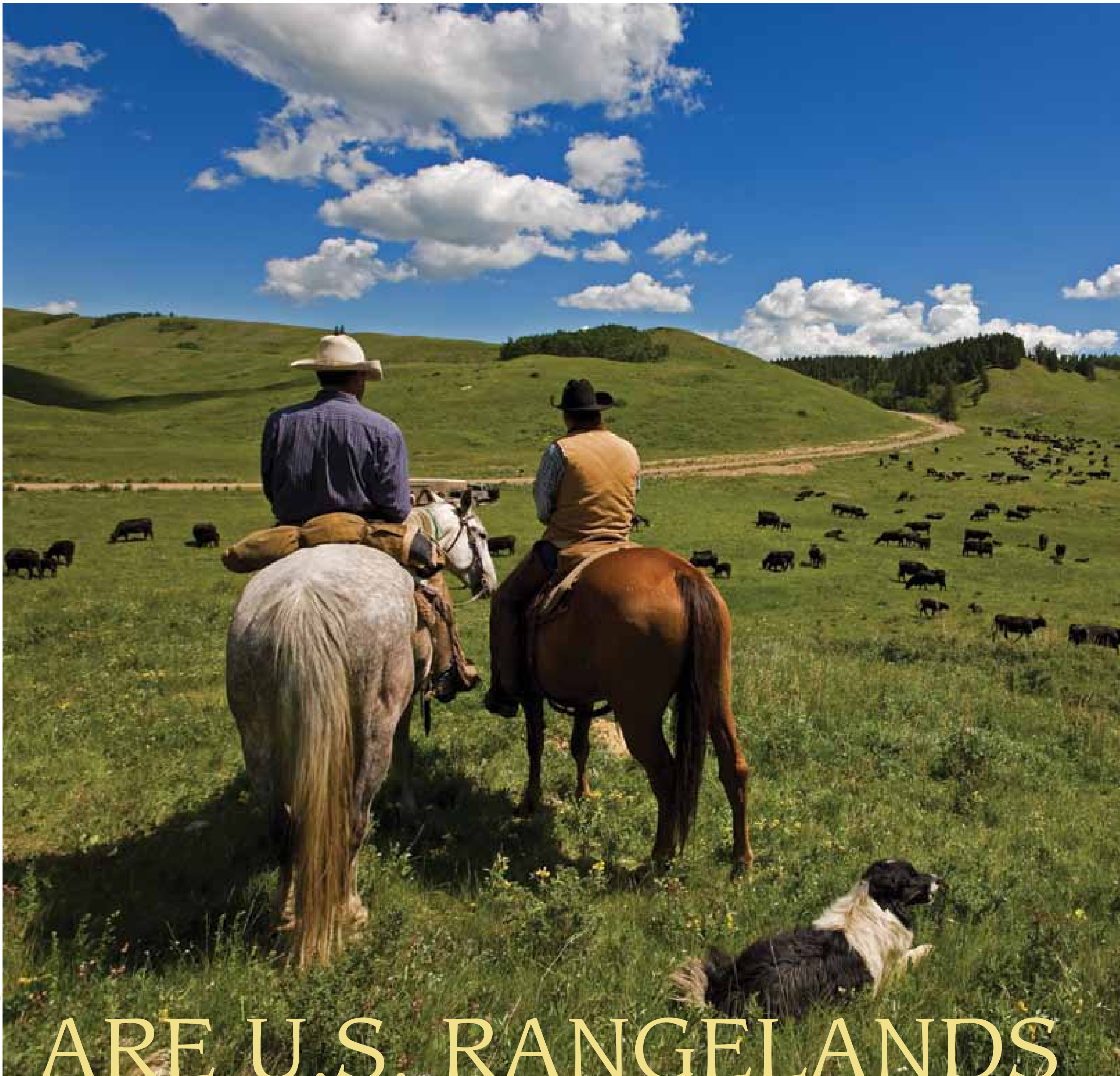
There has also been an exchange from Wyoming to Mongolia.

"Yes, I have been able to take much of what we have learned here to Mongolia, especially in the arena of mine land reclamation and environmental laws," Williams says. "These are areas where they have not a lot of experience. They are VERY receptive to new information, especially in the Republic of Mongolia – less so in Chinese Mongolia (Inner Mongolia)."

Several companies from the United States and elsewhere are involved in mineral and energy extraction in Mongolia. Williams mentions only one – because of its outstanding record there.

"Peabody Energy has done amazing things in Mongolia," says Williams. "They really want to change the environmental paradigm in Mongolia and have done significant reclamation projects over there."

Williams could go on about Mongolia – about a book on the ecology of the Mongolian steppe that was accepted and then turned down. There is the Chinese student who escaped from China and came to UW for his degree. And then the time Williams and company lost that UW student in the Forbidden City in Beijing …



ARE U.S. RANGELANDS SUSTAINABLE? DOES IT MATTER?

Kristie Maczko
Research Scientist
Department of Renewable Resources

John Tanaka
Professor, Department Head
Department of Renewable Resources

Sustainable Rangelands Roundtable members answer a resounding ‘YES’

Although rangelands cover almost 800 million acres in the United States, rangeland sustainability rouses little interest compared to conservation of other land types such as forests or wetlands.

While forest condition has been inventoried and reported for decades and wetlands merit special legislative protections, uniform survey for rangelands is lacking at regional and national levels. Without baseline information, policymakers and land managers struggle to detect trends and changing conditions let alone mount proactive policies to promote rangeland conservation and protect the livelihoods of communities dependent upon rangelands.

Recovery from the recession drags on and broader resource issues like alternative energy production capture policymakers' attention. Do rangelands matter? For participants who volunteer time and effort to the Sustainable Rangelands Roundtable (SRR), that answer is a resounding yes.

SRR endeavors to ensure sustainable supplies of food, fiber, wildlife habitat, clean water, clean air, carbon sequestration, alternative energy inputs, scenic vistas, and open space; this is described more fully in the SRR primer, *Sustainable Rangelands Ecosystem Goods and Services,* available at http://sustainable.rangelands.org.

Represents More than 75 Organizations

The SRR has a 10-year history of advocating coordinated monitoring, assessment, and reporting on social, ecological, and economic aspects of rangeland sustainability. A 2003 report details five criteria and 64 indicators for rangeland assessment.

According to Professor John Tanaka, head of the Department of Renewable Resources in the College of Agriculture and Natural Resources and SRR director, more than 150 individuals representing more than 75 organizations have attended meetings and workshops to identify elements to be measured and evaluated to characterize rangeland sustainability trends.

Participants include rangeland scientists, ecologists, economists, sociologists, producer groups and industry representatives, environmental advocates, policy experts, and land management agency personnel.

Photo by John Tanaka

Sustainable Rangelands Roundtable participants from around the country meet at New Mexico's Valles Caldera Preserve to explore rangeland management strategies for livestock, wildlife, and recreation opportunities.

By working with federal agencies like the USDA Forest Service (FS), USDA Natural Resources Conservation Service, and Bureau of Land Management, SRR participants have motivated interagency assessment efforts to inform stakeholders about emergent issues on sustainability.

Rangeland assessments to support conservation matter from national to local spatial scales. UW Cooperative Extension Service (UW CES) specialist Mike Smith acknowledges individual ranchers managing private lands may need to address warmer and drier conditions by altering stocking rates for sheep and cattle and ensuring adequate forage resources are available to accommodate longer and more frequent droughts.

Monitoring Enhances Decision Making

Monitoring data to track trends in plants, animals, soil, water, productive capacities, socioeconomic effects, and legal and institutional frameworks can enhance decision making by providing information to develop adaptive management techniques.

Rangeland assessment indicators, such as extent of bare ground, vegetation cover, riparian condition, and numbers of livestock are relevant nationally and at the ranch level, although specific measurement metrics may differ.

To adapt the national rangeland sustainability assessment framework to the ranch level, SRR participants developed 17 indicators (see sidebar, page 26) for use by ranchers and land managers. These were selected to contribute to a comprehensive ranch business plan, formulated in concert with the Wyoming Business Council (WBC), to guide overall management of financial and ecological family ranch resources. The SRR guidebook to assist with creation of a ranch monitoring program and business plan is available on the SRR website and through UW CES.

Combining information across social, ecological, and economic disciplines to generate assessments to address issues such as adaptation to climate change and energy extraction can be complex and challenging.

To help decision makers think through available information and to ensure all relevant elements are included in the evaluation process, Texas A&M University assistant professor and SRR steering committee member William Fox notes that SRR has developed an Integrated Social, Economic and Ecological Concept (ISEEC) framework.

What Happens in Period 1 Affects Period 2

The ISEEC recognizes rangeland ecosystem goods and services are the bridge between the ecological and social/economic sides of SRR's conceptual model, shown in Tier 1 (see below). Boxes labeled "Current Biophysical Conditions" and "Natural Resource Capital" represent current state and condition of the biophysical ecosystem. The "Social Capacity & Economic Capital" and "Current Human Condition" boxes represent state and condition of the socioeconomic system and society.

According to Forest Service Rocky Mountain Research Station research economist Dan McCollum, ecological, social, and economic processes act on the states and conditions in time period 1 resulting in the states and conditions present in time period 2.

For example, one response to uncertainty and risk in dealing with climate change is more and better ecological monitoring data contributing to stronger, informed management decisions on the socioeconomic side of the model and potentially

Monitoring data to track trends in plants, animals, soil, water, productive capacities, socioeconomic effects, and legal and institutional frameworks can enhance decision making by providing information to develop adaptive management techniques.

Tier 1 Model

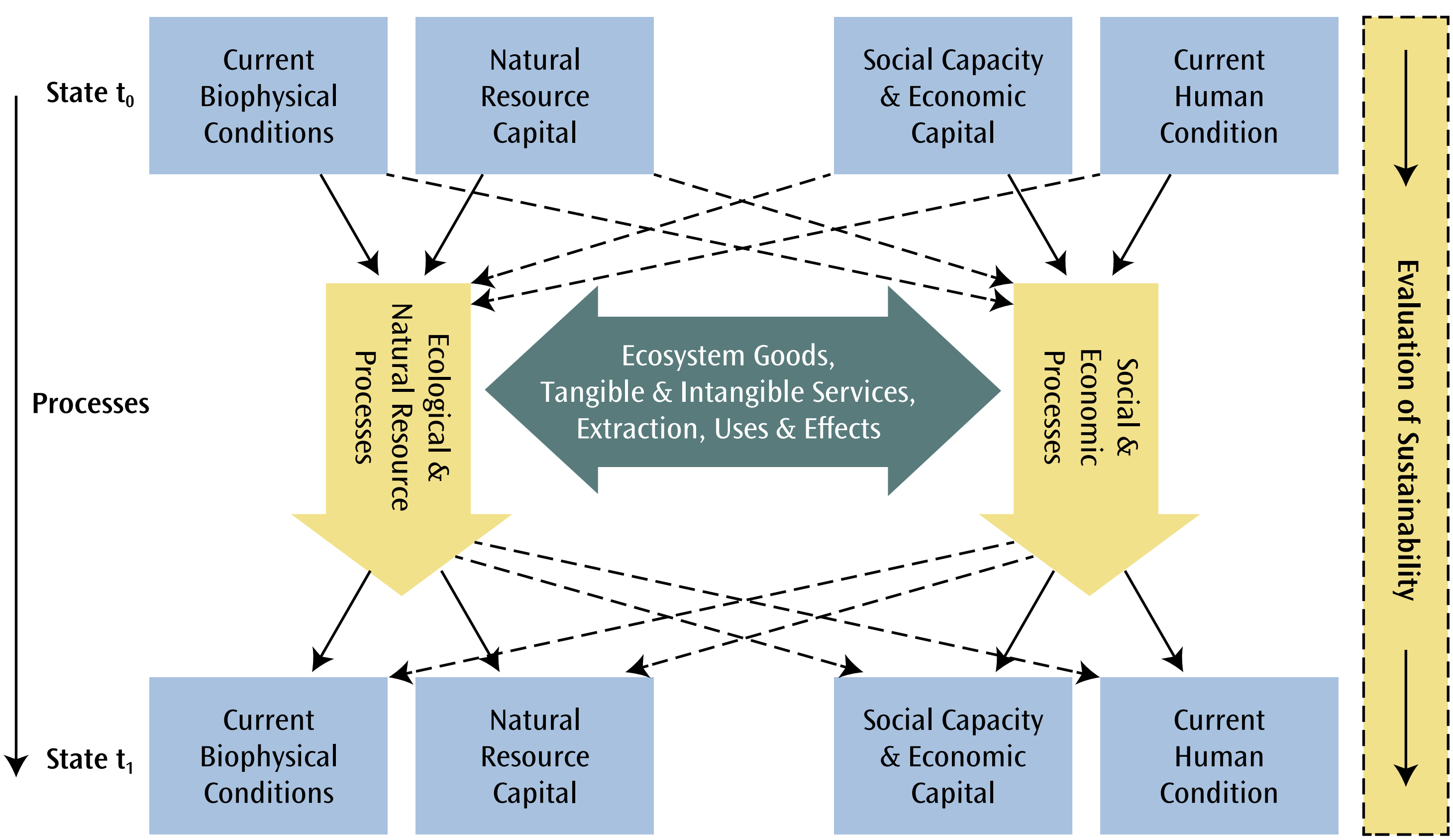


Photo by Natural Resources Conservation Service

A rancher consults with a rangeland conservation specialist about forage quality for livestock production on the family ranch.

more resilient rangeland systems on the biological side.

The ISEEC framework clarifies linkages between system components and social, economic, and ecological states and processes.

Tanaka suggests that thinking within such a framework can help managers identify and assess vulnerabilities to improve decision making and management. The ISEEC framework's intricacy reflects the complexity of ecological, social, and economic elements affecting sustainable rangeland management. SRR volunteer participants continue to improve dialogue about integrated assessments to inform rangeland issues at national, regional, and local levels.

The SRR Steering Committee and staff members invite all interested individuals and organizations to join them on the exciting journey to rangeland sustainability.

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WHAT TO LOOK FOR

Seventeen indicators guide overall management of financial and ecological family ranch resources. These were selected to help build a comprehensive ranch business plan. Interpretation is by observing movement from a known starting point, according to the Sustainable Rangelands Roundtable.

Indicators:

- Percent bare ground
- Soil aggregate stability
- Frequency or duration of surface water
- Volume of water available
- Key species/life form cover and abundance change
- Extent of invasive plants
- Extent of wildfire and prescribed fires by year
- Extent and condition of riparian areas
- Population estimates of fish and wildlife species important to the rancher
- Forage utilization
- Livestock products produced
- Quantity of non-livestock harvestable materials produced
- Cost of livestock production
- Itemized income/expense of each product produced
- Visitor use information for appropriate enterprises
- Continuing education and technical assistance
- Protection of special values

UW scientists use multiple approaches to renovate tired CRP land

Results could be basis for renovating other degraded areas

Anowar Islam
Assistant Professor
Department of Plant Sciences

Michael Smith
Professor
Department of Renewable Resources

Ryan Amundson
Habitat Extension Biologist
Wyoming Game and Fish Department

(Photo by Anowar Islam)

Professor Michael Smith, second from right, views field-dominating crested wheatgrass on the Tinsley CRP land near Wheatland.

The 900-acre Tinsley farm near Wheatland has been in the Conservation Reserve Program (CRP) for nearly 20 years. The farm was initially planted with a seed mixture of crested wheatgrass, smooth brome, intermediate wheatgrass, Russian wildrye, and yellow sweet clover.

Smooth brome and crested wheatgrass appeared to be the only surviving species of consequence.

Crested wheatgrass and smooth brome in this setting do not provide the desirable diversity or forage qualities; they are monocultures of early-greening species of low-forage quality after spring and are not preferred by cattle.

Replacing crested wheatgrass and smooth brome with alternative species is challenging. If not removed, the existing, well-stocked stand of crested wheatgrass competes against any interseeded species. Smooth brome is difficult to kill with herbicide or by mechanical means and may require multiple treatments. Smooth brome also dominates and excludes most other plants. Smooth bromes will likely rejuvenate through rhizomatous growth to its former dominance unless killed.

Initial Discussion and Field Tour

Owner Del Tinsley organized a field walk October 22, 2009. Participants included scientists and extension educators from UW, habitat biologists from the Wyoming Game and Fish Department, the Rocky Mountain Bird Observatory, researchers from the Natural Resources Conservation Service (NRCS), students, producers, and agricultural business personnel. The goal was to replace the crested wheatgrass and smooth brome-dominated vegetation with a mixture of forage plants for greater diversity, more productivity, and better quality over the grazing season.

(Photo by Anowar Islam)

A deteriorated area of smooth brome at the Tinsley CRP land showing a few seed heads with near-dormant leaves in the basal areas.

(Photo by Del Tinsley)

Prescribed burning at the Tinsley CRP land near Wheatland in March 2010.

Recommendations to Consider

It was advised to renovate the CRP land partially to see the results and avoid unnecessary risks. The first recommendation was from the University of Wyoming and the second from the Wyoming Game and Fish Department.

Recommendation I

1. Use Roundup in spring to reduce crested wheatgrass and weed seedlings followed at an appropriate interval by seeding a cover crop such as oats. Wait 10 days to seed after a Roundup treatment.

   Mow residual forage in the areas to be treated relatively early before treatment so the herbicide reaches the green, new growth. Drill the selected seed mixture into the stubble the following late fall or spring. This procedure will allow for a second Roundup treatment, if necessary, to remove residual crested wheatgrass or treatment of areas of intermingled smooth brome.

   Strips or polygons of smooth brome will probably require two Roundup treatments in successive springs. In the first spring, the Roundup treatment should be made at the appropriate rate and phenological stage. Again, a cover crop such as oats could be sown. In the following spring, apply a second treatment of Roundup followed at the appropriate interval by drill seeding the selected seed mixture. 2. Treat relatively small acreages at the outset as a trial to test the efficacy and estimate the cost of these treatments. 3. A potential seed mixture could include sainfoin, cicer milkvetch, or alfalfa depending on the adaptation to soils and precipitation: adapted native forbs such as flax, thickspike wheatgrass, adapted varieties such as tall fescue, tall wheatgrass, and Russian wildrye.

Recommendation II

The following enhancement options will help improve the quality and quantity of vegetation for use by wildlife and livestock.

Option 1: Complete renovation/start over

While possibly the most costly, a new stand of native/introduced grasses and forbs/legumes may provide the greatest benefit. 1. Reduce existing forage/litter through prescribed burning in late winter/early spring (March 1-20) followed by a glyphosate herbicide (such as Roundup) application in spring (May 1-10) followed by direct interseeding of desirable grasses and forbs by May 20.

OR,

2. Reduce existing forage/litter through prescribed burning in late winter/early spring (March 1-20) followed by a glyphosate application in spring (May 1-10). Killing all smooth brome is not likely, so a second glyphosate herbicide application may be necessary in late summer/early fall or early spring the following year. Interseed desirable grasses and forbs/legumes by April 1 the following year.

   Recommended native/introduced species for complete renovation include thickspike wheatgrass, Indian ricegrass, Sandberg bluegrass, western wheatgrass, prairie sandreed, little bluestem, sideoats grama, cicer milkvetch, alfalfa, and sainfoin.

(Photo by Del Tinsley)

Tinsley CRP land on March 31, 2010. The picture was taken after burning and before applying Roundup.

(Photo by Del Tinsley

A seeded area with semi-rough disking at the Tinsley CRP land on May 5, 2010.

Option 2: Enhancement of existing forage only

While the species present may not be the most desirable, enhancement of existing forage may be accomplished simply through prescribed burning or light disking in early spring (March 1-20). Species present will respond favorably. In addition, light disking may result in a short term "flush" of some forbs/weeds. These species will likely persist only for a short time (one to three years) but can create a valuable food source for wildlife and livestock, if their use is properly timed.

Any areas treated through prescribed fire or disked should be rested for the cool-season growth period prior to grazing (until July 15) of the first year following treatment.

Option 3: Enhancement of existing forage with supplemental interseeding

Enhancement of the stand may occur with light disking followed by broadcast seeding of a legume (i.e., dryland alfalfa, sainfoin, cicer milkvetch, etc.). Disking and broadcast seeding should occur April 1-May 1 if possible.

Producers have reported success with legume seeding rates of dryland alfalfa in the 2 to 4 pounds range of pure live seed (PLS) per acre. Leaving the field slightly roughened following disking creates small microclimates for young seedlings to establish and traps moisture in small depressions. Further mechanical treatment may not be needed.

Follow-up Results after Recommendations

Following discussion and recommendations, Tinsley received permission from the Platte County USDA Farm Service Agency board to renovate/reseed his CRP land. Tinsley planned, over the next three years, to reduce existing vegetation by prescribed burning and/or a combination of burning and spot spraying with Roundup and to broadcast the recommended seed mixture followed by a semi-rough disking. In spring 2010, Tinsley reseeded 200 acres. The seeding mixture used is in Table 1 (page 31).

This vegetation situation is representative of many of the older CRP plantings that may come out of contract in the next few years. Our research may provide a test case for returning other areas to productive grazing lands.

The Tinsley family invited us to join the landowner workshop and field day at his CRP farm July 21. More than 50 people ranging from producers to researchers attended.We observed a very good stand of legume-grass mixture averaging more than five legume plants per square foot. Good precipitation and favorable weather conditions following seeding helped rapidly establish the seedlings; however, the spring Roundup treatment of the smooth brome was not as effective as expected. Smooth brome was stunted for awhile but recovered through rhizomatous growth. Two applications of glyphosate are necessary for complete renovation.

There were also inconsistencies in seed germination and seedling establishment. This may be due to varying seeding depths; controlling seeding depth was difficult because of surface residues, soil heterogeneity, and varying moisture content. It is anticipated the legume population, especially alfalfa, will decrease over time and grasses will become more predominant. This will work better for Tinsley's grazing purposes. As a consequence, another 300 acres of land may be brought under renovation this year.

Preliminary results indicate reducing existing vegetation with appropriate methods may enhance seedling establishment the first year and eventually may provide healthier, high-quality, and more productive legume-grass stands. This information will be invaluable not only to scientists at UW but also to producers concerned with establishing legume-grass stands on deteriorated CRP acres.

(Photo by Del Tinsley)

Field walk at the Tinsley CRP land near Wheatland on July 21, 2010.

To contact:

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(Courtesy photo)

Partial view of the workshop at the Tinsley CRP land near Wheatland. Islam and Smith (standing right and left, respectively, against wall) discussed establishment issues.


(Courtesy photo)

Owner Del Tinsley with his wife, Sandy, right, and Laura Quattrini, stewardship biologist with the Rocky Mountain Bird Observatory, one of the funding providers for the project.

Table 1. Seed Mixture Used in 2010 Spring Reseeding on Tinsley CRP Farm Near Wheatland

Grass/legume	Variety	Mixture (%)	Pure Live Seed (PLS) (pound/acre)
Grass			
Thickspike wheatgrass	Critana/Bannock	15	0.90
Intermediate wheatgrass	Oahe	20	2.00
Western wheatgrass	Rosana/Ariba	25	0.90
Legume			
Alfalfa (yellow flower)	Falcata	15	5.00
Sainfoin	Shoshone	25	1.25
Total		**100**	**10.05**

Helping power the future may depend upon first

Researcher examines methods of mediating

By Lisa Cox
Graduate Student
Department of Renewable Resources

The study will analyze the feasibility of mediation strategies particularly pertinent to soils and vegetation found in Wyoming.


Big sagebrush

Uranium mining is a controversial issue in the United States, given the element's radioactive nature. Increased exploration and extraction comes with renewed interest in nuclear power for energy, and Wyoming is the largest producer of the ore.

This project is specific to the rebirth of uranium mining in Wyoming and addresses remediation strategies for radionuclide-contaminated soils to provide an extensive literature review of methods used to mitigate radium-contaminated soils.

Methods for remediating soils contaminated during uranium mining are warranted for economic, environmental, and public affairs reasons. While uranium is removed in the in-situ leaching process, radium contamination is of concern when leaks or spills occur. Some research exists on treatment strategies for radium in soils, including bio- and phytoremediation (use of green plants) and chemical methods. A common strategy, however, is to remove contaminated soil and transport it off-site for disposal at Nuclear Regulatory Commission (NRC)-approved facilities. This can be expensive and involves the risk of transporting radioactive material along public highways.


Lisa Cox collects soil samples for her research study.

Assesses Contaminated Soil Remediation Options

Having plans in place for otherwise dealing with soils in the event of contamination would be beneficial from numerous standpoints. This project assesses the feasibility of various in-situ methods of remediation in Wyoming as possible alternatives to the currently preferred methods of removal and disposal.

The study will analyze feasibility of strategies particularly pertinent to soils and vegetation found in Wyoming. The objective is to provide possible alternatives to removal and disposal of contaminated soils that are more economical to uranium operators, more supportive of future reclamation efforts, and that reduce transport of hazardous wastes on public roadways.

stepping into the past

radium-contaminated soils

Project is Collaborative Effort

The Wyoming Reclamation and Restoration Center is sponsoring the project, which is funded by the University of Wyoming School of Energy Resources and the uranium extraction industry through the Wyoming Mining Association. The effort is collaborative, with multiple parties recognizing the importance of identifying soil restoration methods complying with regulatory standards and that pave the way for successful reclamation of in-situ recovery uranium mine sites.

In-situ leaching (ISL) or recovery (ISR), as opposed to open pit or underground conventional mining, has been used in Wyoming since the late 1960s. This process involves removing uranium from the earth through a group of injection wells surrounding a production well. ISR circulates oxygen-fortified water through a uranium ore body. This liquid is pumped into injection wells through the ore body, where uranium in the host sandstone is oxidized and solubilized, and continues through the sandstone to extraction wells. Here, the uranium-bearing water is pumped to the surface. During this process, pressurization can cause cracks and leaks in pipes that can allow soil contamination. While uranium is removed from the water in the mining process, the daughter element radium-226 remains and is of primary concern to operators in the field.

Operators remove and dispose of radionuclide-contaminated soils to a depth of 6 inches (approximately 15 centimeters) resulting from uranium mining at NRC-approved sites. Soils are complex media for materials to move through, and radionuclides interact with the various chemical, physical, and biological components in several ways.

Common wheatgrass

Radium Differs Chemically from Uranium, Thorium

Methods of remediation have been studied for use in soils contaminated by radioactive elements such as uranium and

Phase I Research Goals

1. Communicate with operators in Wyoming to determine the nature of their particular soil contamination concerns, present or anticipated. This includes specifics of soil and vegetation types on sites.
2. Identify critical regulatory expectations regarding radionuclide-contaminated soils, state and federal.
3. Identify methods in use for mitigation of radionuclide-contaminated soils.
4. Identify methods undergoing research or that have not proved viable.
5. Prepare a comprehensive literature review that addresses primary concerns of Wyoming operators and regulatory personnel and provides options for remediation of contaminated soils.

Photo courtesy Cameco Corporation

In-situ leaching involves the use of a group of injection wells surrounding a production well. The arrangement is called a five-spot or seven-spot.

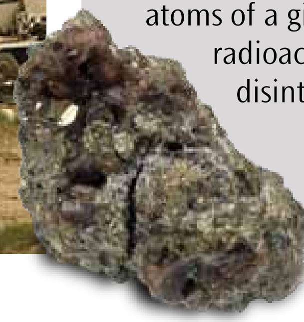
Half-life of selected radionuclides

Radon – 3.82 days

Radium – 1,600 years

Uranium – Uranium 238 is 4.47 billion years, Uranium 235 is 704 million years

(Note: Half-life is the time required for *one half* the atoms of a given amount of radioactive material to disintegrate.)



thorium, but radium is quite different chemically, produced through decay of uranium (radium-226) or thorium (radium-224). Thus, some techniques shown to be promising or successful in the remediation of other radionuclide-contaminated soils may not be useful with radium. This creates a challenge to finding innovative ways to treat these soils. Radium-226 has been shown to vary in concentration in soil solution in relation to cation exchange capacity (CEC), organic matter (OM) content, and pH.

Although Wyoming soils are highly variable, ISR of uranium occurs in areas with similar characteristics in terms of the five soil-forming factors: parent material, climate, biota, topography, and time. A predominance of sites slated for development lie in the Powder River, Laramie, Wind River, and Green River basins. These are generally semiarid in moisture regime, meaning soils are dry much of the growing season with annual rainfall less than 36 inches (~ 90 cm).

Soils may contain secondary carbonates – calcium carbonate ($CaCO_3$), or lime, which is common in semiarid and arid environments and tend toward a high pH. These landscapes host predominantly sagebrush or grassland habitat. Big sagebrush, blue grama, buffalograss, western wheatgrass, and other typical shrub/steppe vegetation may be present in a mining area.

Buffalo grass

Studies of radionuclide-contaminated soil remediation have employed methods from natural attenuation, or monitoring of natural physical, chemical, and biological processes reducing radioactivity, to electrokinetics (electrically driven motion of particles and fluids).

Bioremediation of Radium-Contaminated Soil

This project can quickly eliminate some options from consideration. For instance, radium's half-life of about 1,600 years (see chart above) precludes the use of natural attenuation. Additionally, while studies of bioremediation (use of bacteria, fungi, enzymes, or, in the case of phytoremediation, green plants) of radium in wastewater have been done, little data has been uncovered on bioremediation of radium-contaminated soil, though it has been applied to uranium.

Early research indicates phytoremediation may be a potential strategy for use in Wyoming. Several studies worldwide have looked at radium uptake in a variety of plant species, from grasses to trees. Often conducted to predict radium entry into the food web, this research also is valuable in evaluating whether phytoremediation may be a feasible option for cleaning radium-contaminated soils on uranium mine sites.

While several studies have involved woody species not native to the Wyoming range, some using grasses and one in which sagebrush uptake of radium was analyzed at Colorado State University in the 1980s have provided a basis for further examination. Over the next several months, investigators will analyze research from around the world for use in Wyoming and lab results from uranium mine soils collected in the state.

Results of this research will provide site-specific options for deciding how to deal with radium-contaminated soils in Wyoming in the future.

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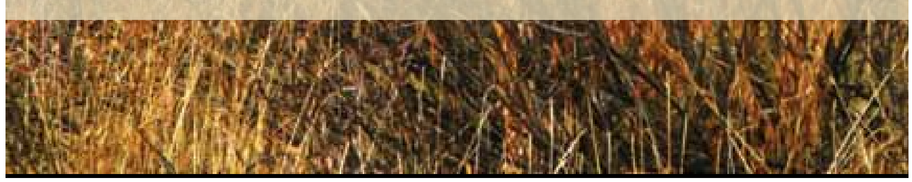
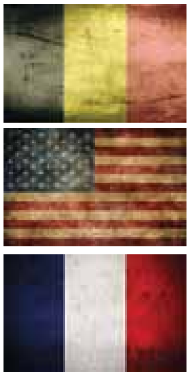
Phase II – The Plan

1. Operators remove and dispose of radionuclide-contaminated soils from surface spills during ISR uranium mining, at Nuclear Regulatory Commission (NRC)-approved sites, removing soil to a minimum depth of 6 inches.
2. Regulations address the first 6 inches separately from deeper soils. Soils are complex media for materials to move through, and radionuclides interact with the various chemical, physical, and biological components of soils in several ways. Therefore, most spills will not penetrate very deeply into soils. Radium-226 is the predominating radionuclide of concern in ISR uranium surface spills.
3. We hypothesize that sampling soils affected by a surface spill to a 2-inch depth will provide a more accurate indication of the concentration of radium in the soil than sampling to a 6-inch depth because, in most cases, surface spills will not penetrate to the 6-inch depth (unless the spill is unusually large or on an area that does not run or drain).
4. Use industry-selected recent spill site for sampling, a 100-square meter area.
5. Remove soil core samples along transects, three each with five samples at 2-inch and at 6-inch depths, taking into account topography and vegetation.
6. Obtain bulk samples at each 2-inch/6-inch sample spot. These are samples taken to 6-inch depth and "bulked" into one bag without separating 2-inch and 6-inch cores.
7. Determine radium-226 content of each soil sample in picocuries per gram and match against NRC regulations and background levels.
8. Analyze whether removing top 2 inches of soil will meet regulations for remediating contaminated soils on this site.



Blue grama



Turning a dissecting eye

Other climates, sheep breeds, landscapes and practices: going abroad to study different agricultural systems can be extremely enriching. (Photo Vincent Lorent)

upon study-abroad students

UW agricultural students have much different expectations studying abroad than European Union students

Louise Lorent • Study-abroad Student • Belgium

Wyoming native Luke Frye spent a month in France last summer learning about French vineyards and the Maine-Anjou cattle breed, among other food production subjects.

Laure Thiallier from France spent a semester at the University of Wyoming learning farm and food trade policy in the U.S.

Frye and Thiallier participated in study-abroad programs. Both experienced new aspects of the different cultures in which they immersed themselves, from drinking coffee in bowls to hugging instead of kissing cheeks, and, even more meaningful, discoveries such as another educational system.

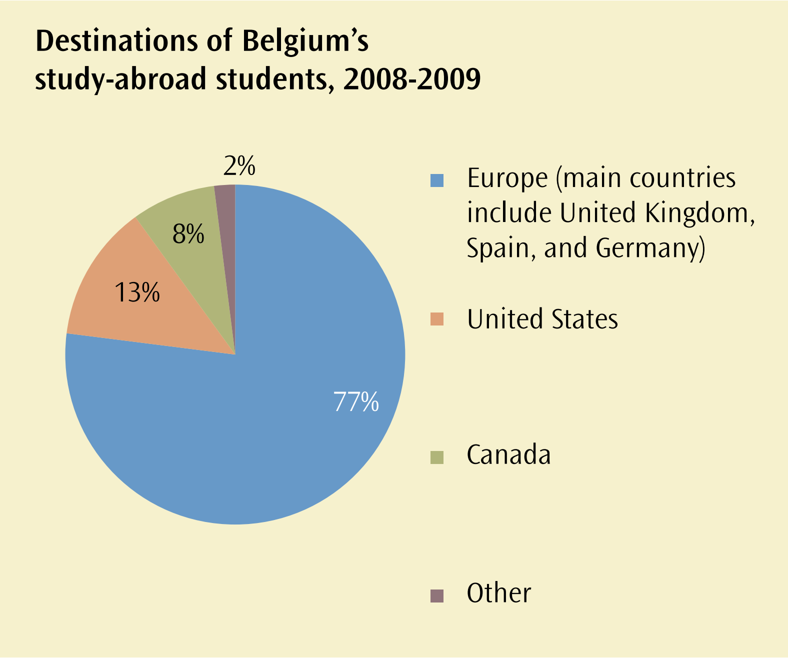
- How different are those educational systems in the U.S. from those in Europe?
- Is there a trend shared by students majoring in agriculture from both regions of the world?

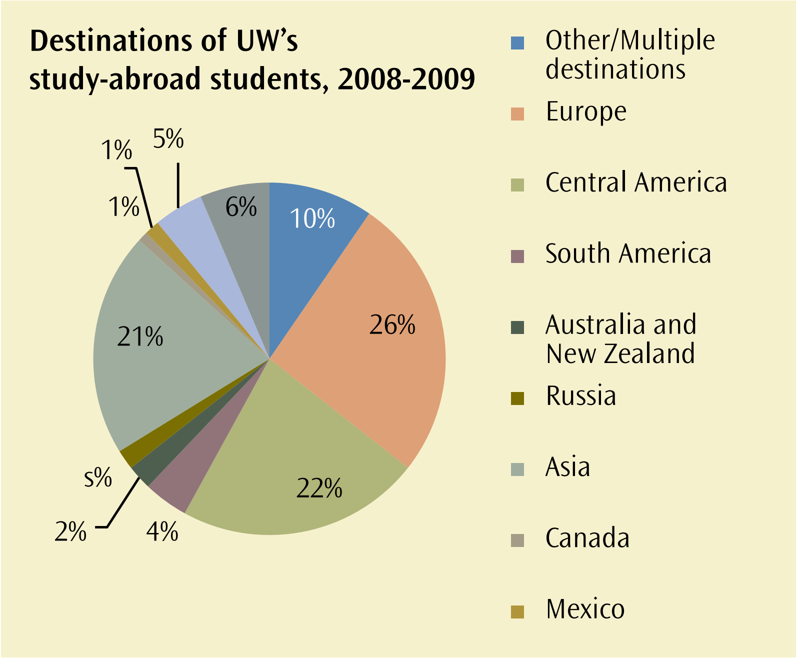
I conducted research amongst study-abroad UW students and those of my home country (Belgium) who went abroad to study this year.

Expectations Separate Students

Students can be separated into two groups based on their primary expectations: Americans expect to see how things are done elsewhere, and Europeans want to learn or polish another language.

U.S. students typically will go abroad to other continents and are not reluctant to visit developing countries. "Experiencing something different" can encompass a broad range of experiences, and it might explain the huge variety in destinations. A European student prefers to stay in the European Union (EU). Interestingly, some destinations for U.S. students are similar to European students: the UK and Spain lead. But,





Funding of study abroad programs is very different in the U.S. and EU. Differences in funding make it easier for a European student to go abroad, especially in the EU, than for American students.

these destinations are closely followed by China, Australia, Mexico, and South American countries, which do not seem to attract European students.

UW students have steadily increased participation in study-abroad programs from less than 50 in 2000 to 250 in 2009. Financial support followed this trend, with around $100,000 awarded in 2009-2010, nearly four times the amount in 2005-2006.

In Europe, exchange programs are also becoming more popular each year. Study-abroad programs in Europe were introduced in the 1980s with a program named Erasmus, which allows students to spend six months or a year at another EU university. Other study-abroad programs exist, especially with universities from Canada, the U.S., South America, or Asia. But, Erasmus became so popular it is now common among college students to talk about "doing their Erasmus" just as you "do your internship."

The total number of U.S. students abroad each year (around 250,000) is low compared with EU students (around 650,000 a year) out of a total number of around 18 million for each region.

U.S. Universities at EU Costs

The United States stands out as a host country. U.S. universities are funded differently than most European ones: higher tuitions for students also mean much better facilities. It is understandable for a French student to come to the U.S. on an exchange program, pay tuition of his or her home university (often virtually nothing by American standards), and live for one year in a haven of convenient and high-tech facilities. Very often, he or she will even be awarded a scholarship to help with remaining expenses.

Funding of study-abroad programs is very different in the U.S. and EU. Differences in funding make it easier for a European student to go abroad, especially in the EU, than for American students. Main financial resources for a European student are Erasmus scholarships (which averaged 272 euros – about $380 – a month in 2008-2009) sometimes supported by a government grant based on social criteria more than merit. In the U.S, most students have to find their own means of financial support to study abroad. Other funding resources include the home university (for example, the International Programs Office at UW awards Cheney scholarships) and private funds. Government support such as Fulbright scholarships are based on merit rather than social criteria.

While European study-abroad students spend on average just more than six months in their host country, a good proportion of American students (73 percent in 2008-2009) go abroad during the summer term or for one term.

Ag Student Data Scarce, Misleading

Finding data on agriculture students through traditional statistics organization is difficult; there is virtually never a section for "Agriculture" as there is for "Arts," "Social Sciences," or "Natural Sciences."

Studying abroad is expensive and can appear sometimes not justified if not to learn a language or to study diplomacy or international politics. In both regions of the world, less than

When I first saw this strip fallow near Wheatland, I wondered what it could be. Belgium has an average annual rainfall between 35 and 40 inches. The size of the field astonished me. (Photo Louise Lorent)

A wheat field in Haute Loire, France. An American student majoring in agriculture could be astonished by its size – not more than 10 acres. (Photo Vincent Lorent)

> UW students have steadily increased participation in study-abroad programs from less than 50 in 2000 to 250 in 2009.

1 percent of the students abroad are majoring in agriculture. Out of 232 students abroad at UW in 2008-2009, two belonged to the College of Agriculture and Natural Resources. This might appear low, but, this data does not entirely reflect reality. The college organizes courses abroad that greatly enhance understanding of the world's agriculture: in past years, several students have spent a month at a family-owned farm in France. Others left in December for Kenya.

Learning how agriculture is practiced around the world is just as important, if not more, than learning about the different political systems. Feeding eight billion people in 2050 will indeed require a global understanding of the world's agro-ecosystems.

To contact:
***Louise Lorent** studied in the Department of Plant Sciences and Department of Agricultural and Applied Economics this past academic year.*

Comparing UW to EU

Louise Lorent from Belgium spent a year studying agriculture in the Department of Plant Sciences and Department of Agricultural and Applied Economics at the College of Agriculture and Natural Resources. Here are differences she observes between UW and the European Union schools.

On Graduate Curriculums

The first difference between any Belgium ag university and the UW College of Agriculture and Natural Resources is the degree of specialization expected from the students. In Belgium, the program starts with three years of very, very general science that could be the curriculum of a chemistry/engineering/biology major, followed by two years of more specific studies. At UW, though there is a core curriculum of science shared by almost any agriculture major, students are allowed to focus on their interests earlier and deeper. I think this is one of the reasons American students are more involved with their studies - they complete several personal projects, join clubs or societies, etc. Research projects start to be introduced in Belgium, but the emphasis put on them is not as strong as here.

On Relationship between Faculty Members and Students

It took me time not to be surprised by the way students in the U.S. are not afraid to ask questions. Professors try to make students participate and expect students to have their own interests and to investigate them in projects. In Belgium, students are expected to learn and master what the teacher says.

On Differences of College Emphasis

The UW College of Agriculture and Natural Resources departments are somewhat different than in Belgium. The first thing is the motivation of each of these institutions: it seems – maybe I am wrong – that one of the UW College of Agriculture and Natural Resources purposes is to serve the state of Wyoming's agriculture by conducting research (on crop varieties, livestock breeds, agricultural practices, economics and finances), by providing consultations with the Cooperative Extension Service, and by educating students. In Belgium, my university wants to produce "agricultural engineers" or "bio-engineers" adaptable to all sorts of situations and employable by industries or exportable to developing countries to improve their agriculture.

Final Thoughts

I would say that, very generally, the American system expects its students to be independent, while the Belgian system expects students to be flexible. I learned a LOT this year at the University of Wyoming and am only sorry that the Belgian system is not more like yours.

Researcher examines regeneration 23 years after sagebrush removal

Michael Smith
Range Management Specialist
Professor
Department of Renewable Resources

Wyoming big sagebrush (*Artemisia tridentata* Nutt. ssp. *wyomingensis* Beetle & Young) was removed with herbicide, 2,4-D, in 1987 from study plots near Saratoga.

For many years, removal of sagebrush to foster more grass as forage for livestock was a goal of many land managers. More recently, interest in sagebrush has centered on regeneration of younger, more vigorous cohorts that would provide better forage for many wildlife species that use sagebrush.

Today, concerns regarding sage-grouse, an obligate to sagebrush habitats and having declining populations in many areas, have increased interest in plant succession in sagebrush habitats and question the wisdom of employing sagebrush management tools.

Original 1987 Study Concepts

The study was originally established to measure forage production increases following sagebrush removal where there were varying amounts of sagebrush. The question was, "How much sagebrush had to be present before the increased productivity following removal would recover the cost of treatment in the selected planning horizon?" Study sites were selected on a landscape of relatively uniform deep, sandy soils (Sandy ecological site) in a precipitation zone averaging 10-14 inches annually. The sagebrush had never been treated, and varying abundance across the area was due to micro-topographic variations that resulted in more or less winter snow cover depending on exposure to prevailing winds.

Individual study plots were selected in locations that varied in sagebrush ground cover from about 4 percent to 40 percent in approximately 4-percent increments. The sagebrush cover was measured on two 100-foot transects with permanently

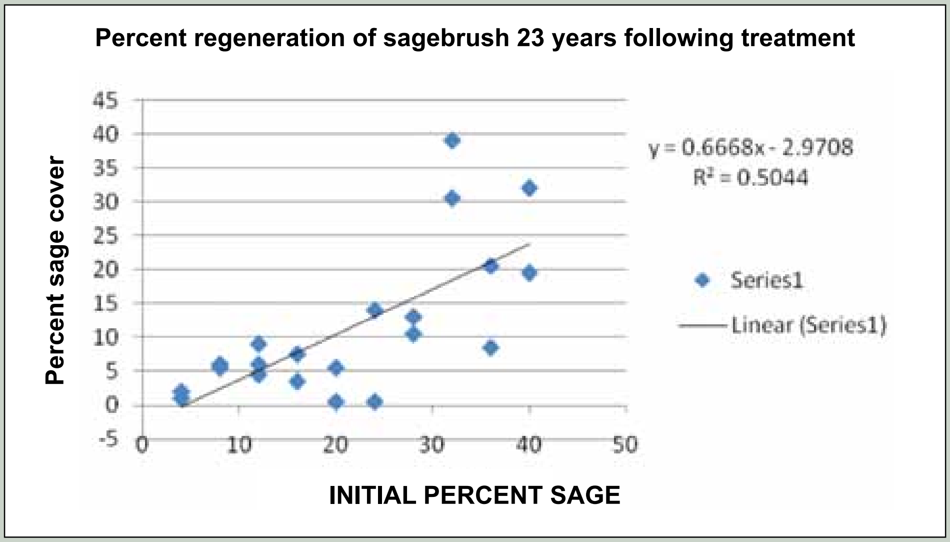


Figure 1. Regeneration in percent sagebrush cover 23 years following removal of that originally present as a function of original sagebrush cover.

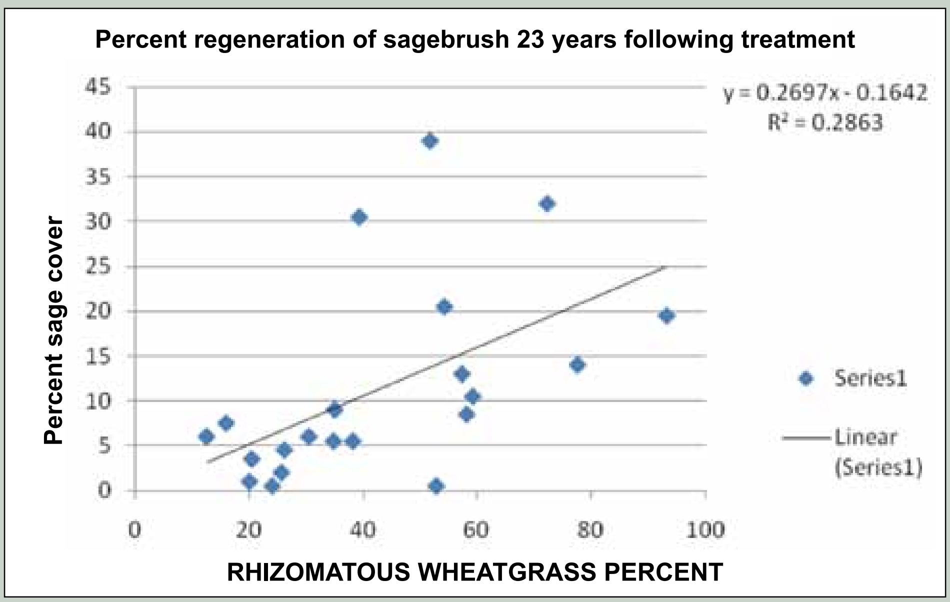


Figure 2. Regeneration in percent sagebrush cover 23 years following removal of that originally present as a function of original needle-and-thread percent composition of herbaceous vegetation.

Because of slow regeneration rates when sagebrush has been removed, thinning would be the treatment of choice in most sagebrush habitat rejuvenation projects regardless of herbaceous understory composition.

marked ends on each plot. In each location, one of a pair of 100 x 100-foot plots was randomly selected for removal of the sagebrush on June 1, 1987. In each following July, forage standing crop was clipped, dried, and weighed. Forages were separated into categories of needle-and-thread grass (*Stipa comata* Trin. & Rupr.), rhizomatous wheatgrass (*Elymus lanceolatus* Scribn. & J. G. Sm.), other grasses, and forbs in the initial sampling year. Total forage yields were measured every year. Relationships of forage yields and seasonal precipitation have been reported in other venues (Smith 2007, MP-111.09).

Measured Again in 2010

In May 2010, sagebrush cover was measured in the same manner as in 1987. The presence/absence of sagebrush directly under the mark

was recorded at every foot along the 100-foot transects. The 2010 measurements were evaluated with respect to the original sagebrush abundance and the relative abundance of the bunch grass, needle-and-thread, and rhizomatous wheatgrass.

There were significant relationships between the sagebrush cover on treated plots, the original sagebrush abundance (Figure 1, page 42), the relative abundance of the bunch grass (Figure 2), needle-and-thread, and rhizomatous wheatgrass (Figure 3, right).

The most important variable explaining the amount of increase in sagebrush was the amount of sagebrush on the site before treatment. Needle-and-thread was more prevalent on the sites with lower amounts of pretreatment sagebrush and subsequently was associated with lower amounts of sagebrush regeneration. Rhizomatous wheatgrass was generally more prevalent on sites with higher amounts of pretreatment sagebrush and subsequently greater sagebrush regeneration. However, for a few locations that had the same amount of pretreatment sagebrush but needle-and-thread was more abundant than on a similar site, there was 10-14-percent less sagebrush cover regeneration suggesting this vegetation state is more resistant to sagebrush encroachment.

Sagebrush Regeneration Averages

Sagebrush regeneration averaged 11 percent over all pretreatment sagebrush abundances with only three high (more than 30-percent cover) sagebrush cover treatments reaching 20 percent or greater cover regeneration. Over the same period, sagebrush cover on untreated plots averaged 2.6 percent (range 9.5- to13-percent cover), and increases were negatively related to the abundance of needle-and-thread but not related to rhizomatous wheatgrass.

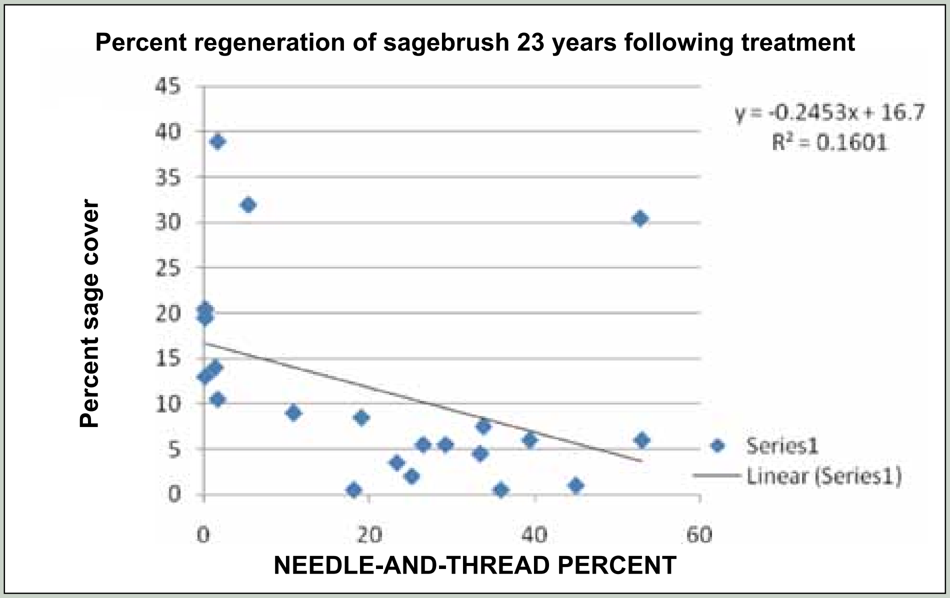


Figure 3. Regeneration in percent sagebrush cover 23 years following removal of that originally present as a function of original rhizomatous wheatgrass percent composition of herbaceous vegetation.

Paradoxically, the sagebrush-bunch grass state, in this case sagebrush-needle-and-thread, is considered to offer the best sage-grouse habitat values for nesting cover (Cagney et al., 2010, B-1203) and is the reference state for the Sandy ecological site.

Sage-grouse managers may find the amount of time required for sagebrush regeneration after sagebrush is removed in this state to be unacceptable where regeneration in "old" or high cover stands of sagebrush is considered desirable for habitat rejuvenation.

A better solution may be thinning sagebrush to a desired cover level with a selective herbicide. Where there are high amounts of rhizomatous wheatgrass, removing sagebrush increases herbaceous plant production, and sagebrush regeneration is faster, but there does not appear to be a shift from rhizomatous wheatgrass to needle-and-thread dominance in the herbaceous vegetation component.

As with the sagebrush-needle-and-thread state, for rejuvenating sagebrush in the Sagebrush-rhizomatous state, thinning would appear to be the treatment of choice for maintaining sage-grouse habitat values.

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Nutrient management

(manure!) for better profitability

By Dallen Smith
Educator
University of Wyoming
Cooperative Extension Service

Management of manure used to be called waste management, but many practitioners believed the name needed to be changed because manure is not a waste but has much value when applied to crops.

Nutrient management is important business – sometimes highly sophisticated and sometimes not.

Management of manure used to be called waste management, but many practitioners believed the name needed to be changed because manure is not a waste but has much value when applied to crops. For example, manure applied to corn is valued around $100 per acre.

Nutrient management has come under more scrutiny since the Environmental Protection Agency (EPA) makes the rules governing how producers manage nutrients on their farms. The EPA tends to become more stringent in its rules.

In Wyoming, the Department of Environmental Quality (DEQ) regulates animal feeding operations. The DEQ has the mandate that their rules must meet or exceed EPA rules or laws. Rules at DEQ are not more stringent than EPA, but they can be.

Take Yearly Soil Samples

The first and most effective action producers who use manure on their ground can do is take yearly soil samples to see if they are meeting or exceeding the crops' nutrient needs. Soil sampling is relatively inexpensive, costing about $20 to $40 per field depending on the test and if the producer gathers samples. Results take about two weeks to come back from a lab. Soil and manure sampling take the guesswork out of where the soils are nutrient-wise. Sending a manure sample in once to determine what is in the manure is also helpful.

There are book values a person can obtain from the Internet for what nutrients (nitrogen- phosphorus-potassium [NPK]) are typically present in beef cow, sheep, dairy, horse, and swine manure.

The amount of nitrogen is highly variable because nitrogen is lost to the air as ammonia. That is what you smell and sometimes see rising from a pile of manure. Remember, all the nutrients in manure are not available the year of application. There are mineralization factors that producers need to consider. Mineralization is the breakdown of manure into a usable form for crops.

Incorporate Immediately

The second most important action is to incorporate manure immediately after it is spread on land to be planted with an annual crop like corn. Losses of nitrogen by volatilization of ammonia are sharply cut as soon as

Losses of nitrogen by volatilization of ammonia are sharply cut as soon as the manure is covered by soil.

manure is covered by soil. Research in Denmark indicated that, if manure spread and plowed under immediately is rated 100 in crop production ability, manure spread and plowed fewer than two days later rates at 71, and manure plowed under two weeks after spreading can be rated at 49.

Spreading manure just ahead of tillage is preferred when manure is not used as a topdressing. When topdressing, alfalfa producers are not concerned with losses of nitrogen since mature alfalfa has a low nitrogen use – alfalfa fixes its own nitrogen.

Do In-corral Composting

The third action feedlot or dairy managers/producers can do in Wyoming's arid climate is in-corral composting. In-corral composting was developed by dairyman Andy Wick near Delta, Colorado. He has been in-corral composting for about 15 years.

To in-corral compost, build manure in the center of the corral to about 3 to 4 feet thick. Leave about a 16-foot space between the feed bunk and the manure or compost pile. Then, taper the pile up gradually so livestock can easily get on top of the pile.

Soil samples can help determine the nutrient levels of a field.

Wick starts turning the piles in his corrals in the fall on a weekly basis. He uses a ripper or disk depending on the consistency of the pile. Then, after it rains or snows, he turns the pile over and creates a dry place for his cows to lie on. He has found that, since he has started in-corral composting, the sematic cell count (bacteria count) has been kept at lower levels than those prior to this practice.

Manure Lagoon Design Important

Manure lagoons are sometimes necessary, but I would recommend these only as a last resort. Some could argue manure lagoons are a liability versus an asset. While working in Utah as a waste management specialist, the only lawsuit I saw dealt with a lagoon that overflowed, which incurred a $100,000 fine.

Most conflicts between DEQ and producers were over management or design of lagoons. If building a lagoon for a livestock operation that has wastewater on a daily basis, a two-pond system is best. The first lagoon should be sized to be always full. A true treatment lagoon – the second lagoon – should be a polishing pond. Polishing is the action in which the air above the pond helps stabilize the pond content. This reduces the amount of odor when the nutrient-enriched water is applied to a field and makes the nutrients more available to crops. The treatment lagoon is best if 16 feet deep, and the outlet should only take wastewater off the top of the lagoon. The polishing pond can be drawn down to use on crops as needed.

Wastewater is contained in fields planted to perennial grasses or a crop in vegetation treatment systems like this one at the Roman L. Hruska Research Center near Clay Center, Nebraska.

Designing lagoons in this fashion minimizes odor from the lagoons and from the wastewater applied to crops.

Vegetation Treatment System

A good alternative to a manure lagoon is a vegetation treatment system (VTS). VTS was developed at the Roman L. Hruska Research Center near Clay Center, Nebraska, as a low-cost and maintenance alternative for managing wastewater runoff of a confined animal feeding operation.

This lagoon captures wastewater runoff.

A VTS consists of a field or pasture in which perennial grass or crops are grown that can be harvested each year. The field also needs to have a berm to contain wastewater in the event of a storm. The VTS needs to be designed to meet a 25-year, 24-hour storm event. A berm above the field filters solids. The normal annual precipitation at the center is 28.4 inches per year. The field was sized so there are 2 acres for every acre of feedlot. In our arid climate, 1 acre of field per acre of feedlot should be sufficient.

In most years, NPK was actually decreasing in the field since nutrients were exported in the form of baled hay.

Methane anaerobic digesters have been built across the country primarily with research funding along with producers' private funds. Methane digesters do not run without extra management, and they have maintenance costs. A digester puts animal or human waste in slurry form into an airtight container and heated to 110° F. Gas collected off the top of the container is piped to a combustion engine or turbine. The engine or turbine turns a generator to produce electricity that can be sold to a power company and used on the grid or used directly on the farm.

I would be very cautious on the design and the expectations on the return of methane digesters. Most methane digesters are not profitable due to overhead and maintenance costs.

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Doctoral student Rajan Ghimire prepares a sample for testing in the laboratory.

More than one way to

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Jay Norton
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Department of Plant Sciences

Naomi Ward
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Department of Botany

Wyoming crop and livestock producers have always had options for utilizing their soil and water resources; they choose sustainable practices for many reasons, including lifestyle choices and maintaining profits against rising costs of fuel, fertilizer, and other inputs.

Many Wyoming producers have started looking at maximizing profits through combinations of reduced inputs and value-added products and with minimum impacts to the environment. Increased interest in certified-organic and reduced-input production approaches reflects producers' concerns about shrinking profit margins with pressures to maintain high productivity, environmental quality, and farming system sustainability.

Research near Lingle

Researchers at the University of Wyoming (UW) responded by starting evaluations of conventional,

raise a crop

UW scientists tap research center near Lingle and area producers to evaluate conventional, reduced-input, and organic approaches in cash-crop and beef-calf forage production systems

reduced-input, and organic approaches toward cash-crop and beef-calf forage production systems. The research project, funded by the USDA National Institute of Food and Agriculture Agricultural Prosperity for Small and Medium Sized Farms Program, was implemented in 2009 at the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle. The farming systems were designed by an advisory board of UW researchers, SAREC farm managers, and producers from eastern Wyoming.

One of the fundamental differences among the three approaches is the method used by each for replenishing soil nutrients. While the conventional, or typical, approach relies mostly on synthetic fertilizers, the reduced-input and organic approaches rely, at least in part, on boosting overall soil health by increasing soil organic matter content. An important component of the reduced-input approach is minimizing soil disturbance with minimum-till or no-till practices that preserve and help accumulate soil organic matter by substituting chemical weed control for cultivation. In the organic approach, both synthetic fertilizer and chemical weed control are off the table, so

Photo by Rajan Ghimire

Crops under different treatment managements in the agricultural system project field.

combinations of cover crops and approved inputs are used to bolster soil organic matter contents and provide nutrients for crops.

The Agriculture Systems Project

The research project engages nearly 20 scientists, along with the SAREC farm crew and several area producers, to evaluate the economical and environmental sustainability of the three management approaches for two production systems prevalent in Wyoming and the northern plains: production of crops for sale and production of calves for sale. This article focuses on soil quality components of the project. To evaluate the three approaches, 24 plots were established on a 36-acre half circle under pivot sprinkler irrigation (see page 51).

Conventional, organic, and reduced-input management approaches are randomly assigned within four blocks of six plots each: three for cash-crop and three for beef-calf systems.

Conventional Management Approach

The conventional approach uses chemical fertilizer to increase crop yields, pesticides to prevent and control insect pest attacks, and antibiotics and hormones to increase livestock production efficiency. This is the approach we consider typical for this area. It aims to maximize production and profitability with advanced technologies. Soil nutrients used during intensive crop and forage production are replaced chiefly with synthetic fertilizers.

Reduced-input and Organic: Alternative Management Approaches

Our reduced-input approach uses a combination of reduced disturbance and carefully applied inputs to maintain and replenish soil fertility. This approach aims to increase profits by merging integrated management of pests and nutrients with conservation tillage practices. Reduced- or no-till systems are included and lead to healthier soils that eventually reduce fertilizer and water needs but require increased use of chemical weed control. As we define it, this approach excludes the use of growth enhancers or antibiotics in livestock farming.

In the organic approach, pest control and nutrient management are based on the natural, non-synthetic or specific synthetic inputs or practices allowed by the USDA National Organic Program (NOP) standards. Soil building is an integral part of the organic production approach and includes inputs of manure, compost, and other organic amendments, as well as growing nitrogen-fixing crops in rotation with grains.

Production Approaches and Soil Quality

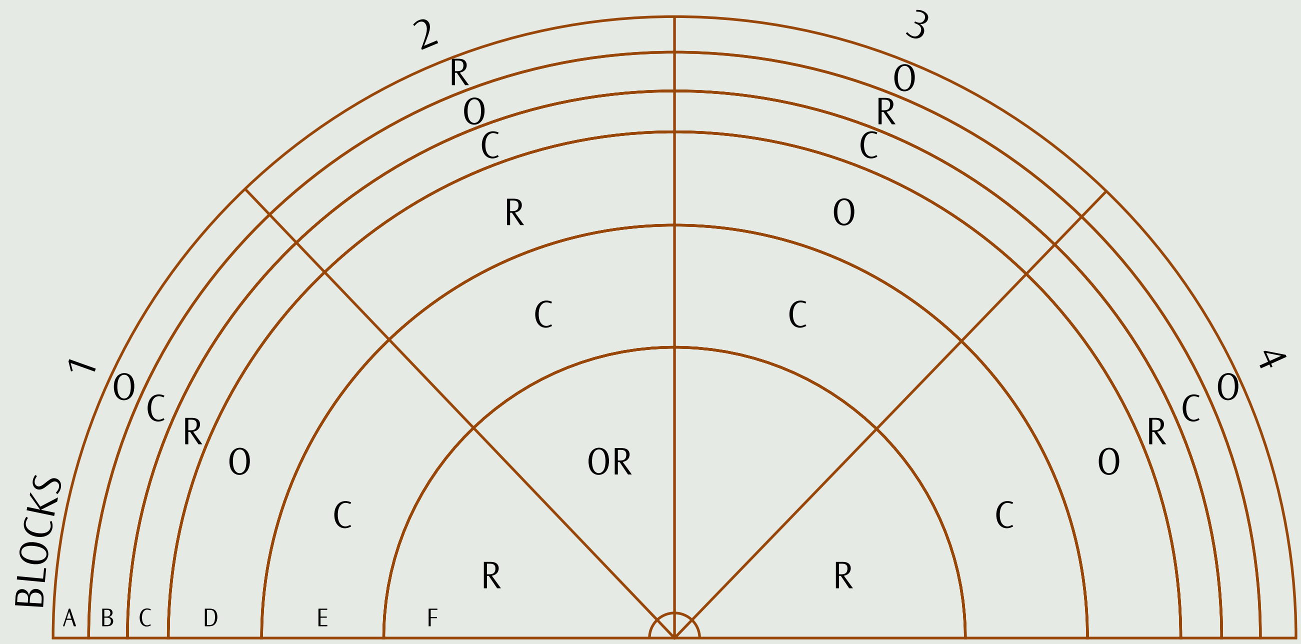
Practices and strategies proven to enhance soil quality include diverse crop rotations, minimum tillage operations, and the addition of organic amendments like animal manure, crop

Soil Sample Collection and Processing

Soil samples are collected from each plot four times a year, i.e., in spring, early and late summer, and fall. Transects are set in each plot, and 16 sampling points are located at regular intervals along the transect. Sampling points are georeferenced to locate the same place for subsequent sampling events. Samples from these 16 points are homogenized, and one bulk sample is prepared for laboratory analysis. Approximately 1 pound of subsamples are placed in three different sterile sample bags and stored in coolers with dry ice in the field. They are moved to the lab as soon as possible and stored at 4°C for evaluating soil properties, -20°C for microbial biomass and -80°C for the activity of nitrogen-cycling microorganisms, until laboratory analyses are completed.

Photo by Jay Norton

Rajan Ghimire takes soil samples from the research field.



Plot layout: Tiers A, B, and C are 1-acre cash-crop plots; tiers D, E, and F are 2-acre beef-calf plots. Entire area has been in conventionally grown continuous corn for six years.

residues, and compost. The organic and reduced input approaches use these strategies to enhance soil quality and environmental sustainability. Compared to the conventional approach, these production approaches maintain higher levels of soil organic matter (SOM) resulting in more beneficial microorganisms, superior soil quality, and higher productivity.

Both organic and reduced-input management maintain productivity partly by increasing SOM content; certified organic approaches through amendments and soil-building crops; and reduced-input approaches through conservation tillage and soil-building crops. One of our research questions is to test the effectiveness of such soil-building practices in Wyoming's high, dry, and cold environment. Effective soil-building practices for organic production might be beneficial for other operations as well.

Soil Quality Evaluation in the Agriculture System Project

Changes in soil physical, chemical, and biological properties, as well as the composition of trace gases emitted to the atmosphere from plots, are evaluated as indicators of soil quality. Figure 1 (page 53) summarizes the project and explains how different physical, chemical, and biological properties are interrelated to influence soil quality.

Soil, Microbial Properties as Soil Quality Indicators

To assess changes in soil quality, we monitor pH, porosity, available nutrients, and SOM components related to short- and long-term sustainability. Changes in total microbial biomass and activities of microorganisms active in the nitrogen cycle are also monitored as indicators of soil quality. Changes in these soil properties indicate whether soil quality is improving or deteriorating in response to the management.

> We expect that, given time, plots will show similar competitive results with respect to soil quality.

Researchers extracted field moist soil samples.

Photo by Rajan Ghimire

Measurement of Microbial Biomass and Activity of Nitrogen Cycling Microorganisms

To study microbial biomass, soil samples (~5 gram) are extracted into a mixture of water, chloroform, and methanol followed by separation into different lipids. The lipids are analyzed, and biomarkers of different phospholipid fatty acids present in the extract are identified through gas chromatography. Different microorganisms have different biomarker fatty acids, thus, presence of these fatty acids indicates different groups of microorganisms present in the soil. More diversity and higher microbial biomass indicate good soil quality because diverse groups perform diverse functions to transform nutrients and make soil more productive.

To evaluate the functional potential of specific microbial groups like nitrogen-cycling microorganisms, soil microbial DNA is extracted from field samples, and molecular biology approaches are applied. For instance, free-living, nitrogen-fixing organisms have a specific gene (nifH), encoding part of a protein (nitrogenase) that performs this function. Estimating the quantity of this particular gene in a soil sample helps estimate the abundance of the nitrogen-fixing organisms in that soil. Similarly, we estimate quantities of denitrifying organisms by evaluating abundance of relevant genes (nirK and nosZ) in different treatments.

Trace Gas Emissions as an Indicator

Soil microbial processes also result in production of several greenhouse gases responsible for climate forcing. The quantity of carbon dioxide, methane, and nitrous oxide emitted from the soil surface is an important and management-sensitive indicator of the rate at which organic matter can be lost to the atmosphere. These so-called trace gases will be measured in the third and the fourth year of the study by collecting gas samples from canisters placed on the soil surface.

Concept Behind this Evaluation and the Evaluation Process

Evaluating soil quality parameters involves field assessment and laboratory analysis of soil properties and crop performance. In this study, soil samples are collected in the field during spring, summer, and fall, processed immediately, and analyzed for different soil quality parameters, i.e., soil organic matter, nutrients, microbial activity, etc.

Research from other regions indicates typical tillage and intensive cropping practices tend to pulverize aggregates and lead to loss of organic matter and decline of quality, while alternative approaches that rely on soil-building practices promote recovery of soil structure and increase diversity of soil biological communities, increasing plant-available nutrients and soil water holding capacity.

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Photo by Patrick D. Miller

Trace gas measurement chambers in the project laboratory in the College of Agriculture and Natural Resources.

Trace gas emissions will be measured starting this year in the field in small chambers and quantified in the laboratory. Within each plot, gas samples will be collected from the chambers, each consisting of a permanent polyvinyl chloride (PVC) pipe anchor (20.3-cm inner diameter; 5.0-cm height) and a PVC cap (20.3-cm inner diameter; 10.0-cm height) with a vent tube and sampling port. Gas samples from inside the chambers will be collected with a 20-mL syringe at 0, 20, and 40 minutes after installation. After collection, gas samples will be injected into 12-mL evacuated glass vials sealed with rubber septa, and gas content will be measured in the laboratory by gas chromatography. In this technique, gas samples collected in the field will be passed through a column and interact with the compounds coated on the walls of the column. This causes each compound (carbon dioxide, methane, and nitrous oxide in this experiment) to react at a different time, which is measured by a sensor giving the respective amount of gases emitted from the soil in a given period of time.

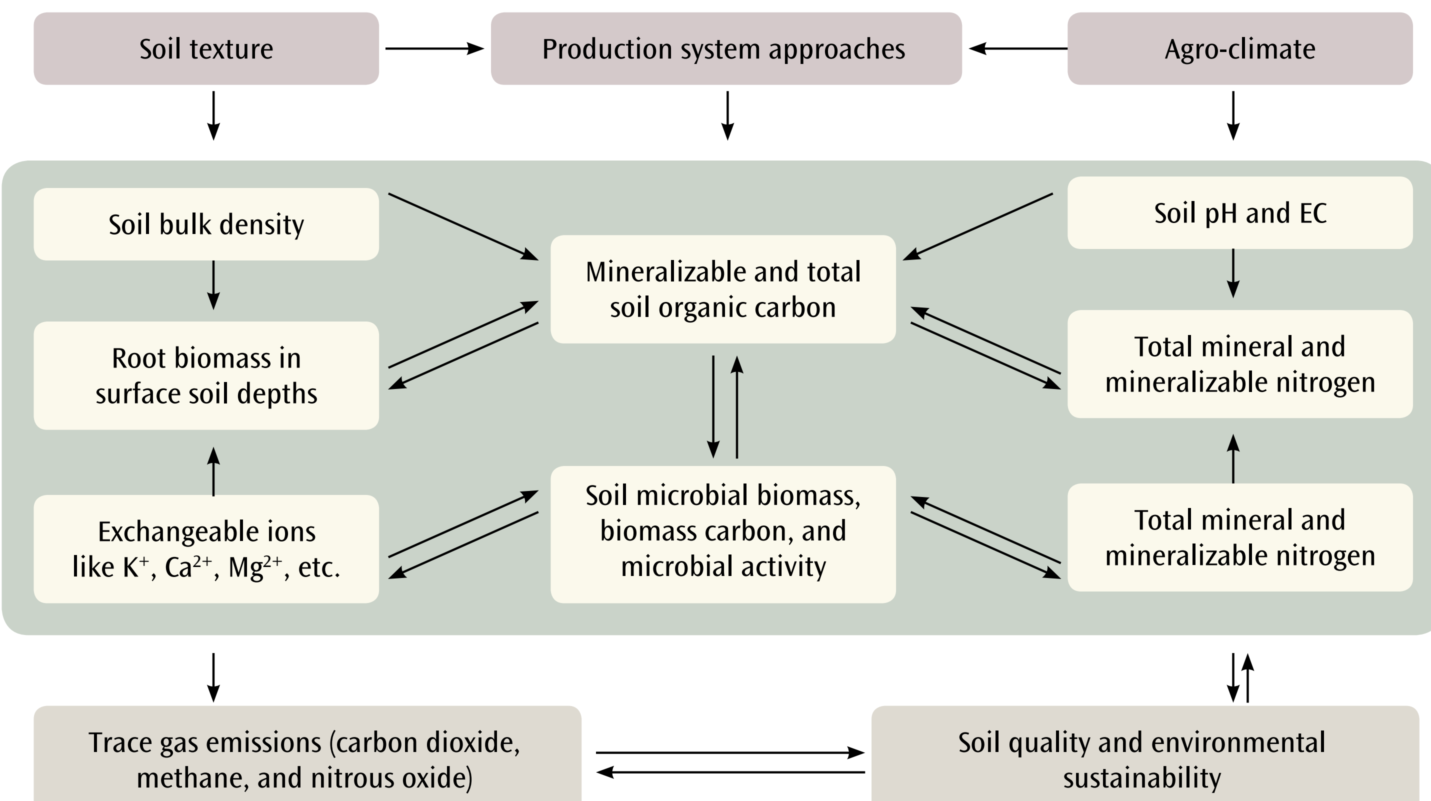

Figure 1. Conceptual framework of the soil quality assessment in agriculture system project.

Map of South Island, New Zealand. Location of AgResearch campus designated by ★

(Map: Google)

UW scientists collaborate with New Zealand researchers

Examine genetics, methane as ways to predict feed efficiency in sheep

Kristi Cammack
Assistant Professor
Department of Animal Science

$$\text{Efficiency} = \frac{\text{Effective output}}{\text{total input}}$$

"Efficiency" has received a lot of press lately.

We think of fuel efficiency, energy efficiency, and even economic efficiency. But what exactly is efficiency? By definition, it is the ratio of the effective or useful output to the total input in any system.

The link between efficiency and profitability is quite obvious. As simply put by Benjamin Disraeli, a British prime minister in the 1800s, "There can be economy only where there is efficiency."

Livestock producers are constantly looking for ways to become more efficient and improve their bottom lines. Traditionally, this has meant looking for ways to increase output, such as boosting carcass weights or getting a better price for their products, or marketing on a grid that rewards carcass merit. However, many are looking at the input side of the efficiency equation to improve profitability.

The greatest input cost for livestock producers is feed. Feed resources typically account for 50-70 percent of total input costs for sheep producers and 60-65 percent for beef cattle producers. While substantial, these input costs also represent opportunities to improve profitability.

Residual Feed Intake

The idea of efficient feed use is not new to the livestock industry. Measures such as feed efficiency and feed conversion are familiar to most. However, residual feed intake (RFI) is a more recent measure of feed efficiency.

RFI was established in the 1960s. RFI is estimated as the difference between an animal's actual observed daily feed intake and the daily feed intake predicted to be required for maintenance of its body weight and a specified growth rate. A **negative** value means the animal consumed less feed than expected for a given maintenance and rate of growth and is therefore more efficient. In contrast, a **positive** value means the animal consumed more feed than

Doctoral student Rebecca Cockrum, right, explains the GrowSafe feed system at the sheep research facility to Stacie Clary, Western SARE communications specialist. The system is the only one in the U.S. specifically designed for sheep.

expected and is therefore less efficient. RFI is not thought to be correlated with rate of gain or body size; therefore, improvements in feed efficiency via selection for RFI should not result in greater mature size – a distinct advantage over more traditional measures of feed efficiency.

Requires Feed Intake Measurements

But, like the traditional measures of feed efficiency, RFI requires feed intake to be measured on individual animals. That is something neither practical nor feasible for most producers or even most researchers! However, the University of Wyoming houses two GrowSafe automated feed intake systems – one for sheep and one for beef cattle. These systems, are useful to identify rams and bulls on-test that are superior for RFI. Unfortunately, only a small number of animals are able to be tested with these systems; therefore, alternative methods of identifying feed efficient animals are needed.

Genetic Markers Important

Genetic markers may be the answer researchers are looking for. Genetic markers are simply DNA variants associated with the trait of interest; in this case, RFI. Development of genetic markers for RFI would allow producers to assess breeding stock by simply sending a hair, tissue, or blood sample to a laboratory for DNA analysis. A report would indicate the predicted feed efficiency of that animal. Selecting breeding stock superior for feed efficiency would greatly impact livestock production because genetic selection provides the opportunity to make permanent, far-reaching changes in production efficiency.

Genetic Selection in Sheep

My colleagues and I are part of a collaborative effort to make genetic selection for feed efficiency a reality for sheep producers. We have paired with researchers at AgResearch in New Zealand (www.agresearch.co.nz/Pages/default.aspx) to identify genetic markers for residual feed intake.

We at UW have the ability to measure RFI in sheep; the team in New Zealand has the ability to test for DNA variants that may be potential markers for RFI. Sheep are tested for more than 60 days on the GrowSafe system at UW to get RFI measurements. Blood samples are collected from each tested animal, and DNA is extracted from


(Photo by AgResearch)

AgResearch campus in Mosgiel, New Zealand.

The partnership between UW and AgResearch of New Zealand allows investigators to address research questions neither group could alone.

each blood sample. The DNA samples are being stored at UW but will be sent to New Zealand for DNA analysis.

This is all the work of my doctoral student, Rebecca Cockrum. Cockrum will have the opportunity this December to spend six weeks in New Zealand assisting with the DNA analysis as part of her dissertation. Her data will be combined with other data being generated in New Zealand and other sheep research stations. “I am very excited about the opportunity to collaborate with researchers at AgResearch in New Zealand as it not only provides me with a chance to learn about different management production systems, but I will be able to gain first-hand experience in using cutting-edge genetic technology,” notes Cockrum.

RFI-Methane Link?

New Zealand researchers are also able to measure methane production in individual sheep. Many research reports have indicated a link between RFI and methane production; animals with better RFI produce less methane gas. This may become of greater public interest as the demand to reduce agriculture’s environmental impact grows.

The partnership between UW and AgResearch of New Zealand allows investigators to address research questions neither group could alone and also highlights today’s trend of research teams becoming more international in a concerted effort to better answer tough research questions.

According to Cockrum, “The University of Wyoming has the unique opportunity to make a major impact on the sheep industry, both locally and internationally, through the collaboration with AgResearch in New Zealand. The use of genetic variants as an indicator of feed efficiency will empower sheep producers to decrease their feed costs and ultimately increase their overall profitability.”

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(Photo by Kristi Cammack)

Sheep using the GrowSafe system at the Laramie Research and Extension Center.

Advising: Beyond concrete walls

By Rachel Watson

(***Editor's note***: The number-one quality of an academic adviser is a caring attitude, which, at a minimal level, can be demonstrated by shepherding students correctly through courses they must take to earn their degrees. At a higher level, that quality is perhaps best demonstrated by an adviser venturing beyond his or her own academic specialty for a broader education – and even engaging in students' lives.)

Snow crunches beneath my woolen Polish boots adding audible punctuation to the crispness of the stargazing night.

It is nearly midnight as I walk along the Nordic ski trails of Black Mountain, Maine. It seems surreal that 12 hours earlier my skiers sped along these trails in their final race – the men and women's teams defending their national titles. The power of their presence passes through me and in ghost-like form I feel their energy. But, in the hours that have passed, the snowflakes have lost their sharp edges, rounding into wet balls and then, with the fall of night, freezing into hard ridges that hold fossilized impressions of skis.

As if awaking from a dream, I perceive the presence of my two co-coaches, Christi and Ashley, and slowly my sense of sound returns.

I am struck first by team member Willie's staccato. "It's crazy to think that we see light from stars that are actually dead now."

Devin answers in his monotone, "Yeah, and that distance makes all that much difference, so like comparing them to the sun, their appearance I mean, and yet compositional equivalence, like elements and everything."

"That's even crazier when you think about the major differences in historical philosophical interpretation.

Socrates saw the sun as that whose light causes sight and allows visible things to be seen. He saw the night as gloom, and the absence of the sun as disabling clear vision. I mean that's crazy when you think that the sun is a star, right?"

"Shut up, Willie," Devin says teasingly. His retort brings a smile to my lips as I appreciate anew their interaction. Willie, an honors student with a near-perfect GPA, benefits from Devin's analytical realism just as Devin, a geology major, gains perspective from Willie's philosophical view.

I chime into the conversation. "Historical views of the stars vary culturally. The ancient Chinese viewed the cosmos, just as they viewed time, as cyclic. They had a cyclical calendar."

"That's like the Hindu culture; they view time as cyclical, too," Willie adds.

Christi, always grounded, calls our attention back to the trail and leads us around the appropriate corner. We begin to descend what was the largest uphill in every race. Called High School Hill, our athletes found this a lame description of such a soul-sucking climb and dubbed it "Gigantor." Willie says, "It looked longer going up."

Ashley has been quiet, but her thoughts are almost audible and are a comforting hum in my subconscious. She says, "In 2005, there was a study done at the University of Virginia that showed people's perception of distance is colored by terrain. That is to say, people overestimated the distance of hills as compared to flat terrain."

"That makes me feel better," Willie sardonically replies

Morgan's face flickers into my mind. A sophomore, she has been dealt many difficulties. Asthma left her staggering on this hill; compartment syndrome frequently cripples her at the race's end. Earlier this day, I ran to the finish line where she collapsed in my lap and shook until I could massage away the tension. Funny, at this moment, the emotion that consumed me was pride. Most Nordic skiers resort to surgery for this affliction and, while this provides temporary relief, most return to the operating table. With massage, Yoga, and time, Morgan has managed a surgery-free race career.

While my pride stems partly from Morgan's training tenacity, it comes more from her determination in the classroom. Only weeks earlier, I sat in my office slogging through course preparations when Morgan called, "I get it coach! I finally get it. Today in biology, we were talking about metabolism and all that stuff and *ox. phos.* and everything and suddenly it just was there, like you said, why we can't use fats anaerobically. Acetyl-CoA has to enter in the TCA cycle. Oh my gosh, I am so stoked."

Morgan never knew that after I shared her enthusiasm over the phone, I cried; tears not of sadness, but of pride as I realized what a beautiful young scholar Morgan was becoming.

Shadows play on the trails, and I can almost see the UW flag with the bucking horse that flew here earlier today. With the flap of the envisioned flag, the stress that only a coach feels returns. In memory, it is as acute as it had been on each day of the prior week. Gnawing at the base of my stomach, it seems to wear away at already raw flesh. My mind returns to the moments prior to the men's classic race as we feverishly applied klister to our racers' skis.

But I am jerked from this reminiscence by the shouts of Willie and Devin, who now playfully throw snowballs. I realize I am standing in front of the trailer that provides the wax room for each team and, because wax can make or break a skier's race, coaches spend night and day pursuing magical combinations. In fact, of the 72 hours prior to the final race, Christi and I spent 60 of them here. A fleeting sense of irony spreads from my stomach as I recall coworkers wishing me a happy ski vacation.

I press my hand against the window of the now empty trailer. Though it is surely cold, I feel warmth spread into my heart. With this inrushing I close my eyes, allowing myself a final reminiscence. I am whirled back to

Who is Rachel Watson?

Rachel Watson is an academic professional in the Department of Molecular Biology and has co-coached UW's Nordic Ski Team for more than 12 years along with Christi Boggs and assisted by Ashley Driscoll. Boggs is an instructional designer and faculty member in Outreach Credit Programs. Driscoll is a doctoral student in biochemical engineering. Watson has received numerous honors for her teaching and advising. Most recently, she received the University of Wyoming's John P. Ellbogen Meritorious Classroom Teaching Award.

the moments following the skate race. John, coming through with a phenomenal performance, ran to the trailer, picked me up, and whirled me around in joy. One of the most successful athletes to graduate from our program, John has earned 15 All-American honors. But in John's arms, I thought not of his athletic prowess but instead of his indescribable academic journey.

Marginalized throughout high school, John was on the street before he was 16. A brilliant musician, he clung to this and somehow made his way to college. Coursework was a struggle; John sometimes teetered. But each year, skiing gave him something to which to return. With time, Christi and I helped as both coaches and advisers, and John realized he could become the high school teacher he never had, the mentor who sees past learning disabilities. John came to understand that of which I tried to remind him: a hot body is nothing without a sexy mind! One hour in the library became many, and John's GPA rose as steadily. Accepted into the physical education program, he became a classroom leader.

Gaining clarity, my focus returns to the window, and I perceive the outline of my fingertips that point like rays of sunshine to the starlit sky. I think back to a conversation in which I relayed to John my pride. He looked at me, eyes wet, and said, "Coach, there would be nothing without you; you have been my guiding star."

Now, in my tears, the brightest stars in the Maine sky blur. I realize that my fellow stargazers have headed to the cars. Our loop is finished and before dawn we must drive to Portland and somehow get 17 exhausted students onto our flight and eventually home to Laramie.

My top 10 qualities of a great adviser

By James Wangberg
Associate Dean, Director
Office of Academic and Student Programs

Thanks in large part to David Letterman, Top Ten lists have been popular for many years. Here is my top 10 list of qualities that make a great academic adviser. I do not claim to have achieved all of these, but it can't hurt to strive toward such a top 10.

1. Caring attitude. A sincere concern for students' well-being and academic success.
2. Accessibility and responsiveness. Students find you highly accessible and responsive.
3. Competent. Capable of guiding students through university policies and procedures.
4. Supportive. Guidance and support for students as they seek opportunities such as internships, jobs, and careers.
5. Know their students.
6. Appreciation of strengths and weaknesses.
7. Focus on the "whole person." Advising is more than getting students registered for classes.
8. Challenging. Urging students to attain their fullest potential.
9. "Tough love." Willing to take unpopular positions for students' best interests.
10. Memorable. An adviser who is long-remembered after the student graduates.

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