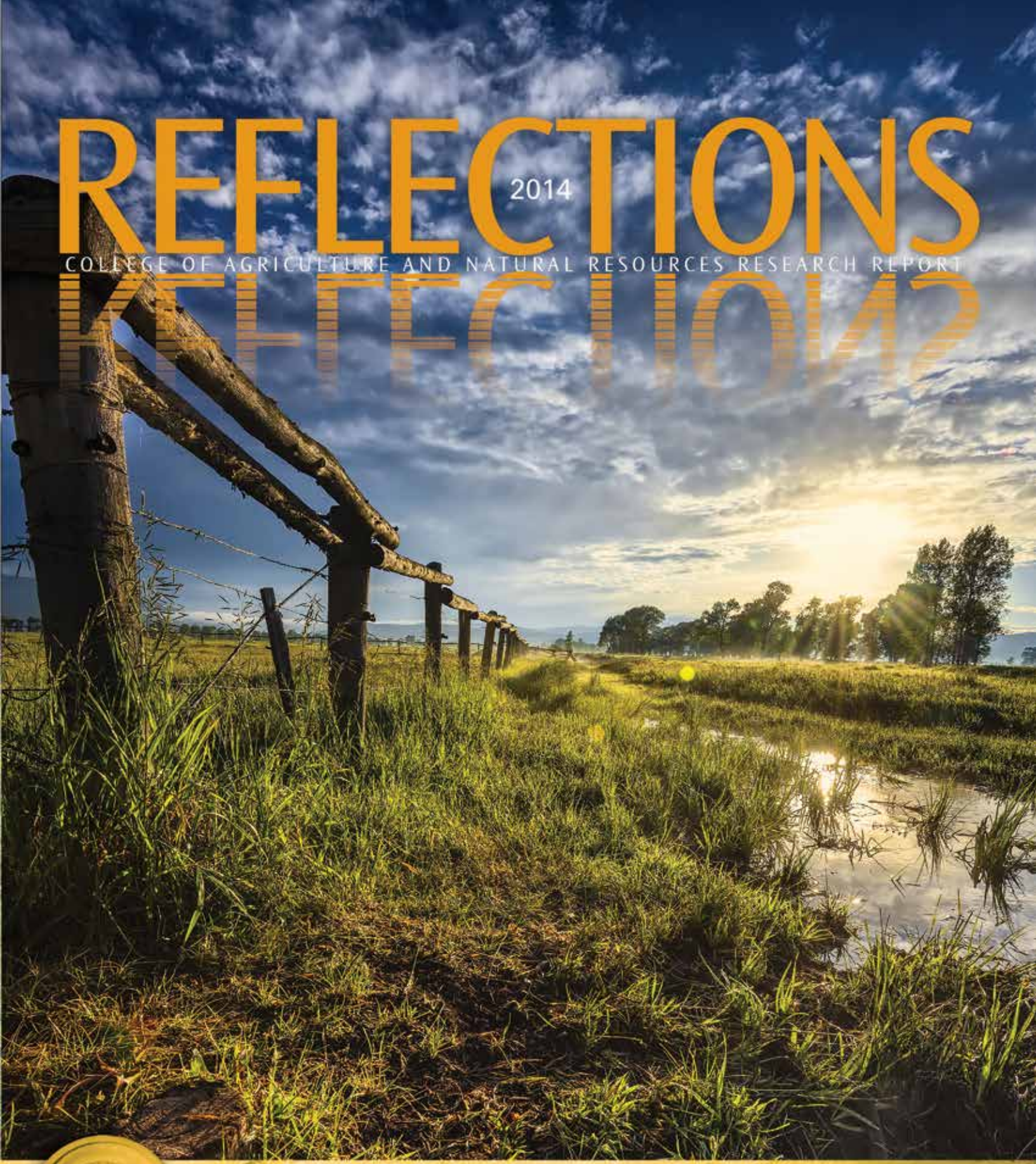

# REFLECTIONS

2014

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES RESEARCH REPORT

UNIVERSITY OF WYOMING

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

I am pleased to introduce the 2014 edition of *Reflections* on behalf of the University of Wyoming College of Agriculture and Natural Resources and Wyoming Agricultural Experiment Station.

Associate Dean Bret Hess

Readers will recognize a change in content this year. Acting upon recommendations by the marketing committee of the Dean's Advisory Board, the Wyoming Agricultural Experiment Station elected to make a modification to the 2014 issue of *Reflections* – the flagship magazine publication for research in the college. Articles describe a specific research area in each department within the college. The department with the best article as chosen by a panel of qualified judges received a cash award to be used for a research-related purpose. This same panel of judges recommended publishing a research-based article submitted by a graduate student. Other student articles submitted will be published in *Ag News*, the official publication of the college.

I sincerely hope readers enjoy the glimpse of the interesting, useful, and powerful research that takes place in every department of the College of Agriculture and Natural Resources.

As always, we welcome your input. Please feel free to contact me with your comments, suggestions, and questions at (307) 766-3667 or aes@uwyo.edu.

Best regards,

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

Search Wyoming Agricultural Experiment Station

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# REFLECTIONS

## contents











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Selected as the
*Reflections* 2014 top story

# HERE COMES THE SUN

## Not to overdo – but sunshine is good to prevent what can ail you

*D. Enette Larson-Meyer*
*Associate Professor of Human Nutrition*
*Supervisor of the Nutrition and Exercise Laboratory*
*Department of Family and Consumer Sciences,*

*Joi Thomas*
*Doctoral Student*
*Associate Director Sports Medicine,*
*UW Athletics Department*

Vitamin D – the sunshine vitamin – has long been recognized for its role in bone health.

Since its discovery in 1921, scientists have slowly uncovered its many functions beyond bone health including muscle growth and development and immune function. Scientists now recognize low vitamin D status increases risk for many health conditions including:

- Heart disease,
- Hypertension,
- Diabetes,
- Multiple sclerosis,
- Arthritis,
- Osteoporosis,
- Inflammatory bowel disease,
- Depression, and
- Certain cancers.

### Vitamin D Status and Health of UW College Athletes

Studies in the UW Nutrition and Exercise Laboratory evaluated the vitamin D status of college athletes in relation to health and injury prevention

UW Photo Service

Sierra Jech, University of Wyoming nordic ski team

over the past five years. In contrast to most published studies and our own work with Louisiana distance runners (noted below), UW college students have excellent overall vitamin D status in the fall and spring seasons.

Vitamin D status drops, as expected, in winter with most of those not taking a supplement experiencing vitamin D insufficiency or deficiency. A recent study of 42 male and female college athletes found 74 percent had sufficient-to-ideal status (Box 2 next page), with only 14 percent and 12 percent considered insufficient and deficient, respectively.

The overall good vitamin D status of UW students may be explained by the sunny and mild climate of Wyoming during the non-winter months combined with its elevation at 7,200 feet above sea level. The climate permits leisure activities or sports training outdoors in near noontime sun (when vitamin D synthesis is most efficient) whereas the high elevation may allow for more efficient synthesis.

Although the effect of altitude on skin production of vitamin D has not been studied in humans or other animals, there is some evidence in cell cultures altitude positively affects synthesis. One study reported 400 percent more vitamin D was synthesized by skin cells in noon sunlight at the base camp of Everest than in cells near sea level (169 feet) at the same latitude (Nepal).

### Excess Body Fat Negative Influence

Studies at UW have also shown vitamin D status is negatively influenced by excess body fat stores (Figure 1 page 6). The negative association between body fat stores and vitamin D status has been reported by other labs but is not well understood. It has been hypothesized that adipose tissue may store or "sequester" vitamin D; however, there

## SUN AND SOURCES OF VITAMIN D

Vitamin D is unique among vitamins in that its requirement can be obtained entirely from synthesis in the skin when exposed to sunlight. In fact, the most apparent reason for suboptimal vitamin D status is insufficient exposure to the sun's ultraviolet B (UVB) rays rather than poor vitamin D intake.

Other than oily fish, most foods in the human diet contain little vitamin D (Box 1 below). Fortification of foods including milk, yogurt, margarine, and ready-to-eat cereals increases the potential for dietary intake, but vitamin D content in the typical diet is miniscule compared to the capacity of human skin to synthesize the vitamin. Sun bathing for 20 to 30 minutes at close to solar noon produces 10,000 International Units (IU) to 20,000 IU of vitamin D2. By comparison, an 8-ounce glass of vitamin D-fortified milk contains 1 percent of that amount at 100 IU (Box 1).

Synthesis of vitamin D by the skin is dependent on many environmental and individual factors including time of exposure, season, latitude, smog, cloud cover, sunscreen use, skin color (or pigmentation), skin area exposed, and aging.

Vitamin D is synthesized most efficiently at close to solar noon—when the shadow is shorter than the body – and is not made in the early morning or late afternoon or during the winter at latitudes greater than 35-37° north or south due to insufficient UVB reaching the Earth's surface at these times (Wyoming's latitude ranges from about 41-45° N). Melanin, the pigment in darker skin, as well as sunscreen and sunblock use, decreases vitamin D production by absorbing UVB rays.

**Box 1. Natural and Fortified Sources of Vitamin D in the Diet**

| | |
|---|---|
| Wild salmon (3.5 oz) – 980 IU* | Orange juice, fortified (1 cup) – 100 IU |
| Sun dried mushrooms (1 oz) – 400-500 IU | Breakfast cereal (1/2 to 1 cup) – varies by brand |
| Sardines (3.5 oz) – 270 IU | Cod (3.5 oz) – 80 IU |
| Farm-raised salmon (3.5 oz) – 250 IU | Margarine (1 Tbsp) – 8-80 IU |
| Milk, fortified (1 cup) – 100 IU | Egg yolk (free range) – 40 IU |
| Subway bun (6-in) – 100 IU | **International Units* |

is little evidence that supports this theory.

Studies with UW and other athletes have determined that maintaining adequate status protects against acute respiratory infection and low-level inflammation. The association with immunity and inflammation is not surprising. Vitamin D has the ability to turn on production of specific proteins called "antimicrobial peptides," which damage invading germs, including those that cause the common cold and certain strains of the flu.

Vitamin D has the ability to turn off production of proteins involved in inflammation including the inflammatory marker tumor necrosis factor alpha (TNF-α). Our results support the idea adequate vitamin D status is required for proper immune function and inflammation control. Length of sunlight exposure at altitude to optimize vitamin D synthesis while minimizing UV damage is not known and clearly more studies are needed (Box 3 at left).

**Box 2. Vitamin D Status in Humans**

Vitamin D status is determined by measuring levels of a specific form of vitamin D, 25 hydroxy D, in blood. The most commonly used criteria are as follows:

| | |
|---|---|
| Deficient | <20 ng/mL |
| Insufficient | ≥20 < 32 ng/mL |
| Sufficient | ≥32 ng/mL |
| Ideal | 40-100 ng/mL |
| Toxicity | >150 ng/mL plus elevated blood calcium |

**Box 3. Recommendations for Sensible Sun Exposure**

Expose arms, legs, and back for 5-30 minutes at close to solar noon twice weekly without sunscreen depending on season, latitude, and skin pigmentation

Apply sunscreen or use protective clothing for longer durations of sun exposure

Guidelines for sensible sun exposure are thought to promote adequate vitamin D status at close to sea level

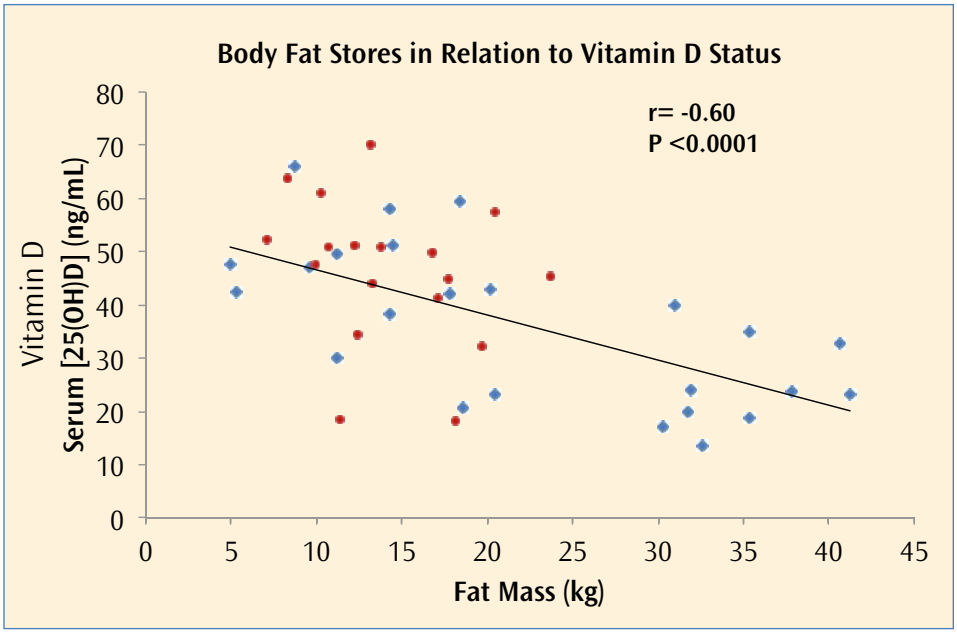


Figure 1. Male (blue diamonds) and female (red circles) with higher body fat stores had lower concentrations of 25 (OH) D in blood indicative of lower vitamin D status. Athletes with the higher body fat stores in our studies include football lineman. Source: Heller et al, in review.

## Vitamin D Function and Health Implications

Vitamin D is also unique in that it functions both as a hormone (which assists with the control of blood calcium) and as a regulator of gene expression. Recent studies report vitamin D "turns on" and "turns off" the expression of more than 1,000 genes including those involved in muscle growth and function, immunity, insulin secretion, and blood pressure. This helps explain how a deficiency of vitamin D is linked to increased risk of many diseases and health conditions.

## Vitamin D Insufficiency and Deficiency

Although vitamin D deficiency was once considered a nutritional problem of the past – it was the primary deficiency in rickets – deficiency of vitamin D has re-emerged as a health concern (see Box 2 for a definition). In fact, some scientists believe vitamin D is an unrecognized epidemic in adults and children not exposed to adequate sunlight.

A higher than expected prevalence of vitamin D insufficiency and deficiency is reported across the United States and worldwide, even in healthy young adults. One study reported 36 percent of 18-19 year olds living in

Animal science graduate students Samantha Fensterseifer, Kacey Myers, and Ben Ingold weigh pigs as part of the vitamin D study.

# VITAMIN D RESEARCH CONTINUES WITH DOMESTIC PIGS

We are interested in expanding our vitamin D research from athletics to the effects of altitude on the skins' ability to make vitamin D and why excess body fat/obesity negatively affects vitamin D status.

Because of the difficulty of addressing these questions in humans, we are exploring using the domestic pig as a human model through collaboration with Associate Professor Brenda Alexander in the Department of Animal Science.

While our future studies have an obvious link to public health, they also have the potential to benefit agriculture and meat production practices. Modern agricultural practices raise swine in confinement with limited exposure to sunlight and risk of vitamin D deficiency. Suboptimal vitamin D in the pig, like the human, may lead to bone disease, increased susceptibility to infection, and poor overall health.

Sunlight supplementation, unlike many other things, is free, and the judicial use of this supplement may have significant implications for human and animal health.

Boston (42° N) were vitamin D deficient at the end of winter. Another study conducted in Minneapolis (49.9° N) reported 93 percent of otherwise healthy individuals with persistent muscle aches had some degree of vitamin D deficiency and 28 percent were severely deficient.

Even in summer, or at latitudes where vitamin D can be synthesized year-round, most research indicates vitamin D status is less than optimal. For example, in the first vitamin D study conducted by the University of Wyoming Nutrition and Exercise Laboratory, a surprising 53 percent of distance runners training in Louisiana (30° N) were deficient or insufficient. Such high rates of insufficiency and deficiency are likely due to sun avoidance at mid-day, clothing worn, or sunscreen use.

## Future Studies

Future studies will attempt to define judicial exposure of sunlight at high altitude and determine how much sun is needed to synthesize sufficient vitamin D while also avoiding known risks of excess sunlight exposure including skin cancer and photo aging.

Indeed – here comes the sun.

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***Acknowledgements***

*A special thank you to Dr. Kent Kleppinger and all the graduate and undergraduate students who contributed to these studies: Tanya Halliday, Jenna Heller, Nikki Peterson, Joi Thomas, and Kentz Willis.*

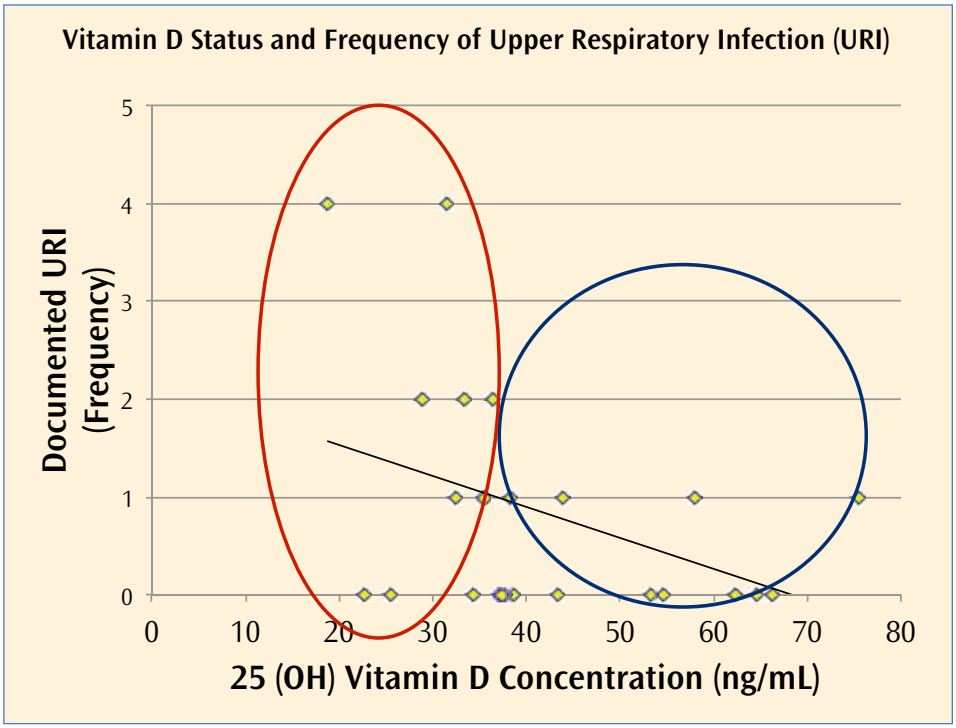



Figure 2. Athletes who had insufficient and deficient vitamin D status (red circle) in the winter and early spring experienced more documented colds and flu than did those with higher status (blue circles). Source: Halliday et al, 2011.

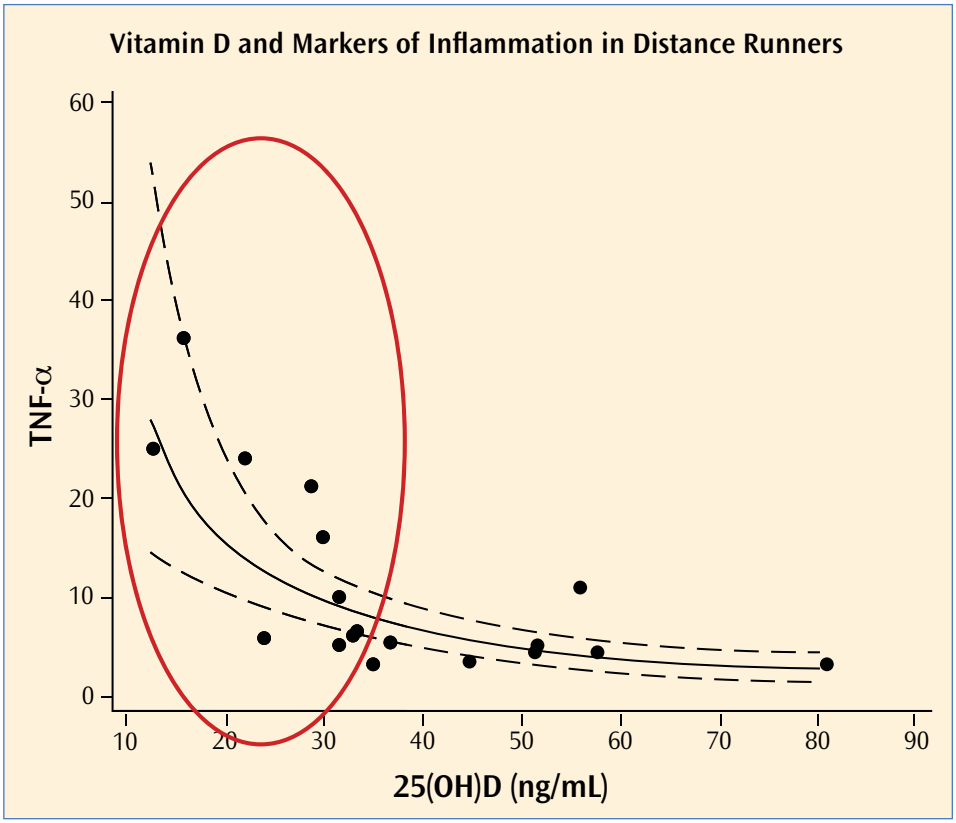



Figure 3. Distance runners who had insufficient and deficient vitamin D status (red circle) had significantly elevated levels of tumor necrosis factor alpha (TNF-α), a marker of inflammation, compared to those with sufficient to ideal status. Source: Willis et al, 2012.

http://bit.ly/hansenA

# CREATING A CONSERVATION EXCHANGE in the Upper Green River Basin

*Kristi Hansen*
*Assistant Professor,*
*Roger Coupal*
*Professor,*
*Department of Agricultural and Applied Economics*

*Ginger Paige*
*Associate Professor*
*Department of Ecosystem Science and Management*

A conservation exchange in the Upper Green River Basin could provide a new way to protect wildlife habitat and riparian function in the basin while providing agricultural producers an additional stream of revenue to help them maintain ranching operations.

Researchers from the College of Agriculture and Natural Resources are working with local partners and others to set up a conservation exchange to achieve these goals.

The Upper Green River Basin is the headwaters for the Colorado River System and home to many bird and wildlife species with environmental and recreational significance. In recent decades, the basin has experienced an energy boom from natural gas and oil extraction. This activity has increased economic opportunities in the basin but has also placed development pressures on the natural resource base.

A conservation exchange is an innovative way to provide financial incentives to private landholders for engaging in environmentally or socially beneficial activities that might not otherwise be

undertaken or continued. Landowners could benefit by implementing practices on their lands that maintain or enhance wildlife habitat and water resources. They would be the "sellers" in the exchange. Examples of practices could include altered grazing patterns and choice of irrigation practices and timing. The "buyers" in the exchange can be energy companies seeking off-site mitigation for their energy-development activities as well as local/national conservation/environmental foundations and second homeowners in the basin looking for ways to support the high-quality recreational and environmental amenities that characterize the basin.

## The Upper Green River Conservation Exchange

Landowners as early as 2007 in the Upper Green River Basin began discussing with the Sublette County Conservation District (SCCD) how they might monetize the ecosystem service benefits they provide society through responsible stewardship of their land and water resources.

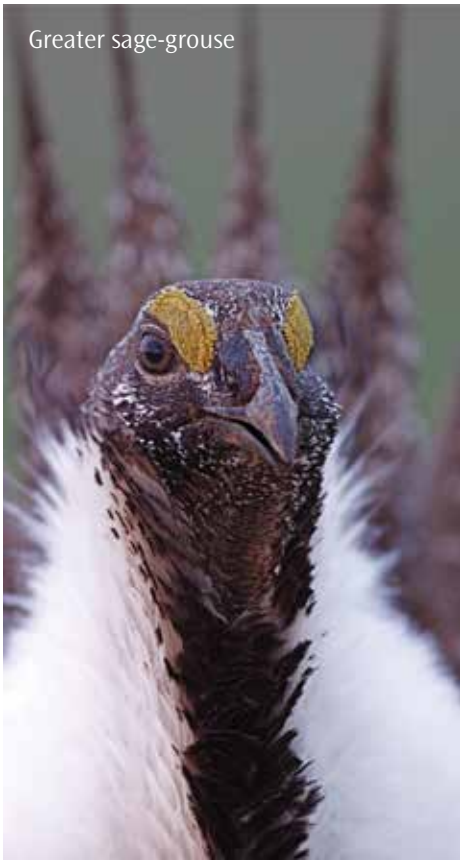
Area landowners and SCCD invited researchers from the University of Wyoming and staff members from the Wyoming Chapter of the Nature Conservancy (TNC) to Pinedale to discuss with landowners different ways to value ecosystem services. These meetings in late 2010 led directly to the formation of a working group to explore creating a conservation exchange in the Upper Green River Basin.

This working group, called the Upper Green River Conservation Exchange (Exchange), has conducted focus groups with landowners, energy companies, and regulatory agencies. In 2012, we added the Environmental Defense Fund (EDF) to our partnership. EDF brings experience in setting up conservation exchanges elsewhere in the western United States.

## What's Been Done

Scoping interviews and focus groups were conducted 2011-2013 in Pinedale, Cheyenne, and Denver with potential sellers (landowners), potential buyers (energy companies), natural resource managers (Bureau of Land Management, Wyoming Game and Fish Department, U.S. Fish and Wildlife Service, among others), and non-governmental organizations (Trout Unlimited, Pinedale-based Wyoming Land Trust, among others).

Landowners like the idea of a two-sided market in which private rather than federal money is used to fund conservation. They prefer local program administration as well as the potential for term contracts (of 5, 10, or 20 years) rather than permanent easements.


Greater sage-grouse

We also conducted a follow-up landowner survey to help us better understand landowner preferences for conservation exchange design. Results indicate landowners have a distinct preference for practices that do not directly interfere with their ranching operations (e.g., opening gates during wildlife migration periods, managing irrigation to maximize return flow, installing wildlife-friendly fencing) over those that do (e.g., removing fencing, altering grazing management).

For energy companies to voluntarily participate, they would require assurances from regulatory agencies the conservation they have undertaken through a conservation exchange would count toward their mitigation requirements for energy development.

Natural resource management agencies are primarily interested in ensuring a conservation exchange is consistent with their goals of protecting the natural resource base and managing public lands for multiple uses. The approximately 50 people interviewed emphasized the importance of scientific research to help better understand the links between conservation actions and ecological outcomes on a site-specific and landscape scale.

The role of federal and state regulatory agencies in facilitating a transaction is potentially crucial to the success of a conservation exchange in a region with a predominance of public land.

Agencies are often subject to strict regulatory requirements for fish and wildlife habitat protection/

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Melanie Purcell, Sublette County Conservation District

A roundup in Sublette County. Landowners in the Upper Green River Basin like the idea of a two-sided market in which private rather than public money funds conservation.

enhancement and threatened/endangered species management. Agencies are also subject to court rulings and state and national level policy deliberations, so they often cannot proffer hard assurances where all parties gain certainty of what the agencies will allow on other aspects of their arrangements with public land managers. This risk to both sides party to a transaction can affect the value of the transaction itself at best and generate a barrier to an agreement at worst.

If the concerns and preferences listed above can be incorporated, a conservation exchange may very well be feasible in the basin.

## What Is Happening Now

Work to determine how best to structure the market continues on four fronts. The exchange partners meet regularly by conference call to work out market design issues. For example:

- What will contracts to implement conservation look like?
- How will the risk that conservation is not achieved be shared between buyers, sellers, and the environment?
- How should the exchange be governed (and by whom) so its structure is transparent and without conflict of interest issues?

Science teams are developing tools to quantify, verify, and value protection and improvement for each of the three ecosystem services – greater sage-grouse habitat, mule deer habitat, and riparian function.

We must also ensure the exchange is consistent with state and federal stewardship objectives for public lands and at-risk species. We are working directly with the BLM and U.S. Fish and Wildlife Service (USFWS) to obtain the most regulatory certainty possible (e.g.,

## A MODEL MOVING FORWARD?

A conservation exchange in the Upper Green River Basin could provide a new way to protect habitat of, most notably, greater sage-grouse and mule deer, and riparian function, such as water quality and water quantity and timing in the basin, while providing agricultural producers additional revenue. Federal land management agencies and Wyoming state officials have expressed interest in using the Exchange as a model to address energy development mitigation needs statewide.

Melanie Purcell, Sublette County Conservation District

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certainty of operating permits) for buyers and sellers generating conservation through the exchange.

We held a mock transaction in March during which many potential buyers, sellers, and regulators met in Pinedale to work through how PES transactions in the Exchange would work. We are also working to inform market design and field-test quantification tools through on-the-ground pilot transactions. These exercises will provide even more feedback toward developing a conservation exchange that can work for landowners, buyers, and regulators, all while maintaining and enhancing high-quality ecosystem services.

We submitted in May an application to the USFWS to become a "programmatic" conservation bank. If accepted, conservation undertaken through the exchange to protect greater sage-grouse habitat will be recognized by USFWS. USFWS is scheduled to make a decision on whether to list the greater sage-grouse in 2015. The exchange may help eliminate the need for a listing. Discussions are under way on how best to scale the greater sage-grouse habitat portion of the exchange up to the state level, thereby providing greater protection for greater sage-grouse across Wyoming.


## FOR MORE INFORMATION

A recent publication through the UW Ruckelshaus Institute of Environment and Natural Resources puts PES markets like the Exchange into context by explaining their relationship to similar market-based mitigation efforts under way in Wyoming and elsewhere in the western United States. The publication, *Market-Based Wildlife Mitigation in Wyoming: A Primer*, is available at http://bit.ly/wyowildlifemitigation.


## Acknowledgments

Our efforts to scope the feasibility of a conservation exchange in the Upper Green River Basin have been funded by a Conservation Innovation Grant from the Wyoming office of the Natural Resources Conservation Service with matching funds from UW Extension and the Wyoming Reclamation and Restoration Center, and a grant from the Dixon Foundation.

The Wyoming Agricultural Experiment Station funded the landowner survey. The impetus for this project came from local landowners and discussions with the Sublette County Conservation District. Without their support and participation, the project could not have occurred. Thanks to project partners Melanie Purcell and Eric Peterson (Sublette County Conservation District), the Green River Basin landowners who have been involved in Exchange discussions and those who have provided us with input, Jen Lamb, Graham McGaffin, and Amy Pocewicz (TNC), Sara Brodnax and Ted Toombs (EDF), Shayna Brause and Erik Anderson (Environmental Incentives), Esther Duke (Colorado State University), and Anne MacKinnon (A. MacKinnon Consulting, Casper).



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http://bit.ly/cammackB

# MICROBIOME RESEARCH could lead to ruminant feed efficiency predictions

## Findings could eliminate time-consuming food intake tests

*Kristi Cammack · Associate Professor · Department of Animal Science*

Tiny microbes may make a world of difference for the livestock industry to make strides in producing ample protein to support a growing world population.

We are investigating the role of the rumen microbiome – the population of organisms that inhabit the rumen – in feed efficiency. Some of the questions are:

- Do more efficient animals have different microbes than less efficient animals?
- If yes, can a microbial profile predict an animal's efficiency?

### Why is this Important?

Feed efficiency is an important trait to the livestock industry. With rising feed costs, producers are increasingly interested in raising livestock that more efficiently utilize feed resources – better feed efficiency means less feed costs. Better feed efficiency provides greater profit potential because of lower feed inputs or alternatively greater stocking rates (i.e., more animals maintained on the same land resource). Feed efficiency takes on greater importance when considering the world's population is expected to increase 34 percent by 2050 and reach 9.1 billion people.

To meet the needs of an ever-growing, urban population, annual meat production will need to increase by more than 200 million tons. That will be challenging given the competition for scarce food and land resources.

### A Beneficial Relationship

The relationship between the ruminant host animal and the microbes it harbors in the digestive system is mutually beneficial. Importantly, microbes provide ruminants with the unique ability to digest forages. I have a deep-seated interest in feed efficiency that stems back to my master's program at the University of Nebraska. I worked jointly with the USDA Meat Animal Research Center to determine the genetic components of feed efficiency. This makes ruminants


Traditional feed intake tests require at least 60 days of data. Researchers are studying whether a simple rumen test could determine if an animal has microbes favorable for feed efficiency.

valuable to the ecosystem as they are able to consume feeds that cannot be consumed by people and also make use of otherwise underutilized resources.

While microbes labor to digest the feed, they provide the animal host with protein and energy, and the animal provides the warm, anaerobic environment most microbes need to survive.

## Interest Began in Graduate School

Upon coming to the University of Wyoming in 2006, I began to revisit that interest and have since built a research program focused on improving feed efficiency through genetic selection.

While of economic importance to livestock producers, feed efficiency is a difficult trait to measure because it requires feed intake to be collected on individual animals for over 60 days – a costly and expensive process. Therefore, for producers to be able to feasibly improve feed efficiency in their herds or flocks, they need to be able to assess feed efficiency in a different way.

## Focus on Rumen

We have researched various tools for easier identification of efficient animals, such as traditional genetic markers. However, our recent research efforts focus more on the rumen microbiome and how it may influence feed efficiency.

Rumen microbes were first discovered in 1843. Much has been uncovered about these microorganisms since then; however, the identity and function of many of the microbes have yet to be fully understood. Methanogens are a class of bacteria responsible for producing methane. The act of methanogenesis,

or producing methane, helps avoid hydrogen accumulation in the rumen. However, production of methane, a greenhouse gas with 21 times the warming potential of carbon dioxide, is not only an environmental concern, but also an energy sink.

Evidence suggests ruminant animals that produce less methane are also more feed efficient. These findings helped investigators establish research partnerships that may otherwise not occur. For example, we have developed research partnerships in New Zealand and Australia aimed at improving feed efficiency in ruminant livestock while reducing methane production.

While primarily interested in improving feed efficiency, our global partners are focused more on methane reduction because of government mandates to reduce the environmental footprint of animal production. A favorable relationship between feed efficiency and methane production has allowed these research teams to pool resources and conduct mutually beneficial research.

## Microbe Variations

Melinda Ellison, a Ph.D. student in my program, is investigating the role of the rumen microbiome in feed efficiency and if certain microbes vary between highly efficient and lowly efficient ruminant animals. If microbial populations do vary with feed efficiency, it may be possible to develop microbial "profiles" that predict an animal's efficiency without having to conduct an expensive, time-consuming feed intake test.

For example, a rumen sample could be collected – a surprisingly easy task – and submitted for microbial analysis to determine the presence and (or) quantity of favorable microbes. Animals with favorable microbial "profiles" could then be retained in the herd or flock or even selected as breeding stock. Ellison has been working closely with colleagues at the University of Missouri to develop an analysis pipeline to characterize and quantify rumen microbial profiles associated with better feed efficiency. She is also working with collaborators in Australia to determine if these same profiles could be used to predict methane production – a trait of primary importance in Australia's dairy industry.

Many questions remain. It's understood the rumen microbiome is highly influenced by diet.

- Are animals highly efficient on a concentrate diet also more efficient on a forage diet?
- If rumen microbial profiles are to be used as a genetic selection "tool" for efficient breeding stock, is this a heritable trait?
- How long-term could the results of feed additives or treatments be when used to "shift" rumen microbial populations?

These are just a few of the many questions we have posed – and are important ones to answer before any producer applications can be realized.

*To contact:* ***Cammack*** *can be reached at (307) 766-6530 or at kcammack@uwyo.edu.*

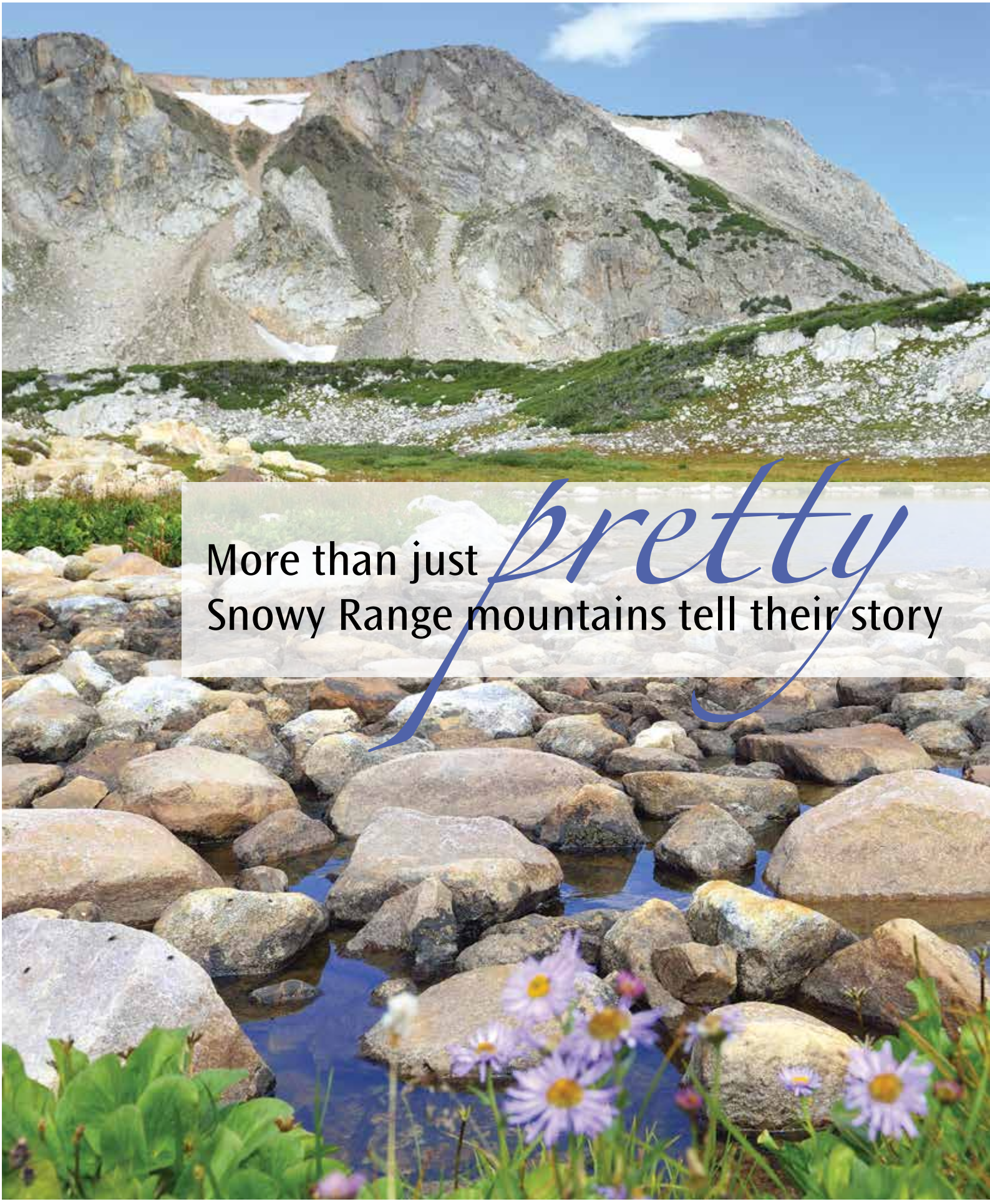
http://bit.ly/cammackC

## WHAT'S YOUR MICROBIOME BEEN UP TO?

The buzzword microbiome has been making headlines. What is a microbiome? The microbiome encompasses all of the microbes residing in and on the body.

The *New York Times Magazine* recently published an article about the effect of the microbial community on human metabolism and disease. National Public Radio aired a story showcasing the role of gut microbes on brain structure and function in humans and how that may influence certain behaviors and emotions.

The vast numbers of microorganisms that comprise the microbiome are thought to influence anything from heart disease to mental health in humans. What if the same is true for livestock – that the microbiome has an influence on many aspects of animal health and productivity?



# More than just *pretty*
## Snowy Range mountains tell their story

*Larry Munn,*
*Professor of Soil Science*

*Amarina Wuenschel,*
*Graduate Research Assistant*
*Department of Ecosystem Science and Management*

# Ice as sculptor scraped and scarred the landscape into what we see today

Imagine a huge sheet of ice sliding down over the north end of Centennial Ridge into Centennial Valley and flowing over Rock Creek Ridge onto the margins of the Laramie Basin.

It did just that. Full of boulders, tree trunks, and gouged-up soil, the unyielding bulldozer was part of a great cap of ice spread from the high crest of the Snowy Range sending lobes south almost to Albany, east and west to the Laramie Basin and Saratoga Valley, and north toward Elk Mountain.

We have inherited its effects. Rocks have physically and chemically weathered to produce clay in the older soils, and the protection from erosion provided by quartzite cobbles affect modern day hydrology and tree growth in the Snowy Range.

One would not recognize the landscape when these ancient processes were at work. This area of Wyoming was beachfront – the southern coast of North America – two billion years ago. Deposition of sand on beaches and shallow marine environments lasted millions of years and would become the Medicine Peak quartzite. The formation is up to 6,000 feet thick.

Modern names have been placed on the landscape, the ice long melted; but the quartzite cobbles from the till remain as markers of the most extensive of the known Pleistocene (about 2.6 million to 12,000 years ago) glaciations of the local mountains. A series of later glaciations were smaller.

This series of small glaciations scratching and clawing at the Snowy Range had their paths constrained by incision of the Middle Fork and North Fork drainages (of the Little Laramie River) and French Creek during interglacial periods. Outwash terraces of varying age extending in front of the terminal moraines also mark the great erosional events in the mountains.

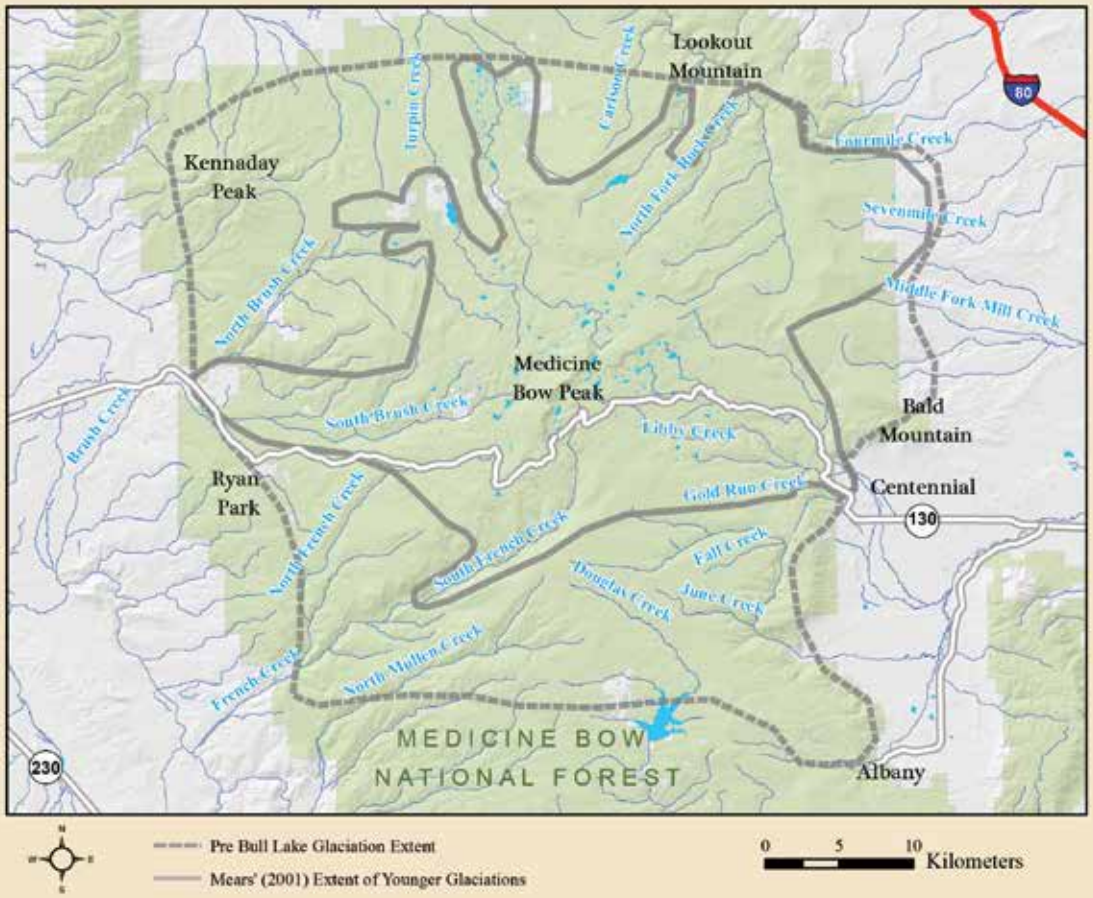
Geologists have identified the major Pleistocene glacial advances in the Snowy Range as Pre-Bull Lake (PBL), Bull Lake, and Pinedale glaciations with minor activity confined to Medicine Bow Peak during the Neoglaciation (for years, see Table 1).

## Medicine Bow Peak was Ground Zero

Medicine Bow Peak, the quartzite ridge that forms the high part of the Snowy Range, served as the gathering point of snow and ice for the glaciers of the last half of the Pleistocene. The Medicine Bow Peak quartzite is densely compressed sand from that ancient beach, which is 60 to 100 percent silicon dioxide. It outcrops now over a 386-square mile area at the top of the Snowy Range.

Chunks of Medicine Bow Peak quartzite are markers of glacial ice flow – they occur as surface cobbles and in soils formed in glacial deposits. They are common in Pinedale and Bull Lake tills, and are often the sole identifier of stones remaining in soils formed in PBL till.

Enormous pressures were at work.




## WHAT IS?

**Moraine** – Boulders, gravel, sand, clay deposits from glacial action

**Till** – Makes up a moraine. Unsorted material deposited directly by glaciers. No stratification.

**Metamorphic** – Exhibiting structural change

**Sedimentary** – Formed by accumulation of mineral and organic fragments deposited by water, ice, or wind

Figure 1. Map of extent of Pre-Bull Lake glaciation (dashed line) and younger glaciations after Mears' (2001; solid line).

Glacial ice carried Medicine Bow Peak quartzite stones across Snowy Range landscapes underlain by a variety of metamorphic and sedimentary rocks and left them pockmarked with pressure fractures. The glacial ice – a much more powerful erosive force than present-day small streams – carried boulders larger than SUVs from the top of the range. The outwash deposits in front of the moraines contain many softball and basketball-sized boulders.

The landscape scraped by the PBL glacier has been widely dissected and eroded. The quartzite cobbles and boulders that remain on upland landscapes mark the outer extent of the PBL ice's extent. The PBL glacial extent was identified by locating surface or soil cobbles of Medicine Bow Peak quartzite with pressure-cracked surfaces. These locations were used to sketch a line of terminal moraines for the PBL glaciation in the Snowy Range (see Figure 1).

The area wears rock armor. The durable quartzite stones in the PBL glacial deposits protected the surfaces from erosion, and many of the ridges extending eastward into the Centennial Valley have a protective cover of quartzite cobbles from the glacier.

Such terrace remnants also occur northwest of 10,810-foot Kennaday Peak (northwest from Medicine Bow Peak). The PBL deposits exist in varied states of preservation from intact, 3-meter thick soils, to a remnant surface stone layer.

One can still spot effects of the PBL glaciation despite the passage of eons. A terrace in Centennial Valley is an outwash remnant from PBL glaciations, and a boulder deposit with clay-rich soils in the South Fork of the Little Laramie River may represent the southern-most glacial ice extent in the Snowy Range.

## Old Landscapes Tell Useful Story

Eons of time wrote a textbook to show how the soils developed. Soil characteristics are reflected in each

TABLE 1

| Rocky Mountain Glacial Episode | Pre-Bull Lake | | Bull Lake | |
|---|---|---|---|---|
| Ending Years Before Present | 700,000 | | 140,000 | |

Glacial block field in Upper French Creek.

time period. With increasing age, forest soils in the Snowy Range:

- become thicker,
- contain more clay,
- have decreased coarse fragment content,
- have increased relative proportions of quartzite coarse fragments, and
- the sub-soil becomes redder/yellower.

Fire and ice meddled in the development of the soils. Surface organic layers are closely tied to fire history and are similar on soils of all ages. The acidity of the litter layer under dense conifer stands creates a universal ashy gray surface mineral layer that becomes thicker with time. Soils under forests become increasingly acidic.

Soils on the younger Pinedale moraines are thin and rocky. The weathered zone of the soils is typically about 29 inches thick with little clay (5 to 10 percent) and 40 to 70 percent coarse fragments. Quartzite comprises 20-25 percent of the stone.

Soils developed in Bull Lake moraines are thicker (to about 69 inches or more) with a rock content of 35 to 40 percent by volume. Quartzite

## TIME AND TEMPERATURE

According to the National Park Service, for 90 percent of the last 600 million years, world temperatures have averaged 72°F; today they average about 58°F – significantly cooler. Yet, during ice ages, world temperatures were cooler still, probably below 50°F.

Half-million year-old soil developed on Pre-Bull Lake moraine (note red color and relative lack of stone).

| | | | | | |
|---|---|---|---|---|---|
| Pinedale |  | Neoglaciation |  | Little Ice Age |  |
| 12,000 |  | 3,000 |  | Post 1850 |  |

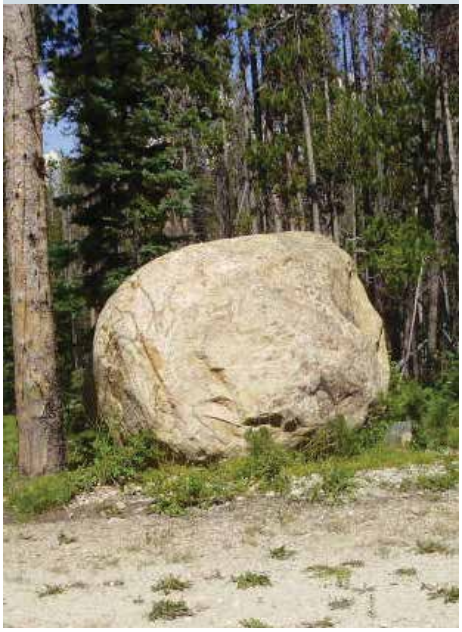
## HOW GLACIERS CARVE ROCK

Scratch a rock with a piece of ice. Will the ice scratch the rock? No. Rock is harder than ice. So how do glaciers manage to carve large tracks of land if ice is softer than the rock?

Two processes are at work. Water infiltrates cracks and joints of bedrock over which glaciers flow, then freezes. As water freezes, it expands and loosens the rock. A glacier can then carry the rock away. This is glacial plucking.

Glaciers can serve as sandpaper and chisels. Sediment and rock frozen to the bottom and sides of glaciers scour, grind, and scrape rock surfaces gradually wearing them down and away. Rock against rock scours the landscape and leaves gouges or even a finely polished surface. The sediment the glacier uses to abrade the surface may be ground so fine it becomes glacial flour. In some cases chips may be vibrated off leaving chattermarks.

*– National Park Service*



Ice-moved quartzite boulder carried from the Snowy Range crest down to the moraine.

Pinedale moraine above Centennial (note the young, rocky soil).

stones make up 40 to 70 percent of this total. Subsoil color is a strong brown, and clay is mixed (vermiculite, illite, and kaolinite).

Soils developed on PBL tills, the oldest, may be thicker than 118 inches. Rock content is 25 to 30 percent with almost all of the rocks being quartzite (95-98 percent). The red subsoil contains an abundance of the highly weathered clay kaolinite.

### Land Use Dictated by Effects of Time

The forces over millions of years shaped present land use and management. The thin, stony soils on Pinedale moraines retain less snowmelt water to support tree growth. They are also poor filters for septic tank leach fields at cabin sites but are less subject to compaction under logging equipment and human feet.

Soils on Bull Lake moraines have higher water holding capacity and are more effective wastewater filters. They are less stony, however, and so are more easily compacted. Soils on PBL surfaces are now quite variable, but the thickest have very high water retention to support tree growth.

There have been other landscape changes in the northern Snowy Range since PBL time. They include incisions by the Middle Fork of the Little Laramie River and Lower Fall Creek of about 131 to 219 yards and deeper incision of French Creek, and the development of a quartzite cobble stone line approximately 12 inches below the surface of Cinnabar Park northeast of Rob Roy Reservoir.

Geologic erosion has also shaped the landscape since the PBL period and is now preserved in widely varying forms from floater quartzite cobbles over granite residuum to soils that are more than 3 meters thick with well-developed profiles. There is an outwash terrace remnant in the Centennial Valley, and the trench dug for the Cheyenne aqueduct between Rob Roy Reservoir and Lake Owen contained Medicine Bow Peak quartzite in alluvial deposits on the northeast corner of Mount Owen. Soils in the South Fork of the Little Laramie River above Albany contain Medicine Bow Peak quartzite cobbles in clay-rich soils. This may be the southernmost extent of the PBL glacier.

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# University of Wyoming SCIENCE POSSE

## Inspiring the next generation of Wyoming scientists and mathematicians

*Jan Truchot*
*Research Scientist · Department of Molecular Biology*

*Megan Candelaria*
*Science Posse Coordinators*

In classrooms across the state and in labs at the University of Wyoming, Ph.D. students with red shirts challenge students to…


Jan Truchot

Investigate the properties of polymers


Jan Truchot

Characterize herbivore and carnivore skulls


Jan Truchot

Infer an owl's diet from an owl pellet


Jan Truchot

Design a successful solar vehicle

Jan Truchot

Teachers Jeanette Wallace of Wheatland High School and Annie Fletcher of Rock Springs High School look for evidence of chemical change during the Subtle Shifts session of the 2012 Exploring Science Workshop for Teachers in Laramie.

## Who are These Red-shirted Ph.D. Candidates?

They are members of the University of Wyoming Science Posse – a unique outreach program to promote science, technology, engineering, and mathematics (STEM) in Wyoming.

This cadre of STEM graduate students, called Fellows, interacts with students on campus and travels the state sharing their research and passion for science. Working with students and teachers and inspiring the next generation of STEM professionals, Fellows provide students first-hand knowledge about their research and engage them in hands-on activities related to the Fellows' fields of study.

Fellows also work with students on their science fair projects. They connect the elements of the students' projects to the real-life research process used in their labs, and individually or in small groups help students brainstorm and flesh out projects. See http://bit.ly/researchtalks.

Middle and high school students explore science and mathematics more in-depth during weeklong summer Exploring Science Camps. The middle school camp, a collaboration with the Teton Science Schools, is at the TSS Kelly Campus. The high school Energy Summer Institute, a collaboration with the School of Energy Resources and the EE Nano GK-12 project, is in Laramie.

## What the Science Posse Provides Teachers

Science Posse Fellows help teachers answer the question, "When are we ever going to use this stuff?" as they connect what they do as scientists and mathematicians in the real world to what students are learning in classes. See http://bit.ly/possefellows.

Fellow Lisa Kunza created a lab based on her research on the nitrogen cycle for Kim O'Connor's eighth graders in Pinedale. After the lesson, Kim commented, "I have been teaching the nitrogen cycle for years, but for the first time, I truly understand it!"

Working with the Science Posse has also given teachers confidence to extend and expand what they offer students.

Julie Eakin, a Laramie Junior High teacher, was inspired to purchase state-of-the-art Vernier probes after watching how excited her students were about using them on a field trip with Posse Fellow and ecologist Jamie Crait.

The Exploring Science Workshop for Teachers, a collaboration between the Science Posse and the NASA Space Grant Consortium, provides summer professional development in science content and pedagogy. Teachers visit UW research labs, learn about campus resources, learn about the posse's and Space Grant's statewide outreach, and learn how to better integrate inquiry into teaching.

Megan Candelaria

Posse Fellow Dan Mays (red shirt and hat) from 2009-2010, and who received a Ph.D. in mathematics in 2010, hikes with students during a Science Camp for Middle School Students at the Teton Science School near Kelly.

## Why is there a Virtual Science Posse?

The Science Posse travels to every corner of Wyoming, but winter travel is often problematic. When travel isn't safe, Posse Fellows conduct virtual visits using video conferencing software. Fellows have virtually visited classes in Thermopolis, Big Piney, Cheyenne, and Meeteetse.

These virtual visits are as interactive, engaging, and effective as an in-person visit. The nitrogen lab Kunza taught to O'Connor's students was virtual; Lisa in Laramie and the students in Big Piney all had the same equipment and worked through the experience together – 300 miles apart. To request a virtual visit, go to http://bit.ly/virtualposse.

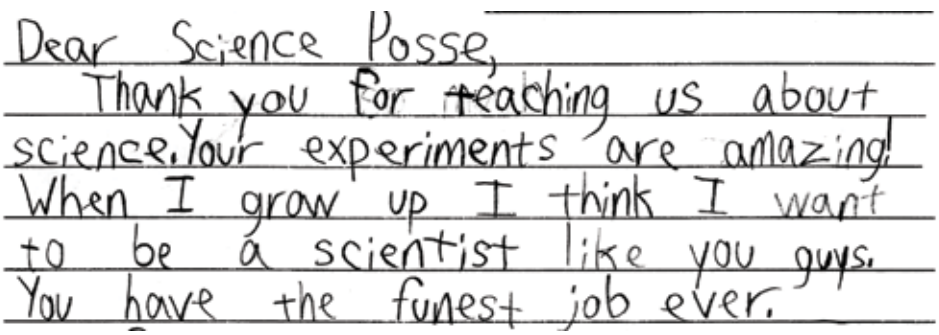
## Science Posse Impact

Many of Wyoming's 576,000 people live in small towns with little local access to research scientists, mathematicians, and engineers. From the time it was started in 2005 by Don Roth (deputy director for academics in the School of Energy Resources), the posse's free programming has reached an average of 3,300 students per year in 113 different schools or afterschool/enrichment programs in 35 school districts in all 23 Wyoming counties.

The Science Posse's statewide STEM outreach brings practicing scientists together with students and teachers on campus, in their schools, in person, or virtually, with lessons that connect classroom learning to the real world of science and mathematics. See http://bit.ly/posselessons.

As one teacher said, "The activities that the Science Posse brought for the students to do were great. The presentations were very interesting, and I think the students got a lot out of it. More importantly, one teaches by who they are. The posse members were terrific models of actually enjoying knowledge and learning and following their passion in productive ways. It was such a gift for them to share themselves and their knowledge with us, given their busy schedules."

For students, learning about the Fellows' careers in science or mathematics, seeing how the Fellows' research has the same elements as a science fair project, being wowed by a mini-lesson on hissing cockroaches, or seeing how classroom learning is


Dear Science Posse,
Thank you for teaching us about science. Your experiments are amazing! When I grow up I think I want to be a scientist like you guys. You have the funest job ever.

Jan Truchot

A member of the Science Posse's Cockroach Corps volunteering for action during an inquiry lesson on energy with Jenny Palm's fifth and sixth graders at St. Laurence School, Laramie.

connected to what the Fellows do in the real world, makes science and mathematics something more than what is in the textbook: it becomes real and relevant to the students' lives.

For teachers, working with the Science Posse's scientists, engineers, and mathematicians in their classrooms or during professional development enhances their knowledge of both content and pedagogy. One teacher wrote on the evaluation, "Other teacher training is often an insult to our intelligence, but this one is giving us a chance to experience the activities and enrich our own learning. We are expanding our knowledge and growing as teachers. There was lots of opportunity for discussion of how to apply the methods in the classroom. The Posse members were great at explaining the science, and I got many good ideas for incorporating more science into classroom lessons. The instructors modeled what they were teaching us about how to engage and enrich learners. Each person giving us information modeled for us."

> Science Posse Fellows help teachers answer the question, "When are we ever going to use this stuff?" as they connect what they do as scientists and mathematicians in the real world to what students are learning in classes.

For Fellows, their unique experiences are creating a generation of research scientists and mathematicians dedicated to and well-versed in communicating their research and its importance to the public. They also promote successful collaborative communication with members of their own fields and the scientific community.

Science Posse Fellows are selected in part because of their potential to be leaders in their fields. In 10 years, they will be university faculty members, managers in industry, entrepreneurs, and government employees who will know how to work effectively with teachers, are interested in doing so, and will encourage others to join them. Moreover, they will be a generation of leaders in scientific fields experienced in and passionate about community and school outreach. Perhaps most importantly, they will have the ability and the drive to communicate the importance, impact, and meaning of the work that they do.

One Fellow summed up the Science Posse experience saying, "I love to work with the kids! It is an amazing feeling when you can see the transformation from uncertainty to excitement. Some kids think science is boring or too hard and all of a sudden, the light goes on. That's priceless!"

The Science Posse's NSF funding continues through April 30, 2015. We are actively seeking funding to ensure all students and teachers access to educational and interactive outreach beyond this time and are hopeful other funding is on the horizon. If so, the Science Posse, once characterized by a member of the UW faculty as "the best ambassadors that the University of Wyoming has in the state," will not ride off into the sunset in April of 2015.

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**For Science Posse audio clips:**
http://bit.ly/scienceposse1
http://bit.ly/scienceposse2

**For Science Posse videos:**
http://bit.ly/scienceposse4

# MINT RESEARCH
## in Wyoming smells sweet

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Wyoming producers could tap into a lucrative and expanding peppermint and spearmint market.

The United States is a major producer of peppermint and spearmint, which is a multimillion dollar business in the Midwest and northwestern U.S. The resulting mint biomass after extraction of the essential oil can be used as animal feed.

The long-term goal of this research at the Sheridan Research and Extension Center (ShREC), the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle, and the Powell Research and Extension Center (PREC), is to establish a sustainable mint essential oil production industry in Wyoming.

Our research efforts focus on four mint species: peppermint (*Mentha piperita*, cv. Black Mitcham), two spearmint species ('Scotch' spearmint, *M. gracilis*, and 'Native' spearmint, *M. spicata*), and Japanese cornmint (*Mentha canadensis*, synonym *M. arvensis*).

### Name has Roots in Greek Mythology

Mints belong to the genus Mentha in family Lamiaceae – a fascinating plant family with many individual plant species producing essential oils. The genus Mentha is named after the nymph Minthe (also called Menthe or Mentha) in Greek mythology. According to Greek mythology, Minthe was a nymph and Pluto's mistress. When Pluto's wife found out, she became enraged and transformed Minthe into a fragrant plant.

Essential oils are plant chemicals called secondary metabolites. They play a role in the plant's defense mechanisms against various pests and diseases. Most essential oils possess antimicrobial, antifungal, antioxidant, or other biological activities.

The essential oils are chemically diverse and very complex. Oil from a single plant species may contain up to 15 main compounds and up to 200 minor compounds. The specific ratio between the main compounds gives them a specific aroma, biological activity, and delineates its uses. Essential oils are highly concentrated natural products. For example, a 55-gallon drum of mint oil is sufficient to flavor 5,200,000 individual chewing gum sticks or 400,000 packages of toothpaste.

Field trials with the four mints were established in spring 2011 at Sheridan.

Valtcho Jeliazkov standing in 'Native' spearmint species.

Peppermint and two spearmint species ('Scotch' spearmint, and 'Native' spearmint) are grown in the United States and around the world for production of peppermint and spearmint essential oil, respectively. Mint oils are used in confectionary, food (chocolate, sweets, ice cream, margarine, jelly, jam) and beverages, pharmaceuticals, aromatherapy, and also in numerous consumer products such as tobacco, chewing gum, toothpaste, and mouthwashes.

## Needs Long Hours of Daylight

Peppermint originated in Europe and was introduced in the United States multiple times with European immigrants in the 17th and 18th centuries. The first peppermint essential oil in the United States is believed to have been obtained in 1790. U.S. peppermint is known for its high quality and conveys premium prices in international markets. Peppermint requires long hours of sunlight each day – more than 14 – to produce high-quality oil. Therefore, peppermint must be grown in latitudes north of the 44th parallel (such as Wyoming) to produce high-quality oil.

Japanese cornmint, also known as menthol mint, is grown in Asia and South America. The essential oil of Japanese cornmint has a high concentration of menthol, making it the only suitable species for production of natural menthol. Menthol is an important aromatic agent used in various industries and consumer products.

Menthol could be synthesized artificially; however, current regulations prohibit the use of non-natural compounds in many areas of food and flavor industries. U.S. essential oil broker companies indicate there is a significant market for Japanese cornmint oil in the U.S. although there is no American production in progress.

## Overall Program Objectives

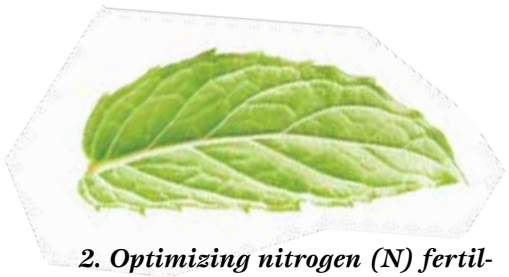
***1. Evaluate the ecological adaptation and productivity of mints species, the composition and bioactivity of mint oils produced in Wyoming.***

All four mint species grew and developed very well in the Sheridan area. Biomass and oil yields of the four mint species were equal or higher than the productivity of the peppermint and spearmint in other U.S. regions. The oil composition and antioxidant capacity of the peppermint and spearmint oils were within the desirable parameters and comparable to the high-quality oils produced in the northwestern U.S. Japanese mint cultivars also provided very good yields compared to literature reports.

Peppermint and spearmints in Wyoming were not infested by fungal diseases or pests, which is a common issue in the typical peppermint growing regions. This may be due to Wyoming's relatively drier climate compared to the more humid climate in Washington and Oregon, where most of the U.S. peppermint is grown.

No winterkill was observed on any of the mints in Wyoming. Our three-year data suggest peppermint, spearmints, and Japanese mints can be grown as perennial specialty crops for essential oil production in northern Wyoming at an elevation of around 4,000 feet.

Two different essential oil glands on peppermint leaf surface. Essential oils re-synthesized and stored in epidermal structures, glandular hairs or trichomes. Density of glands varies depending on the leaf location: in peppermint, there are more glands toward the base of the leaf than toward the tip. When the cuticle of the gland is disrupted, the essential oil evaporates, and we can smell it.



***2. Optimizing nitrogen (N) fertilization and irrigation for the ecological conditions of Wyoming.***

Our three-year data indicated mints would need fertilized with approximately 120 kg N/ha (about 265 pounds per 2.5 acres) for maximum yields. Full irrigation also resulted in greater yields compared to reduced irrigation. This was expected because mints have relatively shallow root systems and need to be irrigated especially in semiarid climates.

***3. When to harvest; could the mints be harvested after the first few frosts in the fall?***

Field studies in 2011 and 2012 evaluated the tolerance of Japanese mint and spearmint to fall frosts. Our results demonstrated Japanese cornmint can withstand the first few fall frosts and provide good yields with desirable oil composition.

'Native' spearmint grown in Wyoming can be harvested after the first few fall frosts (down to 19 F) and still provide desirable yields and oil composition.

***4. Developing means and methods for increased biomass and essential oil yields and for improved oil quality of the mint species.***

Field and controlled environment trials are under way.

***5. New uses and new product development from the mint biomass and the mint oil.***

Mints are being investigated as feedstock for biofuel. We conducted a three-year study funded by SunGrant initiative. The results are very promising.

***6. Demonstrate to potential growers the new crops and production practices.***

The field trials with the four mints are available for demonstration to prospective growers and processors, students, and general public. The mint trials were included in the 2013 ShREC Field Day tour.

The fascinating mints have multiple uses and applications. We continue with our research and hope to reveal some exciting results that can benefit the citizens of Wyoming.

*To contact:*
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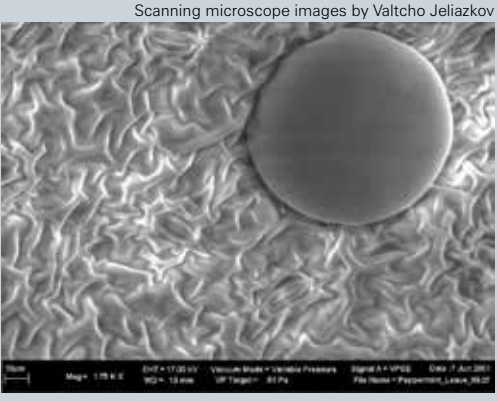
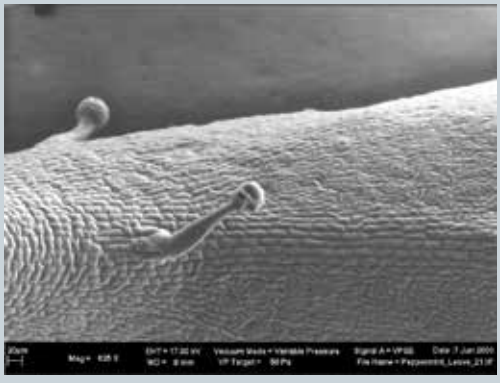
Valtcho Jeliazkov

The four mint species are natural hybrids and generally do not form seeds. The commercial mint varieties are propagated exclusively vegetatively through the underground rhizomes (above) or through rooted cuttings (below).

Valtcho Jeliazkov

Scanning microscope images by Valtcho Jeliazkov





# Wyoming State Veterinary Laboratory
## serves at intersection of animal,

*The Wyoming State Veterinary Laboratory performed diagnostic assays on more than 100,000 samples in 2013.*

UW Photo Services

Marce Vasquez, Virology Laboratory, Wyoming State Veterinary Laboratory

# human health

*Jeffrey Adamovicz*
*Assistant Professor*
*Department of Veterinary Sciences*
*and Wyoming State Veterinary Laboratory*

domestic and wild animals are susceptible to many types of illnesses: infectious diseases, cancer, toxins, nutritional deficiencies, and others.

As with human disease, it's just as important for animal owners and veterinarians to determine the cause of disease to reduce animal suffering and economic losses and to prevent future episodes of disease.

The Wyoming State Veterinary Laboratory (WSVL) provides laboratory diagnostic services to veterinarians and animal owners to assist in animal disease control; however, because animals and humans may be affected by similar or identical diseases, the WSVL also plays a key role – in association with human medical, state, and federal agencies – in promoting human health.

## The One Health Concept

The inextricable links between human health, animal health, and their common environment define the concept of "One Health" and are the basis for the mission of the WSVL.

The WSVL is part of the Department of Veterinary Sciences in the College of Agriculture and Natural Resources. This structure allows Wyoming to leverage the expertise of faculty members to provide required experience and oversight of laboratory diagnostic testing. Diagnostic faculty members are supported by a cadre of professional technical staff members who perform sample receiving, processing, and routine laboratory testing.

In addition, 30 to 40 UW students are employed by the lab and provide additional support and gain valuable experience in diagnostic medicine.

The WSVL is housed in modern facilities that include laboratories, offices, and a newly constructed, high-level biocontainment laboratory.

The Wyoming Game and Fish Department and Wyoming Department of Agriculture Analytical Services have laboratories within the WSVL. Collectively, this provides an integrated operation that serves the veterinary diagnostic needs of the state and surrounding region.

## State Veterinary Lab Provides Extensive Services

The WSVL provides an extensive suite of laboratory diagnostic tests and morphologic pathology services – more than 300 individual tests – to determine the causes of animal disease. A number of these tests are mandated or recommended by the United States Department of Agriculture (USDA) and others by the state of Wyoming through the Wyoming Livestock Board due to the severity of some diseases. The laboratory must meet the standards of the American Association of Veterinary Diagnostic Laboratories (AAVLD) for all testing.

The high-containment laboratories are also inspected and approved for use by the Centers for Disease Control (CDC).

The WSVL performed diagnostic assays on more than 100,000 samples last year. All are performed to strict standards and with proper laboratory controls – a significant undertaking for the nearly 300 assays offered by the WSVL. This diagnostic information is critical to practicing


UW Photo Services

BreAnna Bonner trimming tissue at the Wyoming State Veterinary Laboratory.

veterinarians in determining the cause for a sick animal or herd. WSVL faculty and staff members often perform on-site sample collection, epidemiology studies, field necropsies, and other activities.

They consult on a daily basis with practicing veterinarians, ranchers, and animal owners to provide assistance with animal health issues. Close communication between the animal owners, veterinarians, and WSVL results in an effective system to promote animal health in Wyoming.

## Why Place Diagnostic Lab in University Setting?

The WSVL provides a unique and valuable educational resource to University of Wyoming students. Department of Veterinary Sciences/WSVL faculty members teach a myriad of courses including virology, microbiology, wildlife diseases, toxicology, and basic disease biology to undergraduate, graduate, and medical students. WSVL faculty members bring a unique, well-grounded approach to these subjects through daily diagnostic duties.

The lab also plays a critical role in the educational experience of students seeking careers in veterinary and human medicine, and biomedical research through diagnostic internships, research rotations, and paid student diagnostic work experience. Externships at the WSVL are sought after by veterinary students from a variety of colleges of veterinary medicine wishing to gain experience in laboratory diagnostic medicine.

WSVL faculty members also provide continuing education instruction to practicing veterinarians throughout the U.S. Collectively, these efforts serve to train and mentor the next generation of biomedical researchers, veterinarians, and medical doctors.

## Study Wyoming Pathogens

Department faculty members conduct research activities on some of the most important veterinary pathogens in the state. Research projects include brucellosis, chronic wasting disease, bluetongue, epizootic hemorrhagic disease, canine distemper, and rabies.

Knowledge gained from these studies directly contributes to the body of scientific knowledge leading to better control measures including novel diagnostic tests, management strategies, treatments, and vaccines. Importantly, Department of Veterinary Sciences and WSVL faculty members serve as academic major advisers to more than a dozen graduate students working on these kinds of problems.

The relationships between domestic animals, wildlife, and humans are often complex and interrelated. The ability to detect, diagnose, treat and/or control disease in animals is an important goal for animal and public health. An integrated approach to both animal and human health is the objective of One Health.

The WSVL generates important data that facilitates the ongoing systematic collection, analysis, and interpretation of health information to combat disease.

Laboratory results, when integrated with other sources of information, can provide a powerful and clear picture of clinical disease, disease spread, and effectiveness of any control measures. For more information, please link to http://bit.ly/wyowsvl.

*To contact: **Adamovicz** can be reached at (307) 766-9905 or at jadamovi@uwyo.edu.*

# One Health – A West Nile virus example

The WSVL also plays an important role in public health. Many human diseases also affect, or are carried by, animals. Veterinarians and human medical doctors work closely to monitor and control such diseases – a working relationship often termed One Health.

An example of one such disease is that caused by West Nile virus (WNV). This virus is spread from birds to humans, horses, and other animals through the bites of infected mosquitoes and cause a range of disease from inapparent infection to death.

Wyoming experienced a significant increase in WNV disease in 2013. A number of state and local agencies responding to this outbreak were supported by the WSVL. Human samples were tested for WNV exposure by the Wyoming Department of Public Health, and animal samples were tested by the WSVL.

## Tracking West Nile Virus

There were 41 cases of human disease caused by WNV with one fatality – up from eight clinical cases with no fatalities in 2012. The WSVL detected WNV antibody in 19 horses – up from five in 2012. Testing for the virus in pooled mosquito samples increased from 13 positive pools (5 percent) in 2012 to 52 positive pools (9 percent) in 2013. These results were important in tracking the extent of the disease and its spread across Wyoming.

Lowering the incidence of disease in domestic animals, controlling mosquitoes and mosquito habitat, and monitoring WNV disease can all help to prevent human infections. In addition, the provision of instructional materials on avoiding mosquito contact and the use of repellents is another critical aspect of lowering the chances of human infection.

## Communications Critical

Communication between veterinarians, medical care providers, laboratories, and public health response is critical to reduce sickness and death in humans. This relationship has long been recognized in One Health. The spread of this virus in 2013 could have been much worse if Wyoming had not applied the principles of One Health.

## Dig deeper

- See http://www.uwyo.edu/wyovet/ for information about the Wyoming State Veterinary Laboratory
- See http://bit.ly/statelabfaq for frequently asked questions
- See http://bit.ly/uwresearch for research conducted by the Department of Veterinary Sciences

An example of an improved road through the Fortification Creek Area. Roads are constructed and improved to facilitate increased vehicle traffic associated with energy extraction.

A spike bull elk using a copse of large junipers for cover. Juniper communities form about 10 percent of the FCA, which is dominated by Wyoming big sagebrush and grass.

# Focus area research indicates elk response to energy development

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The intersection of natural gas development and elk conservation in Wyoming provides an exceptional opportunity to investigate the impacts of energy development on wildlife.

One of the main objectives of our research was to evaluate whether elk habitat selection shifted after development began in the Fortification Creek Area in northeastern Wyoming in the early 2000s.

Our research suggests development in the FCA has affected elk patterns and body condition. Through our findings, we provide suggestions to reduce the impacts and promote body condition.

Energy production is Wyoming's leading industry, and, within the U.S., is second only to Texas in total energy produced by a state. Wyoming's rich energy reserves and the fact that global energy demand is predicted to increase 56 percent by 2040 (EIA 2013) suggests Wyoming will continue to play a critical role in energy production.

Wyoming is also home to large wildlife populations, which are of great intrinsic and economic value to Wyoming residents and the large numbers of tourists attracted each year to the state's wide-open spaces.

## Energy-Habitat Overlap

The distribution of energy resources in Wyoming overlaps habitat used by many wildlife populations, which raises questions about the ability of wildlife to cope with increasing impacts from energy development across shared landscapes.

Understanding how energy development influences natural resources and the economies of Wyoming and the surrounding region are focal areas of research in the College of Agriculture and Natural Resources. By improving understanding of how energy extraction affects wildlife populations, we can better inform energy extraction activities to more effectively conserve wildlife populations.

Our study was a collaborative effort with the Bureau of Land Management, energy industry companies, University of Wyoming, and the Wyoming Game and Fish Department (WGFD). We focused on the approximate 300-square mile FCA (Figure 1 page 35). Cattle ranching was the dominant land use in the FCA prior to natural gas development (primarily coal bed natural gas).

As part of the Powder River Basin, the area has seen a rapid expansion of human activity since 2000 associated with natural gas extraction including road construction, well drilling, and maintenance work.

This increased activity may be changing the availability of resources for wildlife species in the area. The FCA is home to a resident elk herd, which is one of the most highly sought-after herd units from which to draw an elk hunting license in the state and underscores the value of these elk to Wyoming citizens.

A typical natural gas drill set up for the Fortification Creek Area. These three rigs were active in late fall 2009 during a brief snow storm.

## Telemetry Feeds Data

To identify environmental (e.g., vegetation cover types, topography, and distance to water) and anthropogenic (e.g., distance to roads and well pads) attributes that influencing elk landscape use, we used telemetry to obtain more than 130,000 locations from elk before (1992-1995, n = 17 elk) and during (2008-2011, n = 59 elk) energy development.

We used our elk location and habitat data to develop models identifying the most important habitat characteristics for FCA elk. In addition, we assessed elk population performance in the FCA including pregnancy and body condition from data collected during development as well as long-term demographic data collected by the WGFD.

Our research indicates development of natural gas was affecting elk in the FCA through avoidance of roads associated with natural gas development. Comparisons of high-use elk habitat before and during development identified shifts in habitat use distribution of 43 percent in summer and 50 percent in winter (Figure 2). This distributional shift was a result of indirect loss of habitat, whereby the habitat was not physically removed, but rather elk avoided the area because of proximity to development activity.

Similar avoidance behavior has been documented for other species, including mule deer (Sawyer et al., 2006) and greater sage-grouse (Kirol 2012) suggesting changes in wildlife distributions are probable following expanding energy development.

## Different Habitat at Night

During development, elk in the FCA were also using habitat differently at night than during the day. These elk used areas with less-rugged terrain and closer to roads at night, suggesting elk were moving closer to roads during the time of day when there was less development activity. The ability to use different habitat at night versus day may allow elk to access forage or other resources that would otherwise be unavailable due to elk avoidance of energy development during daylight hours; however, this offset of habitat availability likely does not mitigate the overall impacts of

Female elk in the Fortification Creek Area, one of which is wearing a GPS collar.

population distributional shifts.

A secondary objective of our study was to evaluate whether energy development has affected population performance for elk in the FCA. In the face of development, calf elk recruitment in the FCA has been consistently productive with approximately 47 calves per 100 adult female elk; however, this trend may change as the rate of pregnancy, although still high, declines. Herd estimates have been consistent, if not slightly increasing, over the last 10 years.

Our assessment of elk body condition, measured through heart and kidney fat deposition from hunter-harvested animals, indicates some decline in body condition where fat content was significantly lower than for a reference elk population in the same region of Wyoming.

Declines in pregnancy and body condition may signal consequences of observed behavioral and distribution shifts.

## Hunting Effects

We also developed a population simulation model that suggests regulated hunting in October is the limiting factor for FCA elk population growth. This means that elk numbers during early stages of development (2000–2011) were likely controlled or limited through hunting and not through the effects of energy development.

Our study includes data from different time periods (i.e., before and during natural gas development) but does not necessarily span the lifetime of an elk. As a result, we may be missing some ability to detect long-term impacts of development on this wildlife population. However, continued monitoring of elk in the FCA in conjunction with energy development provides an opportunity to address these questions at a time scale relevant to elk life spans.

## Additional Research Possible

Measuring the impact of density dependence will also be interesting, because future development may push elk into more restricted habitat within the FCA; this could elicit increased behavioral and population changes resulting in use of areas closer to development or possibly overgrazing and depletion of forage in areas farther from development.

To reduce impacts and promote healthy elk populations, we suggest maintaining large, undeveloped areas within the footprint of energy developments so elk may obtain sufficient forage while avoiding development.

In addition, implementing practices during energy development such as directional drilling, telemetered well monitoring, and piping of energy products (Sawyer et al., 2009) are promising because they reduce costs for energy producers while reducing the impacts of energy development on elk.

Using a wider lens, elk are robust animals. Documenting impacts on these large, mobile animals may suggest greater impacts on more sensitive and/or species that do not freely move. Continued energy development will necessitate efforts from diverse stakeholders to conserve wildlife populations across Wyoming.

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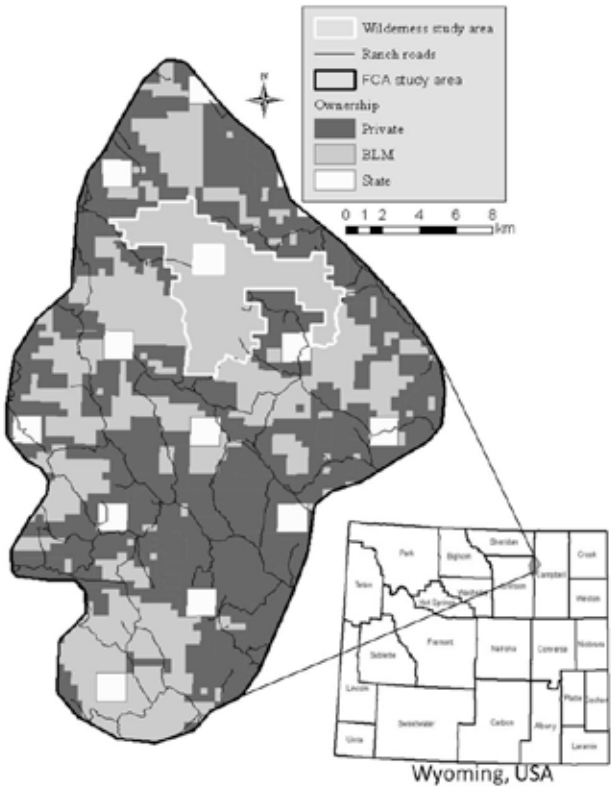


Figure 1. The Fortification Creek Area (FCA) encompasses approximately 300 square miles in northeastern Wyoming. Land ownership within the FCA is approximately 50 percent private and 50 percent public.

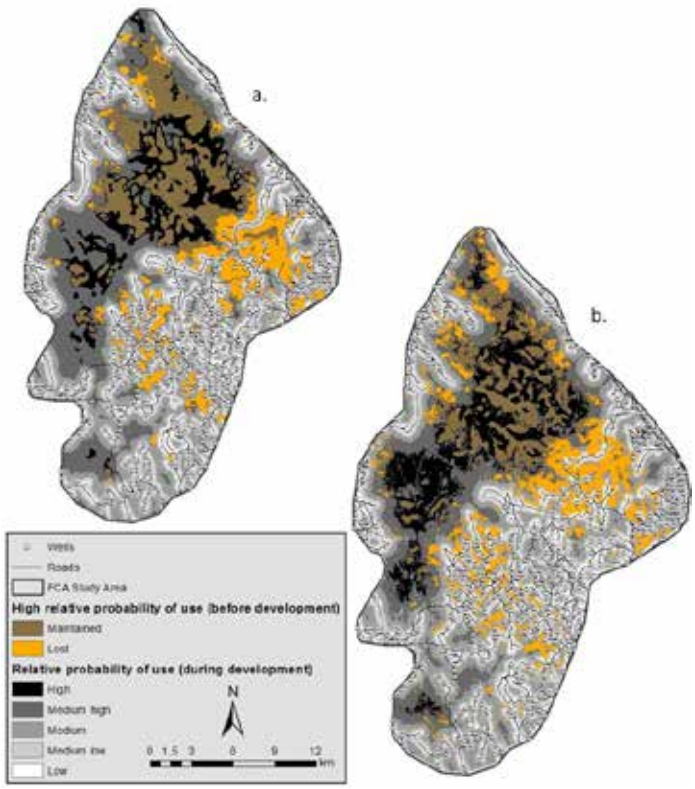


Figure 2. Population-level model and categories of elk use in summer (a) and winter (b) during coal bed natural gas development overlain with areas identified as high relative probability of use before development within the Fortification Creek Area of northeastern Wyoming. Loss of habitat previously identified as high use was approximately 43 percent in summer (a) and 50 percent in winter (b).


# Reflections

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