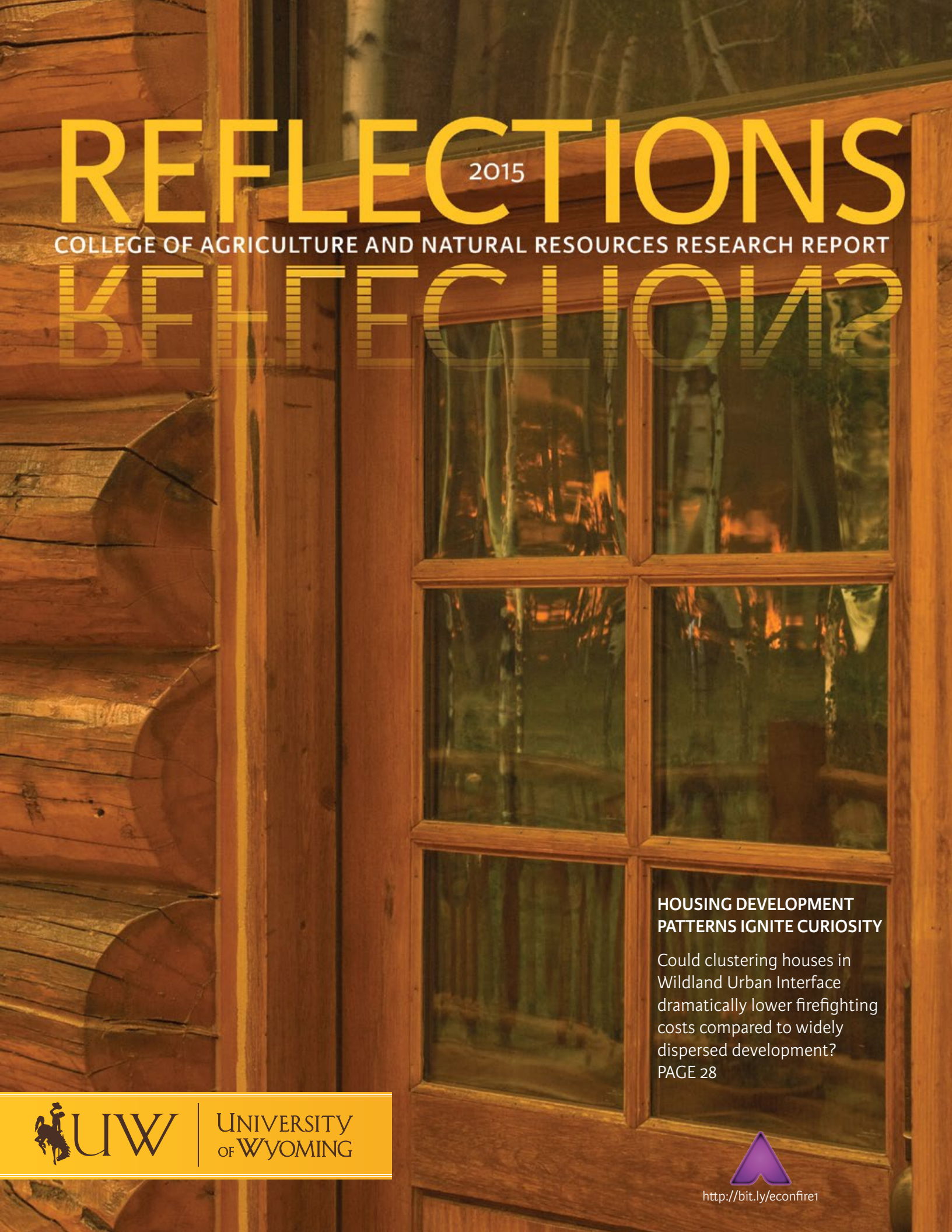
# REFLECTIONS

2015

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES RESEARCH REPORT



**HOUSING DEVELOPMENT PATTERNS IGNITE CURIOSITY**

Could clustering houses in Wildland Urban Interface dramatically lower firefighting costs compared to widely dispersed development?
PAGE 28

UW | UNIVERSITY OF WYOMING

http://bit.ly/econfire1

I am honored to introduce the 2015 edition of *Reflections*.

As the flagship research magazine published by the College of Agriculture and Natural Resources, the Wyoming Agricultural Experiment Station is proud to present this year's readers with a series of articles with high relevance to Wyoming, the region, the nation, and the globe!

The college has always been at or near the top at the University of Wyoming in dollars received for research, and in 2014 was awarded $12.4 million from external sources to support research in:

- Agricultural and Applied Economics
- Animal Science
- Ecosystem Science and Management
- Family and Consumer Sciences
- Molecular Biology
- Plant Sciences
- Veterinary Sciences
- University of Wyoming Extension, and the
- Wyoming Agricultural Experiment Station

Associate Dean Bret Hess

We began publishing in 2014 at least one article from each academic department plus a featured paper written by a student. Each department elects a faculty member to represent its department in the magazine; however, co-authors and topics are chosen by the elected faculty member. A panel of judges selects which faculty article receives honors as the top faculty submission.

The panel also recommends publishing one article submitted by a student. Although there is only enough space in the magazine for one student paper, thanks to the generosity of Cindy Garretson-Weibel with Wyoming Business Council's Agribusiness Division, all student papers will be published in this year's series of *AGtivities*. These papers will also be published in a new online magazine created specifically to highlight the academic rigor of students in the college.

Stories in this edition show how the college's research addresses topics that contribute to a better understanding of agriculture's complex social-ecological system, and include exploration of wildlife-livestock interactions, factors that affect life-long health, natural phenomena in plants, and wildfire at the wildland-urban interface.

These articles highlight only a sample of research in the college that ultimately contributes to the well-being of wildlife, livestock, individuals, families, farmers, ranchers, and rural communities throughout Wyoming and beyond.

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

Search Wyoming Agricultural Experiment Station

@WyAgResearch

http://bit.ly/bretdirect

# REFLECTIONS



To view *Reflections* online, visit:
www.wyomingextension.org/emagazine/reflections2015/

Cover photo by Kari Greer

BRING *REFLECTIONS* TO LIFE
WITH THE FREE AURASMA APP

With the Aurasma app open, point your phone or tablet at a photo with the Aura icon and **watch what happens!**

FIRST-TIME USERS:

**1** • Download and install the free Aurasma app from Play Store or iTunes Store to your phone or tablet.

**2** • Click on Aurasma icon.

**3** • Click the magnifying glass at bottom of your screen and type "UWAG" in the Search box at the top of the screen. Click on the UWAG channel, then choose Follow.

**4** • Click on the open square symbol at the bottom of the screen. Point your phone or tablet at the image that has the Aura icon and watch the magic! Double-clicking enlarges the video to full screen and enables watching the video away from the Aura image.

# COLLABORATION ACROSS

## Predator compensation policies in Wyoming

***Benjamin Rashford,***
*Associate Professor*

***Thomas Foulke,***
*Senior Research Scientist*

***David T. Taylor,***
*Professor*

***Jordan Steele,***
*Former Graduate Student, Department of Agricultural and Applied Economics*

Photo: USFWS

Western gray wolf

http://bit.ly/econpredator1

From jaguars in Argentina and snow leopards in Bhutan, to wolves in Wyoming, wildlife damage compensation has become commonplace.

Policies aim to engender producer tolerance and cooperation by compensating for losses – since the cost of carnivore conservation is often disproportionately borne by livestock producers.

Landowner cooperation is critical to conservation success. This is especially true for wolf re-introduction in Wyoming, given the important role private ranchlands play in supporting wildlife and the food web of the Greater Yellowstone Ecosystem – ranchlands that could be converted to other uses unless raising livestock remains economically viable. Compensating landowners for depredations, however, is complicated. Successful compensation programs need to provide prompt and fair payment, but evidence of depredations can disappear quickly in Wyoming's open range environment. Field research suggests there are seven depredations for each one confirmed.

The U.S. compensation plan pays a 7:1 compensation ratio to account for unverified losses (each confirmed depredation is compensated at seven times the market value). Yet, a growing body of biological research suggests large carnivores also have indirect effects on livestock. Cattle exposed to large carnivores may increase their vigilance behavior, forage less efficiently, be more prone to flight events (stampedes), avoid certain grazing areas, or reproduce less.

Such behaviors could decrease ranch profitability even if no animals are lost and may need consideration in compensation schemes. Yet, little research has considered the economic consequences of indirect effects.

### Economics of Indirect Wolf Impacts

Researchers are investigating the potential economic effects associated with the indirect impacts of wolves. Our team includes the authors and Professor John Tanaka in the Department of Ecosystem Science and Management. We met with ranchers and surveyed the biological literature to identify the

**FOR A CLOSER LOOK**

For a more in-depth look at how our model works, see "Wolf (*Canis lupus*) Predation Impacts on Livestock Production: Direct Effects, Indirect Effects, and Implications for Compensation Ratios" at http://bit.ly/wolfpredation

# CONTINENTS and France

following likely indirect effects:

- Reduced weaning weights,
- Injured cattle/calves,
- Decreased conception rates,
- Increased disease/sickness, and
- Increased management costs.

We then built a computer model to simulate cow-calf production and profitability for alternative levels of direct and indirect predation effects.

Results show predation can have serious financial consequences. Direct predation (i.e., lost calves) reduces ranch net returns by approximately 20 percent on average, given observed predation rates; however, the current compensation policy largely offsets these direct losses (with compensation, net returns fall by 1 percent due to some unverified losses).

Indirect effects, for which there is no compensation, can have even larger financial impacts. Reductions in weaning weights and conception rates, for example, were found to cut ranch returns by 20-30 percent. Moreover, if the indirect effects of wolves occur simultaneously, the cumulative financial impacts can be severe. When decreased conception rates and weaning weights are applied together, the ranch not only has fewer calves to sell, but lighter calves in general. Ranch returns can decrease by as much as 50 percent.

We calculated the compensation ratios needed to fully offset the direct and indirect effects of wolves. Estimated compensation ratios were as high as 24:1 (Table 1, page 6) depending on assumptions about the severity of wolf impacts. These estimates assume all indirect effects occur simultaneously and are cumulative, which may not occur in reality.


Photo: Tom Foulke

Associate Professor Ben Rashford in wolf habitat in the French Alps.

Using conservative assumptions, which recognize the uncertainty about how indirect effects operate biologically, the results imply a compensation ratio of 13:1. This means compensation likely needs to be twice as high as current policy.

## Extending Predation Research Beyond Wyoming

Creating collaborative linkages is a core element of good science. This past year, Rashford and Foulke connected with colleagues in France to expand our compensation research. An article published by the team in *Rangelands* was seen by an employee of the *Office National de la Chasse et de la Faune Sauvage* (similar to our Fish and Wildlife Service), whose work includes studying wolves in France.

France's wolf population is about as large as Wyoming's (250 in France relative to about 300 in Wyoming) and like ours, is growing and preys upon livestock. French livestock producers face some of the same challenges as Wyoming producers, but their approach and policies are different. We were invited to share the team's research results with French researchers and policymakers and learn about France's wolf policies. During a 10-day period in June, 2014, Rashford and

Foulke visited Lyon, Grenoble, and Montpelier, presenting and listening to groups of policymakers, researchers, and students in each city.

The issues in France are similar but also different. Wolves were not reintroduced; they were eliminated by hunting and trapping, but they survived in the Italian Alps (*Alps Maritime*). They have been slowly resettling on the French side for several decades. But wolves, as we know here in Wyoming, travel long distances and are now popping up in other parts of France. Wolves have been reported in the Pyrenees Mountains on the border with Spain just this past year. The main population is expanding and moving westward into more densely grazed lands in central southern France, the *Massif Centrale*, known for its cheese production. Livestock here have a higher value than the meat animals grazed in mountain pastures in the Alps. French authorities are increasingly worried about potential livestock/human/wolf conflicts.

Livestock species and size of operations are some of the important differences between Wyoming and France. Cattle are the predominant livestock species in Wyoming and graze on extensive public land allotments; in France, sheep are the predominant species, and grazing


Photo: Ben Rashford

French and Wyoming policymakers and wolf researchers, left to right, Julien Transy, Eric Marboutin, Sylvain Gatti, Tom Foulke, and Pasquale Eimer in the French Alps.

allotments are smaller and more controlled. And while Wyoming cattle graze with little human intervention, herders with dogs attend flocks around the clock in France.

Compensation for lost animals is different, too. The French system is much more liberal than the U.S. system. Using European Union funds, France's compensation program accounts for not only those animals directly killed by wolves, but also for indirect effects using set fees per animal in each attacked flock. They also use a sliding scale to value depredated animals depending on age and use (meat or milk).

Producers are also paid to implement protection measures to avoid predation events. Payments for protection measures, such as fencing, fladry (flags or pennants attached to rope) and guard dogs, constitute the vast majority of France's compensation program. In 2013, their compensation program spent just over 2 million euros ($2.5 million) to compensate producers for direct and indirect losses, and 10.4 million euros ($12.9 million) to support protection measures.

State and private compensation programs in the U.S. spent $273,548 in 2013 to compensate ranchers for confirmed direct losses. The U.S. Fish and Wildlife Service's grant program awarded producers $425,000 to implement protection measures.

**Table 1. Estimated compensation ratios for different assumed levels of wolf impacts**

| Simulated Wolf Scenario | Compensation Ratio |
|---|---|
| Current Policy | 7:1 |
| Low Wolf Effects | 18:1 |
| Moderate Wolf Effects | 21:1 |
| Severe Wolf Effects | 24:1 |
| Conservative Assumptions | 13:1 |

*Note: The compensation ratio is the number of animals that need to be compensated for each confirmed depredation.*

## What France Can Teach Us

What can we learn from France and France from us? The French system does not focus on actual economic impacts because they have had a

generous compensation fund. The cost of an already expensive program could become unsustainable with the expansion of the wolf population and the potential for more conflicts. That and the continual threat of austerity measures in the French economy could become an issue for policymakers. They would like to better understand the relationship between direct and indirect effects and farm profitability.

We can learn from a French system that is more producer-friendly. French producers are much more likely to report wolf conflicts and predation events, knowing the system will more adequately compensate them for their losses. Broader compensation may foster a better working relationship between government and producers. In particular, the French system's inclusion of indirect effects and significant support for protection measures could be explored in Wyoming.

***To contact:*** *Rashford, (307) 766-6474, brashfor@uwyo.edu; Foulke, (307) 766-6205, foulke@uwyo.edu; Taylor, (307) 766-5682, ttaylor@uwyo.edu.*

## COLLABORATION CONTINUES

Wyoming's research team continues to collaborate with French experts and looks to develop new connections in other countries with similar livestock production systems and predation issues, such as Italy, Switzerland, and Mexico. The objective is to increase policymaker understanding about alternative compensation programs so Wyoming producers and conservationists have the benefits of the latest research to support sustainable ranches and viable wolf populations.

http://bit.ly/econpredator4

## ACKNOWLEDGMENT

We would like to thank colleagues in France for their gracious hospitality. Our exchange has opened up new avenues of research and intellectual inquiry. The following deserve special recognition:

- Jean-Michel Gaillard- Laboratoire de Biométrie et Biologie Évolutive, UCB Lyon
- Eric Marboutin- Office National de la Chasse et de la Faune Sauvage
- Pascale Eimer- Ministère de l'Agriculture, de l'Alimentation, de la Pêche, de la Ruralité et de l'Aménagement du Territoire
- Julien Transy- Ministère de l'Écologie, du Développement Durable et de l'Énergie
- Olivier Gimenez- Centre d'Écologie Fonctionnelle & Evolutive
- Sylvain Gatti- Office National de la Chasse et de la Faune Sauvage

Photo: Jean Aime Esmiol, ONF Bayons

European wolf

## ENVIRONMENTAL PROGRAMMING OF OFFSPRING –

# A TURTLE SAGA

The unassuming red-eared slider set the professor and Rochelle Chair of reproductive biology on a course to understand how the diet of pregnant mothers affects the health of their children – and THEIR children

***Stephen Ford***
*Professor, Rochelle Chair*
*Reproductive Biology,*
*Fetal Programming*
*Director, Center for the Study*
*of Fetal Programming,*
*Department of Animal Science*

Diet during pregnancy can permanently program the lifelong well-being of your daughter and even her children.

My first real exposure to the idea prenatal environment could program gene expression patterns and thus alter phenotype was in a turtle while a faculty member in the Department of Animal Science at Iowa State University.

One day, a zoology professor working with the red-eared slider, a freshwater turtle common in the Midwest, came to see me. The turtles he studied had no sex chromosomes, unlike mammalian species, but instead used environmental temperature to determine hatchling gender. High incubation temperatures resulted in females, while lower temperatures resulted in male hatchlings. Because some females laid eggs in a nest in sunny areas and others in cooler shady spots, female and male offspring were always produced. The mechanism(s)

for this temperature effect on sex was unknown at that time.

### Environment Effects

We conducted a series of studies, which included collecting nesting female turtles and inducing them to lay eggs for transport to the lab. We determined the yolks of these eggs contained high levels of the steroid hormone testosterone (male sex hormone) and a temperature-dependent enzyme called "aromatase," which could convert this testosterone to estrogen (female sex hormone), but only under elevated environmental temperatures.

The ratio of testosterone or estrogen in the yolk then altered gene expression patterns resulting in male or female hatchlings.

That environmental changes can permanently alter gene expression is referred to as epigenetics. This includes mechanisms such as chemical modifications that can lead to long-term changes in gene expression, or phenotype. Chemical reactions can act as switches turning genes on and off, and the environment influences these processes.

### Maternal undernutrition and offspring phenotype in sheep

This early interest in epigenetics led to experimentation with animal models, in which controlled manipulation of maternal nutrition can be accomplished, has confirmed dietary manipulation can alter gene expression and thus phenotype.

To test this hypothesis in livestock, I was able to simultaneously study two flocks of genetically similar Rambouillet/Columbia cross ewes originally derived from a single flock housed at UW 30 years earlier. One portion of the flock had remained at UW and were subjected to a relatively sedentary lifestyle with more than adequate nutrition (UW ewes). The other portion of the flock was purchased by a producer and transported to the Red Desert near Baggs and was adapted to a nomadic existence of grazing native range and experienced limited nutrition year-round (Baggs ewes).

Mature UW and Baggs ewes of similar age, weight, and numbers of previous pregnancies were assigned to a Control (100 percent of nutritional requirements), or a Nutrient Restricted (50 percent of the control diet) diet from early to midgestation, then fed to 100 percent requirements thereafter.

**A PRIMER ON UW'S CENTER FOR THE STUDY OF FETAL PROGRAMMING**

http://bit.ly/fetalprogramming

Two sheep on an obesity trial. The sheep on the left was fed only to requirements while the sheep on the right was fed all it would eat.

## Early Gestation Nutrient Restriction Effects

Previous studies confirmed nutrient restriction during early gestation is much more harmful to offspring health than in later gestation; organ and tissue blood supply and cellular composition and function are largely established during the first half of gestation.

Surprisingly, fetuses gestated by Nutrient Restricted UW ewes, but not those from Nutrient Restricted Baggs ewes, showed marked intrauterine growth restriction, altered tissue and organ development, and reduced blood nutrient concentrations at midgestation compared to fetuses of Control fed UW ewes.

We determined the differences between Nutrient Restricted UW and Nutrient Restricted Baggs ewes in altering fetal growth and development resulted from an increased ability of Baggs fetuses to obtain maternal nutrients via placental uptake.

Nutrient delivery to the fetus is controlled by two major factors: nutrient transporters in placental cell membranes, which convey maternal nutrients into the placenta, and placental blood flow, which carries these nutrients to the fetus.

Demonstrating this, placentae from Nutrient Restricted Baggs ewes exhibited marked increased numbers of placental nutrient transporters and increased numbers of placental blood vessels in response to reduced maternal nutrition while Nutrient Restricted UW placentae did not.

By increasing efficiency of its placenta for nutrient transport to the fetus, Nutrient Restricted Baggs ewes were better able to provide the increasing level of nutrition their fetuses required for normal growth and development even during an extreme bout of maternal undernutrition.

Adult offspring of Nutrient Restricted and Control fed UW and Baggs ewes were then placed on an *ad libitum* (all they could eat) feeding trial to evaluate offspring metabolic differences. The offspring born to Nutrient Restricted UW ewes were hyperphagic (i.e., exhibited increased appetites), accumulated more abdominal and subcutaneous fat, and exhibited less skeletal muscle growth than lambs born to Control UW ewes or Nutrient Restricted or Control fed Baggs ewes.

Further, offspring from Nutrient Restricted UW ewes were severely insulin resistant (prelude to Type II diabetes), exhibited reduced kidney development, and were hypertensive (exhibited increased blood pressure) when compared to their respective Control group or Nutrient Restricted and Control Baggs ewes.

These findings confirm that, after only a few generations under harsh and variable environmental conditions and continual nutritional deficiency, the Baggs ewes placental phenotype was altered resulting in the birth of normal, healthy, growth-efficient lambs under conditions of severe maternal nutrient deficiency.

***To contact:*** *Ford can be reached at (307) 766-2709 or at spford@uwyo.edu.*

### WORLD WAR II STARVATION TRAGEDY LEADS TO HOPE OF IMPROVING CHILDHOOD HEALTH

UW's Center for the Study of Fetal Programming was established in 2001 to investigate effects of maternal malnutrition (undernutrition and overnutrition) on fetal growth, organ development, and endocrine dysfunction and offspring health using sheep as a dual model with implications for livestock and humans.

The realization maternal malnutrition could alter offspring health grew out of an incident at the end of World War II during which the Nazis starved Dutch citizens in retaliation for aiding the Allies. Studies after the war suggested adult offspring of women undernourished during early pregnancy went on to develop obesity, Type II diabetes, and cardiovascular disease at sharply increased rates.

For more information about the Dutch Hunger Winter, see http://bit.ly/dutchhunger. Did you know actress Audrey Hepburn was a survivor?

# WYOMING'S OWN UNIQUE AMPHIBIAN

## Scientists will evaluate grazing, fire potential to restore habitat for critically endangered species

***Melanie Murphy***
*Assistant Professor*

***Julia Polasik***
*Master's Graduate, Department of Ecosystem Science and Management*
*Currently, Biologist for Institute of Bird Populations*

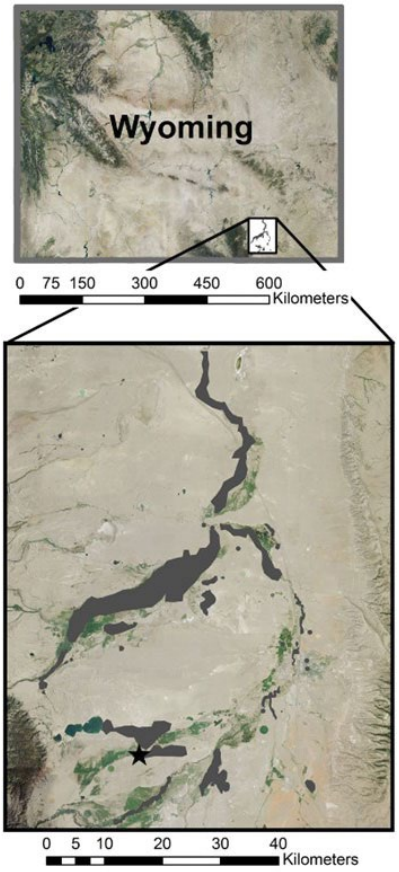
The Wyoming toad (*Anaxyrus baxteri*) was only found on the Laramie Plain.

The once-abundant species declined rapidly in the mid-1970s. The Wyoming toad was listed as endangered under the Endangered Species Act in 1984 and is currently sustained by reintroductions from captive-bred populations. The last remaining Wyoming toads were found at Mortenson Lake National Wildlife Refuge (NWR), now the primary site for the Wyoming toad outside of captivity.

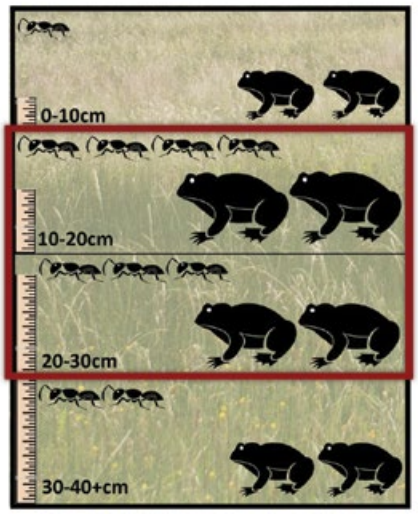
### What Happened to the Wyoming Toad?

Decline and lack of reestablishment of breeding populations could be due to many factors, including inadequate habitat (for tadpoles, young toadlets, and/or adult toads), disease (*Bactrachochytrium dendrobatidis (Bd)*), changes in water availability or water quality, or changes in local climate over the past 30 years.

Wyoming toadlet
Photo Credit: Julia Polasik




Location of the Laramie Plain within Wyoming and main recovery location (Mortenson Lake National Wildlife Refuge).




Toadlets were placed in enclosures with one of four vegetation heights: less than about 4 inches, about 4 inches to 8 inches, about 8 inches to 12 inches, or vegetation uncut (greater than about 12 inches). We found toadlets grew largest in enclosures with mid-vegetation height (4-8 inches), potentially due to more food availability (represented by the number of ants).

Photo Credit: Julia Polasik

Mortenson Lake National Wildlife Refuge southwest of Laramie with toadlet enclosures.

Wyoming toad tadpoles require warm, shallow, vegetated areas for food (e.g., algae) and growth. Toadlets are young toads of the year. We have found toadlets in enclosures grow larger with intermediate vegetation heights, suggesting they need a combination of plant cover to produce insects and open areas for basking. The chytrid fungus, *Bd*, is present at the site and known to cause mortality in the Wyoming toad.

## Grazing, Fire, and Toads

Habitat loss and degradation are potential causes of Wyoming toad decline and subsequent difficulties in reestablishing the species. Grazing by large ungulate herds and fire shaped the Laramie Plain. Bullrush grows thickly around the lake and may not be ideal habitat for Wyoming toad tadpoles or toadlets. Based on our findings, toadlets in enclosures grow largest in mid-vegetation heights; a next step is to test effects of vegetation treatments (grazing, fire, mechanical manipulation) on toadlet survival and growth.

Does this mean use of grazing or fire at Mortenson Lake National Wildlife Refuge would 1) result in 8 to 12 inches vegetation height similar to these experiments and 2) use of these disturbances would be beneficial to Wyoming toad recovery? Our objective is to address these questions over the next several years.

## What Does This Research Mean for Wyoming Toad?

Evaluating grazing and fire effects on Wyoming toad habitat may give managers better tools to manage potential Wyoming toad habitat and meet recovery goals; however, vegetation is only one piece of the puzzle. Additional factors, such as *Bd,* which is known to cause Wyoming toad mortality, are critically important to recovery of the species. We hope to increase the chances this unique

Photo Credit: Julia Polasik


Wyoming toad at Mortenson Lake National Wildlife Refuge.

- **Where is the Wyoming toad found?** The Wyoming toad is unique to Wyoming and was only ever seen on the Laramie Plain. Wyoming toads used to inhabit flood plains, oxbows, and temporary wetlands. The Wyoming toad is a critically endangered species.
- **What do they eat?** Ants, beetles, other insects.
- **What do they look like?** Wyoming toads are small compared to other toads, about 2.2 inches in length, with females being slightly larger than males. They have a cranial crest (ridge on their head). They can be brown, gray, or greenish in color with "bumps" that are generally darker in color.
- **Do they talk?** Not really, but males do call to attract mates in May-June. The call sounds like http://bit.ly/wyomingtoad

species is here for future generations by addressing the effects of grazing and fire.

***Acknowledgements***

This research is funded by a grant from the U.S. Fish and Wildlife Service and is conducted in collaboration with Tyler Abbott and Kim Vincent. James Vance is a master's student in rangeland ecology and watershed management who is continuing research on the Wyoming toad. Jeff Rice recorded the Wyoming toad call (see "Do they talk" upper right) June 5, 2014, for the Acoustic Atlas at Montana State University: www.acousticatlas.org.

***To contact:*** *Murphy can be contacted at (307) 766-5295 or melanie.murphy@uwyo.edu.*

## WHAT IS A NATURAL "DISTURBANCE"?

Ecological disturbances cause quick, major change in an area. While immediate effects can appear detrimental, natural disturbance is often important for nutrient cycling, plant diversity, forage production, and a variety of additional ecosystem services. Fire and grazing are natural disturbances in rangelands that could be important for recovery of the Wyoming toad.

## WYOMING AMPHIBIANS:

Wyoming is cold and dry – not ideal for frogs, toads, and salamanders. Amazingly, Wyoming has 11 species of native amphibians: one salamander, four frogs, and six toads. In addition, bullfrogs have been introduced to Wyoming from the southeastern United States.

Northern leopard frog, one of Wyoming's frogs. Northern Leopard frogs can be found in abundance on Pole Mountain east of Laramie.

Former master's student Julia Polasik taking measurements on a released Wyoming toad. The location of capture, length, and weight were recorded.

# SCIENCE IN MANAGEMENT OF ENDANGERED SPECIES

Endangered species management is based on best available science. Collected data from experimental treatments will enhance the ability of managers to make decisions that have the best chance of establishing breeding populations of Wyoming toads on the Laramie Plain. One goal is that the Wyoming toad will become an example of how science can be incorporated into endangered species management. Establishment of multiple breeding populations is a requirement for reestablishing the species and also for subsequent delisting as an endangered species.

# Researchers study ELDER financial exploitation

***Virginia Vincenti***
*Professor of Human Development and Family Studies, Department of Family and Consumer Sciences*

Elder financial exploitation (EFE) is responsible for much suffering and financial loss to families and society in lost resources, degraded qualities of life, and increased reliance on social support mechanisms.

Research has found approximately 90 percent of abusers are family members and are most often adult children, spouses, and grandchildren. Abusers transcend age, race, gender, and socio-economic status. In addition to physical and cognitive limitations, shame, self-blame, fear of retaliation, further loss of independence, or loss of affection or support from their abusers are major impediments discouraging elders from reporting instances of betrayal by other family members.

Even where suspicions arise, family members often fail to take action due to family relationships, values, and dynamics, or simply deny a problem exists.

## Research Objectives

Our research seeks to identify risk factors for financial exploitation by family members designated by elders to manage their financial affairs if they become incapacitated.

By understanding family values, relationships, communication, and financial management patterns prior to the time elders do end-of-life planning, elders and their professional advisers can make better-informed decisions for their own family situation that will reduce likelihood of later financial exploitation by relatives.

An interdisciplinary multistate team of researchers led by Professor Virginia Vincenti has focused on exploitation perpetrated through misuse of power of attorney (POA), a widely used legal instrument that offers vast potential for abuse.

Seniors are often encouraged as part of end-of-life planning to grant POA to another person to assist with decision making. POA documents can help elders remain autonomous, avoid guardianships, and limit costs at a vulnerable stage of life. Power of attorney was originally created in 1964 as an alternative to guardianship with accountability measures placed on agents, but in 1969 those measures were removed because appointed agents, primarily family members, were assumed trustworthy.

### Preliminary Findings

The first research phase included in-depth interviews of 13 family members aged 18 or older from nine families with elderly relatives who are at least 60 years of age and who have suffered financial exploitation by family members who abused a POA. Interviews revealed the following family and individual family-member characteristics that would appear to have contributed to subsequent elder financial exploitation:

1. Lack of close, trusting relationships fostered by open, honest, and empathic communication,
2. Family and/or perpetrator values of materialism, concern about self-image and impressing others, and an entitlement attitude,
3. Enabling behaviors on the part of victims and other family members that facilitate perpetrators' actions, and
4. Unresolved conflicts between perpetrators and victims and/or other family members.

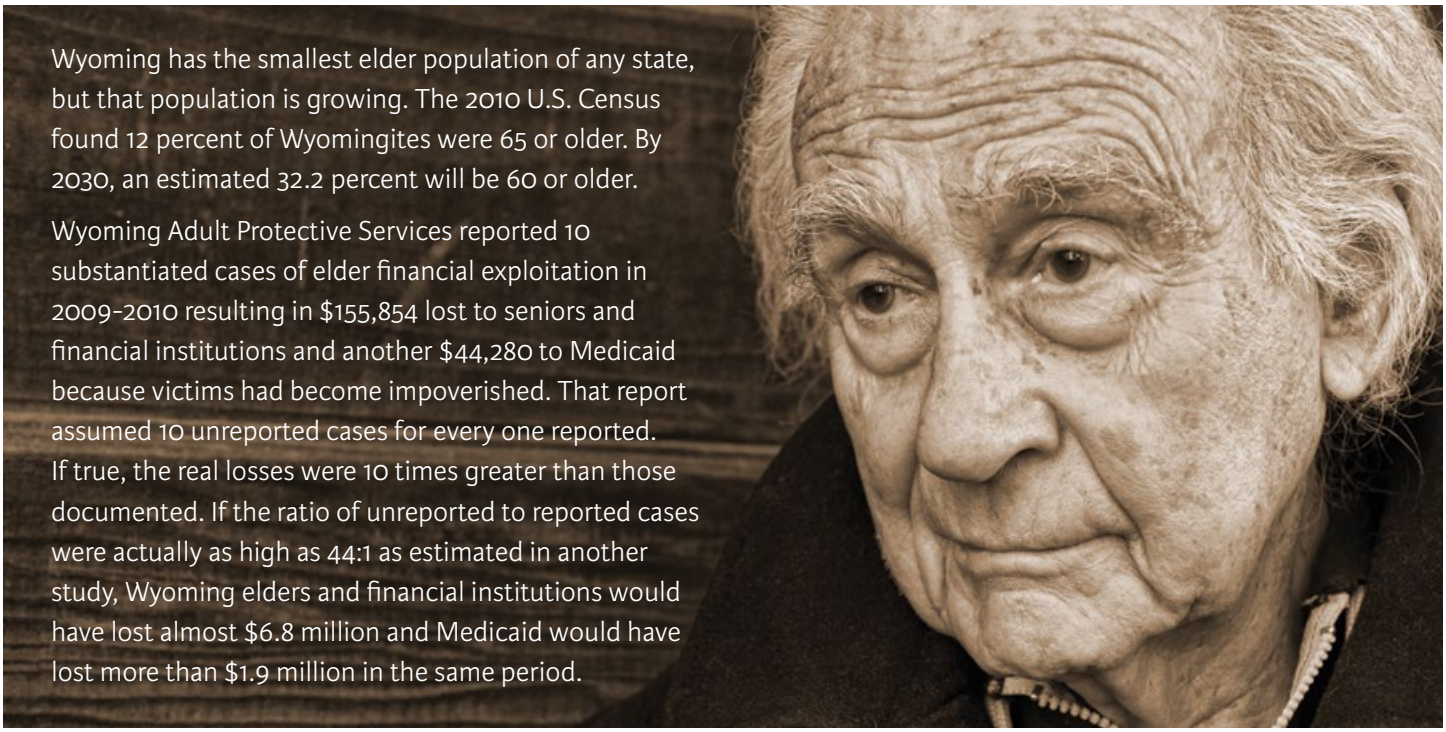
## NATIONAL PROBLEM

The true prevalence and damages from elder financial exploitation (EFE) are largely unknown on a national level.

Estimates of underreporting range from 10 to 44 cases for every one case reported. This is attributable to difficulties in discovering, proving, and prosecuting EFE and is compounded by the lack of adequate individual, state, and national records. What little is known comes from reports like the 2011 MetLife Mature Market Institute study that used only published news articles of substantiated cases. This study estimated $2.9 billion in victims' financial losses in 2010, up 12 percent from 2008.

If the underreporting estimates are true, the real losses to victims could be $29 billion to $127.6 billion annually, not including the burden of additional health care, social services, investigative and legal services, and the cost of related education and research.

These estimates also ignore losses in the value of inheritances to members of affected families and costs incurred by those who intervene to stop the exploitation and recover assets on behalf of the elderly victims. The human costs are also high in emotional damage, increased stress, irreparable family relationships, and the breakdown of families.



Wyoming has the smallest elder population of any state, but that population is growing. The 2010 U.S. Census found 12 percent of Wyomingites were 65 or older. By 2030, an estimated 32.2 percent will be 60 or older.

Wyoming Adult Protective Services reported 10 substantiated cases of elder financial exploitation in 2009-2010 resulting in $155,854 lost to seniors and financial institutions and another $44,280 to Medicaid because victims had become impoverished. That report assumed 10 unreported cases for every one reported. If true, the real losses were 10 times greater than those documented. If the ratio of unreported to reported cases were actually as high as 44:1 as estimated in another study, Wyoming elders and financial institutions would have lost almost $6.8 million and Medicaid would have lost more than $1.9 million in the same period.

Other factors that emerged are dominance and acquiescence in spousal, parent-child, and sibling relationships that can lead to exploitation or in-law interference and undue influence on spousal POA agents.

Lack of parental leadership in teaching healthy dispute resolution and responsible financial management behaviors that are void of secrecy, deception, and enabling of irresponsible financial behaviors seemed to facilitate exploitation in some families. For example, one perpetrator increased an elder's vulnerability by enabling the elder's addiction:

"[R]ight after my dad died, she had… a lot of the family over to the house… .

(Name withheld for anonymity) showed up with a huge grocery sack full of quart bottles of Scotch and vodka. She could not fail to know that (the elder) was an alcoholic."

Interestingly, many participants reported POA agents to be adult children who lived closest to the elders regardless of their competence in financial and life management, cognitive abilities, and emotional stability. This is particularly notable when other adult children were much more competent to manage elderly relatives' financial affairs.

## Identifying Underlying Risks

Prevention is the most effective approach to curbing EFE and its devastating consequences. Although POA documents can be carefully written to limit certain powers, and other vehicles such as trusts can be used to protect assets, little is known about other approaches to preventing exploitation such as requiring the agent to provide a periodic accounting to the family or a third party.

## Future Research Activities

Researchers are still seeking family members who have had exploitive POA family-member agents. The next phase of this project includes participants whose family-member POA agents have successfully managed senior relatives' financial affairs without exploiting them. Comparison of this group with the group from our previous study is expected to further clarify risk factors within families for elder financial exploitation. A survey to gather more details related to identification of risk factors will precede in-depth interviews.

Participants are being recruited who are English-speaking U.S. residents at least 18 years of age with senior relatives age 60 or older where one or more family members have acted as a POA agent to manage the elder's finances. Multiple participants per family will be sought for the interviews to increase the trustworthiness of the results. Persons interested in participating in the study should contact the author.

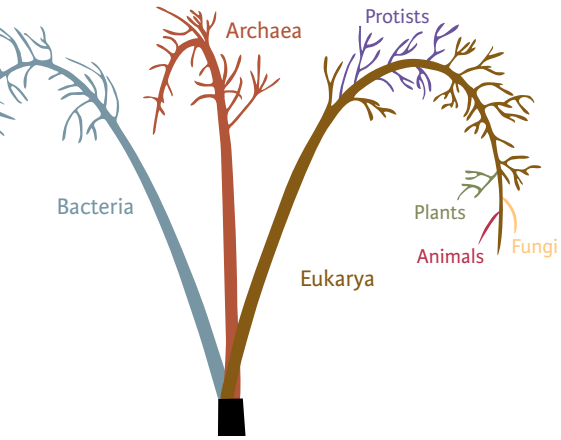
***To contact:*** *Vincenti can be reached at (307) 766-4079 or at vincenti@uwyo.edu.*


# FROM JET LAG TO PLANT PERFORMANCE

## Humans aren't the only ones at the whim of circadian clocks; varied rhythms help some plants produce more seed, others increase growth

***Cynthia Weinig***
*Professor*
*Departments of Botany and Molecular Biology*

**TREE OF LIFE**




I yawn as we begin the descent into Heathrow Airport in London, realizing I will spend several days adjusting to the new time zone and wondering how well I'll fare in the early morning sessions of the meeting I am attending.

Many have experienced jet lag as we travel across degrees of longitude, and many are vaguely aware jet lag is attributable to the so-called circadian clock. Circadian clocks are internal time-keeping mechanisms that manifest as repeating rhythms with cycles of approximately 24 hours.

Circadian clocks are "set" by environmental factors such as day/light or temperature cycles and lead to the sensation of jet lag because the clock cannot be reset instantaneously in response to conditions at one's travel destination.

Few realize circadian clocks are common to the three Domains of Life, including the Archea, Bacteria, and Eukarya (the first two of which include genetically distinct single-celled organisms and the last of which includes organisms with membrane-bound organelles such as humans). Further, while circadian clocks result in jet lag, one might ask: why have clocks evolved in such diverse organisms within the Tree of Life (see lower left), and what function do clocks normally perform?

### Circadian Clocks and Yields

With funding from the National Science Foundation, we have tested for several years how the circadian clock affects yield among agricultural crops and fitness of plants in wild populations.

We first quantify circadian differences among genetically distinct plant lineages by recording rhythms in leaf movement or gene expression among

seedlings. We then test for associations between these rhythms and aspects of performance important to crops and plants in natural settings (how well plants survive stress and how many seeds these plants produce) (Figure 1 below).

We used the plant species *Arabidopsis thaliana* (mouse-ear cress) in our first experiments. *Arabidopsis thaliana* is a "model" plant system; that is, the species serves as a model for processes in other plants, and much of what is understood about plant growth at the cellular, molecular, and genetic level has been learned in this species.

## 24-hour Clock Plants Produce More Fruit

Increasingly, the most important research in this species also tests how these mechanisms (cell, molecular, and genetic) relate to overall plant growth. We compared plants with normally functioning clocks to those whose clock function had been altered by mutation of clock genes. We specifically compared plants with normal (wild-type) clock function to those with exceptionally long (28 hour) or short (20 hour) internal cycles in field settings. We found plants with internal 24-hour cycles that matched natural daylengths survived better and produced more fruit (Figure 2).

**Figure 1.** Plants within the mustard family, including *Brassica rapa* (turnip, cabbage, oilseeds), *Arabidopsis thaliana* (mouse-ear cress), and *Boechera stricta* (Drummond's rockcress) have been measured at the Laramie Research and Extension Center

**Figure 2.** Student Jon Whipps, front, and others at Laramie Research and Extension Center trial plots collect and flash-freeze plant tissue into liquid nitrogen for gene expression analysis.

We were then interested in looking at plants of specific interest to humans with the aim of, for instance, improving crop yield and stress tolerance and understanding how plants perform and survive in natural populations. We continued our work with *Brassica rapa*, which is domesticated as root, leaf, and oilseed varieties and cultivated globally. Although *A. thaliana* and *B. rapa* look superficially different (Figure 3), many processes, including the circadian clock, act similarly.

## Clocks Affect Physiological Processes

We found in *B. rapa* the circadian clock partly determines yield by influencing aspects of physiology, specifically how well plants fix carbon from the air to produce sugars using light energy (photosynthesis). As in all crops, there has been selection by humans to increase the harvestable component in *B. rapa*. Past selection by humans for crop diversification leads to correlated evolution of the circadian clock such that plants (such as oilseeds) with circadian cycles closer to 24 hours fix more carbon in comparison to plants such as cabbages and turnips.

In addition to our studies, the circadian clock has been shown to affect

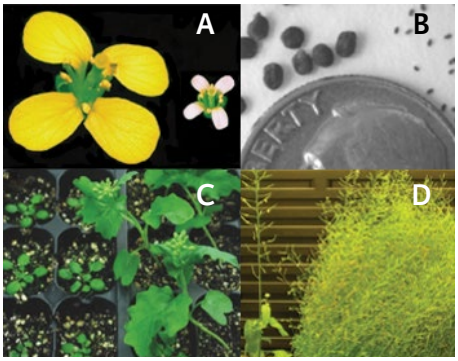



**Figure 3.** Smaller flowers (A) and seeds (B) of *A. thaliana* vs. *B. rapa* (right vs. left-hand side respectively of the picture in A and B), and vegetative appearance of *A. thaliana* vs. *B. rapa* (left vs. right-hand side respectively of panels C and D).

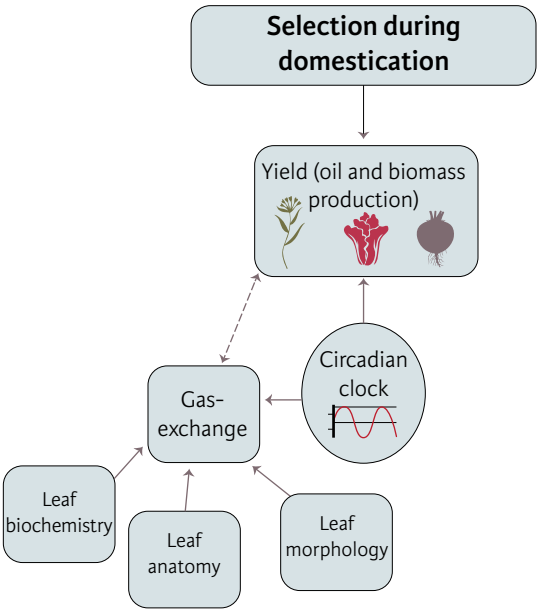
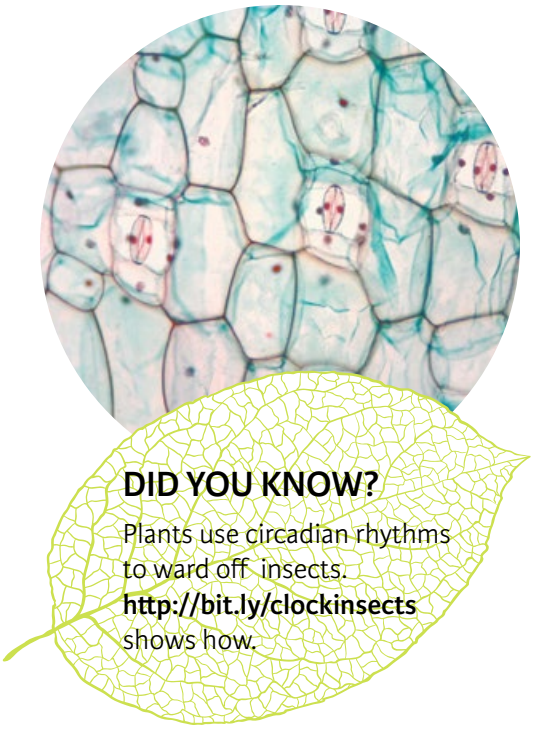



**Figure 4.** Human selection during domestication the last several thousand years has produced varieties of *B. rapa* with high allocation of resources to specific targets of harvest, such as roots, leaves, or oil in seeds. Our research shows the circadian clock affects yield directly and also indirectly through its affects on "gas-exchange," for instance, amount of carbon fixed. Other traits independent of the clock also affect carbon fixation, such as leaf biochemistry, leaf internal anatomy, and superficial leaf morphology.



**DID YOU KNOW?**

Plants use circadian rhythms to ward off insects. **http://bit.ly/clockinsects** shows how.

the timing of when genes are turned on and off, affecting 30 percent of the genes in the *A. thaliana* genome. Based on its extensive effects on trait and gene expression, genetic manipulation of clock function to optimize circadian cycling of different functions may provide a means to further improve crop yield; for instance, clock genes affect the timing of stomatal opening and closing and thereby the opportunity for disease infection and the expression of physiological traits such as water use, to give a few examples.

## Clock Ranges Tied to Seed, Plant Growth

We also work in the Wyoming native plant, *Boechera stricta,* (Figure 5) to understand how the circadian clock might affect plants in natural populations. *Boechera stricta* occurs throughout the montane west at various elevations. We have screened populations from South Brush Creek, North French Creek, Brooklyn Lake, and Crow Creek for their circadian cycles. We find that the range of variation in circadian cycles within one population is about three hours (21.5 to 24.5 hrs); notably, this range is less than among major clock mutants of *A. thaliana* but is the same as the range found in a *global* sample of natural populations of *A. thaliana*.

One may ask how this large range of clock variation is maintained in a single population. We find circadian cycles of variable duration may contribute to different aspects of performance. Specifically, we find that circadian cycles near 24 hours are tied to higher early growth rates, but shorter cycles near 21 hours are associated with higher ratios of root:shoot biomass.

One possibility is high growth rates are favored in some growing seasons because higher growth leads to high


Figure 5. Experimental plant of *B. stricta*, a wild Wyoming relative of the model plant *Arabidopsis thaliana*.

early fruit production — lots of offspring are produced the first year. Higher root allocation, by contrast, may be favored in other growing seasons because high below-ground storage allows plants to survive the winter (more offspring are produced in years following the first growing season). Thus, variable selection may maintain variation in the circadian clock in the wild.

Our research indicates the circadian clock is a key regulator of physiology and performance in natural and agroecological field settings. More generally, for people in Wyoming, studies of plants translate into improvement of crops regionally or globally important and into preservation of wild species found throughout the Snowy Mountains that support wildlife and contribute to the natural beauty we enjoy as citizens of Wyoming.

***To contact:*** *Weinig can be reached at (307) 766-6378 or at cweinig@uwyo.edu.*

# REACHING FOR THE *Sun*

## Researchers study whether factors stretching plants toward sunshine can affect production

http://bit.ly/reachplant


***Andrew Kniss***
*Associate Professor*

***David Claypool***
*Master Technician*

***Louise Lorent***
*Former Graduate Research Assistant*

***Thomas Schambow***
*Graduate Research Assistant, Department of Plant Sciences*


Plants need light – this is one of the first biology lessons children learn in school.

Plants use photosynthesis to convert sunlight into forms of energy the plant can use to grow. Nearly everything humans eat is derived in some way from photosynthesis, whether a tomato picked from a garden or a steak that once grazed grass.

Sunlight seems like a plentiful resource, but there's not always enough sunlight to go around. Sunlight is plentiful for the tallest plant, but, as the taller plants use most of the light, shorter plants may not be able to survive in the shade.

Plants have been competing with each other for sunlight for millions of years and over time evolved mechanisms to help ensure they get enough.

### Tall but Weak

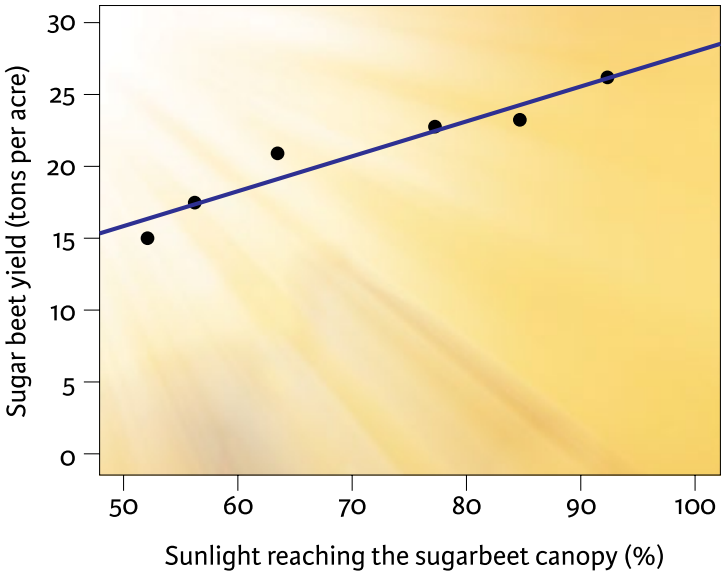
A plant growing in shade tends to grow taller than it would in full sun. Growing tall allows the plant to more effectively compete with surrounding plants. The tallest plant in dense vegetation will often get enough light to survive and reproduce. But energy and resources used to grow tall comes at a cost; the plant will often have a thinner main stem, fewer leaves, a less vigorous root system, and the amount of seed produced can be reduced.

Plants can begin this response even before they experience shade. Plants can "see" nearby plants; and when surrounded by other plants, they can initiate what scientists have dubbed "shade avoidance" responses.

Understanding these shade avoidance responses is important for crop production. Shade avoidance responses may be triggered in a crop plant surrounded by weeds or other vegetation like cover crops. Research in Canada has shown corn and soybean yields are reduced if these shade avoidance responses are triggered early in the crop growing season. Even after weeds are removed by tillage or using herbicides, the crop plants may not recover their earlier yield potential once shade avoidance responses are initiated.

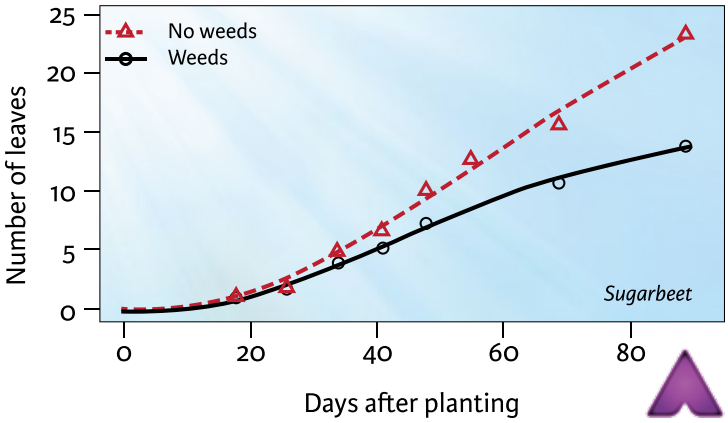
### Impact of Sugarbeet Weed Control

Weed control is critical for all crops, as weeds will compete with the crop for essential resources. Weed control is particularly important in low-statured crops. Sugarbeets, when grown for sugar, don't produce a tall main stem but rather a rosette of leaves that may only reach up to 2 feet




**Sugarbeet yield is significantly influenced by the amount of sunlight received.**

**Figure 1. Effect of nearby weeds on sugarbeet leaf development.**




http://bit.ly/reachsun2

**Table 1. Influence of nearby weeds on sugarbeet root weight.**

| | Sugarbeet root weight (grams) |
|---|---|
| No weeds | 288 |
| Near weeds | 85 |

tall. Consequently, sugarbeet is a relatively poor competitor for light. Expect a 1-percent yield loss in the sugarbeet crop in Wyoming for each 1 percent of full sunlight intercepted by weeds.

Growth may be affected through shade avoidance responses even before the weeds grow taller than the sugarbeet crop. Beans and corn grow taller and reduce branching when receiving reflected light from nearby plants. But in the first year of growth, sugarbeets do not have a main stem, so they have little capacity to grow taller. Instead of harvesting seeds, like for corn or beans, the large storage root is harvested. How shade avoidance responses might affect growth of a sugarbeet plant is unclear. Weeds may affect sugarbeet yield much earlier in the season than previously thought.


Experimental design growing a sugarbeet plant surrounded by weeds.

We have conducted research the last several years to see how sugarbeets respond to light reflected from nearby weeds. The sugarbeets were planted into large pots and surrounded by grassy weeds. Because the sugarbeet plants and weeds were in separate pots, the weeds were not robbing water or nutrients from the sugarbeets; the impacts observed were primarily due to the light reflected from the grass weeds to the sugarbeet plants.

Within 30 days after planting, sugarbeet plants growing near weeds produced significantly fewer leaves. This difference continued to increase until the beets were harvested three months after planting (Figure 1 above).

> Our research the past two years has shown exploiting the bean plant's natural shade avoidance response causes it to grow taller and hold bean pods higher off the ground.

Plants producing fewer leaves are less able to convert light energy into carbohydrates through photosynthesis. In sugarbeets, this resulted in roots three times smaller than beets grown without weeds nearby (Table 1). So even though we often attribute crop yield loss to weeds using necessary resources like water and nutrients, shade avoidance responses may also be partially responsible.

## Increasing Dry Bean Harvest Efficiency

There are circumstances when taller height may be desirable, even if there is potential for reduced yields.

Pinto beans are an important crop for many Wyoming farmers. Pinto bean production is often quite labor and fuel intensive. Bean plants are usually dug or cut out of the ground before harvest. This practice is common because most bean varieties produce pods very close to the soil surface. Cutting them directly with the harvester would cut the pods open, damaging or leaving the beans behind in the field. These harvest losses are a primary barrier preventing widespread adoption of direct harvest practices.

Our research the past two years has shown exploiting the bean plant's natural shade avoidance response causes it to grow taller and hold bean pods higher off the ground. In doing so, there is no need to undercut the beans before harvest. Farmers could direct harvest the standing pinto bean crop while minimizing harvest losses.

That's the good news.

The bad news is that, in field research so far, yield loss associated with the shade avoidance response has been high. Economically, this practice does not seem profitable yet, which means more research is necessary to determine whether this can be done sustainably at the field level. Either way, there is still much to learn about how plants interact with each other in their quest to find the light.

***To contact:*** *Kniss (307) 766-3949 or akniss@uwyo.edu; Claypool, (307) 766-3995 or claypool@uwyo.edu.*

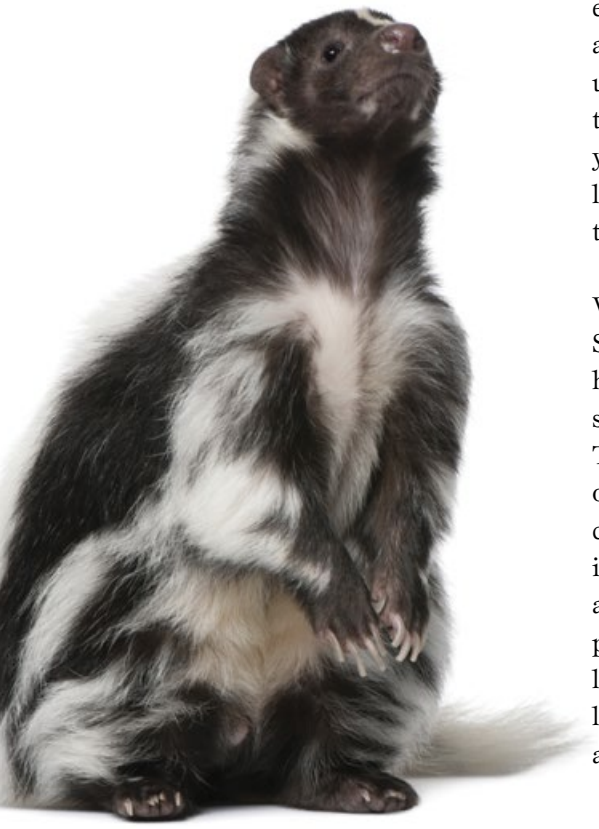

Pinto bean plants at similar physiological growth stages exhibiting a shade avoidance response (left) compared to normal growth (right).

# KEEPING TRACK

## Wyoming State Veterinary Laboratory plays important rabies surveillance role in state

***Myrna Miller***

*Assistant Professor*
*Veterinary Virologist*
*Wyoming State*
*Veterinary Laboratory,*
*Department of Veterinary Sciences*



### Three decades of tracking rabies in Wyoming

For thousands of years rabies has been a feared, nearly always fatal neurological disease acquired from the bite of a "mad" dog or wild animal.

About 60,000 people die of rabies every year worldwide, mostly in Asia and Africa. Human rabies is now uncommon in the United States, with typically only one to two cases per year since the 1990s. This is due in large part to the widespread vaccination of our pets.

Scientists from the Department of Veterinary Sciences and the Wyoming State Veterinary Laboratory (WSVL) have been part of a state-wide rabies surveillance program since 1984. This program has tracked the spread of skunk variant rabies from the first case in Johnson County to the recent incursion of a new strain into Laramie and Goshen counties. This effort has provided valuable information to public health officials, wildlife managers, livestock board, veterinarians, and pet and livestock owners.

#### Rabies a Variable Disease

Rabies does not always cause the same clinical disease in animals or humans. It may also have a highly variable incubation period. Following a bite wound from a rabid animal, or exposure to saliva on a cut or mucous membrane, the virus travels up nerves into the brain, a process that can take weeks to months. The disease is usually not recognized or produce symptoms until the virus reaches the brain. The salivary glands become infected soon after the virus has entered into the brain, and the disease is ready to transmit to a new animal.

Most people associate rabies symptoms in animals as "mad" or aggressive behavior, including foaming at the mouth; however, the signs of rabies can vary. For example, some cases may take the form of "dumb" rabies; in these cases, animals may act depressed, confused, or weak.

Any abnormal behavior in wildlife should raise suspicion of rabies.

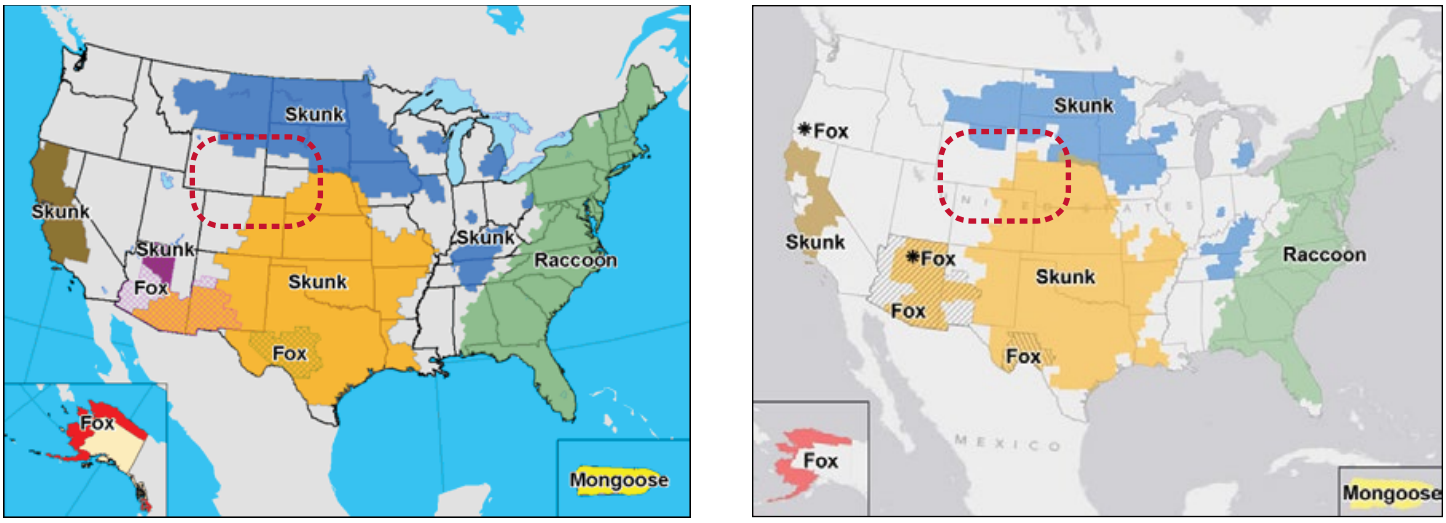



**Figure 1. Distribution of terrestrial rabies reservoirs in the United States during 2007 (left) and 2011 (right). South Central skunk variant (gold shaded) has been expanding north and displacing the North Central skunk variant (blue shaded) in the middle part of the country (red dashed line), including the recent expansion into southeastern Wyoming.**

Skunks, raccoons, and foxes with rabies often exhibit lack of fear and increased activity during the day and may be found wandering in pastures or in town in the daytime. Bats may be unable to fly.

## Rabies Not Single Virus

Rabies viruses can be separated into specific variants associated with a specific mammal reservoir. Genetic differences allow researchers to determine the animal source reservoir and track the spread of specific variants.

Bat rabies is associated with several species of insectivorous bats. Occasionally, spillover into terrestrial mammals and humans occurs, but these cases tend to be infrequent. Rabies in other mammals in the United States occurs as eight variants, each associated with different reservoir species in different parts of the country (Figure 1 above). In the Midwest, the North Central skunk and South Central skunk variant are present. In recent years, the South Central skunk variant has been displacing the North Central variant in the middle part of the country.

## Rabies in Wyoming

The first case of rabies in Wyoming documented as originating from a terrestrial mammal reservoir was identified in 1984 in a skunk in Johnson County. This variant was the North Central skunk strain. Previous cases of rabies had been reported, but the type of rabies was not determined, and these early cases were mostly isolated and did not become established.

Rabies spread from Johnson County into neighboring counties along river drainages and irrigation systems that provided good skunk habitat (Figure 2A see page 26). Researchers found tracking the distribution of rabies in Wyoming meant tracking the location of infected skunks. Skunk monitoring and population control measures were put in place, and the number of cases decreased from the initial outbreak.

By 1993, a five- to seven-year cycle of little incidence followed by one to two years with increased cases became established and is largely tied to years favoring increased skunk populations. Although a few cases of the North

### ANIMALS POSITIVE FOR RABIES IN WYOMING

**1984 to 2014**

- Skunks – 1108
- Bats – 281
- Bovine – 21
- Horse/Mule – 18
- Dogs – 12
- Cats – 17
- Coyote – 1
- Fox – 2
- Raccoon – 1
- Bobcat – 1
- Rodent unspecified – 1
- Squirrel – 1

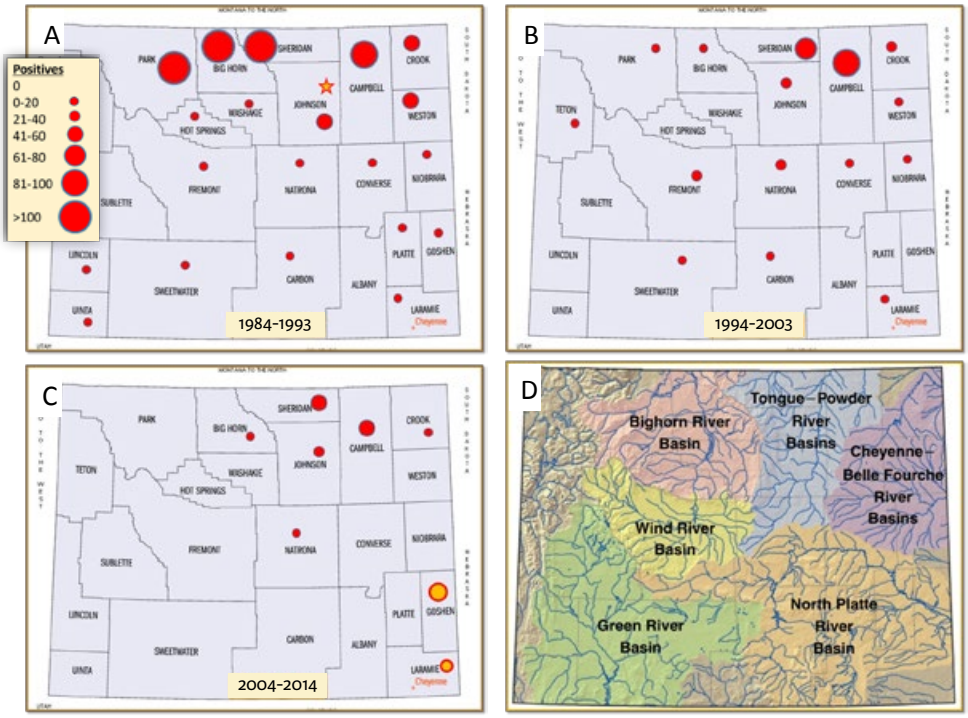



**Figure 2. Diagnosed cases of rabies in animals by decade since the initial typed case in 1984 (A-C). Major river basins in the state of Wyoming are indicated (D).**

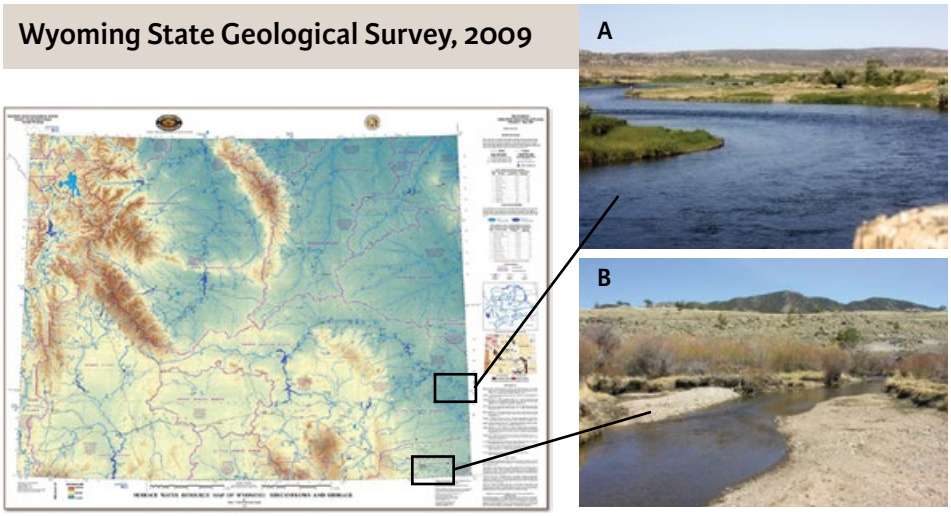



**Figure 3. A topographic map of the state of Wyoming with the major rivers. Rivers (A. North Platte) and small creeks (B. Laramie County) provide riparian habitat and corridors for skunk movement into Wyoming from Nebraska and Colorado.**

Central skunk variant of rabies were found in animals in Fremont County and the Green River Basin over the next 15 years, the virus failed to reach the level needed to become established in the skunk population (Figure 2 B, C).

## New Variant in Wyoming

The South Central skunk variant was seen for the first time in Wyoming in 2011 in Laramie County distributed along small creek drainages flowing into Colorado. This variant originated in Texas in the mid-1800s and has been expanding since. Genotyping found the South Central skunk variant was closely related to lineages from northern Colorado.

The first cases of South Central skunk rabies were found in late 2013 and 2014 in Goshen County. These cases were related to types found in Nebraska, indicating they were spreading along the North Platte River from the east.

The small creek drainages from Colorado and the North Platte River from Nebraska are both corridors for the movement of infected skunks (Figure 3). Incidences of rabies is expected to spread along these routes into central regions of the state.

In Wyoming, cattle are the domestic animal most frequently found to have rabies followed by horses, cats, and dogs (Figure 4 page 27). Cats may be at higher risk for infection than dogs because of a greater likelihood of coming into contact with wildlife.

As previously mentioned, rabies may vary, and the following interesting cases demonstrate important points to remember.

- ***A squirrel bite.*** In 2000, a man was bitten by a ground squirrel when he tried to rescue the animal from his cat. The ground squirrel tested positive for the bat variant of rabies. Although uncommon for rabies infection to be found in rodents and rabbits, any mammal can be infected. Testing any animal is important if there has been potential for human exposure.
- ***A lame horse.*** In 1991, a horse became weak in the rear legs. This weakness progressed until it could no longer stand, and the horse was euthanized. The spinal cord but not the brain was positive for rabies, indicating the exposure may have been a bite wound to a rear leg. This case illustrates any neurologic disease can be due to rabies, and in large animals, rabies

Any abnormal behavior in wildlife should raise suspicion of rabies.

causing progressive rear leg weakness may be identified in the spinal cord.

- ***A fearless miniature horse.*** In 1997, a miniature horse began to chase other animals; first chickens, then other horses, then a bull in the same pasture. Loss of fear and aggressive behavior are common features of rabies in wildlife and domestic animals.
- ***Rabies goes to school.*** In 2007, a bat was found in a school basement, then kept in a classroom terrarium. Two days later, the bat died suddenly and tested positive for rabies. No students had direct contact with the bat, but the teacher and an aide who had cleaned the cage received post-exposure vaccinations. This became a lesson in wildlife rabies, though not the teaching experience anticipated.

### Protecting Pets, Preventing Cases of Human Rabies

Preventing rabies in domestic animal species is the best method of preventing human exposure.

Although 90 percent of rabies in animals in the United States is in wildlife, humans have much more contact with domestic animals. Vaccination of dogs and cats is important, but livestock can also become infected with rabies, so in high-risk areas, any animal that has extensive human contact, such as 4-H animals and horses going to fairs, should be vaccinated.

Public education about safe interactions with wildlife and control of skunk populations are other important control measures.

***To contact:*** *Miller can be reached at (307) 766-9934 or at millermm@uwyo.edu.*

## DOMESTIC ANIMAL RABIES IN WYOMING
### 1984-2014


Figure 4. Number of cases of domestic animal rabies in Wyoming, 1984-2014

### Why are skunks primary carriers of rabies in Wyoming and not other animals?

The reason is not entirely understood, says Myrna Miller, veterinary virologist in the Wyoming State Veterinary Laboratory.

"Rabies virus variants are associated with specific mammalian host reservoir species in a given geographic region," she notes. "Although these variants can spill over into other mammals, they rarely become established in the new host population."

Lack of contact between the reservoir species and a new host may be the reason why these jumps don't occur more often; however, it is known to occur.

According to Miller, "... there also appears to be an element of the virus adapting to the new host," she says. "For example, if the animal lives longer and dies five days after clinical signs instead of two, there is more opportunity to infect a new host. There have been instances in which there was a reservoir host switch. For example, a bat rabies virus became adapted to fox and skunks in Arizona, with ongoing transmission in the new mammal populations."

# MANAGING RESIDENTIAL DEVELOPMENT SPATIAL PATTERN COULD REDUCE COST OF FIGHTING

*Anna Scofield,*
*Master's Student*

*Ben Rashford,*
*Associate Professor*

*Don McLeod,*
*Associate Professor*

*Roger Coupal,*
*Associate Professor*

*Department of Agricultural and Applied Economics*

Government agencies spend billions of dollars annually fighting wildland fires, and wildfire suppression expenditures have increased year-after-year despite advances in fire suppression technology and efficiency.

These increases are largely attributed to expanding residential development in the wildland urban interface (WUI). WUI is the convergence of human development and wildland vegetation – envision homes built on the edge of the forest.

Policymakers need an understanding of how development drives expenditures to develop effective solutions. We examined 281 fires that burned between 2002 and 2011 in Montana, Wyoming, and Colorado to test the influence of the spatial pattern of residential development on fire suppression expenditures.

Largely ignored by previous research, the location of a home relative to other homes significantly determines how costly it is to protect. Dispersed development, which is the dominant form of development in the Rocky Mountain Region, increases expenditures more than clustered development. This means policies to control the spatial pattern of WUI development may be nearly as effective as policies that completely restrict WUI development.

## The Spatial Pattern of Development

There are two main categories of fire suppression resources: ground resources, such as fire engines and hand crews, and aerial resources, such as helicopters and air tankers. Given these resources, there are two corresponding dimensions of spatial pattern that affect fire suppression expenditures.

The first dimension of spatial pattern is whether structures are close enough together for one ground resource to protect multiple homes simultaneously. In Panel A of Figure 1 (page 31), homes (represented by the black dots) are arranged in one cluster, and homes within the cluster are close enough to be protected by a single resource.

Hypothetically, one fire engine could protect all the homes. In Panel B, the homes are not close enough together to be clustered – each home requires its own fire protection resource. Panel B hypothetically requires four fire engines to protect all the homes.

The second dimension of spatial


WILDFIRES

pattern is whether groups of structures are close enough for one aerial resource to protect them simultaneously. In Panel A of Figure 2, two clusters of homes are close enough to be protected by one air tanker. In Panel B, the two clusters of homes are on opposite sides of the fire, so two air tanker trips would be required.

These simple examples illustrate why clustered development may be cheaper to protect than dispersed development – the spatial pattern of development in the WUI should influence fire suppression expenditures.

## Understanding the Effect of Spatial Pattern

Our modeling results indicate the number of structures and their arrangement impact expenditures. The effect of spatial pattern, however, is substantially larger than the effect of the number of structures (for our sample of fires). As much as 40 percent of total expenditures on fires with mostly dispersed development can be attributed to spatial pattern.

The cost savings to fight a fire with completely dispersed structures vs. one with completely clustered structures can be as much as $620,000. Adding just one isolated structure to a fire area can increase expenditures by as much as $225,000. Adding a structure very close to other structures, on the other hand, can increase expenditures by as little as $1,000.

Additionally, our model predicts a fire with more structures that are clustered can actually be less expensive than one with fewer structures that are dispersed. This result challenges most contemporary research that does not consider the spatial arrangement of homes in the WUI.

## Policy Implications of the Spatial Pattern Effect

Our results indicate policies that control spatial pattern of WUI development can be nearly as effective as policies that restrict WUI development altogether. Fire expression expenditures may be reduced without eliminating WUI development. Explicitly understanding the effect of development pattern may therefore lend precision to solutions that capitalize on economic incentives to change the pace and pattern of WUI development.


**Figure 1.** Alternative spatial patterns of individual structures: A – clustered, B – dispersed.

http://bit.ly/econfire3

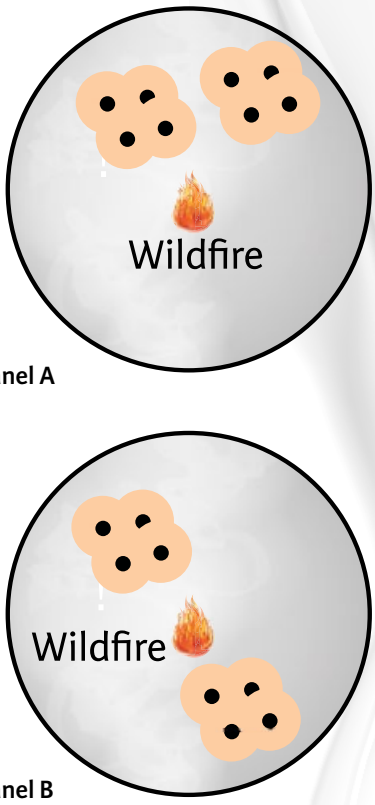



**Figure 2.** Alternative spatial patterns of clusters of structures: A – near, B – far.


# Reflections

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





**Mountain West Farm Bureau Mutual Insurance Company**

Supported in part by Mountain West Farm Bureau Endowment

University of Wyoming
College of Agriculture and Natural Resources
Dept. 3354, 1000 E. University Ave.
Laramie, WY 82071

Nonprofit Organization
U.S. POSTAGE
PAID

Photo Credit: Julia Polasik