UNIVERSITY OF WYOMING

REFLECTIONS

COLLEGE OF AGRICULTURE

Vol. 11 No. 1 June 2001

Steve Horn

For more than a decade, the College of Agriculture at the University of Wyoming has published *Reflections*. I believe it is the most attractive research magazine in the academic world. The design, layout, and visuals make this magazine worthy of any coffee table in America. But it's more than just another pretty periodical. We work hard to ensure well-balanced, entertaining, and informative content. Between its slick covers you will find the essence of the land-grant philosophy: research, service, and instruction. In the College of Agriculture, we view ourselves as epitomizing the land-grant mission and we take pride in that role.

Whether it is investing in today's students or tomorrow's workforce, ensuring a dependable food supply, renewing rural economies, or achieving environmental balance, the people of the College of Agriculture are dedicated to serving the needs of Wyoming and the world.

Enjoy this year's offering of *Reflections*; it was written for you. And when you're done reading, place it back on the coffee table for others to enjoy.

Steven W. Horn

Dean, UW College of Agriculture

Background Photo: Edgar Reeves

I've heard many times that problems come in the form of complex, overlapping issues, while universities are organized around disciplinary departments. Knowing that educational demands and identified problems are extremely variable and complex, the College of Agriculture, with Dean Horn's vision and leadership, stresses what it believes are the three keys to success: cooperation, integration, and balance.

Despite the focus on these key ingredients, concerns remain regarding the programs offered by our college. Some critics suggest there is too much emphasis on production agriculture at the expense of human and renewable resources. Other critics indicate that the college has moved too far away from production agriculture. In response, I would like to point to the many articles and briefs in this year's *Reflections* that highlight the College of Agriculture's outstanding ability to focus on both. For example, currently, we participate in cross-college, multidisciplinary research activities, including WIN the Rockies, coalbed methane water quality, and mine land reclamation. Some of our research and extension center personnel collaborate with community college faculty to teach in off-campus degree programs. Our Global Perspectives Program encourages faculty and staff to internationalize teaching, research, and extension efforts to benefit Wyoming students and clientele. And our IPM work integrates farming practices from Australian producers.

COOPERATION, INTEGRATION, AND BALANCE: the KEYS to our success

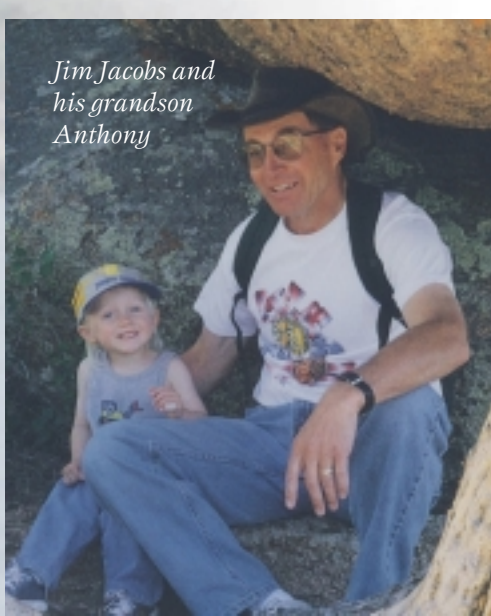
Jim Jacobs, Associate Dean and Director, Wyoming Agricultural Experiment Station

Regarding undergraduate education, many people are not aware of the the numerous degree programs offered by the College of Agriculture. For example, students can begin training for a career as a veterinarian, a microbiologist, or a childcare provider. In addition, students in each of the seven departments have numerous opportunities to work directly with researchers throughout Wyoming and to participate in national and international internships and exchanges to obtain active learning experiences.

To maintain the value of the college to Wyoming residents, research and outreach efforts are continually emphasized. Through the college's research and extension centers, county extension offices, and numerous applied research and demonstration projects with cooperators across the state, the college is dedicated to uncovering new knowledge, applying the latest discoveries, and addressing identified concerns and issues from our constituents.

This year's *Reflections* is dedicated to Dean Horn in appreciation for his nearly eight years of leadership and commitment to the college, UW, and the people. For more information about the College of Agriculture, visit the college's Web site at www.uwyo.edu/agcollege, or contact any of the departments listed on the inside back cover of the magazine.

I hope you enjoy *Reflections*.



Jim Jacobs and his grandson Anthony

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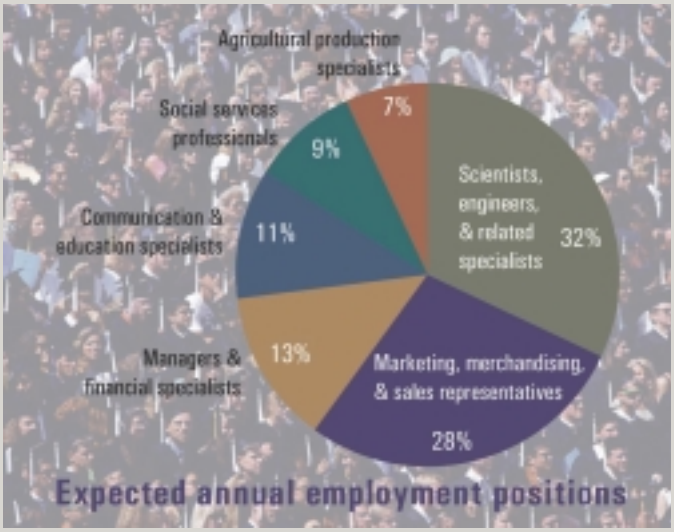
Academic Program's FORECAST.

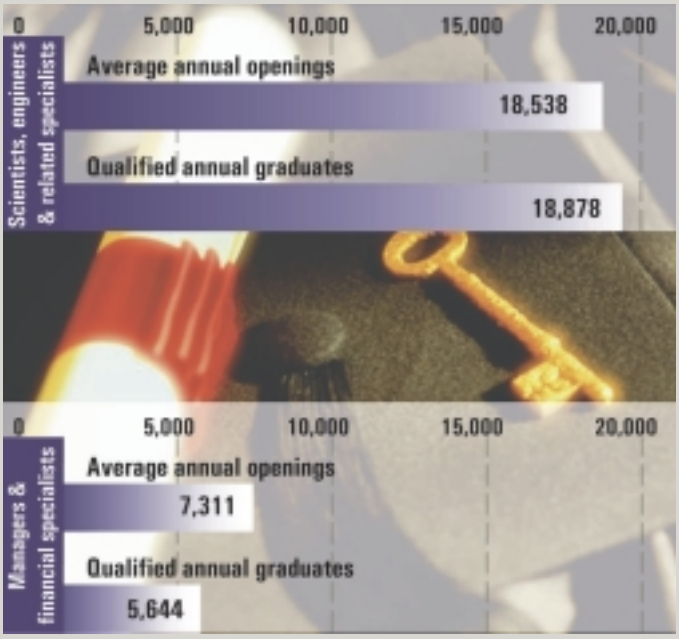
Career opportunities for our graduates

The results are in, and according to a study conducted by the Cooperative State Research, Education, and Extension Service of the U.S. Department of Agriculture and Purdue University, College of Ag grads are in high demand. In fact, researchers predict that over the next four years, annual employment openings will be substantially higher than the actual number of students graduating in the fields of agriculture, forestry, natural resources, and veterinary medicine. Projections anticipate 57,785 annual openings with only 57,175 graduates.

Scientists, engineers, and related specialists

More scientists, engineers, technicians, and related specialists are being employed each year in the U.S. food, agricultural, and natural resources system. However, slightly more than enough qualified graduates are expected to enter the market during the next four years.





The strongest employment opportunities are anticipated for food scientists, food process engineers, plant and animal geneticists, water quality specialists, turf scientists, horticultural scientists, plant and animal inspectors, and food and agricultural waste management specialists.

Managers and financial specialists

Strong employment markets are expected for personnel managers, golf course managers, and landscape horticulture enterprise operators. Also, accountants and financial managers in food, agricultural, and forestry business organizations should continue to fare well.

A somewhat weaker employment market is expected for middle managers in agribusiness firms and credit operations. Continued consolidation of businesses in the food and agricultural economy is expected to exert further downward pressure on the market. With fewer farmers, ranchers, and agribusiness organizations in the future, more consolidation of government agency services is anticipated. These changes will likely reduce management opportunities in agricultural and forestry agencies.

Marketing, merchandising, and sales representatives

Marketing, merchandising, and sales positions will continue to be a primary employment market for new grads. Fewer graduates will be hired to market goods and services to farmers and ranchers; rather, more will be involved in selling food, forest, and horticultural products to domestic and international consumers. Also, more will utilize emerging electronic technologies to complete marketing and technical service functions for their businesses.

Communication and education specialists

Very strong employment opportunities are projected for advertising representatives, public relations specialists, secondary school agricultural science and business teachers, and international communication specialists, especially those who are skilled in providing products and services via the World Wide Web.

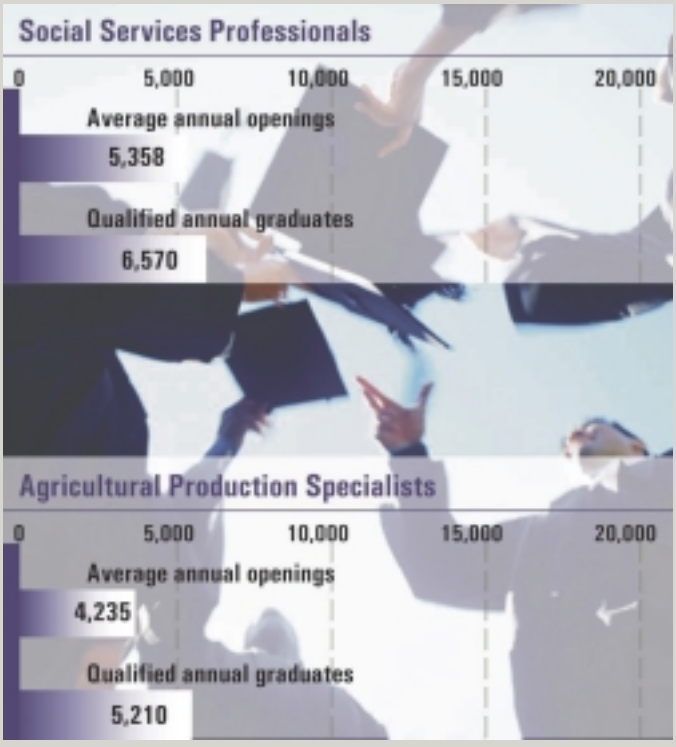
Stable, or perhaps declining, employment opportunities are forecast for writers, editors, and newscasters. Little change is expected in the aggregate market for college and university faculty, post-secondary technical schoolteachers, and extension services personnel.

Social services professionals

Dietitians and nutritionists, outdoor recreation specialists, land use planners, and food inspectors lead the list of social service professionals expected to enjoy a strong job market during the next five years. A somewhat weaker employment market is expected for rural sociologists, labor relations specialists, and government agricultural agency representatives.

Agricultural production specialists

Although farmers, ranchers, and farm managers will account for about 85 percent of new openings in the agricultural production specialist employment cluster, more than enough qualified graduates are expected to be available in general farming and ranching operations. During the next five years, an increasing proportion of new agricultural production managers will be hired or contracted in contrast to being owner operators. Forest managers, horticultural crop producers, landscape nursery operators, and swine and poultry production managers are expected to have good opportunities during the next four years.



Terrific textiles:

FCS professor recognized for creative research

Family and Consumer Sciences (FCS) Associate Professor Donna Brown likes to create textile pieces that are "truly wearable." When she has combined her flair for design with this knack for functional textile construction, the results have earned accolades.

Brown's latest award, for the piece "Littlest Mermaid Goes to the Opera," was an honorable mention in the Wearable Art, Professional Category of the Everyone Loves Sulky Challenge 2000. While designing according to contest specifications might not fit the usual image of creativity, Brown uses such requirements to inspire her.

Another successful contest entry, "Glittering Tibetan Jewel," won third place in the Wearable Art, Professional Category of the 1999 Everyone Loves Sulky Challenge, and was part of a year-long Sulky traveling exhibit. Brown's piece "Jeweled Collage" was awarded second place vest in the McGehee 1998 Challenge.

After an international selection process based on artists' cumulative work, Brown was named as a designer for the 1999-2000 Fairfield Processing Corporation Wearable Art Fashion Show. "In the field, this has been considered the ultimate honor and recognition—to be invited to design for Fairfield based on your past work, rather than on one particular design," Brown commented. "No Time to Change," Brown's career style/evening wear Fairfield design, traveled with the show for more than a year.

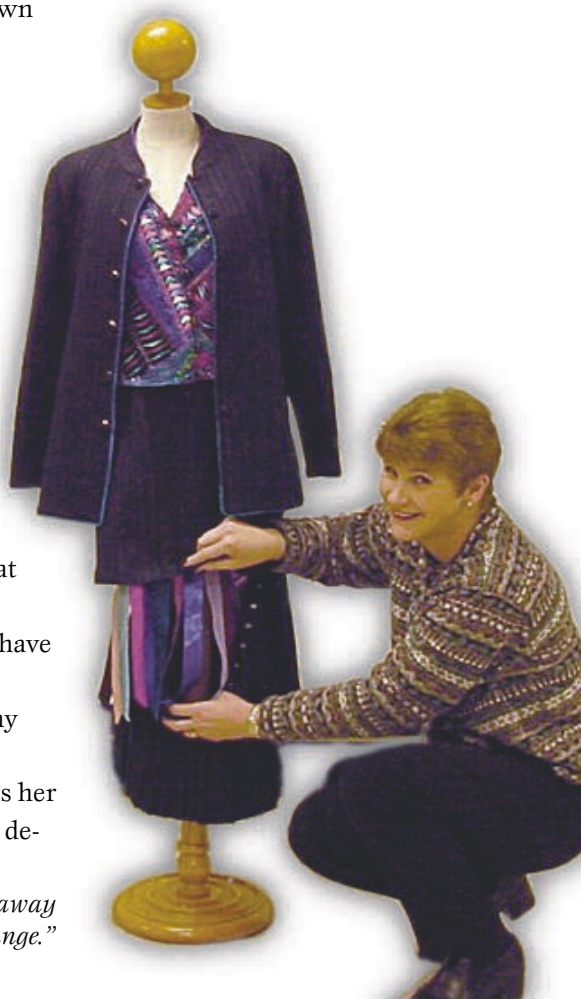
Brown's professional expertise also has been tapped by the textile industry. Richland Silk Co., a manufacturer of silk batting used primarily in quilts, recently asked Brown to design a series of garments to demonstrate the use of this material in clothing. This type of work fits into Brown's creative scheme, as silk is her "medium of choice."

Brown's academic and creative career began with an undergraduate degree from the University of New South Wales (UNSW) in Sydney, Australia. She went on to earn a Ph.D. in Textile Technology with a focus in Wool Science from UNSW, but was inspired to get involved in textile design after viewing garments from the Fairfield Show at Quilting in the Tetons (QIT). Her creative process developed as she took QIT classes over the years and taught herself techniques from books and periodicals.

"My creative pursuits are now very closely linked to what I teach in FCSC 5101: Special Topics, Fiber Arts," Brown noted. In this class, Brown teaches UW students over 100 fabric techniques, including hand painting and dyeing, marbling, airbrushing, three-dimensional manipulation, and a variety of embellishment styles. "The students learn a lot of the techniques that I use in my work, as well as techniques I have picked up attending classes to enhance my own skills."

Brown continues her art despite the other demands on her time. "It still gives me a sense of accomplishment, as well as a sense of self," she said. Donna Brown is one of many UW faculty members who excel at both teaching and creative pursuits, letting each academic area enhance the other and setting an example of professional achievement for Wyoming college students.

Hattie Penny, Editor, Office of Agricultural Communications and Technology



Donna Brown demonstrates the tear-away feature of "No Time to Change."

RESEARCH & BRIEFS

SUCCESS WITH "LEY" FAR

The greening of Wyoming

Australians call the rotation between wheat and annual pasture "ley" farming. Every year, annual medics (relatives of alfalfa) regenerate from a soil seed bank. In the pasture phase of the rotation, livestock graze nutritious medic forage. In the crop phase, medics are obliterated at wheat planting, and the wheat crop benefits from nitrogen produced by previous pastures.

Since the 1940s, legume pastures have largely replaced fallow across the semi-arid southern Australian wheat belt, and the ley system has restored and maintained soil productivity on millions of acres. Medic pastures might do the same on the U.S. Great Plains.

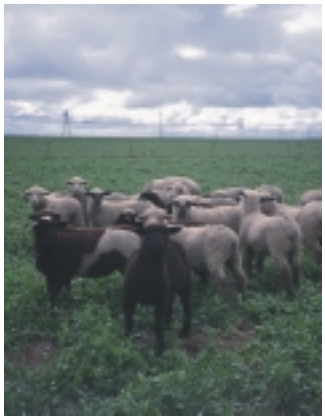
Researchers at the UW Archer Research and Extension Center harvest medic seed with an Australian vacuum harvester-thresher.

Early studies at the University of Wyoming Archer Research and Extension Center revealed that annual legumes produce forage yields on par with dryland alfalfa. Along the way, researchers learned that when spring-planted peas or lentils were plowed down by the first week of July, soil moisture reserves could be replenished by late summer rains to a level comparable with the traditional 14-month fallow period and sufficient for September wheat planting. Researchers also learned that fall-seeded Austrian winter pea would survive Wyoming winters, so they proceeded to a system of fall-planted peas with termination of growth by the first of July. And, like Australian farmers, researchers introduced livestock in hopes of not only adding value but also speeding up the cycling of biological nitrogen fixed by the legume pasture.

Results from several years of field research are promising. The five-year mean performance of 60 to 90 pound lambs grazed at a stocking rate of 14 lambs per acre on Austrian winter pea for three weeks in June was a total gain of 139 pounds per acre, resulting in a gross lamb value gain per acre of $83 or $125 at projected market prices of $0.60 or $0.90 per pound, respectively.

At winter wheat planting, the total soil moisture content within the upper 3 feet of the soil profile (5-year average) was 7.2 inches after fallow and 7 inches after grazed pea. Wheat yields following Austrian winter pea were only slightly more or less (depending on the year) than yields after the full 14-month fallow. Importantly, the wheat protein after the grazed peas has always been higher compared to 14-month fallow. This means that after almost a century of farming, Great Plains soil is becoming responsive to biological nitrogen cycled through livestock.

All of this is encouraging, but one more important step is needed to attain a true ley system. The legume must have the capacity to reseed itself and then regenerate from the soil seed bank, and Austrian winter pea requires sowing with every pasture phase.



Sheep graze Austrian winter pea at the UW Archer Research and Extension Center in mid-June.

In light of this, researchers looked at the annual medic types that form the foundation for the Australian ley pasture system. Forage production of these medics was satisfactory when spring planted at Archer, but reseeding was poor, and none survived the Wyoming winter when fall planted. Next, they evaluated many medic species from high latitudes and elevations in Eurasia, and some of these have proven to be both winterhardy and good seed producers.

The greatest success has been with a rigid medic species from north of the

MING

Fertile Crescent where Turkey red wheat originated. This rigid medic has survived six consecutive Wyoming winters when sown in mid- to late-summer. In the winter of 1999 to 2000, large plots of rigid medic survived much better than yellow sweetclover or black medic when sown in August after winter wheat. In fall 2000, regeneration at 22 plants per square foot from seed was on par with what Australians expect from their medics.

If future results mirror those of previous years, researchers will have taken a major stride toward the development of a new wheat production system for the High Plains that will integrate livestock, provide soil nitrogen, improve soil quality, decrease soil erosion, and increase agricultural profitability.

Jim Krall, Professor, Department of Plant Sciences

Robin Groose, Associate Professor, Department of Plant Sciences

Ron Delaney, Professor and Head, Department of Plant Sciences

Jerry Nachtman, Research Associate, Torrington Research and Extension Center

Viticulture research flourishes in northeastern Wyoming

Grape, or viticulture, research began at the UW Sheridan Research and Extension Center (SREC) in 1988. Grape production questions are now the number one type of horticulture inquiry from SREC clients. Vigorous and nearly disease free in Wyoming's arid climate, grape plants have delicious fruit used for making jelly, juice, and wine, and for dyeing wool.

For high-quality fruit production, grape growers must learn to prune aggressively; effective pruning should result in 30 to 40 buds per plant per year. The optimal time to prune grapes is in the dormant season, between late October and mid-March.

To ensure a consistent fruit crop with hardy wine grapes, as well as with more tender seedless varieties, fall burial is critical. While burial does help with winter protection, the practice is mainly designed to keep vines from growing too early in the spring and from getting injured by the last frost in May.

Hands-on training in pruning, fertilization, and burial techniques, and selection of grape varieties suitable for Wyoming is offered at the SREC's annual fall grape production workshop. Interested grape growers may call the SREC at (307) 737-2415 or send an e-mail to wyarno@uwyo.edu for more information.

Roger Hybner, Director, Sheridan Research and Extension Center

A canker caused by *Cytospora chrysosperma*

Cytospora canker of cottonwood trees

The golden leaves of cottonwood trees are an integral part of Wyoming's beautiful fall scenery. Although several species of cottonwoods occur in the state, the most common is the narrowleaf cottonwood, *Populus angustifolia*. Groves of this native tree are found along most riparian areas, as well as in city and state parks. One of the largest cottonwoods in Wyoming stands stalwart on the Padlock Ranch near Dayton.

Even though there are some prized cottonwood specimens in the state, other trees are not as healthy. Cytospora canker (caused by the fungus *Cytospora chrysosperma)* is currently the most destructive disease for Wyoming cottonwoods. The fungus has the potential to infect even healthy trees; however, trees under some type of stress, particularly drought or freeze injury, sustain the most damage. Transmitted through the spread of fungal spores by insects, small animals, wind, or one of Wyoming's infrequent rain storms, the disease can cause serious injury or even death once it is established in a tree's tissue.

Research in the Department of Plant Sciences seeks to determine the incidence and distribution of Cytospora canker in Wyoming cottonwoods. Preliminary data from surveys carried out in city parks throughout the state and in native groves along the Laramie River drainage system indicate that the disease is widespread in both areas. Trees in native groves appear to have a higher incidence of the disease than trees in city parks, most likely due to the close spacing of trees in groves, which facilitates the spread of the fungal pathogen. Further, trees in native groves do not receive regular care and are generally under more stress than park trees.

In addition to conducting surveys, the Department of Plant Sciences is investigating a botanically derived compound and a possible biological control organism. Both are being tested in the laboratory and on live trees as possible control agents for Cytospora canker. This vein of research holds great promise for keeping the cottonwoods' colors a part of the fall beauty of the Cowboy State.

Fred A. Gray, Professor, Department of Plant Sciences

Karen L. Panter, Extension Horticulture Specialist, Department of Plant Sciences

Emily E. Ewart, M.S. Candidate, Department of Plant Sciences

SCIENCE

IMMU

The mission of the UW Department of Veterinary Sciences and the Wyoming State Veterinary Laboratory (WSVL) is to provide timely and accurate diagnostic services, animal disease research, and education to veterinarians, animal owners, students, and the people of Wyoming. Recently, a focus of the department's research and diagnostic service has been the development of immunohistochemistry (IHC) diagnostic tests.

IHC is a technique that involves staining sample tissue on a microscope slide with a chemical, such as an antibody, that can specifically identify evidence of disease-causing agents. The stains are labeled in a manner that allows identification of a virus, bacteria, or abnormal protein by simply viewing a slide under a microscope. Not only can the diagnostician view the tissue for injury, but with special stains, he or she can identify some causes of the injury.

This technology was developed and is used extensively to identify the protein associated with Chronic Wasting Disease of deer and elk. The tech-

IMMUNOHISTOCHEMISTRY: An important new tool for animal disease diagnosis

nique is also used to identify scrapie, a brain disease of sheep. The department's expertise in this field recently led to its selection as one of four regional centers officially approved by the federal government to do these tests.

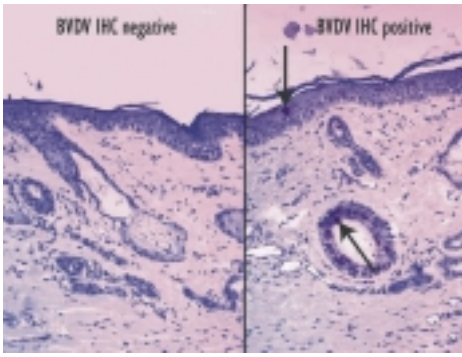
Several new tests have recently been added to the department's IHC diagnostic service. The new tests, now available upon request, include detection of bovine viral diarrhea virus (BVDV), equine herpesvirus-1 (EHV-1; "Rhino"), and infectious bovine rhinotracheitis (IBR or bovine herpesvirus-1; "Red nose") in preserved tissues. IHC tests improve detection and diagnosis of these significant causes of abortion and other diseases in horses and cattle. In addition to these three new tests, researchers are developing new IHC assays to help identify certain types of tumors in small animals, along with assays to detect other infectious diseases of both small and large animals.

An example of the utility of IHC is the test for BVDV. This potentially devastating virus can cause clinical disease (with symptoms such as pneumonia and/or diarrhea), illthrift (with poor production), and abortion. Of more concern, some animals are born persistently infected (PI). Those PI calves are carriers of the disease and lead to repeated infections, often resulting in abortions and disease in a herd. The Department of Veterinary Sciences and the WSVL recently expanded IHC testing to include identification of cattle that are PI with BVDV. Currently, identification of PI cattle is based on an enzyme-linked immunosorbent assay (BVD ELISA) or classical virus isolation. A few laboratories also use a polymerase chain reaction (PCR) assay.

IHC on biopsied skin shows potential as a method that also may be useful to detect PI animals. Skin is biopsied from live animals using ear notches, 8 millimeter punch biopsies, or brisket punch samples. Samples are fixed briefly in a chemical solution, treated with a BVDV-specific monoclonal antibody followed by a color reaction, and examined by a pathologist. Viral antigen, if present, is detected in keratin cells from the skin and/or hair follicles, and to a lesser extent in other cells (Figure 2). IHC is cheaper and faster than virus isolation and is comparable in turn-around time and cost to the BVD ELISA.

For more information about the use of IHC for animal disease diagnosis and related cost, call the department at (307) 742-6638, or visit the Wyoming State Veterinary Laboratory Web site at wyovet.uwyo.edu.

These calves are the same age. Note the small calf at the right, which tested as persistently infected (PI) with BVDV. Such animals are often stunted, prone to disease, and most importantly, capable of transmitting the disease to other animals. This is of special concern in pregnant cattle, as BVDV often causes them to abort. The animal on the left is normal. (Photo courtesy of Hana Van Campen).



Skin samples from the ears of two cattle are stained for BVDV using IHC. The sample on the left is negative. The sample on the right is from a calf that is PI for BVDV. Note the dark red staining cells highlighted by arrows–this color reaction indicates the cells contain BVDV, and that this calf is infected.

Frank D. Galey, Department Head and Professor, Department of Veterinary Sciences, and Director, Wyoming State Veterinary Laboratory

Donal O'Toole, Professor, Department of Veterinary Sciences

Todd Cornish, Assistant Professor, Department of Veterinary Sciences

Lynn Woodard, Professor, Department of Veterinary Sciences, and UW Extension Veterinarian

Sheridan College and the Sheridan R & E Center: A new design for collaboration

The Joe and Arlene Watt Regional Agriculture Education Center, a 14,000 square-foot addition to the Sheridan College campus, is scheduled to open next spring. The $7 million state-of-the-art facility will house a meats processing lab and test kitchen, as well as laboratories focused on food safety, biotechnology, and aquaculture.

Other features of the Watt Center, including a greenhouse, a livestock handling facility, and a land laboratory, will be shared with the UW Sheridan Research and Extension Center (SREC). The land laboratory will include garden, vineyard, and orchard areas, as well as space for research on small grains, forage plants, and turfgrass.

Recent collaboration between Sheridan College and the SREC has resulted in a tremendous research opportunity. An official Kentucky bluegrass trial (173 varieties) from the National Turfgrass Evaluation Program was planted in the spring of 2001 and uses the latest in pop-up irrigation technology. A $12,000 USDA grant accompanies this research project.

Having worked together on a variety of projects since the late 1980s, Sheridan College and the SREC also

have implemented a new academic possibility for students. The associate's degree in horticulture science was first offered in the fall semester 2000. The new facilities and degree program serve as an example of collaboration that enhances education and quality of life in the state of Wyoming.

Roger Hybner, Director, Sheridan Research and Extension Center

ONLINE EDUCATION

UW offers new distance programs in child development

Many Head Start teachers in the Rocky Mountain region live far from college campuses. Others want to begin careers as daycare or preschool teachers but are raising families and cannot relocate. With these realities of rural life in mind, the Department of Family and Consumer Sciences (FCS) saw a need that an outreach program could fill.

The Family and Consumer Sciences Professional Child Development Option Distance Degree Program began in fall 2000. Developed jointly with Casper College, the program seeks to meet the needs of sitebound students.

Most of the courses for the degree program are available online, with others offered through flexible enrollment and audio-teleconferencing. Current professional child development students represent the states of Wyoming, Colorado, Montana, Maryland, Georgia, Minnesota, Nebraska, South Carolina, and Texas.

The response to the professional child development option has been dramatic. All of the program's fall and spring semester early childhood courses had full enrollment, with some students pursuing the new Early Childhood Program Director's Certificate and others completing the degree program and director's certification simultaneously.

For more information on the FCS professional child development option degree, visit www.ecampus. uwyo.edu, or call the Department of Family and Consumer Sciences at (307) 766-5688.

Karen C. Williams, Associate Professor, Department of Family and Consumer Sciences

MITOCHONDRIA

Basic cellular research may lead to health-related discoveries

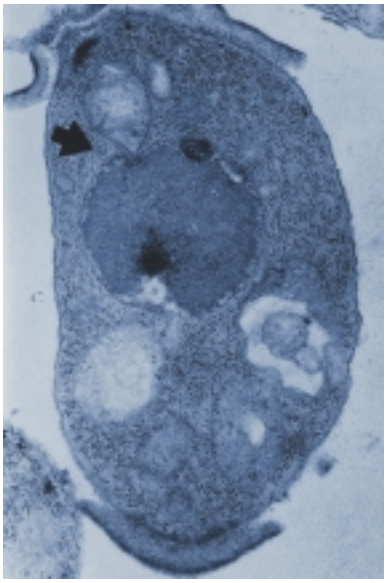
Mitochondria are small compartments found in the cells of virtually every multicellular organism. Optimal mitochondrial function is required for life of all large, multicellular organisms, such as human beings, due to their central role in producing the cell's energy. A growing number of human maladies, including old age, can be ascribed to diminished mitochondrial function. Although correlative in nature, evidence strongly suggests diminished mitochondrial activity is a direct cause of at least some age-related degenerative processes.

Associate Professor Peter Thorsness, Department of Molecular Biology, is particularly interested in processes that result in the timely inheritance of mitochondrial compartments and mitochondrial DNA into new cells during an organism's growth. Mitochondria contain only a small amount of the genetic material in a cell, but this material is absolutely essential for normal growth. To study these growth processes, Thorsness' research group uses various strains of yeast that are closely related to that used in bread making.

People may not like to be compared to a single celled organism, but humans share virtually every major cellular process with yeast. Many of the genes and cellular structures that those genes are responsible for creating can actually be exchanged between yeast and human cells. In addition, yeast are cheap to grow, easy to manipulate experimentally, and have certain unique features with respect to their requirements for mitochondrial function. Unlike most other organisms, yeast can generally grow well even if their mitochondria are incapable of providing any energy from food. Hence, mutations that interfere with mitochondrial DNA inheritance or optimal energy production are viable in yeast, whereas in other organisms these defects would lead to death of the cell.

Members of the Thorsness Lab analyze mutant strains of yeast that are genetically predisposed to lose their mitochondrial DNA during cell growth and division. Recent work from the lab has identified a direct link between factors controlling the shape and distribution of the mitochondrial compartment and the ability to accurately inherit mitochondrial DNA.

Interestingly, researchers in the Thorsness Lab have observed that mitochondrial DNA frequently escapes the mitochondrial compartment and migrates to the cell's nucleus. Migrating mitochondrial DNA could result in the some of the same deleterious effects in the cell for which invading viruses are famous. The mitochondrial or viral DNA present in the nucleus sometimes interferes with important nuclear genes, leading to the loss of important gene functions or the inappropriate expression of other genes, which can cause serious pathologies, including cancer.



The arrow on this electron micrograph of a yeast cell denotes the point of interaction between a mitochondrion and the degradative organelle of the cell—the vacuole. The defective mitochondria of this yeast are taken up and destroyed by the vacuole, ultimately liberating mitochondrial DNA that migrates to the nucleus.

Mitochondrial DNA migration to the nucleus also has implications regarding cellular evolution. The study of cellular evolution has historically been a descriptive process, but researchers in the Thorsness Lab have captured an aspect of evolution on the petri plate and can now study an important mechanism of evolution experimentally.

Peter Thorsness, Associate Professor, Department of Molecular Biology

GROWTH & GAIN

Ranchers, heifers, and experiment station adventures

What happens when ranchers come together with UW faculty members, Cooperative Extension Service educators, Torrington Research and Extension Center (TREC) staff, and 176 heifers? The result is a grassroots-driven research project that will yield information that is, according to rancher Larry Cundall, "critical to the economic viability of Wyoming cow-calf operations."

This replacement heifer project taps the expertise of Extension Beef Specialist and head of the Department of Animal Science Doug Hixon, Extension Educators Wayne Tatman and Frank Henderson, and Lynn Woodard of the Wyoming State Veterinary Lab. The project involves two types of mineral supplements and two different regimens for growth and weight gain for the developing heifers.

When the project began, heifers were sorted 4 ways with 8 replications in the 32 feedlot pens at the TREC. One fourth of the animals received an organic (chelated) mineral supplement and were fed just over 1½ pounds per day to reach a target breeding weight. Another fourth were fed trace mineral and salt in the same linear rate of gain.

The other 2 groups of heifers received the 2 different mineral supplements, but were fed a maintenance diet of just over 1 pound of grain per day until 60 to 70 days prior to breeding, when they were flushed with approximately 2½ pounds of grain per day. All heifers were scheduled to reach their target breeding weight one month prior to the anticipated breeding date.

Researchers completed a variety of tests on each group of heifers. They examined such factors as blood mineral content, disease resistance, and presence of internal parasites. The team also estrous synchronized and artificially inseminated each animal during its stay at the TREC.

Replacement heifer project collaborators visit the cattle feedlot at the Torrington Research and Extension Center.

Long-term data collection and research into the effects of the varied nutritional schemes is continuing with heifers back on their owners' ranches. This ongoing research will lead to a replacement heifer program that keeps animals productive for the longest possible time.

Rancher contributions to this research have created a winning situation for everyone involved. As is true of most research endeavors, it will take time to determine the outcome of the heifer development project. But if energy and enthusiasm count, the project is already a success.

James Freeburn, Director, Torrington Research and Extension Center

SIZE ACCEPTANCE

Breaking Size Prejudice video improves students' points of view

Wellness IN Wyoming (WIN Wyoming) is a statewide UW Cooperative Extension Service program that encourages people to respect body size diversity and to enjoy the benefits of active living, pleasurable and healthful eating, and positive self-image. The Albany County Nutrition Council is a task force of Well Aware, a WIN Wyoming-affiliated local health organization. Several years ago, the council proposed a youth-focused educational video to address size acceptance from a practical point of view.

Youth between the ages of 11 and 17 were recruited to assist with the *Breaking Size Prejudice* video. Joan Gunnerson's sixth grade class from Linford Elementary worked on the story board, script, and graphics for the video. Laramie Junior High ninth grade drama students, under the direction of Jennifer Stone, acted in the video. Students also conducted research with first graders to determine early prejudices against size and interviewed adults to find out how they deal with unique body sizes.

Students involved with the video's production showed improved attitudes and behaviors related to diverse body types. The journal entries of the sixth grade students showed an increased understanding of size acceptance and improved communication with size-diverse people. Ninth grade students who completed pre- and post-assessments reported an average of 13 improved behaviors, as well as improved attitudes and communication skills.

The *Breaking Size Prejudice* video includes thought bullets that can serve as discussion points and is accompanied by a 21-page educator's guide. The guide includes activities that use the video, activities beyond the video, assessment ideas, and resources for further information. Activities are coded with state and national health education benchmarks to assist public school teachers.

The complete educational packet is available to WIN Wyoming members as part of the initial project grant; orders for additional packets will require a fee to cover production expenses. The Wyoming Department of Education has purchased 54 packets for distribution to school districts around the state. For more information or to order a packet, call Misti Stangel at (307) 766-5375, or e-mail her at studer@uwyo.edu.

Mary Kay Wardlaw,
WIN the Rockies Project
Education Specialist

UW TV manager Tony Pedersen looks over the script for Breaking Size Prejudice *with Kendra Wardlaw. The video was designed to address size acceptance issues among adolescents.*

Tonya Talbert

Micro-rate herbicide applications benefit sugar beet producers

Sugar beets, the number two cash crop in the state, provide Wyoming producers over $42 million annually in revenue. In recent years, the price of sugar has been declining, reducing profits for producers. Attempting to counteract high input costs, producers band apply herbicides over the sugar beet rows and cultivate between rows for weed control. However, this is a labor intensive and expensive technique. In response, University of Wyoming researchers recently developed a micro-rate herbicide program for weed control in sugar beets.

The micro-rate program involves using low rates of the herbicides Betanex®, Betamix®, or Progress® in combination with UpBeet® plus Stinger® plus methylated seed oil (MSO) three or more times a year at five- to seven-day intervals. The program is designed to begin as soon as weeds start emerging, and sugar beet size is not important. The rates of the herbicides in the micro-rate program are 66 to 75 percent lower than the conventional rate. The MSO is essential to increase weed control with the low herbicide rates. If grassy weeds are a problem, micro-rates of Assure II®, Select®, or Poast® can be added to the tank with each micro-rate application or applied at full rate with the final micro-rate application.

Three broadcast applications of the micro-rate have generally provided better weed control than two applications of the conventional rate. However, 3 applications of the conventional rate have given 5 to 7 percent better weed control than three applications of the micro-rate, especially on difficult to control weeds such as kochia, redroot pigweed, and common lambsquart-ers. The micro-rate will not provide adequate control of redstem filaree (stork's bill) or ALS resistant kochia, which are becoming increasing problems in the Big Horn Basin.

Micro-rates are safer than conventional rates, causing 10 percent less crop injury than conventional treatments across 12 locations. With the added crop safety, producers have the ability to apply herbicides all day without risking significant injury to the sugar beet crop. Grass herbicides can be added to the tank mix with less antagonism than in conventional treatments. Fungicides and insecticides can be tank mixed with micro-rates, although not at the same time.

The 2000 growing season was the first year that the micro-rate program had a federal label for application, and adoption of the micro-rate herbicide program has been extensive in Wyoming. In the Big Horn Basin and North Platte Valley, 90 and 45 percent, respectively, of the sugar beet acreage was treated with the micro-rate program. The percentage of acres treated with micro-rates is expected to increase in 2001, especially in the North Platte Valley.

Craig M. Alford, Temporary Research Scientist, Department of Plant Sciences

Stephen D. Miller, Professor, Department of Plant Sciences

Abdel O. Mesbah, Research Scientist, UW Powell Research and Extension Center




AROUND THE WORLD

The value of global perspectives

American society has long promoted democracy, freedom, security, and prosperity at home and abroad. Our nation's position as a world leader in education, science, and industry depends upon our ability to recognize and cooperate with others to advance common interests. The results of various public opinion polls show American society continues to support policies to build a safer, more prosperous, and more democratic world.

Farm and Ranch Specialist John Hewlett and the WIRE team offer a course in integrated management to Queensland, Australia, producers and educators.

Educational leaders realize our colleges and universities have an obligation to help more Americans to acquire global perspectives and international experiences, yet most educational institutions have a scarcity of resources and international expertise for the task.

With the support of a generous donor, College of Agriculture Dean Horn started the Global Perspectives Program in 1998. This new college-wide competitive grants program has awarded approximately $10,000 annually in small grants to help internationalize teaching, research, and extension programs. Faculty and academic professionals from each of the college's various departments and units have secured small grants to foster mutually beneficial, sustainable relationships with foreign partners.

The series of projects conducted with Global Perspectives funds has involved work with foreign experts in Asia, Australia, Europe, and South America. Projects have successfully advanced knowledge in legume cropping systems, dryland cropping systems, integrated crop and livestock systems, salinity control methods, grasshopper controls, new cultivars, drought management, animal nutrition, business education programs, regional economic analysis, and economic education for nations in economic transition.

The Global Perspectives Program already pays dividends. This work has increased the capacity for research and instruction in the college and expanded the perspectives of all involved. Faculty and academic professionals already are developing more creative problem-solving approaches by looking at research and instructional challenges in a broader context.

Ed Bradley, Head, Department of Agricultural and Applied Economics

The WIRE team learns about land management issues in Queensland, Australia, on a tour of area ranches hosted by representatives of Vision 21, Landcare, Future Profit, and the Department of Primary Industries.

A very small and impressive world: Parasitic wasps

Adult parasitic wasp

About five aphids occur in small grains in Wyoming and the western Great Plains states. Since the late 1980s, one of these in particular, the Russian wheat aphid, has resulted in approximately $650 million in regional industry costs, including those associated with yield reduction and insecticide applications. In an attempt to address this problem, scientists introduced very small wasps that parasitize the Russian wheat aphid and other small grain aphids. This biological control effort was collaborative and involved international, federal, and state cooperators in the foreign exploration for natural enemies in Europe and Asia, mass production and release of natural enemies in 16 western states, and recovery of these beneficial organisms after their release.

A total of 407,028 parasitic wasps (9 different species) were released into wheat, barley, and oats between 1989 and 1996. Releases mainly occurred in the three most southeastern counties of Wyoming where the winter wheat industry is concentrated and the greatest plant damage was occurring. There were subsequent recoveries in these and other counties, including those in the Big Horn Basin where the barley industry is most concentrated. Three species were dominant in the recoveries: *Aphelinus albipodus*, *Aphelinus asychis*, and *Diaeretiella rapae*. The *Aphelinus* species were newly introduced into this area, and *Diaeretiella rapae*, which is native to the region, was extensively redistributed.

The adult wasps are very small and not easily seen without magnification, as in the photograph of *Aphelinus asychis* shown here. But their work is impressive, as shown by the photograph on page 19 of a healthy Russian wheat aphid (the green one) and aphids mummified due to parasitism by *Aphelinus albipodus* (the black mummy) and *Diaeretiella rapae* (the tan mummy). After being parasitized, the aphid quickly turns into a mummy, which has an immature wasp developing inside its body. After a few weeks, an adult wasp will emerge from the mummy and will quickly seek out more aphids to parasitize.

Coincidental to the spread of these parasitic wasps, Russian wheat aphids are on the decline. Economic infestations of 10 percent or more infested tillers occurred frequently in the late 1980s and early 1990s, but this infestation rate fell to a low of less than 1 percent infested tillers in fields regularly sampled from 1997 to 2000. During intensive field inspections, rates of aphid parasitism (measured as percent of aphids mummified) were as high as 90 percent toward the end of the growing season.

Spotty infestations still occur, but heavy economic infestations have not been seen since the early 1990s. With a $10 per acre insecticide savings and little to no yield loss due to the aphid, the decline in Russian wheat aphids represents a substantial benefit to small grain growers, particularly those who are part of the large winter wheat industry.

Certainly, care in monitoring for Russian wheat aphids on wheat

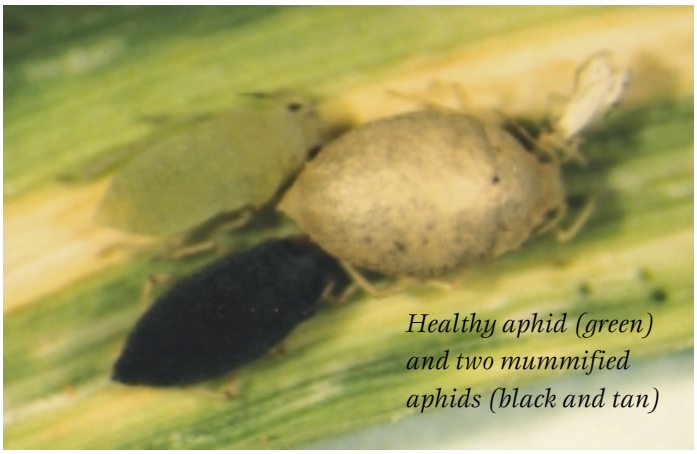
control small grain aphids

and barley should still be taken, given the aphid's high reproductive capacity and short generation time. But it appears that the action of parasitic wasps does aid in maintaining Russian wheat aphids at low, and often noneconomic, levels.

How stable is this control, and can the abundance of these parasitic wasps be further increased? Researchers in the Department of Renewable Resources Plant Protection Entomology Laboratory will address these questions during the next several years. Researchers will consider whether Russian wheat aphid control may be improved by the presence of these parasitic wasps in spring-planted crops grown in rotation with winter wheat and in nearby grasslands. These refuges for parasitic wasps may be particularly important during the summer months when winter wheat is not in cultivation.

Winter wheat growers, particularly those planting a winter wheat-sunflower-fallow rotation, who wish to participate in future studies of these small but impressive wasps are encouraged to contact Michael Brewer (e-mail: elmich@uwyo.edu; phone: (307) 766-4261).

Michael J. Brewer, Associate Professor and Specialist of Entomology, Department of Renewable Resources



Healthy aphid (green) and two mummified aphids (black and tan)

College of Agriculture provides tools to help producers anticipate drought

Last summer, the drought in Wyoming limited livestock water and hay supplies and lowered forage production and quality. Subsequently, livestock gains were less and hay supplies were more costly. Because drought is an inevitable part of normal climate fluctuation in this part of the world, it should be considered as a recurring, albeit unpredictable, environmental feature that must be addressed in planning. The College of Agriculture's Renewable Resources Department provides drought response tools that can help agricultural producers engage in risk management instead of crisis management.

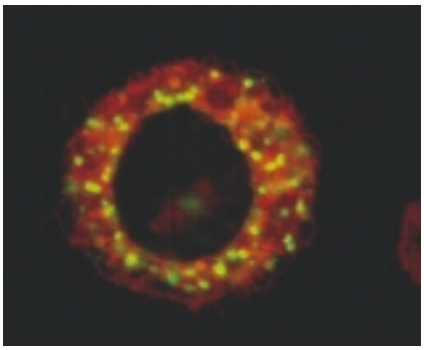
Since 1987, Professor Michael Smith, Department of Renewable Resources, has been conducting research at a site near Saratoga to establish a drought early-warning forage production tool to identify upcoming shortfalls in rangeland forages. The Saratoga site is in a precipitation zone similar to a significant portion of the state, and April precipitation is the most effective predictor of forage production for the following grazing season.

This early-warning of forage availability allows ranchers to plan for alternative forage supplies, make plans for dealing with stock water shortages, and/or consider early marketing of animals. An early warning also helps guide decisions regarding the number of stocker cattle to purchase, which leads some ranchers to buy more or less, depending on the season's predicted forage production. Currently, the Department of Renewable Resources is developing and validating this type of forage production tool for other regions of the state.

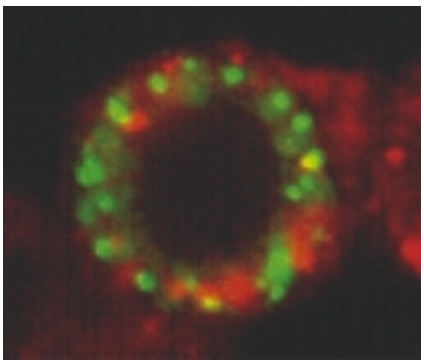
Michael A. Smith, Professor, Department of Renewable Resources

BACULOVIRUSES: From biological control to human gene

I was introduced to baculoviruses in 1986 when I first met Max Summers, one of the scientists responsible for developing the baculovirus expression vector system. At the time, he was intoxicated with success and, mildly so, with the local brew. I vividly remember the flask he held—a small vessel containing perhaps a half-liter of baculovirus-infected insect cells that were grown in his lab. Swirling the flask around in "mad scientist" fashion, he told me it contained $100,000 worth of ß-interferon, a human glycoprotein that had been produced by the baculovirus-infected cells.



A newly identified insect cell, alpha-mannosidase (green), colocalizes with a dye (red) that stains the Golgi apparatus. The overlap is yellow.



A newly identified insect cell, alpha mannosidase (green), does not colocalize with a dye (red) that stains the lysosomes. There is little yellow.

The baculoviruses are a huge family of viruses that infect only invertebrates. Most infect insects and are highly specific for only one species. Historically, scientific interest in the baculoviruses has been fueled by their promise as biological pesticides. Several baculoviruses were registered as pesticides and used mainly in forests, but this endeavor met with limited success.

Interest in the use of baculoviruses as biological pesticides was re-stimulated by the development of methods that could be used to create genetically modified viruses. Researchers in the College of Agriculture's Jarvis Lab worked with DuPont scientists to develop an engineered virus that produced an insect-specific neurotoxin early after infection and killed insects three times faster than the wild virus. Despite this scientific success, this area of agricultural biotechnology has gone dormant, due to economic considerations and public perception of the risk associated with the release of genetically modified organisms into the environment.

The ability to produce a genetically modified baculovirus was originally developed in the early 1980s by Summers and Gale Smith at Texas A&M University, and, concurrently, by Lois Miller and her colleagues at the University of Idaho. Their work stemmed from the observation that baculoviruses produce crystals in host cells, which are composed mainly of a single viral protein called polyhedrin. Neither polyhedrin nor crystal production is required for viral replication, at least not in lab-cultured insect cells. These observations suggested that scientists could use recombinant DNA methods to replace the viral polyhedrin gene with a gene encoding any protein of interest. The recombinant baculovirus could be used to infect cultured insect cells, which would produce large amounts of the protein of interest to be used for various biomedical applications, including vaccines, therapeutics, and diagnostic tests.

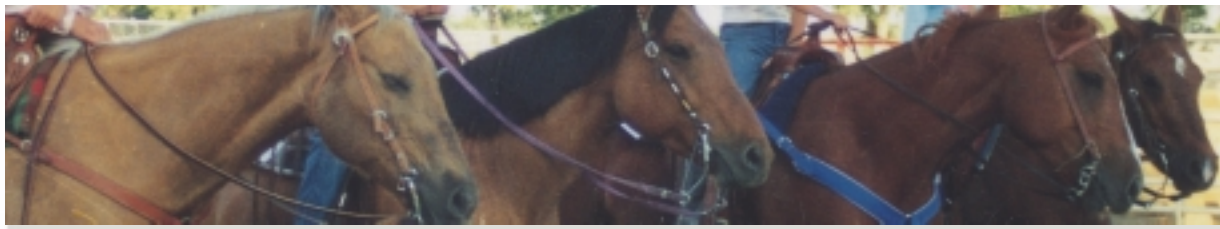
These ideas held up, and the baculovirus-insect cell system is now used for recombinant protein production worldwide. But despite its success, this system has limitations, which have been the focus of research in the Department of Molecular Biology. For example, the baculovirus-insect cell system provides only transient recombinant protein production because the virus eventually kills the host cells. To address this problem, researchers developed methods and DNA vectors for genetic insect cell transformation. They recognized that many investigators needed to produce recombinant glycoproteins, but little was known about protein glycosylation in insect cells. Therefore, they began studying insect protein glycosylation, and

therapy

their results, together with those from many other labs, revealed that insect cells lacked the enzymes needed to produce certain types of glycoproteins. This led researchers to engineer baculoviruses and insect cells with the mammalian genes encoding these enzymes.

The success of the baculovirus-insect cell expression system serves as a constant reminder of the value of basic research, as few would have guessed that studying an insect virus could have such a dramatic impact on diverse areas of biomedical research. Recent studies have shown that these viruses can deliver foreign genes to many human tissues, including liver and brain cells, which are intractable to other methods of gene delivery. Therefore, these insect viruses might have an additional role, as vectors for human gene therapy, in their future.

Don Jarvis, Professor, Department of Molecular Biology



Intercollegiate Horse Show Association members experience showing from the other side

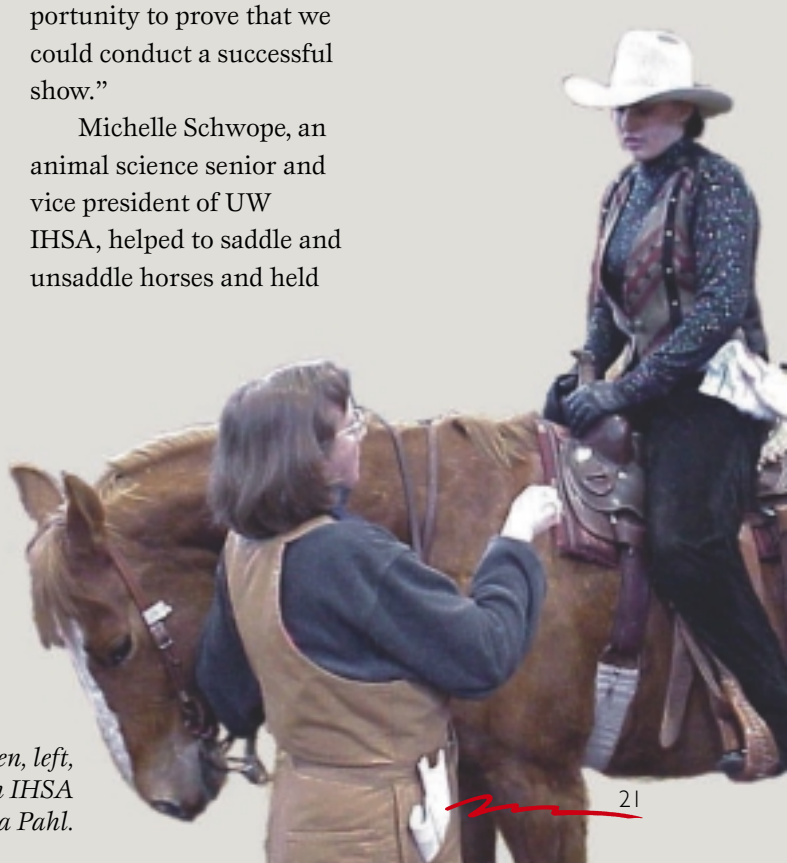
Last November, University of Wyoming Intercollegiate Horse Show Association (IHSA) members gained a look into the horse show management world. For the first time, UW hosted an IHSA Stock Seat (Western) three-day horse show. Colorado State University (CSU) generously provided the horses and the CSU B.W. Pickett Equine Center in Fort Collins, and UW students were responsible for everything else, from the showbills for entry to cleaning up after the show.

Fourteen UW IHSA team members helped to saddle the 30 CSU horses used in the show, held horses for competitors, kept track of results and points on the official program, and helped to cool off horses after the competition. There were more than 120 riders and 140 entries each day.

Codi Burris, an animal science senior and president of UW IHSA, helped to run the draw table for the three-day show. In intercollegiate horse show competitions, competitors draw horses by lot for each ride to make the competition more even among students. "Putting on the show was a great learning experience," said Burris. "It really promoted teamwork and gave us the opportunity to prove that we could conduct a successful show."

Michelle Schwope, an animal science senior and vice president of UW IHSA, helped to saddle and unsaddle horses and held horses during the competition. "Being a member of IHSA has really added to my college experience," she said. "I have visited with many different people in the horse industry, which helps establish connections for greater post-graduate opportunities."

Karen Hansen, Associate Professor, Department of Animal Science, UW IHSA Coach



Coach Karen Hansen, left, discusses technique with IHSA team member Justina Pahl.

Exploring uses for coalbed methane product water

K.J. Reddy, Assistant Professor, Department of Renewable Resources
Q.D. Skinner, Professor, Department of Renewable Resources
Ian McBeth, M.S. Candidate, Department of Renewable Resources

Coalbed methane (CBM) is an important energy resource, and demand for this abundant and clean-burning fuel is rapidly increasing. Many coal-producing states are exploring the extraction of methane, but Wyoming's CBM industry is leading the way with the development of gas reserves in the Powder River Basin. Located in the heart of the basin, Campbell County, is experiencing a boom in methane production.

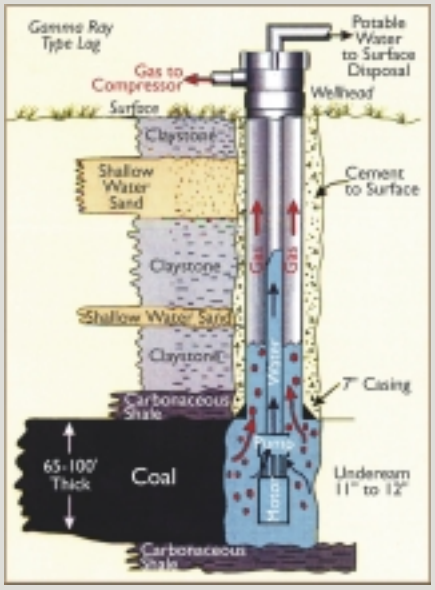
Recovery of methane from coalbeds is accomplished with extraction wells, which can now be seen dotting the landscape of the Powder River Basin. The production of methane gas requires that some of the coalbed groundwater be removed as well. This "product water" can be produced at a rate of approximately 18 to 20 gallons per minute per well, depending on the individual well. (The per well production appears to increase toward the west, into western Campbell and eastern Johnson Counties, as the depth of the coal formation(s) deepen.)

In Campbell County alone, there are over 2,000 such wells, and the numbers are rising. Two to 10 of these wells are typically manifolded together into one discharge point. Estimates indicate that up to eight trillion gallons of product water may be produced while extracting methane in this part of Wyoming.

While much of this water could eventually flow (via river systems) into neighboring states, most CBM product water is now being re-injected into groundwater aquifers or released into constructed unlined ponds or onto Wyoming rangelands. Until issues associated with product water release across private property and state boundaries are resolved, this will continue to be the case.

Water is a valuable resource in the semi-arid western United States. However, the opinions of local residents, the CBM industry, and Wyoming government agencies differ as to how water is stored in coal and how that which is pumped to the surface during methane gas extraction should be managed. Three broad management questions are as follows:

- What is the impact of product water chemistry on soils and range plants?
- What are the best options for managing this new water supply in methane extraction areas?
- Can this new source of water benefit Wyoming?



Coalbed methane extraction well schematic, courtesy of Barrett Resources Corporation

In order to find answers to these questions, concerned Campbell County residents contacted researchers in the Department of Renewable Resources in the fall of 1998. In the summer of 1999, the Campbell County commissioners funded both university researcher travel time and graduate student assistance for a new CBM research project.

Utilizing a growing network of partners, the overall goal of this research project is to develop research methodology and water quality data regarding beneficial uses for product water that are transferable state- and nation-wide. The specific objectives

Coalbed methane product water holding pond

of this research project are two-fold: to determine if there is a difference in the quality of CBM product water when it is stored in ponds as opposed to when it is first discharged from wells and to determine whether or not the water is toxic to range plants in the general discharge area or in areas where it may be used for irrigation.

In addition, the Campbell County commissioners asked that researchers become involved with a network of various citizen, landowner, and CBM industry groups, as well as state and federal agencies interested in activities associated with the extraction of methane gas; conduct a general survey of existing CBM water quality and quantity data reported to government agencies; evaluate the quality of product water for beneficial uses such as drinking, irrigation, and livestock watering; and, finally, transfer research results to the public through the partnership network.

The study area

The waters and range plants selected for the research project were from Campbell County, and were representative of those CBM-produced waters and plants from 33 miles north of Gillette to 24 miles south of Wright. The study area is approximately 18 to 36 miles wide from east to west and is located along Wyoming Highway 59. Surface mines that form the eastern edge of the study area recover coal from the Wyodak coal seam.

Building partners

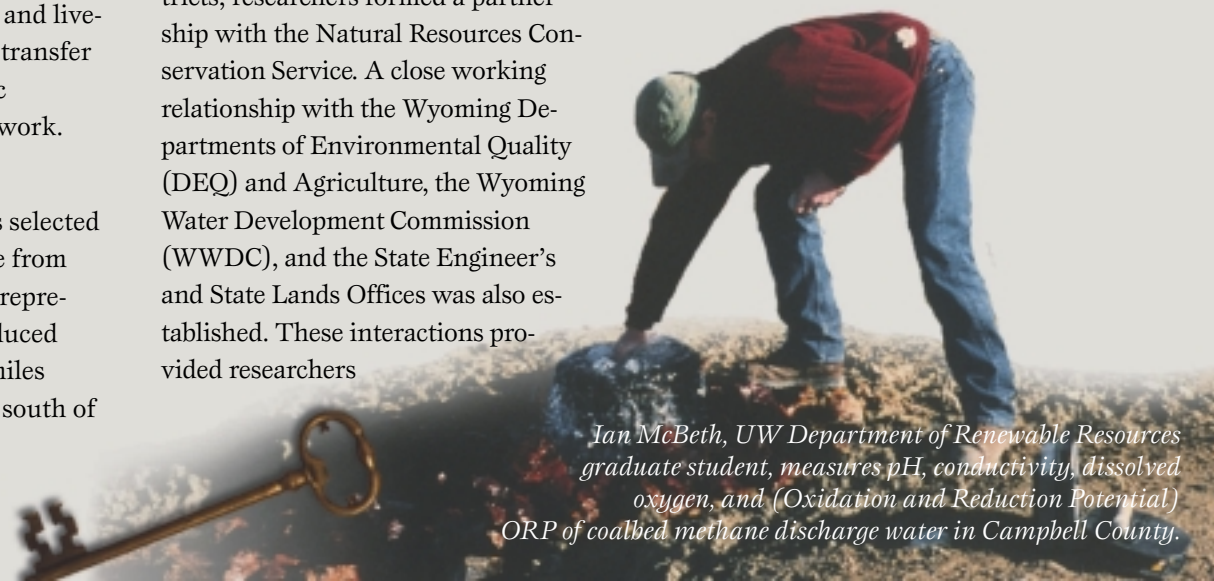
With the assistance of the Campbell County commissioners and local University of Wyoming Cooperative Extension Service (UW CES) personnel; the participation of the Dead Horse, Spotted Horse, and Wild Horse Creek Cooperative Resource Management (CRM) Teams; and the cooperation of the Campbell County Conservation District, researchers developed a working relationship with Campbell and Johnson Counties. Through working with the Campbell County and Lake DeSmet Conservation Districts, researchers formed a partnership with the Natural Resources Conservation Service. A close working relationship with the Wyoming Departments of Environmental Quality (DEQ) and Agriculture, the Wyoming Water Development Commission (WWDC), and the State Engineer's and State Lands Offices was also established. These interactions provided researchers with input into present and future research and educational programming.

Fifteen well and pond sites were selected in the study area with the help and advice of this comprehensive network of partners. The well and pond sites, located in the Little Powder, Belle Fourche, and Cheyenne River watersheds, were sampled to evaluate discharge and pond water quality differences to meet the intent of the Campbell County commissioner grant.

The partnerships developed during the two-year research period led to two additional coalbed methane projects sponsored by the WWDC and DEQ, respectively. The WWDC project investigates the interaction of CBM product water and plant sediment. The DEQ project seeks to demonstrate how plants can be used to stabilize sediment and stream channels where CBM product water is released to rangeland and channel landscapes. The DEQ collaborative project is led by the Lake DeSmet Conservation District, with the CBM industry and University of Wyoming supporting their efforts.

Quantity and quality survey of CBM product water

Researchers conducted a general survey of the permitting data submitted to the DEQ, the State Engineer's Office, the U.S. Geological Survey, and



Ian McBeth, UW Department of Renewable Resources graduate student, measures pH, conductivity, dissolved oxygen, and (Oxidation and Reduction Potential) ORP of coalbed methane discharge water in Campbell County.

the Wyoming oil and gas industry to observe the range of product water quality and quantity in the study area. A comparison of this data with that collected by project researchers at the 15 study-area sampling sites indicated that the data were nearly the same; researchers generally found no significant difference in quantity and quality between the two sources of information.

Quality of discharge and pond water

Preliminary research results indicated that the quality of CBM product water at discharge sites was different than when it was stored in ponds. Researchers noted definite reactions of CBM product water with soils, and these reactions altered the quality of product water stored in ponds. Although pond water quality in the study was shown to be altered, pond and well water data did appear to meet most regulatory agency chemical standards for drinking, livestock watering, and discharge purposes in Wyoming. Also, salt concentrations in product water tended to increase in the Little Powder River watershed compared to the Cheyenne and Bell Fourche watersheds.

This brief study illustrated that it is extremely important to consider how soils, sediments, and CBM product water react with each other. These factors should be considered before deciding if and when to use product water for irrigation or discharging it downstream through other landscapes and bordering states.

CBM product water and toxicity to rangeland plants

Western wheatgrass is abundant throughout the study area, is used as forage for wild and domestic ungulates, and is likely to be found in other states where CBM is to be developed. The potential toxicity of CBM product water was evaluated using this plant. Preliminary results indicated that CBM product water from the previously discussed 15 discharge sites was not toxic to western wheatgrass. All plants fed a full dose of this water survived, and when a 50 percent nutrient solution was added, the plants responded to this assumed fertilizer treatment by increasing leaf numbers and weight of above-ground biomass. This was expected, as chemical analysis of the CBM product water used had no chemical constituent concentrations that researchers believed would cause toxicity; however there is little doubt that it was nutrient deficient.

Kent Drake, left, and Ian McBeth take water samples for the project.

Potential uses for CBM product water

Even though the straight CBM product water tested was non-toxic, when it is applied to or mixed with soil and sediment resources, the water chemistry is sure to change. In light of this, researchers strongly recommend that when evaluating the use of this water resource for irrigation or releasing it as channel flow, a careful examination of how CBM product water will react with soil, sediment, water, and plant resources be conducted.

Since these studies began, many data sets by various groups of people have been or are being collected to help answer the multitude of questions regarding the development of the coalbed methane industry in Wyoming. The Wyoming Legislature has allocated funding to create a management plan for this new water resource since it may drain into surrounding states. This planning should be based on a watershed scale. Coordinated resource management teams, which include all concerned citizen, landowner, CBM industry, and management agency groups, are in place to help in this planning effort. A CBM coordinator position has been established for the Campbell, Johnson, and Sheridan County areas. With this type of effort, much will be known about how to manage and use this water resource as this new industry moves from the Powder River Basin to coal reserves in Wyoming and other western states.

OUTLAWS IN THE CLASSROOM

Dave Wilson, Director of the Agricultural Research Greenhouses and Lecturer, Department of Plant Sciences

Wild Mustard

In some ways, weeds are the outlaws of the plant kingdom. Instead of contributing to agriculture, they take away from the farm's nutrient and water resource base, much like an outlaw robs a bank. Under this analogy, the mustard plants *Brassica kaber* and *Brassica rapa* would be the Butch Cassidy and Sundance Kid of the Wild Mustard Bunch.

Mustard plants are members of the family Brassicaceae, or Cruciferae, in recognition of the cross-shaped petal pattern of the flowers. Not all brassicas are outlaws, though. The family also contains cabbage, cauliflower, brussel sprouts, broccoli, radish, forage and oil rapes, kale, rutabaga, and kohlrabi. In fact, turnips, pak choi, turnip rape, Chinese cabbage, and brocoletto are all subspecies of the *Brassica rapa* weed species.

An unusual aspect of the Brassica family is the relative ease with which it cross-hybridizes with other Brassicaceae species. The genus *Raphanobrassica,* for example, was created synthetically by crossing a cabbage with a radish. Wild mustard can cross itself with forage or oil rapes and other mustard species. Out of 3,200 species in the Brassica family, 21 "outlaws" are listed in the newest edition of *Weeds of the West*.

Is it possible, then, that a plant gone bad could become a useful tool for humans? Ralph Waldo Emerson once wrote, "A weed is a plant whose virtues have yet to be discovered." Emerson must have had wild mustards in mind.

Wild mustards are now used as a ground cover in orchard systems. These shallow rooted plants do not compete for resources with trees, but do attract beneficial pollinators and natural predators, which results in increased pollination, more fruit, and fewer fruit tree insect pests. Much like its cousin the radish, white mustard shows the ability to be used as a trap crop

Students with completed hydroponics set up for their project.

The flower petals of members of the Brassica family are arranged in a cross or crucifix pattern.

in sugar beet farming. The University of Wyoming has investigated the use of white mustard plants to decrease nematode (a parasite that lives in plant roots) populations. Because the nematodes cannot survive on the mustard plant, they die. This biological control decreases the nematode population the following season and results in higher sugar beet yields.

The mustard plant can be genetically manipulated very quickly. This discovery led to the establishment of the Crucifer Genetics (CRG) Laboratory in Madison, Wisconsin. Researchers at the CRG Lab developed Rapid Cycling Brassicas (RCBr) from wild populations of *Brassica rapa*. RCBrs bear the nickname Wisconsin Fast Plants, and as the name indicates, they are perfect for research—where time and growing space are limited. These tiny wild mustards were the first plants sent into space by NASA.

RCBrs have been used for almost a decade in agroecology classes because they are ideal for hands-on plant biology studies. Their life cycle has been shortened from 6 months to 6 weeks (42 days), and their mature height is less than 10 inches. Five plants can be grown in a container the size of a film canister, and two or more generations can be grown in a single semester. Agroecology professors in the College of Agriculture use the plants to teach basic plant biology and genetics, as well as for experimentation. Phytotoxicity experiments, which look at substances that can be poisonous or toxic to plants, teach students about plant growth, dangers to the environment, and phytoremediation (using plants to remove chemicals or pollutants from the soil). Classic examples of phytoremediation include removing radiation from the soils at Chernobyl with sunflowers, selenium from Wyoming's Big Hollow with milkvetch, creosote from the Laramie River tie plant site with alfalfa, and sodium salts from the soil by many plant species, including another outlaw—Russian thistle.

Brassicas fulfill several important teaching goals. In lab, students are required to design, sow, and care for their own experiments, building their knowledge of plants and plant growth. Group projects encourage collaboration to simulate a normal on-the-job situation. Each student is assigned specific tasks, as would occur with a consulting position or as part of a corporate team of investigators. Students learn how impartial research is conducted to explain objective conclusions, and projects must be properly researched and statistically verified.

Cross-pollination of mature (3-week-old) RCBr, Brassica rapa plants.

In phytotoxicity research, students' creative abilities are challenged, since they are not allowed to duplicate any of the more than 150 studies previously done on brassicas in the UW agroecology classroom. Over the years, agroecology students have studied the effects of many hormones and chemical compounds on RCBrs, including those labeled as environmentally friendly. One study showed that the estrogen in birth control pills stimulated growth and flowering in brassica plants. This study was completed three years before several horticultural publications suggested people use birth control pills to improve the

A student adds Pepto Bismol® to test brassica phytotoxicity.

growth of house plants. A subsequent agroecology study proved that estrogen-based livestock implants worked as well as human birth control pills—at a fraction of the cost. Students also found that testosterone-based implants improved growth but did not increase flowering.

On an ecological level, students have investigated product manufacturer claims about the environmental safety of their products. In most cases, certain aspects of the claims were proven false. An environmentally safe antifreeze was safe for animals but did not prove safe for plants. Students also tested phosphorus-free household cleaners and detergents. These products were shown to be true to their phosphorus-free claims, but further investigation revealed the manufacturers had actually substituted far less environmentally friendly ingredients, such as sodium and potassium salts or nitrates, to get around the federal guidelines for phosphorus-free labeling.

Even products most people consider safe have been tested. A single drop of food coloring was found to be lethal for RCBrs. This may not be surprising, considering food coloring contains the same main ingredient as the environmentally safe antifreeze—propylene glycol. Aspirin, coffee, alcohol, and tobacco were highly toxic to brassica plants, and students also discovered that since beer is more than 95 percent water, a little bit is good for plants, but a lot can kill them. That was probably not a bad take home message.

However, not all products tested proved to be toxic to brassica plants. Baby products showed an almost complete lack of phytotoxicity. Students were able to grow healthy brassicas in 100 percent crayons and even in scented baby powder—without any soil. Children's milk formulas also proved nontoxic, and brassica plants actually benefitted from the added calcium. A "child-safe" insect repellent that contained DEET, on the other hand, did not fare so well. It proved as carcinogenic to plants as animals, causing lethal mutations in brassicas.

Although mustards will still be a problem in shallow-rooted crop systems, such as cereal grain crops, this outlaw does have a good side. It is unusual for university freshmen to do valid research and somewhat ironic that a weed can help them learn more about the environment. But, in the College of Agriculture, a little outlaw weed is doing just that, while at the same time, teaching agroecology students that not all weeds are all bad.

"A weed is a plant whose virtues have yet to be discovered."

RALPH WALDO EMERSON.

Land Reclamation/Restoration Ecology

Peter D. Stahl, Assistant Professor, Department of Renewable Resources

Throughout history, human activities have altered and disturbed the natural landscape. Because ancient populations were small and their tools primitive, impacts of early humans were not overwhelming. But as human populations have grown and technology has advanced, the demand for natural resources and the subsequent land disturbances have escalated.

In Wyoming, remediation of the inevitable change in landscape created by natural resource and mineral extraction is an integral part of mining. Although many remediation techniques have been developed in recent years, there is still much to be learned regarding increased efficiency and effectiveness and cost reduction.

The University of Wyoming has a long history of research toward improving methods for remediation of disturbed and contaminated land. In UW laboratories, faculty, staff, and students have studied the reclamation of land that has been impacted by surface mining. They also have looked at remediation of soils that have been contaminated by petroleum hydrocarbons, selenium, and heavy metals. The Land Reclamation/Restoration Ecology Lab in the College of Agriculture plays a key role in revegetation and remediation research on campus. Researchers conduct investigations aimed at understanding the ecological impacts of land disturbances and improving mine land reclamation and contaminated site clean-up technologies.

Phytoremediation research site near Casper, Wyoming

Undergraduate, graduate, and high school students from across the country participate in land reclamation and restoration ecology in the College of Agriculture. These students are involved in the initial project planning, fieldwork, laboratory procedures, and data analysis and interpretation.

As abundant as sagebrush is in most of Wyoming, it is difficult to reestablish in reclaimed areas. Yet, this process is mandatory and regulated by the Wyoming Department of Environmental Quality. Using a plant-soil-microbial systems approach to revegetation, researchers in the College of Agriculture are inoculating disturbed land with native soil microorganisms (including mycorrhizal fungi) that may increase nutrient availability and stress tolerance of sagebrush seedlings and using sunflower as a companion crop to sagebrush. Companion crops may increase soil water availability by trapping snow and shading the soil surface.

The integrated plant-soil-microbial system is crucial to this research. To successfully revegetate an area, soil nutrients must be present, and soil micro-

Lab works to remediate disturbed sites

organisms are essential to the process. Plants cannot survive without microorganisms and suitable soils, and soil microorganisms cannot survive without plants. Microbes in the soil decompose organic matter, which consists of the remains of dead plants and animals, thereby releasing the nutrients and making them available for future generations of plants. Mycorrhizal fungi form beneficial relationships with native grasses, forbs, and shrubs, increasing their ability to uptake nutrients and water.

Along those same lines, students and faculty in the Land Reclamation/Restoration Ecology Lab are looking into the role of soil organic matter in sustainable nutrient cycling. After careful data analysis, researchers will be able to make recommendations to the mining industry and regulatory agencies regarding topsoil salvage procedures and the use of alternative plant growth materials. It is important to understand the impacts of disturbance on soil microorganisms because microbial activity is vital to the health of the plant community and necessary for high-quality soils. Researchers in the Land Reclamation/Restoration Ecology Lab use molecular analyses of microbial DNA and RNA extracted from soil to understand the response of the microbial community in disturbed ecosystems.

Hundreds of reclamation sites contaminated by toxic substances (either through accidental spills or improper management) exist across the country. These sites represent a threat to environmental quality and human health primarily because toxins can spread from the sites into groundwater. Excavation, disposal, and replacement of contaminated soils can cost up to $15 million or more per acre.

Biologically based in-situ remediation strategies offer more cost-effective alternatives to waste removal and disposal. Phytoremediation, allowing plant processes to naturally clean up a site, and bioremediation, using microorganisms to break down organic contaminants, have both been used extensively at toxic waste sites.

In cooperation with two UW civil engineering faculty, Marjorie Bedessem and Drew Johnson, and a Department of Renewable Resources water quality expert, K.J. Reddy, the Land Reclamation/Restoration Ecology Lab is investigating strategies to remove pollutants from a petroleum contaminated site in Wyoming. Those involved in the lab work hope to develop a clean-up strategy that uses both native vegetation and microorganisms, especially those that do well in a cool and dry climate. The results of this study will provide an affordable strategy for future organic contaminant remediation.

Graduate student Jason Peel collects data on contaminated soils.

Researchers in the College of Agriculture strive to address current issues that extend far beyond the state's boundaries. By allowing students and faculty to work together on issues that impact the entire western region, the college believes it will graduate well-trained professionals who have the experience and skills to tackle and solve the tough environmental remediation problems that will undoubtedly arise in the future.

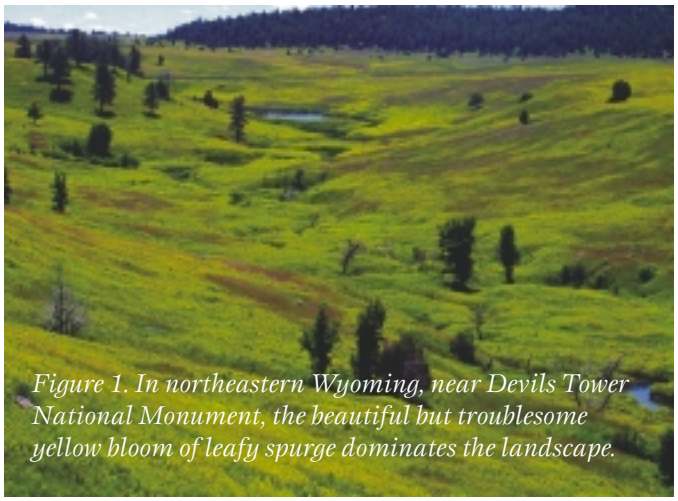


Figure 1. In northeastern Wyoming, near Devils Tower National Monument, the beautiful but troublesome yellow bloom of leafy spurge dominates the landscape.

Wyoming. This plant has taken over millions of acres of western grazing land, not only in Wyoming, but also in Montana, Idaho, North Dakota, South Dakota, and Alberta, Canada. Habitats commonly affected include rangelands, pastures, and riparian corridors. It often forms dense stands that displace native vegetation and forage plants. Leafy spurge also

Using beetles and remote sensing to

Amy Parker Williams, Ph.D. Candidate, Department of Botany

Driving north on U.S. 14 from Moorcroft, Wyoming, toward Devils Tower, you travel through wide-open rangelands. To the right stretches the blue expanse of Keyhole Reservoir, and up ahead the land rises in forested hills. A few more miles as the highway climbs up from the prairie, and you enter the northwestern edge of the Black Hills. After passing through the small town of Carlile, you head west on Cabin Creek Road; it winds along its namesake, a tributary of the Belle Fourche River. A dusty drive down this county road puts you in the heart of leafy spurge country. The view out the pickup truck window is a wide expanse of rolling prairie with forested ravines and ridges. In June, this landscape is dominated by the bright yellow of leafy spurge in full bloom (Figure 1).

The problem

Leafy spurge (*Euphorbia esula* L.) is the bane of ranchers in northeastern Wyoming. This plant has taken over millions of acres of western grazing land, not only in Wyoming, but also in Montana, Idaho, North Dakota, South Dakota, and Alberta, Canada. Habitats commonly affected include rangelands, pastures, and riparian corridors. It often forms dense stands that displace native vegetation and forage plants. Leafy spurge also contains a milky latex that is an irritant to the mouth and digestive system of cattle and horses. Infestations of leafy spurge destroy the quality of grazing lands for cattle and horses, degrade the forage base and structure of wildlife habitat, decrease plant diversity, and reduce land value.

Figure 2. Left to right: (1) Healthy leafy spurge has a characteristic bright yellow-green color. (2) An adult black flea beetle (A. lacertosa) on a leafy spurge plant. (3) Adult flea beetles feed on and damage the above ground portions of the plant, (4) while larval beetles attack the root system. These two modes of attack lead to eventual death of the plant and, over several years, to large-scale control of leafy spurge.

Figure 3. A dense riparian leafy spurge infestation in 1998 (top) prior to release of beetles. Two years later (bottom), leafy spurge has been reduced in a 21.9 yard diameter "crater" surrounding the marker post. Each year, the impact of the beetles will continue to move outward from the initial release site as they attack additional leafy spurge plants.

battle leafy spurge on Wyoming rangelands

David J. Kazmer, Assistant Professor, Department of Renewable Resources

Biological control

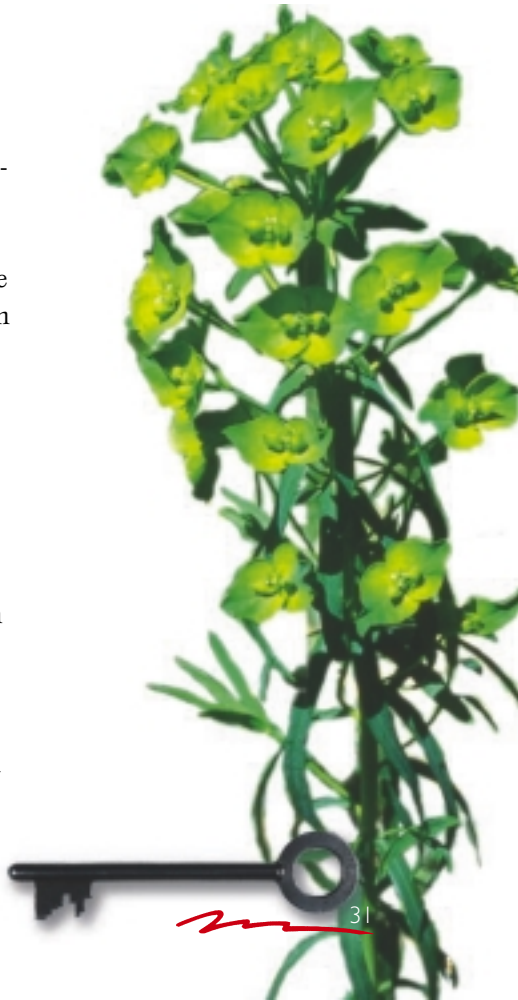
Herbicides have been used on leafy spurge for many years. They are successful in controlling the spread of infestations and in catching new infestations before they become established; however, because of the remarkable ability of leafy spurge to resprout from its extensive root system and spread over large acreages of rangeland, herbicide use is neither cost-effective nor practical on large, well-established infestations.

Fortunately, biological control using insects has become a highly effective tool for controlling leafy spurge on rangelands and along riparian corridors. Two species of flea beetles (*Aphthona nigriscutis* and *A. lacertosa*) are having a huge impact on leafy spurge in northeastern Wyoming. Introduced from Eurasia, the native home of leafy spurge, the flea beetles feed on the leaves and roots of leafy spurge and, over time, kill the plant (Figure 2).

Research jointly conducted by the UW Departments of Renewable Resources and Botany and the USDA Agricultural Research Service (USDA-ARS), and funded by USDA-ARS and the Wyoming Space Grant Consortium, sought to determine the rates at which the flea beetles impact leafy spurge and if these rates varied with slope, slope aspect, habitat type, and topographical position. In 1998, 3,000 *A. nigriscutis* and 3,000 *A. lacertosa* were released at each of 77 research sites in a 25 square-mile area in Crook County. Another 32 Crook County locations, where no beetles were released, served as control sites.

By summer 2000, two years after the research began, the dramatic impacts of the flea beetle releases were apparent. The average canopy cover of leafy spurge on the center of the release sites was reduced from 47 percent in 1998 to 12 percent in 2000, whereas no significant changes in canopy cover were observed on the control sites (Figures 3 and 4). Researchers noted that the average area over which this impact was observed increased from about 60 square yards in 1999 to more than 500 square yards in 2000.

At this time, researchers also noted that the black flea beetle, *A. lacertosa*, was nearly three times more abundant than the brown flea beetle, *A. nigriscutis*, and was most likely responsible for the greater part of the results (Figure 5). Given that most biological populations increase at geometric or exponential rates in the presence of abundant resources, researchers expect these impacts to be much greater in 2001 and beyond.



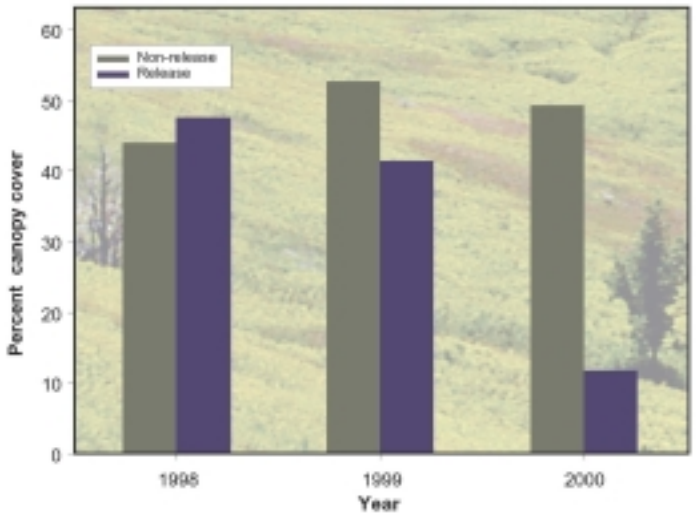


Figure 4. Percent cover of leafy spurge on release and non-release sites.

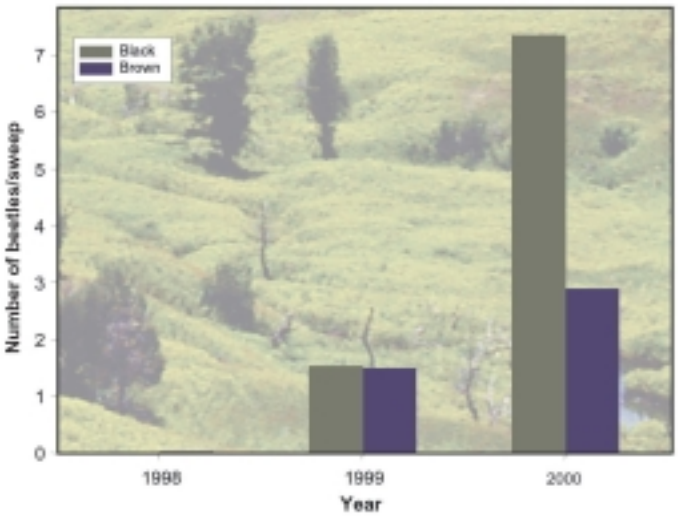


Figure 5. Number of Aphthona flea beetles on release sites.

Significantly, the impacts of the flea beetles do not appear to vary with slope, slope aspect, habitat type (prairie or woodland) or topographical position (upland, draw, or riparian). This suggests that, at least in Crook County, the flea beetles will be able to suppress the vast majority of leafy spurge infestations. Moreover, the release sites had good regrowth of perennial forage grasses with the decline in leafy spurge cover. Recovery of the grazing potential of leafy spurge infested lands appears imminent.

Results such as these, combined with the availability of the two species, have stimulated interest on the part of private and public land managers in obtaining flea beetles. Crook County Weed and Pest District personnel collected more than 6 million flea beetles in 2000 and moved them to new sites across Wyoming. Also in 2000, another 16.5 million flea beetles were collected and moved to new sites in Montana, Wyoming, and the Dakotas by The Ecological Area-wide Management (TEAM) Leafy Spurge Project. (TEAM Leafy Spurge is a collaborative effort involving private, local, state, university, and federal entities and is funded through USDA-ARS.)

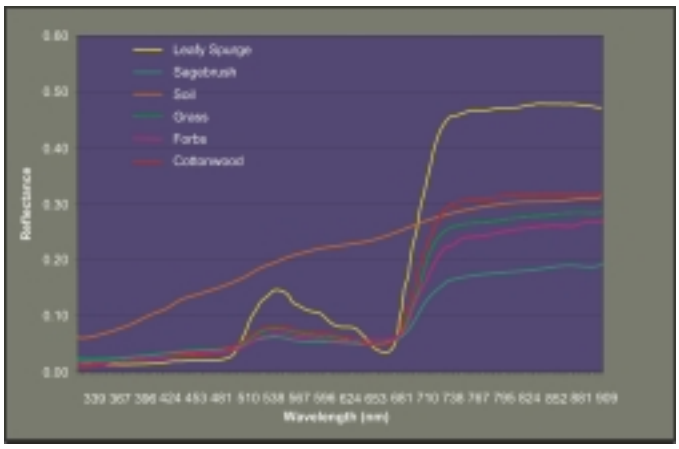


Figure 6. Field reflectance spectra of leafy spurge and other vegetation.

All signs indicate that the biological control program against leafy spurge will be a major success. Unlike most other pest management tactics, successful biological control results in long-term, self-sustaining, area-wide suppression of the target pest with few, if any, undesirable side effects. Despite the need for an initial investment in the research and development of biological control agents, these properties of successful biocontrol provide extremely favorable long-term economic cost-benefit ratios, estimated by some to be as high as $31 returned for each $1 invested.

But when will there be successful leafy spurge control at appreciable spatial scales? This is a difficult question, as most current studies providing quantitative data on leafy spurge and other invasive plants are of relatively short duration and encompass small spatial scales. New tools are needed to facilitate research at greater spatial and temporal scales without excessive cost.

Remote sensing of leafy spurge

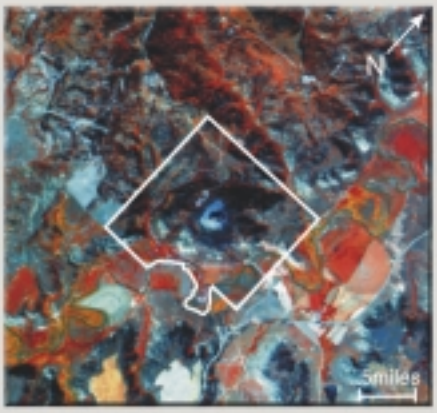
Recent advancements in remote sensing technology may provide these research tools. The key to using airborne or satellite imagery

to detect and map a single plant species, such as leafy spurge, lies in the ability to distinguish the target species from other kinds of green vegetation. Newer, "hyperspectral" sensors offer hope in this vein. Relative to sensors that provide limited color information (i.e., 4 broad measures of reflectance representing the blue, green, red, and near infrared portions of the color spectrum), hyperspectral or "many color" sensors provide much more data (i.e., up to 256 reflectance measures spanning the blue to middle infrared regions of the spectrum). This information helps detect subtle differences among green plant species.

Researchers in the Departments of Renewable Resources and Botany are now investigating the use of hyperspectral sensors to distinguish leafy spurge from other green plants. The first step was to employ a ground-based spectrometer held over leafy spurge and other vegetation in the field. The spectrometer took detailed measurements of the reflectance signatures, or color, of the vegetation. Researchers knew that if it was not possible to distinguish leafy spurge under these ideal conditions, then it was unlikely that leafy spurge could be distinguished in higher altitude imagery. Fortunately, during the May and June bloom, leafy spurge has a unique spectral signature that allows its quantitative separation from other vegetation (Figure 6).

With that result in hand, researchers obtained high-resolution imagery of about 25 square miles in Crook County from an instrument called the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS). In essence, AVIRIS provides a hyperspectral, digital picture of the ground. The AVIRIS picture contains 256 bands of color information for each pixel measuring 21.9 by 21.9 yards on the ground. As with the ground-based spectrometer, leafy spurge has a unique signature in the AVIRIS imagery. Moreover, techniques were developed to calculate the percent cover of leafy spurge in each pixel (Figure 7). These advances allow both the extent and abundance of leafy spurge to be mapped. This is a truly powerful step forward.

Digital maps of leafy spurge distribution and extent are being constructed based on the AVIRIS data collected in 1999. With repetition of the mapping in a few years and integration of the maps into a Geographic Information System (GIS), researchers and land managers can quantitatively describe patterns of leafy spurge spread and assess the effectiveness of biocontrol at large scales. This information holds tremendous value for leafy spurge control programs and also shows promise for future applications to other weed species throughout the Western region.



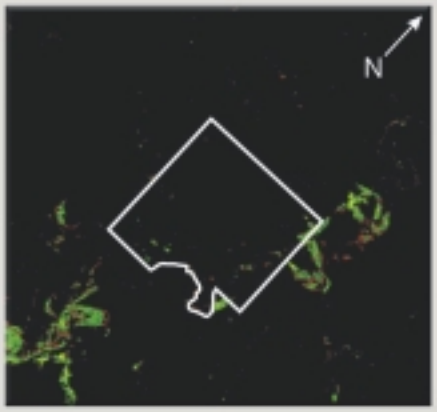
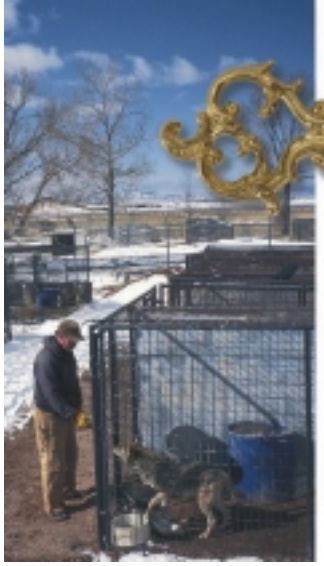


Figure 7. Top right: Airborne Visible/ Infrared Imaging Spectrometer (AVIRIS) image of the Devils Tower National Monument (white boundary) area. The image is a false color composite with green vegetation appearing bright red, leafy spurge appearing orange, conifer forest appearing black, and soil and exposed rock appearing bluish white. Notice the boulder field and shadow of Devils Tower in the center of the image. Most leafy spurge in this area follows the floodplain and tributaries of the Belle Fourche River, which runs across the bottom half of the image from left to right.

Bottom: Map of leafy spurge distribution and density. For reference, this image covers the same area as the color composite above. Remote sensing techniques allow researchers to map infestations of leafy spurge and also estimate the density of the infestation. Colors correspond to leafy spurge abundance: yellow – very high; bright green – high; dark green – moderate; brown – low; and black – none.

Tana Stith



PREDATOR
Responding to

Charles Stith, Ph.D. Candidate, Department of Animal Scie

Not many animals look at coyotes as prey. Their numbers and range have expanded over the plains since the mid-1800s when wolves displaced them in the montane regions. Once human beings began to reduce coyote populations using traps, poisons, and firearms, their litters naturally increased in size. The expansion of coyote populations in the West has caused enormous stress for livestock producers.

To successfully raise a litter of healthy pups, the female coyote must increase her calories by approximately 400 percent from the time she breeds through late spring when she weans her pups. Coyotes are opportunistic hunters, so it's no coincidence that this time period corresponds to the fawning, lambing, and calving season.

By eliminating pregnancy, it may be possible to reduce predation levels by as much as four to six times. In addition, the number of prey that are killed or crippled by the female coyote when she takes the pups from the den and teaches them to hunt may be eliminated altogether. Producers have relayed stories of finding as many as 10 lambs wounded and dying from being attacked by coyote pups in a single night.

In many states, predator control policies have come under severe public criticism. Poisons haven't been legal since 1972 and, in some areas, using traps has been banned by public referendum. Currently, the primary method of intervention is through the use of federal- and state-sponsored programs that assist producers only when predation becomes severe.

In 1995, the University of Wyoming College of Agriculture initiated a program to study reproductive control in coyotes. Using new drug compounds to prevent reproduction, researchers hope to lessen predator impacts on domestic livestock.

Dean Steven W. Horn supervises coyote control research at UW. Twenty-four male and female coyotes are housed off-campus at university lab facilities in Albany County. The current project is two-fold. Researchers are attempting to temporarily eliminate sperm production in male coyotes with the use of a specific oral drug compound. And in females, they are testing an anti-hormone compound, Mifepristone, which inhibits the effect of progesterone, a hormone necessary for pregnancy.

Coyotes are monogamous and breed once a year. Preliminary data from the current studies suggest that fertile male

CONTROL PROJECT:
the needs of Wyoming producers

ence, and USDA Veterinary Medical Officer ❖ *Steven W. Horn, Dean, UW College of Agriculture*

Tonya Talbert

Steve Horn, left, and Charles Stith check to see if a female coyote is pregnant. Research scientist Joe Bobbit, far right, points to developing fetuses on the ultrasound monitor.

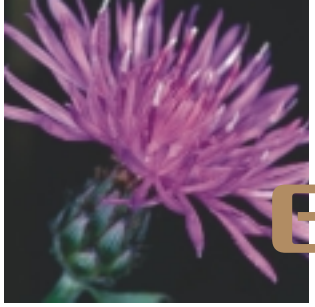
coyotes experience a significant reduction in sperm production when they are given small doses of the trial drug in meat bait. (Because of the predictability of the breeding season, exposure of nontarget species to the oral compounds that interrupt reproduction is limited.)

The antispermatogenic compound has no secondary side effects; male coyotes retain their libidos and aggressively defend their territories. In effect, this means that other coyotes will not immigrate into and reproduce in the area, even if the existing pack ingests the oral compound and is not reproducing. Subordinate and immature males are still not allowed to bond and breed with a female.

UW College of Agriculture researchers also are experimenting with dose-response to Mifepristone in female coyotes. Depending on when the drug is given, Mifepristone may prevent ovulation, inhibit implantation of the embryo, or cause the pregnancy to be terminated.

Previous studies have shown that a dose of 30 milligrams of Mifepristone per kilogram of body weight given once a day is 100 percent successful in preventing the birth of pups. Researchers are now attempting to determine the lowest effective dose and treatment time necessary to prevent the female coyote from giving birth. The next step will be to extend the effects of a single dose.

The Wyoming Wool Growers Association, the Wyoming Game and Fish Department, the American Sheep Industry Association, Wyoming Predator Districts, and the Wyoming Animal Damage Management Board fund the UW coyote control research.



GIS technology fights

John Gillham, M. S. candidate, Department of Renewable Resources ❖ Ann Hild, Assistant Professor,

Grazable rangelands make up an estimated 62 percent of the United States' total land base. These lands, in proper condition, hold immeasurable value for resource production, scenic, and recreational returns. Because noxious weeds decrease the value of grazable range, weed invasions are a longstanding land management problem.

The solution to the weed problem lies in Geographic Information System (GIS) technology. Joint research at the UW Spatial Data and Visualization Center (SDVC) and the Department of Renewable Resources has produced the GIS-based Wyoming Weed Invasion Susceptibility Prediction (WY WISP) Modeler© to help combat noxious weeds on the western range.

With initial research funded by the Wyoming Integrated Pest Management Program, the Bureau of Land Management, and the Wyoming Space Grant Consortium, the modeler is designed for semiarid rangelands in southwestern Wyoming but is flexible enough to adapt to nearly any site in the region. A fully-automated ArcView© extension allows even novice GIS users to benefit from this technology (Figure 1).

Predicting weeds

The WY WISP Modeler© is currently programmed for five noxious weed species, but users can easily add more. These five preliminary species are perennial pepperweed (*Lepidium latifolium*), hoary cress (*Cardaria draba*), black henbane (*Hyosycamus niger*), leafy spurge (*Euphorbia esula*), and spotted knapweed (*Centaurea maculosa*).

Although predicting the exact location of a weed invasion is nearly impossible, predicting land susceptibility is feasible. GIS technology makes this relatively easy to accomplish. A GIS-based comparison of the environmental parameters of the land with the biological requirements of individual weed species is used to create a predictive model (Figure 2).

Perennial pepperweed, for example, is a water-loving plant that usually grows near stream, pond, or marsh areas. Taking this growth information into account, the modeler evaluates all sections of a study area and highlights those close to a direct water source. Through GIS technology, the highlighted areas are given a higher susceptibility rating, thereby beginning a scoring system.

The WY WISP Modeler© further evaluates high-risk pepperweed areas with parameters such as landscape disturbance, soil texture and pH, slope, aspect, elevation, surrounding vegetation, and annual precipitation (Figure 3). After all factors have been assessed, the modeler scores the area and creates a contoured "risk of susceptibility" map (Figure 4). The layers

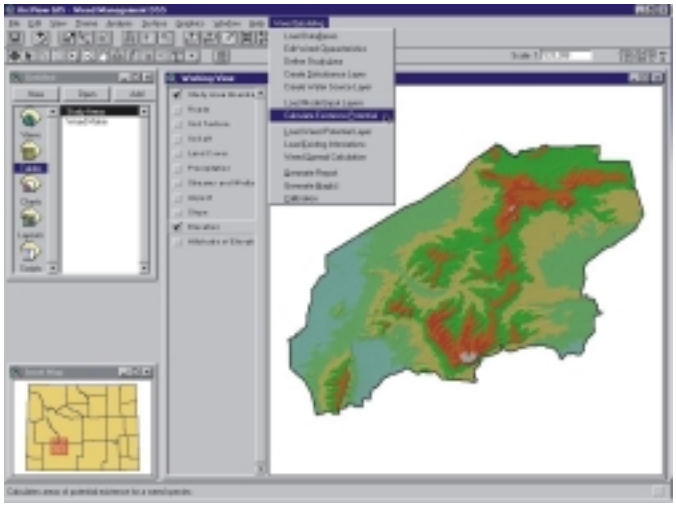
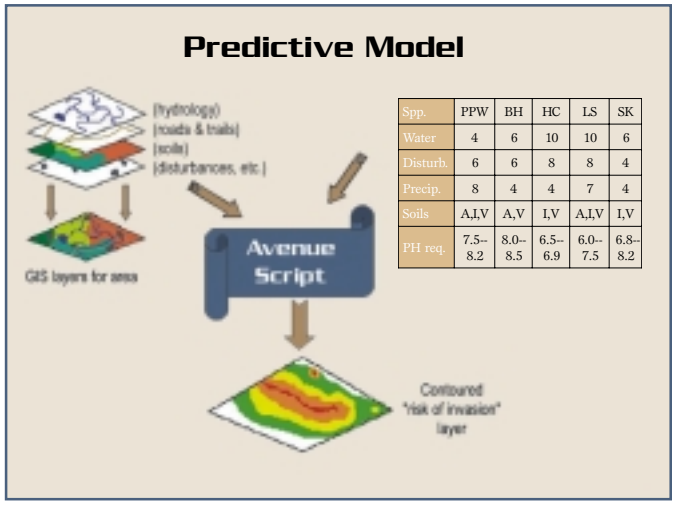


Figure 1. Wyoming Weed Invasion Susceptibility Prediction Modeler© runs within ArcView® GIS.



Spp.	PPW	BH	HC	LS	SK
Water	4	6	10	10	6
Disturb.	6	6	8	8	4
Precip.	8	4	4	7	4
Soils	A,I,V	A,V	I,V	A,I,V	I,V
PH req.	7.5--8.2	8.0--8.5	6.5--6.9	6.0--7.5	6.8--8.2

Figure 2. Environmental data layers are combined with weed species biological requirements.

Department of Renewable Resources ❖ Thomas D. Whitson, UW Extension Weed Specialist, Department of Plant Sciences

on this map allow land managers to locate weed infestation hot spots within the study area. This reduces the time and expense of on-the-ground surveys.

Seeing into the future

As there is rarely sufficient funding to control all weed infestations, resource managers must effectively focus their control efforts. Even with a ground-surveyed map, however, managers often cannot predict which invasions are likely to spread quickly without evaluating complex environmental and biological information. The WY WISP Modeler's© "future spread" feature conducts such an evaluation.

The modeler references the known infestation layers and assesses potential spread according to the same environmental and biological rules used in the susceptibility feature. After determining realistic spread rates for each infested section of the study area, the modeler creates maps of how the infestations may look like at five-year intervals (Figure 5). This tool allows land managers to see into the future and develop the most effective control plan.

The WY WISP Modeler's© final tool is a "report generator" option. After completion of either the susceptibility or future spread process, this tool quickly calculates the number of acres of possible infestation for the weed species. It also gives descriptions, pictures, and possible control options for the species. Resource personnel can use this feature when developing reports for management proposals.

The modeler is easy to use and can be adapted or updated by anyone who is familiar with the ArcView® computer program. If used properly, it can save time and money by allowing land management personnel to predict an area's potential for invasion by specific weed species.

A CD-ROM version of the GIS-based WY WISP Modeler© was released in the spring of 2001, allowing land managers to be more effective and efficient in fighting the war against noxious weeds. For more information on the modeler or to request a copy, log on to w3.uwyo.edu/ ~ annhild/wisp. html.

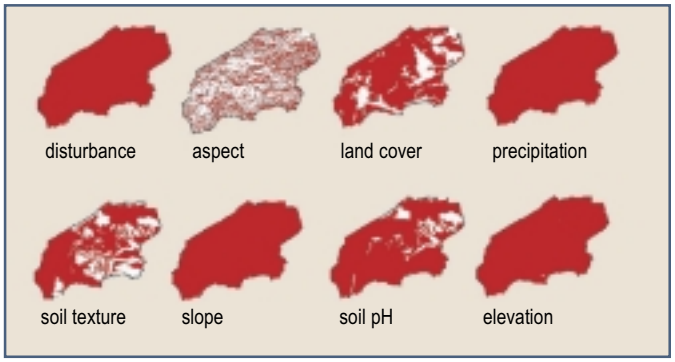


Figure 3. Suitable weed establishment areas for biological factors are used in the model.

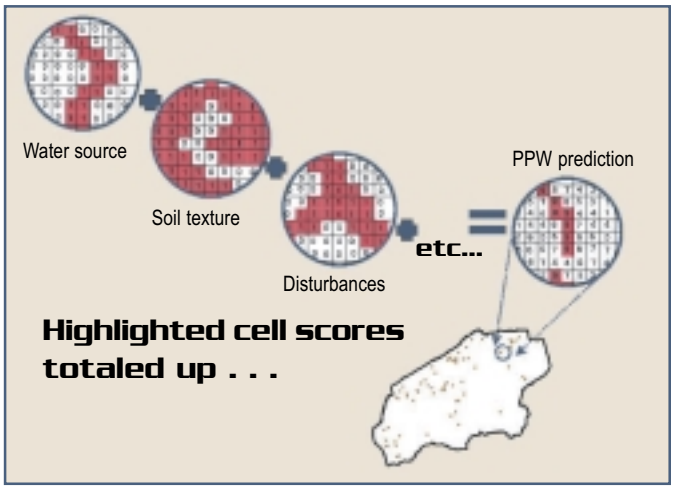


Figure 4. Highlighted cells are scored to create a contoured "risk of invasion/susceptibility" map.

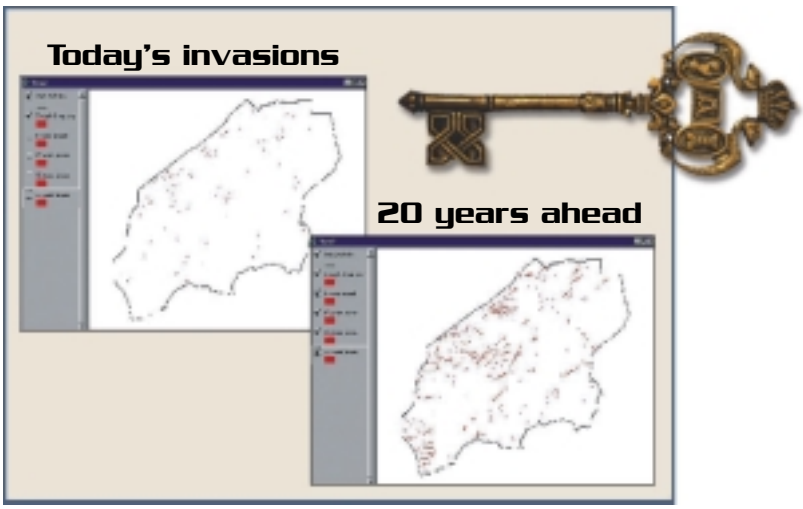


Figure 5. The future spread predictor feature maps the area for today and predicts what it is likely to look like 20 years from now if control methods are not implemented.

UW faculty receive NIH grant funding

The Department of Health and Human Services has awarded a $6.4 million grant to the University of Wyoming Departments of Molecular Biology, Chemistry, and Zoology & Physiology for a project titled, "Biology of Spatiotemporal Nitric Oxide Gradients." This is the largest NIH grant ever received by the university.

The grant will be used to examine the biological actions of nitric oxide in the human body. Nitric oxide is a colorless and potentially poisonous gas formed by combustion of nitrogen and oxygen. It causes smog and acid rain in the environment, but in the human body it acts as a chemical messenger with many functions. It serves as a neurotransmitter, affects blood pressure, and is produced by the immune system to help fight against infection and cancer. Although nitric oxide is very useful to the body, it also can have a toxic effect on the cells in the body and has been associated with Huntington's disease, Alzheimer's, and arthritis. The research will lead to the development of new nitric oxide release and detection mechanisms.

An interdisciplinary group of UW investigators will conduct five medically related research projects, each having unique but complementary experimental systems. Each investigator will examine how different concentrations of nitric oxide impact certain diseases, reproduction, and immune system responses. The five-year research program will support the six investigators' work by establishing a Center of Biomedical Research Excellence (COBRE).

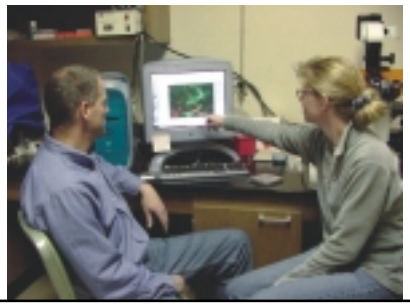
UW Department of Chemistry Professor Scott Bohle is the principal investigator of the research program. The funding will be used to purchase imaging equipment and other instruments to track the molecule and create models that mimic how cells produce nitric oxide. The grant money also will be used to hire additional faculty and personnel.

Bohle will devise methods to deliver nitric oxide to the models similar to the way it is released in the body. Bohle and co-investigator Robert Atherton, professor in the Department of Zoology & Physiology, will test new hypotheses of fertility and contraception by investigating nitric oxide production in the eggs of fish and sheep. The researchers believe there will be a need for new methods of birth control and inexpensive ways to achieve fertilization.

Assistant Professor Scott Boitano, Department of Zoology & Physiology, will study the close balance between specific cell

Scott Boitano
Shelly Robertson

Scott Boitano isolates rabbit tracheal cells in his laboratory.



Bob Heinzen and Shelly Robertson examine a digital image off the flourescence microscope.

Paul Wade, center, discusses the project with his research assistants.

Photos by Tonya Talbert

physiology, pathology, and signaling pathways involving nitric oxide production in the upper airway epithelium and its role in controlling disease caused by respiratory tract pathogens. This is the body's defense to keep bacteria, dust, and pollutants from reaching the lower lungs. His research will develop new approaches for the treatment of asthma and the control of infectious diseases and other health problems associated with tobacco products.

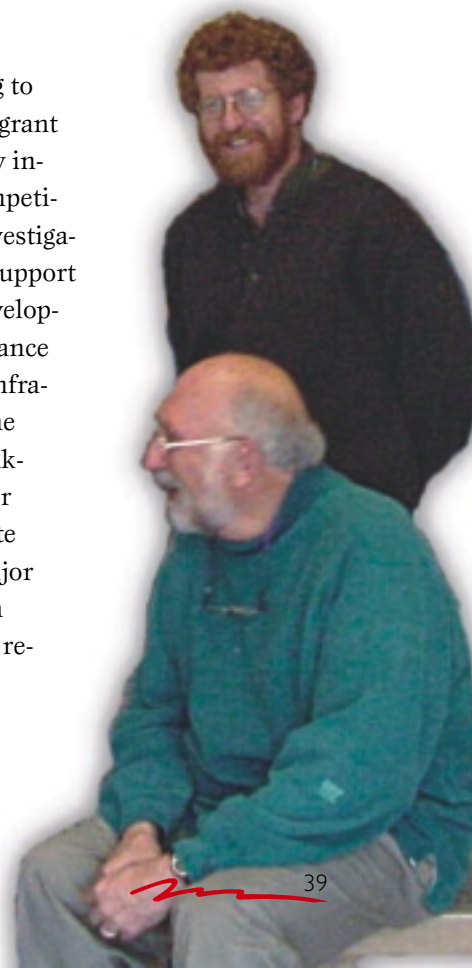
Paul Wade, assistant professor in the Department of Zoology & Physiology and in the WWAMI Medical Education Program, will study nitric oxide's role in controlling gastrointestinal function and how it changes with age. Chronic diarrhea and constipation are two of the most persistent problems reported by elderly individuals. This research will help researchers understand how neural control of these problems changes with age and could lead to improvement in the quality of life for elderly people.

Assistant Professor Shelly Robertson, Department of Molecular Biology, will study the role of nitric oxide in retrovirus induced central nervous system diseases. Retroviruses can cause severe immune deficiencies and debilitating nerve disorders in a number of animal hosts, including humans. This research will lead to new approaches for prevention and treatment of neurological diseases.

Robert Heinzen, assistant professor in the Department of Molecular Biology, plans to examine the role of nitric oxide in controlling infection of intercellular bacterial human diseases such as Rocky Mountain spotted fever and Q fever. His studies will lead to a better understanding of host defenses against infection by obligate bacterial parasites.

In addition to providing significant data for future studies and building a foundation for additional NIH funding, the research will serve as an educational tool for UW undergraduate, graduate, and post-doctoral students. "One of the exciting aspects of receiving this grant is that it will provide many learning opportunities for students," said Robertson.

According to Heinzen, this grant will ultimately increase the competitiveness of investigators through support for faculty development and enhance the research infrastructure of the university, making it easier for UW to compete with other major universities in health-related research.



Scott Bohle
Robert Atherton

WIN the Rockies

The United States Department of Agriculture (USDA) awarded a $4.375 million grant to the University of Wyoming Colleges of Agriculture and Health Sciences for a four-year project titled, "WIN (Wellness IN) the Rockies."

WIN the Rockies is a ground-breaking and synergistic health improvement project involving Wyoming, Montana, and Idaho, their land-grant institutions and Cooperative Extension Services, along with state organizations, community groups, and each state's medical education program. The project will incorporate research with education and extension at the community, state, and regional levels. Project goals are to enhance attitudes and behaviors related to food, physical activity, and body image and to build communities' capabilities to promote and sustain these changes. In addition to serving the general population, the project will provide specific outreach programs to youth, heavy adults, and audiences with limited resources.

The competition for the grant money was fierce with more than 1,000 proposals submitted and only 86 funded. UW's grant was the largest single award given nationwide.

"WIN the Rockies was the top-ranked proposal in the Factors Affecting Food and Nutrition Behavior of Consumers Program," said Etta Saltos, nutrition and food safety program director for the CSREES National Research Initiative. "This project stood apart from the other proposals because it clearly showed the integration of research with extension and education, it had a community-based focus, and it built upon and expanded an existing successful program (WIN Wyoming)."

U.S. Senator Craig Thomas visits the WIN the Rockies display at the Food and Agricultural Science Exhibition reception in Washington, D.C. Also pictured are Suzanne Pelican and Linda Melcher.

The UW project team includes project director and co-principal investigator Sylvia Moore, director of the Division of Medical Education and Public Health and professor of family medicine in the College of Health Sciences; co-principal investigator Suzanne Pelican, a food and nutrition specialist with the UW Cooperative Extension Service (CES) in the College of Agriculture Department of Family and Consumer Sciences, who co-wrote the grant proposal; Mike Liebman, professor of human nutrition; Linda Melcher, director of the Cent$ible Nutrition Program; and the grant writer, Fred Vanden Heede. Gary Warhonig has been hired as the state coordinator for WIN the Rockies in Wyoming.

Team members hired to help develop and implement the project in all three states include Betty Holmes, regional project manager, who was also part of the UW team that submitted the proposal;

receives federal funding

Mary Kay Wardlaw, project education specialist; and Kim Puls, office associate.

Team members from Montana are Phyllis Dennee, nutrition education extension specialist, Montana State Expanded Food and Nutrition Education Program (EFNEP) coordinator, and assistant professor of health and human development at Montana State University; Lynn Paul, extension food and nutrition specialist and associate professor of health and human development at Montana State University; Dwight Phillips, associate director of Montana's WWAMI (Washington, Wyoming, Alaska, Montana, Idaho) Medical Education Program and professor of anatomy at Montana State University; Barbara Wheeler, Montana project coordinator; and David Young, director of Montana's Area Health Education Center (AHEC) Program and professor of comparative pathology at Montana State University. Steven Guggenheim, who is retiring as director of the WWAMI Medical Education Program in Montana, was a member of the team that submitted the grant proposal.

Idaho team members are Michael Laskowski, assistant dean at the University of Washington School of Medicine, director of the WWAMI Medical Education Program, and professor in the Department of Biological Sciences at the University of Idaho; Audrey Liddil, associate professor and Idaho State EFNEP coordinator at the University of Idaho; Martha Raidl, assistant professor and extension nutrition education specialist at the University of Idaho; and Julie Harker, state project coordinator.

Fred Vanden Heede (consultant) shares information about narratives for the formative evaluation component with Suzanne Pelican (co-PI) and Sylvia Moore (project director and co-PI).

"I am very positive about working so closely with Cooperative Extension," Moore said. "We have a long history of using extension personnel as public health educators in rural communities. Because extension educators are an integral part of all three states, they are valuable members of our tri-state team. CES educators know the people and they know how to network."

The research team plans to look at attitudes and behaviors related to food, physical activity, and body image from many different perspectives. Researchers will collect data on subgroups of adults and fifth graders in small rural demonstration communities in each state and compare the information with

COLLABORATI

1997

Fall: Development of the four-year plan of work for UW CES Food and Nutrition Program based on the concepts of "healthier at any age, weight, and income." Plan of work team consisted of state-based food and nutrition specialists and county-based family and consumer science educators.

1998

March: First *Size It Up!* presentation. By the end of 2000, this presentation will have been delivered to over 5,000 adults and youth.

June: Publication through UW CES: *Childhood and Adolescent Obesity in America: What's a Parent to Do?*

July: With funding from Wyoming AHEC, a multi-disciplinary think tank of 27 county-, state-, and university-based individuals concluded that a pressing need exists for programs that address the concepts of "healthier at any age, weight, and income" and vitality (physical and emotional vigor) and that UW CES is the appropriate entity to organize and coordinate programs that address these concepts.

September: Naming of the new initiative (WIN Wyoming), initiation of the Web site uwacadweb.uwyo.edu/winwyoming, and submission of a grant proposal to UW CES for funding.

October: With funding from Wyoming AHEC, WIN Wyoming spearheaded incorporation of two questions related to portion size and physical activity into Wyoming's Behavioral Risk Factor Surveillance System (BRFSS) survey.

November: Mission and guiding principles drafted by a volunteer sub-group of 15 WIN Wyoming members, representing a range of agencies and organizations.

1999

January: WIN Wyoming awarded a $40,000 seed grant from UW CES.

February: Mission and guiding principles finalized.

April: First statewide meeting of WIN Wyoming members in Casper.

May: Funding of model projects in Albany and Sweetwater Counties.

October: Incorporation of WIN Wyoming lessons and evaluation questions into the Cent$ible Nutrition Program (UW CES program for limited resource audiences).

2000

January: WIN Wyoming selected as one of three health programs of excellence nationwide by CES < www.cesprograms.org/ndh > .

February: WIN Wyoming team pilot-tested a University of Missouri Extension curriculum consistent with WIN Wyoming's mission and principles.

April: *Shaping a Healthy Future: A Rocky Mountain Conference on Weight Realities* co-sponsored by WIN Wyoming and Wyoming Dietetic Association in Jackson with over $20,000 in outside funding. The three-day conference drew more than 300 educators and health professionals from throughout the country.

May: Grant proposal submitted to USDA to fund a three-state project (WIN the Rockies) based on WIN Wyoming's mission and principles and representing collaboration among the Cooperative Extension Services and the WWAMI Medical Education Programs in Wyoming, Montana, and Idaho.

September: WIN the Rockies received $4.375 million from USDA.

data collected in separate rural comparator communities. In addition to physical measurements, these volunteers will be assessed in terms of some unique behavioral and attitudinal variables, including frequency of sweetened beverage consumption and enjoyment of food and physical activity. The adult participants of the study also will be monitored for changes in blood sugar, cholesterol, and insulin levels.

According to Liebman, the project is pursuing some new and exciting areas of weight management research and approaches. "For example, excess body fat undoubtedly increases the risk of disorders such as diabetes and hypertension in many individuals," he said. "However, a number of well-conducted studies suggest that other factors, primarily level of fitness, may be more powerful predictors of overall health and longevity."

Holmes concurs. "As a society and as individuals, we need to worry much less about weight and focus more on healthful habits," she said.

WIN the Rockies has objectives similar to WIN Wyoming (Wellness IN Wyoming < uwacadweb.uwyo.edu/winwyoming >), a statewide partnership of more than 70 educators and health care professionals representing over 55 public and private entities at the community, state, and university levels. Pelican also coordinates WIN Wyoming, which educates people to respect body size diversity and to enjoy the benefits of active living, pleasurable and healthful eating, and positive self-image.

The Wyoming AHEC and the WWAMI Medical Education Program at the University of Wyoming have helped support WIN Wyoming from its inception. The WWAMI program is also a key component of WIN the Rockies at the community, state, and regional levels. The College of Health Sciences' new Center for Rural Health Research and Education will serve as the project's home.

"WIN the Rockies focuses mostly on rural communities because investigators believe that even though rural people deal with many of the same health issues as their urban counterparts, they may face unique challenges when attempting to live a healthy lifestyle," Melcher explained. "Many rural people face limited food choices and do not have access to exercise facilities, especially in bad weather."

Accordingly, another goal of the project is to help build communities' capacities to foster and sustain healthy lifestyle changes by urging community leaders to open high school gyms, National Guard armories, or other buildings during off hours so residents can have a place to participate in exercise activities.

Ultimately, the project seeks to reverse the rising tide of obesity in Wyoming, Montana, and Idaho by focusing on prevention and health rather than body weight. A portion of the project funding will be used in the first year to generate educational materials for print publications, videos, and the Web, making the project more available to the public throughout the three states during the next two years. The project team also plans to purchase public television and radio advertisements to help promote the avenues and strategies for better health.

The success of the project will rely heavily on support from local communities. "There's no way any of us can make meaningful changes simply on the basis of quick sound-bite messages," Pelican said. "We believe in long-term changes, which means the change has to be grounded in education and community commitment. Individuals need to make changes, but communities must help individuals and families sustain healthful lifestyles."

In the final year of the project, investigators will analyze and interpret collected data, publish the results, and make the intervention strategies and materials available beyond the project states.

WIN the Rockies project staff hold their first planning meeting. Left to right: Barbara Wheeler (Montana project coordinator), Kim Puls (office associate), Betty Holmes (regional project manager), Gary Werhonig (Wyoming state coordinator), and Mary Kay Wardlaw (project education specialist).

INTEGRATED PEST MANAGEMENT
helps enhance agricultural production in Wyoming

Integrated pest management (IPM) is the use of a combination of control methods to lessen the economic impact of disease, insects, and weeds in agricultural production. In an effort to serve Wyoming producers, the UW IPM Program has facilitated research on a variety of production, crop management, weed control, and disease issues.

Commercial horticulture (tomato production)

UW College of Agriculture researchers Jim Krall, Jerry Nachtman, Jack Cecil, Wayne Tatman, and Ron Kaufman investigated weed control and tomato growth at the UW Torrington Research and Extension Center. Using experimental IPM methods, tomatoes were harvested 13 times in 1996; total yields exceeded 50 tons per acre.

Tomato test areas covered with landscape fiber mulch produced significantly higher yields and had fewer weed problems than areas left uncovered. In addition, areas covered with the mulch had significantly higher soil temperatures.

Crop rotation systems (reducing weed seedbanks)

Weed management in crop rotation systems depends on the interaction of seeds in ecological systems over time. Therefore, selection of crop species and order of rotation can shift the dominant weed species in the system. When the two major weed species in a wheat rotation have a one- to two-year seed life, then a single year in an alternate crop will help eliminate those weeds. If seed life is greater than three to four years, then longer rotations, coupled with a weed management system, may be the best solution. After completing seed burial studies, UW researchers Steve Miller, Dave Wilson, Shankar Sharma-sarkar, and Phil Rosenlund went on to research seed survival within several crop rotation systems.

Proso millet and oilseed sunflower were studied for crop rotation in spring or winter wheat fallow systems to help eliminate weed seed banks in the soil. The wheat fallow system rotation combinations included a two-year alternating wheat-fallow and wheat-millet rotation,

a three-year wheat-sunflower-fallow rotation, and a four-year wheat-millet-sunflower-fallow rotation. The three- and four-year rotations had the greatest impact on decreasing seed bank levels (Table 1). Decreases in jointed goatgrass seed followed the sunflower growing season in both the three- and four-year rotations.

Crop rotation systems (Australian legumes for rotation)

Jim Krall organized a study tour that covered over 1,000 miles of southern Australia. The tour provided Wyoming producers and scientists an opportunity to learn about new crops and crop rotation systems, among other agricultural issues. IPM funds were used to produce a tour video with Robin Groose as producer and moderator. Because Australian producers operate in a semi-arid environment, the video may be useful for Wyoming producers interested in new rotation systems.

Noxious and rangeland weed management (musk thistle competition)

Musk thistle is a biennial noxious weed that has become a problem in the Jackson Hole area. Long-term management of musk thistle using various perennial cool-season native grasses was the goal of an experiment conducted by Jay Hanson, Tom Whitson, and Fred Lamming in Grand Teton National Park.

Cool-season grass yields collected in 2000 indicated that grasses producing greater than 1,000 pounds per acre, namely slender wheatgrass, big bluestem, Canada wildrye, and western wheatgrass, provided enough competition to stop the reestablishment of musk thistle.

Noxious and rangeland weed management (leafy spurge root measurements)

Herbicide application has been used to control leafy spurge for many years, but the effects on root systems have been unknown. Minirhizotron technology is being tested by Summer Alger, Tom Whitson, and Gene Gade to determine if this non-destructive root viewing technique can be used to measure changes in root systems following various management techniques.

One year after herbicide treatment, minirhizo-tron technology detected a significant decrease in root intercepts after use of herbicides, 4-D® and Plateau®. Tordon® exhibited no real difference in root intercepts, while Roundup® showed significant increases in root intercepts in the upper range of the root system.

Producer Dave McKamey, left, and Dave Mischke, Holly Sugar agronomist, survey a field of radish.

Noxious and rangeland weed management (Russian knapweed grazing systems)

When applied following the bloom stage, herbicides are quite effective in controlling Russian knapweed. When control is attained, however, a proper grazing system must be implemented to prevent the weed from re-establishing. Studies near Riverton sought to determine the effects of long-term grazing systems on the re-establishment of Russian knapweed. Ron Cunningham, Alex Malcolm, and Tom Whitson conducted these studies.

Comparisons were made between areas treated with Tordon 22K® and those left untreated. Ungrazed areas were compared to areas grazed for one year prior to yield sampling in treated and untreated areas. When areas

Table 1. Effect of crop rotation on jointed goatgrass seed bank levels in soil.

	Jointed goatgrass seeds per 5 pounds of soil				
Rotation	Year 1	Year 2	Year 3	Year 4	Year 5
Wheat-Fallow	14	5	9	5	11
Wheat-Millet	11	7	7	2	7
Wheat-Sunflower-Fallow	11	5	2	2	1
Wheat-Millet-Sunflower-Fallow	11	5	5	0	0

were treated with Tordon® in 1997 and no grazing was done, perennial grass yields increased 1,739 pounds per acre, while Russian knapweed decreased 1,181 pounds per acre. In grazed trails treated with Tordon®, Russian knapweed was reduced 92 percent; in that same area with no grazing, Russian knapweed stands were reduced 99 percent. The grazed areas only had 7 percent less Russian knapweed control when using a late grazing management system.

Noxious and rangeland weed management (competition against foxtail barley)

Foxtail barley, a short-lived perennial grass, causes mouth and throat irritation in livestock. In an effort to control foxtail barley, an experiment was designed to compare the competitive ability of five cool-season grasses. Jerry Langbehn and Tom Whitson studied these five species at the Ash Witt Ranch near Thermopolis.

Tall wheatgrass (Jose) and hybrid wheatgrass (Newhy) were the two perennial grasses that established well the first year and provided significant competition against foxtail barley three years after establishment. Areas seeded to tall wheatgrass provided 90 percent foxtail barley control in 1999 and 96 percent control in 2000. Newhy hybrid wheatgrass provided 56 percent control of foxtail barley in 1999, but it continued to establish and become more competitive, providing 94 percent control in 2000.

Disease management in alfalfa

Fred Gray, Charla Hollingsworth, Dave Koch, and Tom Heald surveyed the occurrence of brown root rot (BRR) in five Wyoming counties and initiated BRR management strategies.

The following practices were found to reduce losses from BRR: integration of a three-year crop rotation with a spring-sown small grain, good harvest and grazing management practices, good fertility practices, and the selection of resistant alfalfa varieties that will survive well in Wyoming.

Nematode management in sugar beets

The most destructive and costly pest of Wyoming sugar beets is the cyst nematode (SBCN). Dave Koch, Fred Gray, James Gill, and Jack Cecil conducted research to test the use of trap crops to control SBCN, rather than using the expensive fumigant Telone®.

Department of Plant Sciences graduate student Summer Alger tests minirhizotron technology out in the field.

Various radish and mustard varieties were compared to the traditional Adagio variety at standard and lower than normal seeding rates. When 15 pounds per acre of Adagio seed was used, rather than 25 pounds per acre, similar results were obtained with a $17 per acre seed cost savings. Trap crop radish and mustards control SBCN and show promise as an alternative to pesticides.

Costs of growing trap crops are about one-half that of a commonly used fumigant. Furthermore, this research, as well as producer demonstrations, has shown that the cost of growing trap crop radish can be defrayed by livestock grazing in the fall. The use of trap crops for weed control is also environmentally beneficial.

A full report of all IPM research is available from the Department of Plant Sciences. For more information, call Tom Whitson at (307) 766-3113 or e-mail him at twhitson@uwyo.edu.

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