

# FUTURES

AGBIORESEARCH • MICHIGAN STATE UNIVERSITY  
SPRING/SUMMER 2011 • VOLUME 29 NOS 1 & 2



## The Art of Partnership

Leading Innovation through Collaboration

## The Art of Partnership — Leading Innovation through Collaboration

Partnerships are the lifeblood of many institutions. Whether in marriage, business, sports or academia, teamwork and collaboration are the cornerstones of success, providing mutual benefit and outcomes that often wouldn't otherwise be possible.

Michigan State University (MSU) AgBioResearch scientists are long-time believers in the value of partnerships and their importance in advancing science that is relevant and applicable to society.

"AgBioResearch scientists do not work in a vacuum — the results of their studies are used by various groups of people who apply them to real-world situations and problems," said Steve Pueppke, AgBioResearch director. "Because of this, scientists must be up-to-date not only on the latest research techniques but also the current needs of industries, commodity groups, government agencies, citizen groups, growers and consumers. Partnerships are critical to the success of all our research endeavors."

In this issue of *Futures*, you can read about some of the innovative partnerships that undergird the important research being done to generate economic prosperity, sustain natural resources and enhance the quality of life in Michigan, the nation and the world.

Potatoes are the most important vegetable crop and the fourth most-consumed food crop in the world, after rice, wheat, and corn. Therefore, research on the genetic improvement of this crop is critical. Great progress in this area is being made by the MSU potato breeding and genetics program, headed by an AgBioResearch scientist who credits leading-edge science and strong partnerships with the program's long-term success.

The partnership between the MSU wheat breeding program and the Soft White Wheat Endowment is another example of a productive alliance. The combined efforts of these two groups are meeting the needs of Michigan's milling industry and producing beneficial results for the state's wheat growers, who harvested 560,000 acres of wheat in 2009, with a production value of \$164 million.



The Interregional Research Project No. 4, or IR-4, is almost 50 years old, and MSU and AgBioResearch have had strong ties to this USDA-funded program from the very beginning. IR-4 has been instrumental in helping specialty crops thrive. The project's secret to success? Researchers, commodity groups, chemical companies, producers and others working together for a common good.

For decades, MSU has teamed up with the United States Department of Agriculture Agricultural Research Service (USDA-ARS) to tackle key issues and challenges in production agriculture. AgBioResearch scientists and other MSU researchers work closely with two on-campus USDA-ARS units — sugar beet and bean, and the Avian Disease and Oncology Laboratory — combining proximity, world-class expertise, and state-of-the-art technology and facilities to keep these sectors healthy and profitable.

Managing and conserving our wildlife resources is no small task. In recognition of this, MSU has bolstered its wildlife research capacity with the establishment of the Quantitative Wildlife Lab in the Department of Fisheries and Wildlife and has teamed up with the Boone and Crockett Club — one of the oldest wildlife conservation organizations

in the United States — to create the Boone and Crockett Chair in Wildlife Conservation. The aim of this innovative partnership is to develop programs and initiatives that advance the responsible management of wildlife resources and inform conservation policy.

On Earth Day in 1993, the MSU College of Agriculture and Natural Resources and the Michigan Department of Natural Resources (DNR) signed a joint operating agreement called the Partnership for Ecosystem Research and Management (PERM). Originally a partnership between MSU and the Fisheries and Wildlife divisions of the DNR, PERM has expanded to include the DNR Forest Management Division, the Great Lakes Fishery Commission and the Great Lakes Science Center, which is part of the U.S. Geological Survey. Over the past 18 years, this unique partnership has brought a novel approach to applied research and narrowed the gap between research and implementation.

We hope you enjoy this issue of *Futures* on partnerships and how, through these alliances, AgBioResearch scientists are helping to shape our world. We hope these articles help you to understand a little more about AgBioResearch and the research it funds. If you have comments about this issue or would like to subscribe (it's free!), send a note to *Futures* Editor, 109 Agriculture Hall, Michigan State University, East Lansing, MI 48824-1039, or send an e-mail to [osowskiv@msu.edu](mailto:osowskiv@msu.edu). You also can call 517-355-0123.

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VAL OSOWSKI



#### **4 Collaborating to Create a Better Potato**

Thanks to teamwork, AgBioResearch expertise and technological advances, potato breeding and genetics research at MSU is realizing “spudtacular” success.

#### **10 Forging Alliances to Safeguard Specialty Crops**

Since 1963, the Interregional Research Project No. 4, or IR-4, working with the U.S. Department of Agriculture and land-grant universities — including MSU — has given specialty crop growers hundreds of new pest control uses. AgBioResearch scientists have played a significant role in IR-4’s success.

#### **16 Growing the Future Together: The MSU-Agricultural Research Service Partnership**

U.S. Department of Agriculture employees have been part and parcel of the MSU on-campus research scene since the early 1920s, working with university scientists to provide practical science that addresses real-world challenges. This partnership has especially strong ties with AgBioResearch, an entity known for its contributions to the sustainability and success of production agriculture in Michigan since 1888.

#### **26 Building Bridges to Wildlife Conservation Leadership and Policy**

The recent establishment of the Boone and Crockett Chair in Wildlife Conservation and the MSU Quantitative Wildlife Laboratory brings more science and richer collaboration to the area of wildlife ecology, and offers new solutions to the most difficult challenges of wildlife conservation.

#### **31 The PERM Paradigm: Relationships Matter**

For 18 years, the Partnership for Ecosystem Research and Management (PERM) at MSU has successfully brought together university scientists and state and federal agencies to solve problems and apply research results to keep Michigan’s natural resource base healthy and sustainable. Nine of the 11 PERM faculty members are also AgBioResearch scientists.

#### **42 Research in the News**

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# Collaborating to Create a Better Potato

Every so often during his *Futures* interview, Michigan State University (MSU) AgBioResearch scientist Dave Douches said, “Boy, things are so exciting!” And — by his own confession — he’s been saying that, every so often, for almost 25 years.

“There’s a lot of promise with the technologies that are out there, and some of them are maturing into great tools,” said Douches, who heads the MSU potato breeding and genetics program in the Department of Crop and Soil Sciences. “We are in such exciting times for tackling some of our potato growing problems.”

Douches joined MSU in 1987 with a passion for decreasing the agricultural constraints associated with producing potatoes and as a scientist open to the new tools being developed. In the process, he also established a program with partnerships reaching across interdisciplinary areas at MSU and other universities, and with Michigan potato growers and processors.

As the only full-time MSU faculty member focused on potato research, Douches spearheads the development of varieties that position potato farmers to grow the best potatoes for their markets.

Potato varieties are very difficult to breed, Douches noted.

“Whenever you create a cross, you have created a whole new combination of plants,” he explained. “Potatoes don’t breed true. Every variety is a unique creation.”

So why all the excitement about and attention to potatoes?

The potato (*Solanum tuberosum* L.) is the fourth most important crop in the world behind wheat (see sidebar on page 8), rice and maize, and is the world’s No. 1 non-grain food commodity. In 2009, worldwide production of potatoes reached a record 329.58 million metric tons, according to the Food and Agricultural Organization of the United Nations. The potato produces more food energy and food value per unit of land area than any other crop. Compared with grain crops, the potato is a superior source of nutrition. Among the major crop plants, however, the potato is arguably the most intensively managed. In addition, tuber quality requirements are complex and must be maintained during harvest and storage.

### Achieving advances through teamwork

Given the significance of the potato, research on the genetic improvement of this crop is critical. AgBioResearch scientist C. Robin Buell is a vital partner in Douches’ work. Buell, an associate professor in plant biology who joined MSU in 2007, has expertise in genomics, bioinformatics and sequencing.

“Previously, people made crosses and then they would wait for the growing season to get the plant or tuber and see what phenotype [the observable physical or biochemical characteristics of an organism] they had,” Buell said. “Then they would go to the next generation. They were essentially working blind, and it was a time-consuming process. With new technology, we now can do the work in a short period of time in a lab and accelerate the process of making crosses and selecting the ones needed to make the final variety.”



AgBioResearch scientists Dave Douches and C. Robin Buell look over genetic databases that will be used in combination with traditional breeding techniques to accelerate the development of new potato varieties.

In 2008, a project supported by the Agriculture and Food Research Initiative Applied Plant Genomics Coordinated Agriculture Program of the U.S. Department of Agriculture’s National Institute of Food and Agriculture was funded at MSU. Douches is the director and Buell one of the co-directors along with researchers from Cornell University, the Ohio State



C. ROBIN BUELL  
AgBioResearch plant  
biologist

“SolCAP is providing an opportunity and a forum for the exchange of information.”

University, the University of California-Davis and Oregon State University.

The project, called SolCAP, *Solanaceae* Coordinated Agricultural Project, focuses on the two most important vegetable crops in the *Solanaceae* family: potatoes and tomatoes. The idea is to link researchers from public and private institutions and related industries so that they can collectively focus on translating genomic advances to crop breeding programs.

“Twenty years ago, we were developing the first genetic maps in potatoes with the promise that we could map traits but the techniques were cumbersome and had time and cost limitations,” Douches said. “Now with the technology advances, we can do so much more. We are closer to the promise of using genetic markers in our breeding program. That has come about through the SolCAP project.”

“The project is bringing plant breeding into the 21st century,” Buell added. “We are capitalizing on technology improvements in biology and computer science.”

The SolCAP project already has yielded major accomplishments, including the development of tools that allow for easy use of genomics in breeding approaches. These tools are being applied to look at past breeding decisions and will eventually be used to accelerate breeding decisions.

Buell sees another important goal of the project.

“SolCAP is providing an opportunity and a forum for the exchange of information,” she said. “Dave may learn a lot about informatics and genomics, and I am learning a lot about breeding. That opportunity to be educated in both directions is really powerful.”

## Joining forces to tackle potato disease

Douches also collaborates closely with AgBioResearch scientist Willie Kirk, who works with real-world disease problems in potato production.

“When growers and industry representatives have potato disease problems, I’m the person in Michigan they come to first to answer their questions,” said Kirk, a plant pathologist and an MSU Extension specialist. His answers are based on more than 30 years of researching potato diseases.

The most famous — or infamous — potato disease is late blight.

“Globally, late blight is the No. 1 disease of potatoes and costs millions in crop production losses and control — and there is no 100 percent cure,” Kirk said.



**Fusarium dry rot (pictured above) is a potato disease affecting tubers in storage and seed pieces after planting. Fusarium dry rot of seed tubers can kill developing potato sprouts and cause crop losses up to 25 percent.**

Potato late blight, caused by the water mold *Phytophthora infestans*, proliferates in wet weather with moderate temperatures (60 to 80°F), high humidity and frequent rainfall, so Michigan potato fields are a prime target for this disease. Under the right conditions, the disease can spread very rapidly and can completely defoliate fields within three weeks of the first visible signs of infection if no control measures are taken. In addition to attacking foliage, *P. infestans* can infect tubers at any stage of development, before or after harvest. Soft rot of infected tubers often occurs in storage and destroys the harvested tubers.



**WILLIE KIRK**  
AgBioResearch plant pathologist and Extension specialist

“When growers and industry representatives have potato disease problems, I’m the person in Michigan they come to first to answer their questions.”

An important part of Kirk’s work is keeping growers updated on the conditions that can cause late blight by using systems that can forecast the risk five days in advance. Updates allow growers time to use integrated pest management tools to stem disease development. Kirk is keeping a watchful eye this year because there are indications that late blight may be a problem.

“We’ve already found late blight in tubers — that has not happened before,” he said.

Kirk oversees a website devoted to the latest information about potato diseases — [www.potatodisease.org](http://www.potatodisease.org), and a toll-free hotline provides information for potato growers — 888-379-9012. And in a nod to new technology, there also is a Twitter account — [http://twitter.com/late\\_blight](http://twitter.com/late_blight) — where growers and other stakeholders can keep track of important news on late blight in Michigan.

It is possible to breed potatoes with late blight resistance as well as resistance to other diseases. That’s where Kirk’s input is helpful to Douches in the breeding process. In addition, Kirk supervises field trials of various resistant varieties developed by Douches.

“MSU is one of the few places in the United States that does late blight inoculated trials,” Kirk said. “We do controlled epidemics of late blight to see what pest management tools work and how resistant breeds can withstand the pathogen.”

## Cultivating industrial strength allies

In addition to his work with Buell, Kirk and other MSU colleagues, Douches has a close relationship with the Michigan Potato Industry Commission (MPIC). Ben Kudwa has been the executive director of MPIC since 1986, just before Douches came to MSU.

“My first assignment was to ensure that a new potato breeder was hired at MSU,” Kudwa said. “MPIC offered MSU start-up funds for the breeding work when MSU replaced a breeder who had retired.”

Today there are about 100 potato growers in Michigan. That’s down from 500 in 1987. The acreage devoted to potatoes in Michigan is also slightly down, but yields per acre have increased. The farm gate value of the Michigan potato crop was a record \$164 million in 2009, according to National Agricultural Statistics Service data.

“The 2010 farm gate value may be significantly higher because growers got good yields and the prices were high,” Kudwa added.

In 1999, MPIC opened the Cargill Research and Demonstration Storage near the MSU Montcalm Research Center. The storage facility is managed with the assistance of the farm manager at the Montcalm Research Center, an important AgBioResearch facility for potato research.

“This was a major step forward for the Michigan potato industry,”

Kudwa said. “With this facility, the industry is now able to monitor new breeding selections and released varieties under a number of commercial-scale storage environments to learn the best handling requirements for each. It has been crucial to Michigan’s reputation for quality potatoes.”

A companion structure was built in 2008 for research on storage diseases.

“This adds to the potential for greater volumes of quality potatoes out of commercial storages,” Kudwa said. “Because of the research from these facilities, growers are building similar storage facilities on their farms.”

“Michigan is able to deliver potatoes in a day to many markets,” Douches said. “We also have the land, the soils and the water to grow potatoes. Pennsylvania and New York can grow chipping potatoes and other varieties, but these states do not have the land and water resources that Michigan does. Further, because of its climate, Michigan can store potatoes and supply them to chipping companies from late July through the spring of the next year.”



**BEN KUDWA**  
executive director,  
Michigan Potato Industry  
Commission

“The Michigan potato industry turned into a powerhouse for chipping potatoes by building exceptional relationships with customers through dependability and quality, and also by its willingness to work jointly on challenges that manufacturers face in strengthening their own industry.”

Michigan was not always the major chipping supplier.

“The Michigan potato industry turned into a powerhouse for chipping potatoes by building exceptional relationships with customers through dependability and quality, and also by its willingness to work jointly on challenges that manufacturers face in strengthening their own industry,” Kudwa said.

### Meeting grower needs

Brian Sackett is a fifth generation potato farmer. He and his dad, Alan, and brother, Jeff, are partners in Sackett Potatoes. They farm 6,500 acres in Mecosta and Montcalm counties, including 3,350 acres of potatoes. Annually, the Sacketts harvest 120 million pounds of potatoes.

“MSU has done a tremendous job in helping with pest problems such as the potato beetle and with chemical resistance problems,” Sackett said. “Dave [Douches] has done a good job of developing varieties that growers need and has been especially helpful in developing varieties that are resistant to scab. That’s a big problem in Michigan.”

Scab is caused by a soil-dwelling plant pathogenic bacterium. It does not usually affect total yields, but because the marketplace for potatoes is quality-driven, the presence of scab lesions on the potato significantly lessens its marketability.

The Sacketts sell all of their potatoes to the chipping industry and have storage facilities on their farms. Brian Sackett understands the importance of being able to store potatoes and keep them free of disease.

“We store about 100 million pounds of potatoes,” he said. “We start

shipping fresh from the fields in August, September and October. Then, from November through May, we ship out of storage. Our current varieties do OK in storage, but we’re always looking for something better, a variety that stores longer or one better able to resist storage diseases.”

### Chipping away at a better potato

The Michigan potato industry is dominated by the chip processing sector, which uses more than 80 percent of Michigan’s 43,500 acres of potato crop. Frito Lay is the biggest purchaser of Michigan chipping potatoes, but regional chip processors, such as Better Made, Shearers and Snyder-Lance, are significant buyers.

Speeding up the breeding work is what Better Made Snack Foods chief operating officer Mike Schena thinks is most needed, especially in developing a potato with better storage qualities. Better Made Snack Foods is a Detroit-based company that has been in business more than 80 years. Schena has been purchasing potatoes for processors for more than 35 years, has worked



Skin texture and sugar content are two important factors in selecting potatoes for the chipping industry.

## Being Proactive Yields Positive Results

Passion plus necessity equals a successful partnership. At least, that's the case with the MSU wheat breeding and genetics program.

When the MSU wheat breeder left the university in 2006, members of the Michigan State Millers Association were concerned about the future of wheat research in the state, especially work on soft white wheat.

"Soft white wheat is used in ready-to-eat cereals and by the baking industry in cakes, cookies and crackers," said Deirdre Ortiz, a research fellow with the Kellogg Company in Battle Creek. She heads wheat research programs at Kellogg.

Although wheat is not the first product that comes to mind when people think about Michigan agriculture, state growers harvested 560,000 acres of it in 2009, with a production value of \$164 million, according to the Michigan field office of the National Agricultural Statistics Service (NASS). Soft white wheat is primarily grown in Michigan and some other states east of the Mississippi River. Some soft white wheat is grown in Ontario and New York, but acreage has declined dramatically over the past 15 years. Soft white wheat is also grown in the Pacific Northwest, but its food processing qualities are different from those of Michigan-grown wheat, and because a number of companies that use soft wheat are based in Michigan, a nearby source is important.

Seeing the necessity, Ortiz contacted members of the Michigan State Millers Association to find a way to support soft white wheat research at MSU. Members of the association include the Kellogg Company, Kraft, General Mills, Chelsea Milling, Star of the West Milling and Knappen Milling. The result was the establishment of the Soft White Wheat Endowment Fund at MSU, which helps to fund special needs of the wheat breeding program. Soon after the fund was established, MSU hired a wheat breeder — Janet Lewis.

"We wanted a wheat breeder who could do research with soft white wheat that was collaborative and would work to bring people together," Ortiz said. "Janet is the perfect solution."

Lewis, an AgBioResearch scientist and assistant professor of crop and soil sciences, was hired in October 2007 as director of the wheat breeding and genetics program, which is in the MSU Department of Crop and Soil Sciences.

That's when passion met up with necessity.

"I have a personal commitment to help benefit society, and agriculture is at the foundation of society," Lewis said. "If I can make improvements in agriculture, even small improvements, everyone benefits. I chose to work with wheat because of its role as a staple food. Also, being from Michigan, I want to see the state thrive, and wheat is a sizeable part of the economy in Michigan. Wheat grown in Michigan is in food products eaten in Michigan and around the world."

The main goal of the wheat program is to develop improved varieties of soft white and red winter wheat that are adapted to Michigan growing conditions and meet the needs of the growers and the rest of the wheat industry in the state.

"That's where the partnership aspects come into play," Lewis explained. "We want to reduce the risks and improve the gains of wheat production in Michigan."

Michigan primarily grew white wheat until 1996, when there was an



PHOTO: JIM PALMER, MICHIGAN CROP IMPROVEMENT ASSOCIATION

epidemic of *Fusarium* head blight, or "scab," which causes an accumulation of toxins in the grain that makes the grain unacceptable to the milling industry. This hurts farmers, who then have to sell the wheat for animal feed at a much lower price. In 1993, the ratio of white wheat to red wheat was 70:30; today it's 40:60, according to NASS data.

Another problem with growing wheat is pre-harvest sprouting — a germination of the seed before the farmer can get the wheat out of the field. This breaks down the starches in the wheat and dramatically changes its utility and value.

Because of these challenges, a key focus of the breeding program is the development of resistant cultivars. Lewis and her research team do about 200 crosses per year, but new cultivars take years to develop.

"It takes about 10 years to create a new variety from time of crossing to variety release," Lewis said. "We would like to decrease that time."

New technology — especially DNA sequence information and the availability of technologies to reduce labor-intensive tasks in the breeding process — is helping to reduce the time required for breeding. Lewis hopes this will speed up introduction of varieties and the amount of gain seen each year in the breeding cycles.

Some things, however, will not change, she contends.

"We always have to maintain field evaluations," Lewis said. "We cannot breed in a test tube alone. We can improve our speed and efficacy of breeding using laboratory techniques, but final selections have to be done in the field."

A wheat breeding nursery in Mason, Mich., is used for testing early generation material, and Lewis uses locations in farmers' fields to test advanced generation materials. Recent releases include Ambassador and Jupiter wheat, both high-yielding soft white wheat varieties.

Perhaps one of the lasting accomplishments of this partnership is that Lewis is encouraging students to get involved in plant breeding and creating interest in wheat breeding.

"Janet's effort in training students is a valuable asset because there are not that many wheat breeders," Ortiz said.

Lewis looks to the future and sees the possibilities.

"I'm driven by the whole picture," she said. "Science is fun, but I'm not doing science just for science's sake. I'm doing it to meet a need." 🌱

JANE L. DEPRIEST





MIKE SCHENA  
COO, Better Made Snack  
Foods

“The only way for the potato industry in Michigan to thrive is to develop new varieties that are resistant to some of the problems we have growing and storing potatoes . . . the MSU potato breeding program is on top of this.”

closely with MPIC and Michigan potato growers, and is familiar with the MSU potato breeding program.

“The biggest problem for our company is not with the potato but having quality potatoes available from storage into the summer until the harvest begins,” Schena said. “When potatoes stored in Michigan run out in the spring, we have to go to the South to get fresh potatoes and that increases the cost because of transportation. Chippers need a constant supply to continue production.”

To that end, regional potato chip processors are contributing money to the U.S. Potato Board to fund faster breeding using the new technologies.

“The only way for the potato industry in Michigan to thrive is to develop new varieties that are resistant to some of the problems we have growing and storing potatoes,” Schena said. “I think the answer lies in genetic engineering, and the MSU potato breeding program is on top of this.”

In addition to the establishment of numerous potato varieties to be used by the chipping industry, Douches has also developed quite a few varieties for the fresh market. These varieties include Beacon Chipper, Jacqueline Lee, Liberator, and Missaukee and Purple Haze that were just released by MSU in 2010.

“We select these varieties for their culinary quality and for their resistance to pests,” Douches said. “The farmers benefit because they can manage the crop better with less reliance on chemical protection and have a better quality potato. Over time, we have developed a good selection for farmers to choose from to fit their markets and their production challenges. There’s a lot more that we still can do, and with the tools we now have, I’m confident that we can do even better.”

So what lies ahead for “team potato?”

Douches sees a bright, exciting future for the potato breeding and genetics program, and he also sees the increasing value of partnerships within the program.

“Partnerships are how we do our research,” he said. “It’s a life lesson for anyone going into any research field. Partnerships are a key at so



AgBioResearch scientists Willie Kirk (*left*) and Dave Douches (*right*), and Alejandro Rojas, a graduate student who works in Kirk’s lab (*center*), examine plates of healthy mini-tubers, which range in size from 1 to 1½ inches in diameter. They are planted whole and yield full-size potatoes.

many levels. You have to work together with people of a variety of backgrounds and disciplines. The best things I do are through partnerships. I do it because partnerships are the most successful way to get to solutions.”

JANE L. DEPRIEST

# Forging Alliances to Safeguard Specialty Crops

IR-4 — It sounds like something out of a James Bond movie. In reality, the Interregional Research Project No. 4, or IR-4, is a model partnership that has given specialty crop growers new options for controlling pests and getting healthy food to the marketplace.

The initiative is a long-standing collaboration between the U. S. Department of Agriculture (including the National Institute of Food and Agriculture and the Agricultural Research Service) and land-grant universities. Since 1963, IR-4 has been the major resource for supplying safe and effective pest management tools for specialty crops (fruits and vegetables, tree nuts, dried fruits, horticulture, and nursery plants) — also called minor crops — by developing research data to support new pesticide tolerances and legal uses set by the EPA for existing products. The IR-4 Project is the only publicly funded program that conducts research and submits petitions to the EPA to establish new tolerances and labeled uses for specialty crop growers.

“The things IR-4 does are remarkable,” said AgBioResearch scientist Robert Hollingworth, the IR-4 North Central Region director and a professor in the MSU Department of Entomology. “It has been very successful.”

Four regional labs participate in the project — at MSU, Cornell University, the University of California-Davis and the University of Florida. Twelve Midwestern states run their registration projects through MSU, which then works with the other regional labs and IR-4 headquarters at Rutgers University to obtain national registration of products.



Although they are grown on low acreage compared with corn, wheat, soybeans and cotton, they are worth \$40 billion and make up 40 percent of the total value of all U.S. crops. Specialty crops such as cherries, blueberries, potatoes, cucumbers, asparagus, nuts, herbs and flowers are a major part of Michigan agriculture. They make up more than 50 percent of the state's plant-based agriculture and add more than \$1.16 billion to the state's economy, according to Michigan Agricultural Statistics Service data.

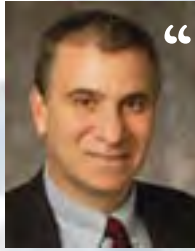
IR-4 became even more important in 1996 when the Food Quality Protection Act set new standards for food safety. The law gives added protections from pesticide exposure on food, especially for infants and children. As a result, many crop protection products used on specialty crops were removed from the market. Because the process to register or re-register these products is expensive and time consuming, chemical companies concentrate on developing products for the most widely grown crops — corn, wheat, soybeans and cotton — because they can recoup the development expense more quickly than products for specialty crops. Consequently, specialty crop growers are often left without essential tools to produce their crops.

IR-4 helps alleviate this problem.

“There have been almost 14,000 new registrations of crop protection products for specialty food crops and 11,000 registrations on ornamental crops since the inception of IR-4,” said Jerry Baron, executive director of IR-4. “Every year, IR-4 helps establish permanent pesticide tolerances, which support hundreds of new uses. As one of the key land-grant universities participating in the program, MSU has played a significant role in this success. The work of the North Central IR-4 lab and the field sites in Michigan are very important.”

IR-4 is a broader partnership than it might appear at first glance.

“If the IR-4 Project did not have a university partner, it could not fulfill its mission



JERRY BARON  
executive director, IR-4

“Every year, IR-4 helps establish permanent pesticide tolerances, which support hundreds of new uses. As one of the key land-grant universities participating in the program, MSU has played a significant role in this success.”

to research and collect data on crop protection products,” said John Wise, MSU associate professor of entomology and the research and Extension coordinator for the Trevor Nichols Research Center in Fennville, Mich., an AgBioResearch Center and one of the few facilities in the state that can accommodate IR-4 field residue trials (*see sidebar on page 13*). “And if MSU and other land-grant universities did not have IR-4, we couldn't provide these new tools for farmers because IR-4 works with the EPA to get new registrations.”

Commodity groups and chemical companies are also important partners in this project, Wise said.

“With just IR-4 and MSU, the program would not work,” he said. “Commodity groups are a part of the political will for this federally funded initiative. If commodity groups did not communicate this program as a priority to the government, it wouldn't exist. And if the chemical companies didn't have safe, environmentally friendly products and weren't willing to sell them for a particular use, none of this could happen.”

### **Pursuing plentiful, pest-free crops**

To ensure an inexpensive, high quality food supply, pest management chemicals are essential. This is true even for organic production systems where the use of pesticides is allowed, although the kinds of pesticides used are restricted. IR-4 also works to provide these allowable tools to organic growers.

AgBioResearch plant pathologist Mary Hausbeck plays a key role in the IR-4 Project.

“I see my involvement in IR-4 as multifaceted,” said Hausbeck, a professor and Extension specialist in the MSU Department of Plant Pathology. “One of the important pieces is that, each year, there is a national food use workshop and an ornamental workshop. My role is to help assess where there are critical gaps in these areas and bring forth tools that I believe can fill those gaps. I think MSU in particular does a nice job of having representatives at this meeting, and that is important because we attend in support of the many specialty crops grown in Michigan. We also have to stay current on the needs of the specialty crop industry in Michigan and know what tools can be most useful. I see that as a key role.”

Once the priorities are set on the basis of input from the workshops, Hausbeck and other scientists may do research on various projects.

“In my lab, we may test to see if certain products are safe for a particular plant, and we also do tests that are needed for determining pesticide residues and from those residues, the tolerances are set and registrations are obtained,” Hausbeck explained. “That's the other piece of my involvement with IR-4.”

Hausbeck specializes in disease management and disease predictors for vegetables and ornamental crops. She and Blair Harlan, the lead research technician in Hausbeck's lab, work on a wide range of studies conducted for IR-4 and other projects. One example of the IR-4 work they've done is with two fungicides used on Michigan asparagus.

“These products are not applied to the

edible spear,” Hausbeck said. “They are applied post-harvest to protect the asparagus fern so it can replenish the asparagus plant and sustain yields for the following year. If the foliage is not protected, the plant loses its leaves and becomes weakened and more susceptible to root rot.”

Asparagus growers needed new crop protection products because they struggled with increasing disease problems. Asparagus



**MARY HAUSBECK**  
AgBioResearch plant  
pathologist and Extension  
specialist

“Without IR-4 we wouldn’t have achieved those registrations and the asparagus growers would have suffered losses in yield and spear quality.”

is an important crop to Michigan, and the growers needed support to move these products forward. That’s where IR-4 stepped in and made it happen.

“Without IR-4 we wouldn’t have achieved those registrations and the asparagus growers would have suffered losses in yield and spear quality,” Hausbeck said.

John Bakker is the executive director of the Michigan Asparagus Advisory Board, representing 200 growers. Michigan is the No. 3 producer of asparagus in the country. Growers produce about 20 million pounds of asparagus annually with a farm gate value of about \$15 million.

“The asparagus industry is very progressive in using an integrated approach for controlling pests,” Bakker said. “To do this effectively, we need multiple tools — including pesticides — to efficiently drive the system. IR-4 has been helpful in giving us a variety of products, not only for diseases but for weed control. We have obtained some extremely important crop protection tools through the IR-4 program.”

Bakker is also the director of the Michigan Onion Committee. He credits MSU entomologists and IR-4 with developing tools for controlling onion thrip, a tiny insect that attacks plant leaves.

“Without the IR-4 program, there would be no onion industry in Michigan or most of the United States, for that matter,” he said.

### A testing time for herbicides

Herbicides for weed control are another important aspect of IR-4 work. Weed control is the specialty of MSU AgBioResearch scientist Bernard Zandstra, a professor in the MSU Department of Horticulture,

priorities. “Diseases and insects tend to be somewhat cyclical. Weeds are always there. It is the biggest labor expense if there are no herbicides, and the herbicides are the largest dollar expense.”

Zandstra and his research team, headed by field managers Rodney Tocco and Sylvia Morse, work with herbicides for vegetable crops and small fruits such as raspberries, blackberries, blueberries and grapes.

“MSU doesn’t do product development work on herbicides,” Zandstra said. “We’re testing herbicides developed by chemical companies. We do field trials to test for timing, placement, applications, uses in combinations and what time of year to apply the products.”

The research team also tries to find ways to use products that are already on the market for specialty crops. When they find uses, the scientists work through IR-4 to obtain the registration.

“We spend a lot of time testing products to get supportive data to show that the product is in fact safe and economical and that it can work into the overall plan or recommendation,” Zandstra said.

Each vegetable crop needs different herbicides because each crop responds differently, according to Zandstra.

“There are a number of serious gaps in herbicides for some crops,” he said. “Right now there is nothing for lettuce — no registered herbicide — but we are working on that. Every crop has a different problem.”

Zandstra sees growers as important partners in this work. He is in daily contact with farmers who produce numerous crops in Michigan to find out what tools are working successfully and what else might be needed.

“Their input is a valuable asset to the IR-4 work,” he said.

Like Wise, Zandstra considers chemical companies major partners in the work of IR-4.

“We would have nothing without chemical companies producing new products,” he said. “Currently

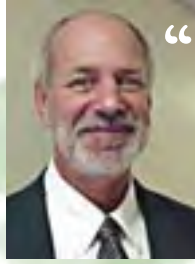
who works closely with the IR-4 Project.

“Traditionally, growers spend more money on weed control than all other pesticides; weeds are an ongoing, every year problem,” said Zandstra, who also attends the food use workshops and helps IR-4 set



**Rodney Tocco, a research assistant in the MSU Department of Horticulture and one of Bernard Zandstra’s field managers, connects drip irrigation tubing in an IR-4 muskmelon residue trial being conducted at the MSU horticulture farm.**

we see about one new herbicide active ingredient every two years. The advantage for chemical companies is that the university has space where we can put out unregistered product on crops. We don't have to worry about these crops being consumed or sold. The university is an important partner for the companies and IR-4 and agriculture in general because it has public facilities where we can do this kind of work. The results are public information and available to everyone."



**JOHN BAKKER**  
executive director, Michigan  
Asparagus Advisory Board

“ IR-4 has been helpful in giving us a variety of products, not only for diseases but for weed control. We have obtained some extremely important crop protection tools through the IR-4 program.”

The cooperation between the chemical industry and IR-4 began immediately when the project was formalized. IR-4 has provided a very useful bridge between the products commercialized for use in major markets (high acreage crops such as corn, soybeans, wheat and cotton) and their availability for use in specialty or minor crops. Typically, after a product was introduced into a major

market, university researchers and minor crop growers began to test ways that the new product could be useful on specialty crops. IR-4 facilitated this research and helped obtain registration for these uses after the use was established in the major markets.

Recently, IR-4 has taken a much more aggressive role in both the testing of new

development candidates and the registration process. It has established an effective collaboration with industry to begin testing for use in minor crops very early in new product development. This effort has led to the inclusion of minor crops in the initial marketing registration of most of the new reduced-risk pesticides in recent years, making these valuable new products avail-

## AgBioResearch center specializes in GLP field trials

Testing chemical compounds developed for use on specialty crops to make sure they meet legal standards is an important part of the Interregional Research Project No. 4, or IR-4. The Trevor Nichols Research Center (TNRC) — one of 14 MSU AgBioResearch centers located across the state — is one of the few facilities in Michigan capable of conducting field residue trials following good laboratory practices (GLP).

“Field residue trials use test substances that are not currently legal as commercial products,” said John Wise, MSU entomologist and the research and Extension coordinator for the TNRC in Fennville, Mich. “You can't go to a farm and spray these products on a crop that is going to market.”

Field residue trials at the TNRC involve blueberries, cherries, peaches, apples, grapes, plums and pears — fruit crops that play a major role in Michigan's economy. These field residue trials are very specific.

GLP are rules and procedures set by the U.S. Environmental Protection Agency that refer to a system of management controls for research laboratories and organizations to ensure the uniformity, consistency, reliability, reproducibility, quality and integrity of chemical tests.

“These are extra stringent guidelines, and it takes years to understand all of these procedures,” Wise said.

He added that none of the fruit products raised at the TNRC are sold.

“It takes away risk,” he said. “We can confidently work with experimental materials at no risk of them entering the food system while serving the people and farmers of Michigan.”



**John Wise, Trevor Nichols Research Center (TNRC) coordinator, (right) discusses pest problems with TNRC farm manager Jason Seward. Data from ongoing research at the center is used to develop new farm-level pest management strategies for Michigan fruit growers.**

JANE L. DEPRIEST

able to minor crop producers at the same time they are available to the major crop producers.

IR-4 has also taken an active role in guiding the EPA in a more science-based registration process through the use of a broader crop grouping system and a harmonized approach to registration. This will lead to more rapid access, where appropriate, to global export markets.

“The close collaboration between IR-4 and the chemical companies in recent years has meant that minor crop producers are able to see the benefits of new chemistry years earlier than originally envisioned by the founders of the IR-4 Project,” said Wynn John, program manager at DuPont. “This collaboration has been extremely important from an industry and commodity group perspective as the need for newer, safer, reduced-risk chemicals has developed. The entire industry has benefited from this improved collaboration among all of the players in the minor crop production arena in the past decade. IR-4 has been the catalyst in sponsoring much of this collaboration.”

By EPA standards, reduced-risk crop protection products by EPA standards have low impact on human health; low toxicity to non-target organisms, such as birds, fish



BERNARD ZANDSTRA  
AgBioResearch horticulturist

“The university is an important partner for the companies and IR-4 and agriculture in general because it has public facilities where we can do this kind of work.”

and plants; low potential for ground water contamination; lower chemical use rates; and compatibility with integrated pest management.

“Today’s pesticides are safer than ever in the history of pest management,” Hausbeck said. “IR-4 gives us the opportunity to make sure our crops in Michigan can use some of the newest and safest materials that are available.”



Plum curculio (top insert) is a difficult-to-control insect that attacks apples and stone fruit such as sweet cherries. Orchard equipment such as airblast sprayers (pictured above) is used by fruit growers to help protect their crops from insect pest damage.

The blueberry industry is another commodity group that has benefited from the work of IR-4. Dave Trinka is the director of research for MBG Marketing-The Blueberry

that we recommend and our members use are the result of the IR-4 Project and its partnership with the blueberry industry, the EPA, registrants, and land-grant university researchers and Extension specialists.”

Trinka credits MSU researchers John Wise, Rufus Isaacs, Bernie Zandstra and Annemiek Schilder as outstanding partners with the blueberry growers and IR-4.

“The reason that IR-4 has been so successful is its unique ability to foster cooperation of the various stakeholders in setting priorities, making decisions and carrying out its core mission to provide growers of specialty crops access to the safest pest management products.”

### Riding the IR-4 wave

AgBioResearch scientists hope that the IR-4 Project continues because there is much work to be done.

“Globalization opens the doors for many kinds of pests and invasive species to come into the United States,” Hollingworth said. “New and serious problems are always just around the corner.”

People, a cooperative that markets fresh and frozen blueberries for its members and affiliated blueberry growers from 10 states. In addition, MBG Marketing provides horticultural production consulting services to the more than 300 growers who produce blueberries.

“Pest management consulting is a major component of that service,” Trinka said. “The majority of the pest control products



DAVE TRINKA  
director of research, MBG  
Marketing—The Blueberry  
People

“The reason that IR-4 has been so successful is its unique ability to foster cooperation of the various stakeholders in setting priorities, making decisions and carrying out its core mission to provide growers of specialty crops access to the safest pest management products.”

A good example of this occurred with coleus, a common ornamental annual that is grown in many gardens.

“Historically, coleus was an easy crop to grow because it had few problems,” Hausbeck explained. “It was pretty much a foolproof crop, and gardeners loved it. Some of the newer, showier cultivars are produced offshore. The cuttings come into the United States to be rooted, grown and sold. Downy mildew [a type of leaf mold] was likely a hitchhiker. Now it is a new pest that leaves coleus plants looking like

miniature palm trees when the blighted lower leaves drop off.”

Another challenge is that some weeds are becoming resistant to glyphosate, the active ingredient in the widely used herbicide Roundup. That fact may inspire more research.

“There’s a good chance that we will see more herbicide discovery and development from the major chemical companies,” Zandstra said. “We need herbicides that can be used with glyphosate in a total weed management system.”

Wise would like to look at a totally different issue in the coming years.

“Based on the work of IR-4, listening to farmers and my own research, the next area to work on is optimizing the delivery of these new tools in our cropping systems so that growers can realize higher levels of performance, reduce waste and protect the environment,” he said. “The focus historically has been on how to replace the older, higher risk tools with reduced-risk tools. The next question is how to replace old delivery methods with better systems to bring the products to the pests. For the past 80 years, we have largely relied on ground sprayers to deliver these products. There has to be another way. I’m doing some research on how to deliver pest control materials in fruit trees that would eliminate spray drift, worker exposure and negative effects on beneficial organisms.”

No matter what the future holds, the significant accomplishments of IR-4 and the partnerships that have grown with it are an asset for Michigan agriculture.

“One of the rewarding aspects of being involved with IR-4 is that the effectiveness of the work is so easily measured,” Wise said. “Every year, new pest management tools are registered and released as a result of IR-4 submissions to the EPA. They are easy to count, and we also have some understanding of how they are implemented by the farmers. It’s a quiet effort but a vital one. All this happens without much fanfare.”

JANE L. DEPRIEST



The Ornamental Horticulture Program became part of IR-4 in 1977. It addresses the disease, insect and weed management needs of growers of ornamental plants grown in greenhouses — such as marigolds and coleus — and landscape plantings, Christmas trees, sod and indoor plants. Alexandra Rodebach (left), an MSU food science undergraduate student, and Ronald Heslip, an MSU plant biology undergraduate student, inspect ornamental plants for disease.

# Growing the Future Together:

## The MSU-Agricultural Research Service Partnership

**For long-standing relationships, few pairings have anything on the partnership between the U.S. Department of Agriculture (USDA) and Michigan State University (MSU).** USDA employees have been part and parcel of the MSU on-campus research scene since the early 1920s, working side by side with university scientists to provide practical science that addresses real-world challenges.

This partnership has especially strong ties with MSU AgBioResearch, which was created by federal legislation passed in 1887. The goal of the law was to establish a nationwide network of agricultural experiment stations through the land-grant college system to help the United States become the most effective and efficient producer of food and fiber in the world.

“The notion behind establishing these stations was that there needed to be a state-federal partnership to bring science to agriculture,” said Steve Pueppke, AgBioResearch director. “If you look back at the 19th century, many U.S. farmers were in great debt, and there was simply no capacity or coordination anywhere in the country to answer

very practical questions related to agricultural production. Times have definitely changed, but this partnership has changed with them and continues to make significant contributions to the sustainability and success of production agriculture in Michigan and beyond.”

In 1953, the USDA consolidated most of its research functions and created the Agricultural Research Service (ARS) as its chief scientific agency. Its charge is to find solutions to agricultural problems that affect Americans every day from field to table. ARS employees are at 100 research locations, including two units at MSU — the Sugarbeet and Bean Research Unit and the Avian Disease and Oncology Laboratory (ADOL).

### SMALL BUT MIGHTY: THE ARS SUGARBEET AND BEAN UNIT

What do a sugar beet, a can of beans and an apple have in common? They are all economically important commodities in Michigan and research priorities of the USDA-ARS Sugarbeet and Bean Research Unit at MSU.

“This unit has been associated with MSU for more than 60 years,” said Renfu Lu, unit research leader. “Even though we are a small unit, we work on a number of crops that are of huge importance to Michigan growers and the production agriculture industry.”

The unit has 11 full-time employees, including four research scientists, who are housed in the Plant and Soil Sciences Building and Farrall Hall at MSU. The unit is known for its technological innovation in genetics, genomics, breeding,

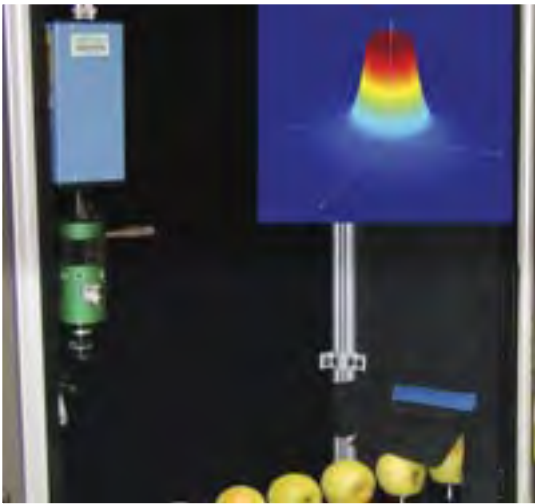
pathology, and quality assessment and utilization of diverse food crops including sugar beet, dry beans and fruits and vegetables. In addition to their research assignments, all four ARS scientists have adjunct appointments in their respective host departments in the College of Agriculture and Natural Resources, and participate in graduate student advising activities with their MSU colleagues.

#### Quality that's more than skin-deep

Lu's expertise is in applying state-of-the-art, light-based sensor technologies to assess the quality and condition of fruits and vegetables before, at and after harvest. He partners with faculty members in several MSU departments — Biosystems



PHOTO: RENFU LU, MSU



Using a spectral imaging system, researchers can collect light scattering at selected wavelengths over a spectral region from fruit such as apples and peaches to detect product firmness. The inset (above right) shows the spectral profile acquired from the apple, with different colors being used to indicate different light scattering intensities.

A laboratory gloss measuring system (pictured below, camera not shown) captures more than 100 images from each apple. The acquired images are then analyzed by computer to determine the average gloss level for the fruit.

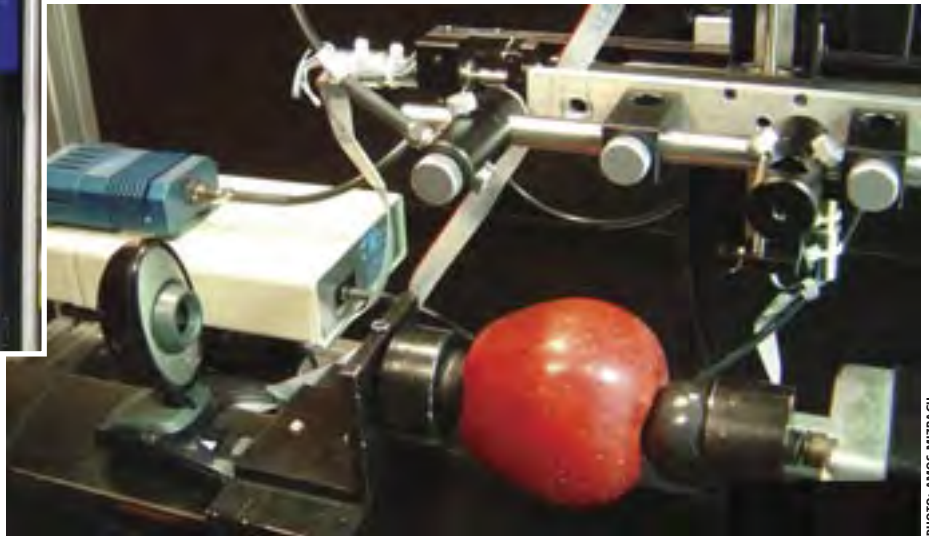


PHOTO: AMOS MIZRACH

and Agricultural Engineering, Horticulture and Packaging — to address priority needs of the fruit and vegetable industry.

One priority fruit in Michigan is apple. It is critical for Michigan, as the No. 3 producer of apples in the country, to maintain the fruit’s quality and attractiveness. A key attribute of a marketable apple is its sheen or gloss. Several years ago, the Michigan Apple Committee was concerned about how Michigan apples — particularly Red Delicious apples — stacked up to competitors in this regard, so they approached MSU for help.

influence of the apple’s shape on wax applications. Lu came up with a new glossmeter.

“This non-destructive technology is much more accurate because you can take into consideration the curvature of the fruit with the gloss and measure the gloss very quickly,” Rubino said. “Once we determined the best wax formulations and application protocols, we wanted to go one step further and see how gloss decayed with time. Again, thanks to Lu’s glossmeter, we were able to document this process under various conditions.”



RENFU LU  
research leader, USDA-ARS  
Sugarbeet and Bean Unit

“ This unit has been associated with MSU for more than 60 years. Even though we are a small unit, we work on a number of crops that are of huge importance to Michigan growers and the production agriculture industry.”

“Consumer research shows that shiny apples sell,” said AgBioResearch packaging scientist Maria Rubino. “To apply a good gloss, we needed to be able to evaluate various types of waxes to see how their application to the apple surface influenced the gloss. Conventional glossmeters required peeling the waxed fruit and then evaluating the gloss on a flat surface, which destroyed the apple and limited our ability to assess how the curvature of the fruit affected the gloss.”

Rubino approached Lu to see if he could develop a technology that wouldn’t damage the fruit and that could account for the

Research findings were published last summer and are informing Michigan apple packers on how to achieve the best possible gloss finish in the state’s high-humidity climate.

Lu also works with a futuristic-sounding technology called hyperspectral or multispectral scattering, which uses lasers or a broadband beam to detect the firmness and sweetness of fruit.

“Skin-deep appearance gives us the first impression about fruit quality, but its internal qualities — mainly flavor and texture — that ultimately deliver consumer satisfaction,” he said.

AgBioResearch horticulturalist and MSU Extension specialist Randy Beaudry has collaborated with Lu to evaluate the firmness tester and other prototype systems, and has provided storage space and the fruit needed for Lu's research.

"Lu is probably the world's leading authority on light-based sensor technology for non-destructively determining fruit quality," Beaudry said. "There's nobody else at MSU or on the planet that's doing the kind of work that Lu is doing. Without his expertise, without his presence and the funding supplied through the USDA for his program, the work that we do together just wouldn't happen."

Dan Guyer, AgBioResearch biosystems and agricultural engineering scientist and Extension specialist, partners with Lu to help identify industry issues, propose research, and disseminate the knowledge and technology that Lu generates.

"Lu often develops the fundamental technology, and then I complement that by working with growers and processors to apply his work and help them better understand the problems that they're facing," Guyer said. "I'm much broader in my research, work across commodities and am more applied, so we complement each other very well. I like to say that between Renfu Lu and me, one plus one equals three."

Lu also works with Guyer on using opto-electric techniques to assess the post-harvest quality of potatoes.



**DAN GUYER**  
AgBioResearch biosystems  
and agricultural engineering  
scientist and Extension  
specialist

“ [Renfu] Lu often develops the fundamental technology, and then I complement that by working with growers and processors to apply his work and help them better understand the problems that they're facing.”

### Building a better bean

Dry beans are another significant crop for Michigan. The state is the No. 2 producer of dry beans in the country, and dry beans contribute more than \$170 million annually to Michigan's economy.

To keep the state's bean crop booming, innovative research



**AgBioResearch scientist Randy Beaudry (above) collaborates with ARS scientist Renfu Lu on fruit maturity studies and provides controlled-atmosphere storage space for the fruit materials Lu needs to evaluate his new technologies.**

to ensure that this important commodity consistently meets market demands is key. ARS plant geneticist Karen Cichy's research focuses on the genetic characterization of seed traits related to consumer acceptance and the nutritional and culinary quality of dry beans. As part of her research, Cichy maintains bean plots at the Saginaw Valley Research and Extension Center, one of 14 off-campus AgBioResearch facilities across the state.

"If you look at navy beans, for example, 90 percent of them are eaten as a canned product, so what the bean looks like in the can is really important," Cichy said. "There's a lot of genetic variability for that trait, so part of my research involves identifying those lines with superior canning quality and finding ways to identify that quality without having to go through the whole canning process."

To help her in this endeavor, Cichy collaborates with AgBioResearch plant breeder Jim Kelly and AgBioResearch food engineering scientist Kirk Dolan.

"We work very closely with Karen on bean processing quality because the materials that get developed in our program have to meet the quality characteristics of the industry for the consuming public," said Kelly, who has more than 30 years of experience in dry bean breeding and genetics. "We are also developing more of a relationship with her on the nutrient quality aspects of beans — if Karen can identify sources of higher nutrients in beans, we would certainly be interested in partnering with her and her team to improve our local varieties."

Though Cichy has a lot of expertise with bean breeding



KIRK DOLAN  
AgBioResearch food  
engineering scientist

“Having a team of people at MSU who understand thermal processing and the needs of the industry gives processors a place to come and test their beans.”

and sensory testing for beans, (e.g., looking at color, texture, the number of broken beans) that’s only part of the bean-building equation.

“You can breed lots of varieties and make changes in your bean, but if you don’t know what’s going to happen when it actually comes out of the can, then it’s hard to say which bean you want to choose,” Dolan said. “So Karen’s team and Jim Kelly work on breeding traits and nutritional quality on the front end, and then we provide the expertise to make sure that the beans are canned properly and heated at the right temperatures for the right time to ensure that they represent what people would consume in their homes. It’s a really good partnership because neither one of us can do the whole thing.

“Further, having a team of people at MSU who understand thermal processing and the needs of the industry gives processors a place to come and test their beans,” he said. “The partnership also benefits the industry in that my students get involved and learn thermal processing, and the industry snatches them up. It’s a win-win for everyone.”

“This collaboration provides a great opportunity for bean growers and processors in Michigan to have a strong basis for research,” said Bob Green, executive director of the Michigan Bean Commission. “We have certainly seen some industry-changing research come out of this ARS-MSU partnership. For example, Cichy’s predecessor, George Hosfield, developed the best variety of small red beans that the United States has ever had — Merlot. Released in 2004, it now represents 80 percent of the U.S. small red bean production. That’s impressive.”

### “Beeting” soil-borne disease

Michigan is the No. 4 producer of sugar beets in the United States, with revenues from the crop totaling \$444 million for fiscal year 2010. Although the state’s sugar beet crop is thriving, continuous research efforts are required to stay on top of the various diseases that affect seedling vigor and stand persistence, including *Cercospora* leaf spot, *Rhizoctonia* crown and root rot, and infections caused by the *Fusarium* species, including wilt or yellow, root rot and seed stalk blight.

The focus of ARS plant pathologist Linda Hanson’s research program is on soil-borne diseases of sugar beet and crops



PHOTO: RANDY LAURENZ

ARS and MSU scientists are teaming up to identify bean varieties with superior canning traits such as appearance (not split in half or broken), a nice shape and a firm texture.

grown in rotation with sugar beet — cucumbers, potatoes, dry edible beans, wheat and onions. Of particular interest to Hanson are seedling diseases.

“The survival of what’s planted is a big issue, particularly in Michigan,” Hanson said. “For sugar beets, about 60 percent

“We have certainly seen some industry-changing research come out of this ARS-MSU partnership.”

BOB GREEN, executive director, Michigan Bean Commission

of what is planted actually makes it to final stand, so we’re trying to find out why. We work quite a bit with *Rhizoctonia*, which is the No.1 pathogen of sugar beets in the United States. It can affect seedlings, cause root rot later in the season and make beets more susceptible to other diseases.”

Hanson added that she and her team are interested not only in the sugar beet crop itself, but in the entire cropping system.

“Particularly with soil-borne diseases, there can be a lot of influences, depending on what else is being grown in the area or in the same field,” she said.

AgBioResearch plant pathologist Jianjun Hao is interested in the soil microbial community that is associated with plant

Michigan sugar beet production has increased more than 80 percent over the past 15 years. Michigan growers today produce about 4 million tons of sugar beets that become 1 billion pounds of white sugar.



***Rhizoctonia solani*** (shown above growing from infected plant tissue) — the No. 1 pathogen of sugar beets in the United States — can affect seedlings, cause root rot and make beets more susceptible to other diseases.

pathogens, and in using biological control agents and natural products to manage disease. One project that he works on with Hanson is studying potato common scab. Common scab is a disease caused by a soil-borne bacterium, *Streptomyces scabies*, which causes scab lesions in a number of root-grown crops including beet, carrot and potato. The disease occurs wherever potatoes are grown, and potatoes are often grown in rotation with sugar beets.



JIANJUN HAO  
AgBioResearch plant pathologist

“Pooling our resources provides us with very good strains that can be used for disease management.”

“Although Linda’s research focus is sugar beets and mine is potatoes, we deal with many of the same pathogens because they cross crops,” Hao said. “In the instance of *Streptomyces*, we collect isolates from Linda’s sugar beet studies, inoculate our plants with them, and then compare the ecological and biological aspects to see how that diversity of species survives and spreads, and how they interact with the host. Our findings inform Linda’s work, too. It’s very synergistic.”

Hao and Hanson also exchange a lot of materials and cultures to see if they have a good candidate for a biological control agent.

“Pooling our resources provides us with very good strains that can be used for disease management,” Hao said.

Hanson also collaborates with AgBioResearch weed scientist and MSU Extension specialist Christy Sprague. Both researchers conduct a lot of their field trials at the Saginaw Valley Research and Extension Center.

“We’ve really been trying to understand some of the interactions between diseases and weed management strategies,” Sprague said. “More specifically, over the past few years, my team has been doing a lot of work with Linda to see if applications of Roundup, or glyphosate herbicide, may be increasing disease incidence or severity in sugar beets. So far, it doesn’t appear — particularly with *Rhizoctonia* — that these applications are causing more of an issue. We’re also looking at other strategies to decrease *Rhizoctonia* in sugar beet and are doing some work with *Cercospora* leaf spot and the interactions of glyphosate with fungicides.”

In related research, Sprague is teaming up with ARS plant geneticist Mitch McGrath to look at the genetics of various Michigan weeds to see if a particular weed is spreading resistance traits — particularly herbicide resistance — to other weeds.

Hanson also partners with AgBioResearch scientists Randy Beaudry (sugar beet storage), Mary Hausbeck (cucumber diseases), Willie Kirk (sugar beet diseases) and Francis Trail (comparative studies on post-harvest infection in sugar beets and wheat).

### Partnering for sweet success

While Hanson focuses on what happens to sugar beets once they germinate and start to grow, McGrath works one

“It’s a major benefit for us to have our breeding program located in the producers’ growing environment.”

MITCH MCGRATH, ARS plant geneticist

level up, developing germ plasm with novel traits and combinations and new knowledge about the genetic control of qualities important to sugar beet productivity and profitability.

McGrath is interested in the intersection of breeding and molecular biology. There are very few places in the world that have one person hired to do both of these functions, McGrath noted.

“I call it breeding for genetics,” he said. “Basically, we’re using the biology of the sugar beet to discover what’s going on so that we are able to improve the crop,” he said. “I think that this is going to be really, really useful in the long term to help identify which responses are environmental and which are genetic. If it’s genetic, then it’s responsive to selection; you can cross it and develop a comprehensive set of tools to enhance the crop.”

McGrath planted about 1,000 sugar beet genotypes this summer at the Saginaw Valley Research and Extension Center. It’s located near Frankenmuth, Mich., in the heart of the state’s sugar beet growing region.

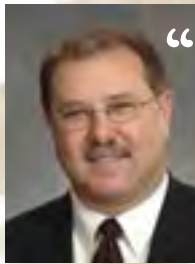
“It’s a major benefit for us to have our breeding program located in the producers’ growing environment,” he said. “We’re looking at selection for *Rhizoctonia* resistance, and we’ve got a couple of new germ plasm releases — SR98 and SR98-2 — that are specifically targeted to *Rhizoctonia* for both the adult root rot phase and, more importantly, seedling resistance. No one had described seedling resistance until a couple of years ago; we found it here.”

McGrath has developed a number of tools to assist growers, including a seedling resistance screen that predicts the potential

for seedling vigor and is beginning to be used in the industry. He is also working on germ plasm development for nematode and *Cercospora* resistance and improving the genetics of sugar beets for storability.

Having worked in the sugar beet industry since 1978, Paul Pfenninger, vice president of agriculture for the Michigan Sugar Company in Bay City, Mich., understands the value of having a team such as MSU-ARS on his side.

“Back 15 or 20 years ago, average sugar beet yields were 18 to 19 tons per acre in a good year,” he said. “Three years ago,



PAUL PFENNINGER  
vice president of agriculture,  
Michigan Sugar Company

“We have research partners that collaborate with our internal research arm and, together, we’re looking for varieties that produce more sugar, more tons, better disease control — a bigger, better package that growers can implement. . .”

we reached almost 29 tons per acre, and last year, 26 tons per acre. What’s doing it? We have research partners that collaborate with our internal research arm and, together, we’re looking for varieties that produce more sugar, more tons, better disease control — a bigger, better package that growers can implement; that’s where the big gain has come from.”

“It’s a great partnership,” McGrath added. “I don’t know who gets the better deal — I think we all get a great deal.”

## AVIAN DISEASE AND ONCOLOGY LABORATORY: IT’S ALL GONE TO THE BIRDS

Marek’s disease. Avian leukosis, or ALV. Reticuloendotheliosis, or REV. For almost 73 years, the Avian Disease and Oncology Laboratory (ADOL) has worked with MSU scientists and the poultry industry to tackle these and other emerging poultry diseases.

Established as the Regional Poultry Research Laboratory in 1939 by the USDA and the northeastern and north central agricultural experiment stations, ADOL is the world’s preeminent

research laboratory on tumor viruses and genetic resistance to disease in poultry. The lab was formed during an epidemic of what was then called the avian leukosis complex, which was later found to comprise Marek’s and ALV.

“In the late 1930s, a lot of poultry — chicken primarily — were developing tumors and dying to the point that it became a serious threat to the development of the poultry industry as we know it,” said Aly Fadly, ADOL research leader and



(Left to right) USDA-ARS scientists Henry Hunt and Hans Cheng and AgBioResearch scientist Jerry Dodgson have collaborated closely on many research projects, including chicken genomics and bird immunology.



More than 40 genetically characterized lines of chickens are maintained at the ADOL facility.

director of the laboratory now operated by the USDA-ARS. “To get a handle on the problem, the USDA needed research space away from the major poultry producing states — Georgia, Arkansas, Alabama, Delaware — so that genetic lines for research could be grown where there would be no risk of the chickens getting infectious diseases. The USDA chose Michigan because there wasn’t much poultry grown here.”



ALY FADLY  
research leader and director,  
ADOL

“ Access to MSU services is not only essential and an integral part of the research conducted at ADOL, but it also saves significant research funds that otherwise would be needed to generate stand-alone facilities at ADOL.”

Laboratory scientists immediately began developing various genetic lines of chickens to see if they could breed animals that were resistant to tumors. Early research efforts at the lab resulted in holding Marek’s disease in check and laid the foundation for the identification of ALV as the causative agent of lymphoid leukosis (a major cause of death in adult broiler breeders and layers) and the development of diagnostic reagents essential for ALV eradication programs. In 1972, ARS

veterinary medical officer Richard Witter (now retired but still collaborating with ADOL) and colleagues, including MSU scientists, developed the first effective vaccine against Marek’s. The group has subsequently developed and/or tested combinations of newer vaccines as the disease has evolved.

“It’s still a major threat to the poultry industry because new strains continue to emerge to challenge the current vaccine,” said Witter, former ADOL director from 1976 to 1998. “But so far, we’ve been able to keep a lid on it. Obviously we need to develop new and improved vaccines in case a new and more aggressive field virus emerges.”

### Share and share alike

Located on a 52-acre tract bordered on three sides by MSU, ADOL includes a 15,000-square-foot main laboratory and 21 additional buildings, most of which house breeding and experimental chickens.

“In addition to the main lab, the property has two farms — the west farm and the east farm,” explained Fadly, an ARS veterinary medical officer and certified poultry veterinarian. “The west farm is the ‘clean’ part of ADOL chicken housing facilities. That means we don’t even vaccinate the chickens housed on this farm, so we have to keep them under very strict biosecurity measures. The east farm contains our experimental housing, where we bring chickens from the west farm and infect them to study their responses to vaccination and challenges to disease.”

The ADOL facility has 33 U.S. government employees, including seven principal investigators, 12 technicians and three visiting scientists, and a long of history of collaboration with MSU, Fadly said.

“In the early years, there was a researcher, Al Lucas, a

USDA-ARS employee who was housed in the Poultry Science Department [now animal science] at MSU,” he said. “He put together the first hematology [blood picture] and descriptive anatomical skeleton of the chicken, which was a significant help to us and others who work with poultry. We also collaborated closely with MSU animal scientist Paul Coussens [an AgBioResearch scientist], who did a lot of significant work on the molecular biology of Marek’s disease virus. Over the years, we’ve worked with MSU scientists in Animal Science, Pathobiology and Diagnostic Investigation, Microbiology and Molecular Genetics and Veterinary Medicine. We also receive graduate student assistance from these departments. It’s a very team-oriented, multidisciplinary partnership.”

The close proximity of ADOL to MSU provides strong academic and scientific linkages between related research programs.

“Access to MSU services is not only essential and an integral part of the research conducted at ADOL, but it also saves significant research funds that otherwise would be needed to generate stand-alone facilities at ADOL,” Fadly said. “More broadly, our scientists benefit from the much larger intellectual environment at MSU through access to seminars, symposia, joint graduate programs and a broad array of faculty expertise. Such an environment is also an asset to ADOL when it recruits new staff members, most of whom come from an academic environment.”

MSU, in turn, greatly benefits from its relationship with ADOL.

“ADOL provides access to many unique lines of chickens that are a one-of-a-kind asset to MSU research in the area of immunogenetics and genetic resistance to disease,” said John Baker, DVM., MSU AgBioResearch associate director. “ADOL also shares with MSU collaborators access to its animal facilities, which cannot be replicated on campus, and has also served as a training site for the National Institutes of Health-funded student summer research program for the MSU College of Veterinary Medicine. Further, five of its seven scientists hold adjunct faculty appointments in MSU departments.”

### **Charting a map for poultry health research**

The United States is the world’s largest poultry producer and the second largest egg producer and exporter of poultry meat, according to the USDA Economic Research Service. The research conducted through the ADOL-MSU partnership is critical to the continued viability of the poultry industry, and keeping one step ahead of the next new virus strain or emerging disease is no small feat.

AgBioResearch scientist Jerry Dodgson joined MSU in 1979 as a microbiology and molecular genetics researcher and has worked with ADOL scientists for more than 30 years.

“ADOL provides access to many unique lines of chickens that are a one-of-a-kind asset to MSU research in the area of immunogenetics and genetic resistance to disease.”

JOHN BAKER, associate director, AgBioResearch

“My work with ADOL began back in the 1980s,” Dodgson said. “Lyman Crittenden was the geneticist at ADOL, and he was interested in genome mapping of the chicken and in doing some other things that were, at the time, a little outside of the main ADOL mission, so he and I developed a project that has grown into the genomics project that ADOL research geneticist Hans Cheng — Crittenden’s successor — now oversees.”

Cheng and Dodgson have collaborated ever since, including serving as co-coordinators of poultry genomics for the USDA National Animal Genome Research Program.

“I was very lucky, because Jerry and Lyman started up all of the genetic mapping efforts for the chicken and then handed it off to me,” said Cheng, who received his bachelor’s degree in Lyman Briggs microbiology at MSU. “They set up the population and then I helped populate it with all the genetic markers to create the chicken genome sequence. Since that time, we’ve used the sequence to identify a lot of genes that confer genetic resistance to the specific disease we’re working on. We’re hopeful that people can start using this information in marker-assisted selection or genomics selection rather than the traditional way, which is to challenge birds with the virus and then select those that live.”

Dodgson also works with ADOL microbiologist Henry Hunt.

“Jerry and I have collaborated on many projects over the years, and it’s been very productive,” Hunt said. “We’ve developed numerous lines of chickens that are clearly more resistant or more susceptible to certain diseases — ADOL now has more than 40 lines of chickens. We’re also using ribonucleic acid (RNA) interference technology to inhibit virus replication by making a transgenic animal [one that carries a gene that has been deliberately inserted into its genome] express certain types of inhibitory RNAs, and we’ve been successful in doing that. We’ve had a proof of concept and published papers that are leading the way for other groups that are trying to make influenza-resistant animals using similar technologies.”

Cheng added that interactions and cooperative agreements



HANS CHENG  
ADOL geneticist

“ We take a lot of pride in the fact that our organization has a very good working relationship with the industry.”

with the poultry industry inform and direct ADOL-MSU research efforts.

“Industry provides us with a lot of input and solid money for research that it is specifically interested in,” he said. “In addition to gathering their input to meet short-term needs, we also make sure that we’re thinking long-term — a key benefit to the industry is that ADOL can play a strategic role in long-term, high-risk research. We take a lot of pride in the fact that our organization has a very good working relationship with the industry.”

### Partnering to protect an industry

At a meeting of the ADOL Poultry Industry Coalition (APIC) in April at MSU, stakeholders met to discuss current and future research and ADOL collaboration with the industry’s key sectors.

Janet Fulton, a molecular biologist at Hy-Line International, one of the top providers of layer breeding stock worldwide, stressed the importance of ADOL to Hy-Line’s work and its ability to do business in a global marketplace.

“We’re highly international — we sell not only in the United States, but all over the world — and we have customers questioning whether the breeding stock we are providing is indeed ALV-free,” said Fulton, APIC co-chair and former ADOL post-doctoral student. “The advantage ADOL brings is that it has an extremely good international reputation. So our customers say, ‘OK, you say that your stock is fine — then we’ll send samples to ADOL and we’ll go with whatever ADOL says the test results show.’ Of course, the stock tests negative for ALV, as we knew it would, but ADOL’s word provides credibility to our customers so that we can continue to feed into that market.”

Gregorio Rosales, vice president of veterinary services for Aviagen, Inc., a leading supplier of poultry broiler and turkey breeding stock, added that the basic research and expertise that ADOL provides on poultry disease is critical to the survival of the industry.

“In the 1990s, the primary breeders in the broiler industry faced a crisis with a new sub-group of avian leukosis viruses called sub-group J,” said Rosales, who is also an APIC co-chair. “I don’t know what we would have done without the

“ The advantage ADOL brings is that it has an extremely good international reputation. ADOL’s word provides credibility to our customers so that we can continue to feed into that market.”

JANET FULTON, molecular biologist, Hy-Line International

“ In the 1990s, the primary breeders in the broiler industry faced a crisis with a new sub-group of avian leukosis viruses called sub-group J. I don’t know what we would have done without the support of ADOL . . .”

GREGORIO ROSALES, vice president of veterinary services, Aviagen, Inc.

“ If ADOL wasn’t around to do the basic research on these diseases, it would be much more costly to provide new solutions as these viruses evolve and change.”

DAVID SMITH, director of veterinary services and marketing, Merial Select, Inc.

“ Being new to the U.S. market, it is critical for us to have an independent third party lab evaluate our kits and provide feedback.”

GWEN SLACUM, veterinarian and poultry product specialist, BioChek

“ ADOL is doing great work — I just encourage everyone to remember that [when it comes to vaccine cost] anything times a million is a lot, and it adds up fast.”

DON RITTER, veterinarian, Mountaire Farms

support of ADOL to elucidate the cause of the problem and characterize the virus so that we could develop diagnostics and control strategies. It was a real benefit to us to have an institution that had the resources and the expertise that saved the industry from devastating losses.”

“ADOL plays a critical role for us because we don’t have the resources to do the basic research that’s needed to develop our products,” said David Smith, director of veterinary services and marketing for Merial Select, Inc., a company that provides a comprehensive selection of vaccines for breeders, broilers and layers. “It’s just not practical for us from an economic standpoint to spend money doing research if, somewhere down the line, we don’t have fairly high assurances of a payback in the form of a product. If ADOL wasn’t around to do the basic research on these diseases, it would be much more costly to provide new solutions as these viruses evolve and change.”



ADOL also provides important resources and services to the diagnostic sector of the industry, said Gwen Slacum, a veterinarian and poultry product specialist for BioChek, an international company in the Netherlands that supplies veterinary diagnostic kits for poultry, pigs and fish.

“Being new to the U.S. market, it is critical for us to have an independent third party lab evaluate our kits and provide feedback,” Slacum said. “ADOL fills this need nicely for poultry viruses.”

Don Ritter, a veterinarian who works with Mountaire Farms, a large broiler processing company based in Millsboro, Del., impressed on the group that the broiler industry needs cost-effective solutions to its problems to remain viable and competitive.

“The big thing about the broiler business and agriculture in general is that it’s a high-volume, low-margin industry so, as a veterinarian, my first job is to prevent and control diseases that are economically important to producers,” Ritter said. “Next, I have to find the best bottom-line solution to do that, and that doesn’t necessarily mean using the cheapest vaccine. I’ll pay \$100 per thousand for a vaccine if it returns \$150, but I can’t pay \$100 per thousand and get \$20 back. You might say, ‘Well, this vaccine is only \$1 more per thousand than what you’re paying.’ Well, there’s 8 billion broilers raised in the United States annually, so an extra \$1 per thousand adds \$8 million to the cost of U.S. broilers. ADOL is doing great work — I just encourage everyone to remember that anything times a million is a lot, and it adds up fast.”

## Birds of a feather

As the poultry industry continues to be on guard for a new and more virulent strain of Marek’s, ALV or other emerging diseases, ADOL and MSU stand ready to continue their collective efforts to develop and evaluate practical and economical methods for the diagnosis and control of these economically important diseases.

“The complementarity of research agendas and the collaborative arrangements between MSU faculty members and ADOL staff members have generated novel discoveries, external funding, important papers and successful graduates,” Fadly said. “It’s a very dynamic relationship and I see it becoming only stronger and more fruitful.”

Fadly contends, however, that the real beneficiaries of the research partnership are poultry producers and consumers.

“Ultimately, all of the work we do is to help the poultry producer so that he/she does not lose a lot of chickens to disease,” Fadly said. “This, in turn, helps keep production

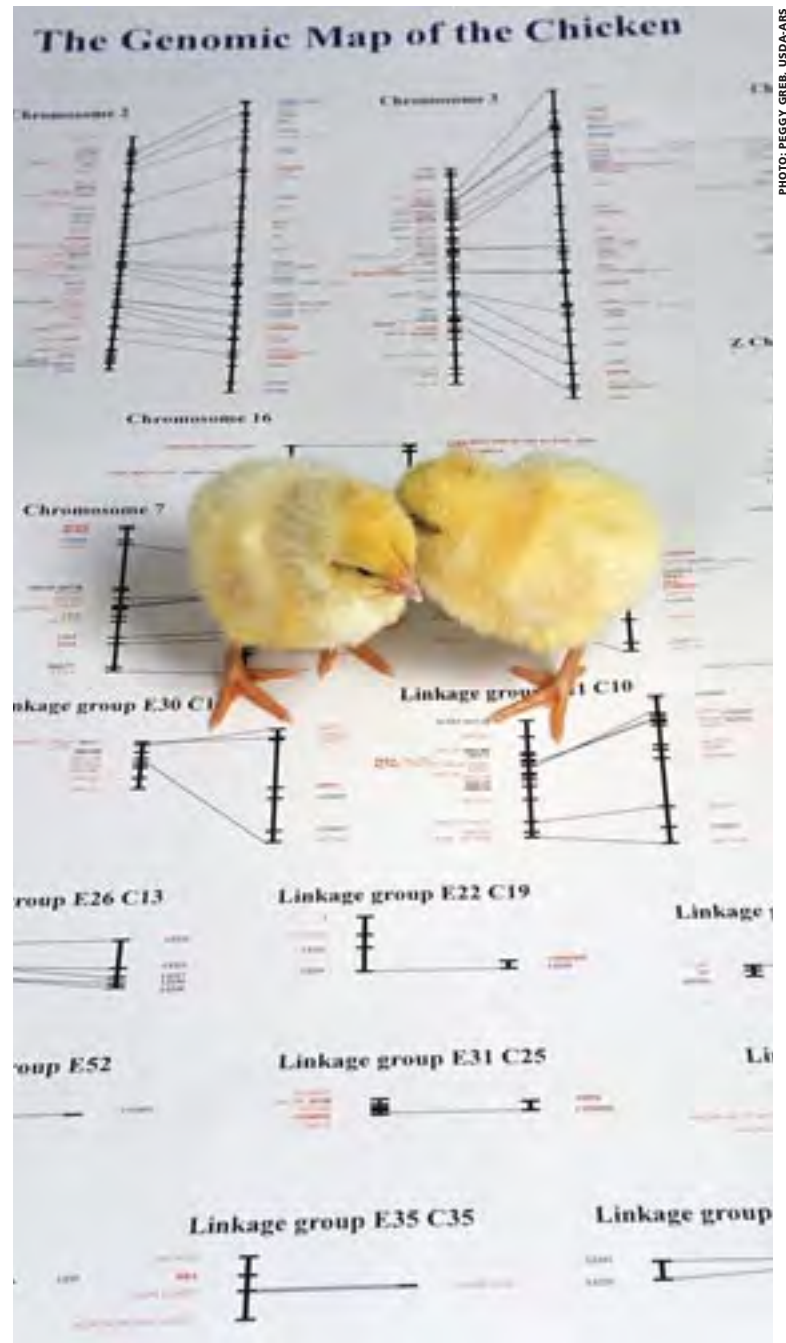


PHOTO: PEGGY GREEN, USDA-ARS

A key accomplishment of the MSU-ARS partnership is the development of the first molecular genetic map of the chicken (above). This map has been used as the framework for the chicken genome sequence, which has allowed researchers to identify the genes that confer genetic resistance to the specific disease they’re working on.

costs down so that you and I can continue to purchase a chicken at the supermarket for \$4 or \$5. If this research isn’t done, significant numbers of chickens are going to die, and consumers will likely end up paying a lot more for a chicken. That’s the most important aspect of the work.”

VAL OSOWSKI

# Building Bridges to Wildlife Conservation

**The recent establishment of the Boone & Crockett Chair in Wildlife Conservation and the MSU Quantitative Wildlife Laboratory combines partnerships and practical science to better understand the ecology of wildlife species and offer new solutions to the most difficult challenges of wildlife conservation.**

To understand the passion and commitment involved in the Michigan State University (MSU) Boone and Crockett Program in Wildlife Conservation and the partnerships it is fostering, you need to know something about the history of conservation in America.

“Wildlife conservation in America has realized unbelievable goals in the past 100 years,” said William Porter, the first Boone and Crockett chair in wildlife conservation at MSU, and director of the Quantitative Wildlife Laboratory (QWL) in the MSU Department of Fisheries and Wildlife. “In the late 1800s, when Theodore Roosevelt was establishing the concept of wildlife conservation, most of America’s wildlife — including big game and many species of birds and fish — was gone because of unregulated harvest, especially to supply markets in the eastern United States, and loss of habitat because of clearing land for settlements. Wildlife was viewed by many as a commodity rather than as a key element in the American heritage.”

To help address these issues, Roosevelt and other influential Americans founded the Boone and Crockett Club in 1887. The group championed the passage of laws to regulate hunting and the designation of wild lands that today make up our nation’s national forests, parks and wildlife refuges.

“These people started with nothing — no financial or political resources beyond what they brought to the table, no wildlife populations and no societal ethic that valued wildlife,” Porter said. “From a passion for wildlife, they inspired a vision for conservation so that today we have wildlife populations unlike anything that five generations of Americans have seen.”

## **Building a strong foundation**

This background sets the stage for wildlife conservation activities at MSU. In 2007, the Boone and Crockett Club announced that it would create an endowed chair in wildlife conservation at MSU.

“The fact that the Boone and Crockett Club selected MSU for this endowment is a

wonderful tribute that underscores our strong tradition of forging partnerships with organizations that share similar missions and values,” said William Taylor, AgBio-Research scientist and university distinguished professor in global fisheries systems. Taylor, former chair of the MSU Department of Fisheries and Wildlife, was instrumental in setting the vision and mission for the Boone and Crockett endowed chair.

After an extensive search, Porter was selected for the position and was also named QWL director. He arrived on campus in August 2010. Before that, Porter was a professor at the State University of New York’s College of Environmental Science and Forestry in Syracuse. He also served as the director of the Adirondack Ecological Center and the Roosevelt Wildlife Station, both affiliated with the college.

“Bill Porter is the perfect choice for our first Boone and Crockett chair,” said Michael Jones, professor and chair of the MSU Department of Fisheries and Wildlife and co-director of the Quantitative Fisheries

# and Leadership Policy

Center. “He brings with him an unparalleled track record in research and leadership in wildlife conservation. Bill has already proven to be a terrific addition to our faculty. He is a great leader and colleague and has, in a remarkably short period of time, built a really strong research group in the QWL.”

“The wise use of our natural resources with an emphasis on responsible, sustainable land use and conservation practices aligns well with our mission to support Michigan agriculture while creating the research base for programs and initiatives to boost Michigan’s economy and conserve the state’s natural resources,” said Steve

graduate research programs to accomplish many goals quickly. He sees three important mandates:

- Putting in place a Quantitative Wildlife Laboratory that would complement the Quantitative Fisheries Center (also housed in the MSU Department of Fisheries and Wildlife).
- Building a graduate student research program that focuses on ecological science and leadership.
- Establishing the Michigan Boone and Crockett Partnership.

Work on accomplishing these goals is well under way.



**WILLIAM TAYLOR**  
AgBioResearch fisheries  
and wildlife scientist

“ The fact that the Boone and Crockett Club selected MSU for this endowment is a wonderful tribute that underscores our strong tradition of forging partnerships with organizations that share similar missions and values.”

Pueppke, MSU AgBioResearch director. “The establishment of this position and the partnerships being developed give us an opportunity to apply more science to the understanding of our natural resource base, both in Michigan and more broadly.”

Porter is drawing on his experiences with building partnerships and innovative

## **Wildlife conservation you can count on**

Researchers in the QWL are concentrating their work in wildlife ecology in four areas: the societal value of wildlife and its stewardship, land use change, climate change and shifts in species ranges, and wildlife diseases and species invasion.



PHOTOS: TOP — DAVE KENYON, DNR CENTER AND BOTTOM — WILLIAM PORTER, MSU



STEVE PUEPPKE  
director, AgBioResearch

“ The establishment of [the Boone and Crockett chair] and the partnerships being developed give us an opportunity to apply more science to the understanding of our natural resource base, both in Michigan and more broadly.”

“These four areas are game changers,” Porter said. “What happens in these areas will have an enormous effect on wildlife conservation. We are developing research and leadership training programs that focus on these.

“For example, with the societal value of wildlife stewardship, most of U.S. society doesn’t have much contact with hunting,” he continued. “People generally don’t have a problem with hunting because they believe that state and federal governments manage wildlife populations in a scientifically and culturally responsible manner. If that perception by a majority of Americans were to change — if we were seen as irresponsible in managing the hunting of wildlife species — there would be a wholesale change in the way we do wildlife conservation.”

Porter added that the most immediate effect of such a change would be a tremendous reduction in the amount of money spent on wildlife conservation because not only do hunters and anglers pay for licenses, tags and stamps, but there is a federal excise tax on fishing, hunting and shooting equipment and supplies that helps support national and state conservation programs.

“For these and other reasons, it’s important that the government agencies managing wildlife do it in the most responsible way,” Porter said. “To do that, we need a strong scientific foundation to understand how wildlife populations fluctuate and how hunting has to be adjusted to accommodate those fluctuations.”

Porter pointed to wild turkey hunting as an example. In the 1930s, wild turkeys in the United States were headed for extinction. Now, because of conservation efforts, wild turkeys number in the millions.

“This represents the best example of

how a partnership of hunters, agency biologists and university researchers came together to restore a species,” Porter said. “The pressure for careful stewardship is growing because of the increased interest in hunting wild turkeys. It is one of the few areas of hunting that is growing, and growing substantially. Michigan prides itself on having a wild turkey hunting season that maximizes the quality of the hunting experience, so we need to figure out how



WILLIAM PORTER  
director, QWL and  
Boone and Crockett chair  
in wildlife conservation

“ The goal is to use the lab as a cornerstone for a much larger program involving students and faculty members in fisheries and wildlife programs at universities throughout the Midwest and the nation.”

to maintain the quality of the experience and ensure that the wild turkey populations are not diminished as we get more and more people interested in hunting wild turkeys.”

That’s where the quantitative analysis techniques used by researchers in the QWL come into the picture.

“We are analyzing factors that are causing wild turkey populations to rise and fall,” Porter said. “We believe that land use and weather are the primary reasons, so we are trying to bring land use and weather together to predict what wild turkey populations are going to look like in the coming years to more effectively distribute the hunters or distribute the wild turkey populations.”

### Priming the conservation leadership pump

Two key members of the QWL are assistant professor Amy Dechen Quinn and research associate David Williams. They recently joined the lab after completing their doctoral degrees at the State University of New York. Quinn’s research interests include the evolution of mammalian behavior and the ecology and management of wildlife disease. Williams, with a strong background

in mathematics, is focused on the influences of landscape characteristics on animal movement and behavior, and how they affect the spread of wildlife diseases. In addition, Ph.D. and master’s degree students are helping to move the work of the lab forward at a rapid pace.

“The goal is to use the lab as a cornerstone for a much larger program involving students and faculty members in fisheries and wildlife programs at universities throughout the Midwest and the nation,” Porter said.

Students play a key role for the future.

“Students are the reason that the university is such an important partner,” Porter said. “People who are making decisions on conservation and wildlife today recognize

# The MSU Boone and Crockett Program

One of the most recent, exceptionally innovative programs to emerge at MSU is the Boone and Crockett Program. The vision of the program is to integrate science, law and outreach to bring about conservation policies for the wise use and sustainability of natural resources. The initiative is unlike any other in the nation — it connects a host of private and public organizations and individuals with cutting-edge research that is relevant to real-world experience, and it links wildlife and fisheries science with business, innovation and application that results in increased quality of life and enhanced prosperity. Several well-established MSU disciplines, schools and colleges are program partners: the College of Agriculture and Natural Resources, the Eli Broad College of Business, the College of Law, James Madison College, MSU AgBioResearch, MSU Extension and the MSU Graduate School. In addition to campus relationships, the program partners with private and public organizations such as the Great Lakes Fishery Commission, the Michigan DNR, and the Hal & Jean Glassen Memorial Foundation.

In addition to the Boone and Crockett Endowed Chair in Wildlife Conservation, the program also funds a Boone and Crockett wildlife Extension specialist. The establishment of this position represents a first-of-its-kind partnership between the Boone and Crockett Club, a major university and a state natural resources management agency. The position is a unique venture of Boone and Crockett, MSU Extension and the Michigan DNR, and is focused on public outreach and engagement to promote and improve joint stewardship of Michigan's natural resources.

The position is held by Jordan Burroughs,

wildlife outreach specialist for the MSU Department of Fisheries and Wildlife.

Burroughs is currently running "Gourmet Gone Wild," a program that uses a series of events to introduce the concept of conservation to young, urban foodies. The first Gourmet Gone Wild event took place in May. More than 150 young Lansing area professionals had the opportunity to sample professionally prepared wild fish and game harvested in Michigan and to learn about the health benefits of eating local and the role that hunters and anglers play in conserving our state's natural resources. The Michigan United Conservation Clubs and the Michigan DNR are partners in the Gourmet Gone Wild program.

Other key enterprises affiliated with the Boone and Crockett Program include:

## ● William A. Demmer Scholars Program

Designed to articulate the history, policies and significant impacts that the Boone and Crockett Club has had on conservation in North America, this program, led by Mark Rey, the inaugural Demmer endowed scholar in natural resources enterprise and conservation leadership, provides opportunities for MSU undergraduate and graduate students to become paid interns at federal and non-governmental organizations focused on natural resources. Students also take a senior-level class in natural resources policy while working full-time. This is another way to ensure leadership for enhancing wildlife sustainability and prosperity in the years to come.

Rey is a former undersecretary of agriculture for natural resources and environment. He also served as a staff member with the U.S. Senate Committee on Energy and Natural

Resources and was the lead staff person for the committee's work on national forest policy and forest service administration.

## ● Executive in Residence Program

The goal of this program is to bring executives with national or international reputations to campus to share their insights with MSU students, staff members and faculty members from a real-world perspective that links theory to practice. Mark Rey, the William A. Demmer endowed scholar, is the current executive in residence.

Rey works with policymakers, natural resource managers, faculty colleagues and natural resource industries to help make decisions and shape policies related to fish, wildlife and natural resource productivity. He collaborates with the Boone and Crockett Club members throughout the United States as well as with William Porter, the holder of the Boone and Crockett Chair in Wildlife Conservation at MSU.

## ● Distinguished Lectureship Series

This program offers public seminars and lectures by leading conservationists to stimulate and enhance the intellectual climate of the university and surrounding communities. Hal Salwasser, dean of the college of forestry at Oregon State University, was the inaugural speaker for this series and shared his views in the "Foundations of American Wildlife Conservation Past and Future: The Need for Leaders to Match the Times." Another lecture is being planned for fall 2011. The general public and the university community are invited to these events. 🌲

JANE L. DEPRIEST



PHOTOS: LEFT AND CENTER — DAVE KENYON, DNR RIGHT — WILLIAM PORTER, MSU



**BILL DEMMER**  
CEO, Demmer Corporation

“Michigan State University is a national leader in developing working partnerships with groups focused on benefitting the public and on partnerships that support the development of its students.”

that there will be huge challenges facing a generation of professionals that will be in place in 2030. We are training those decision makers in our labs and in our classrooms to ensure that they come out with not only the very best tools and scientific understanding, but the leadership skills to be effective with that science.”

Members of the Boone and Crockett Club are also reaching out to the next generation to help enhance leadership skills. The Boone and Crockett Club is made up of major corporation executives and leaders in government conservation.

“These people have access; they have influence; they have the ability to help young people move into positions of responsibility,” Porter said. “The club is trying to help students get to know its members and help members get to know the students so that, as today’s leaders retire, there is an educated generation with leadership skills to take on these roles. It’s a powerful idea.”

### Partnering for the public good

Another important task for Porter is the formalization of the Michigan Boone and Crockett Partnership. This is an ad hoc group made up of individuals who had a role in creating the endowed chair and working out the details of its vision and mission and who will continue providing input to help ensure the long-term success of the endowed chair. The partnership includes Michigan members of the national Boone and Crockett Club and representatives of the Michigan Department of Natural Resources (DNR), the Hal & Jean Glassen Memorial Foundation and MSU.

“Michigan State University is a national leader in developing working partnerships with groups focused on benefitting the

public and on partnerships that support the development of its students,” said Bill Demmer, CEO of the Demmer Corporation in Lansing, an ardent outdoor sportsman and conservationist. He is the executive vice president of the Boone and Crockett Club and a member of the Michigan Boone and Crockett Partnership.

“Dr. Porter was selected to lead this partnership at MSU because of his wonderful track record, his passion for the mission and his passion to leave a lasting mark on his students,” Demmer said. “Boone and Crockett Club members are delighted to be part of a national, cutting-edge partnership that includes the MSU QWL, the Michigan DNR and the Boone and Crockett Club.”



**RODNEY STOKES**  
director, Michigan DNR

“We have a strong working relationship with MSU and the wildlife lab. We want the seamless transfer of information for policymaking, and we need the very best science to be able to apply it to policy.”

Demmer received his bachelor’s degree in mechanical engineering at MSU in 1970, and was recognized this spring with the Claud R. Erickson Distinguished Alumni Award by the MSU College of Engineering. He helped establish and contributed significantly to the endowment for the Boone and Crockett Chair in Wildlife Conservation.

The Michigan DNR is another key player in the partnership and with QWL activities.

Becky Humphries, former director of the

Michigan DNR, was part of the group that established the MSU Boone and Crockett endowed chair. The DNR also plays an active role in the MSU Boone and Crockett Program and other affiliated enterprises (see sidebar on page 29).

“We have a strong working relationship with MSU and the wildlife lab,” said Rodney Stokes, Michigan DNR director. “We want the seamless transfer of information for policymaking, and we need the very best science to be able to apply it to policy.”


The expectations for the endowed chair and the QWL are very high.

“We want MSU to be known as the leader in directing conservation for the public good in the 21st century,” Taylor said.

That’s a role that Porter understands. He is reaching out to the academic community, wildlife managers, policymakers and other stakeholders.

“A key piece is being able to provide solid science and current research to support conservation endeavors now and in the future,” Porter said. 🌱

JANE L. DEPRIEST



Former DNR Fisheries Division chief John Robertson (*left*) and AgBioResearch scientist Bill Taylor (*right*) teamed up to create an innovative joint agreement between MSU and DNR that narrowed the gap between research and implementation.

## The PERM paradigm: **Relationships matter**

For 18 years, the Partnership for Ecosystem Research and Management (PERM) has successfully brought together university scientists and state and federal agencies to solve problems and apply research results to keep Michigan's natural resource base healthy and sustainable.

The word “paradigm” has long been employed in science to describe distinct concepts. The original Greek term — *paradeigm* — was used in texts such as Plato’s *Timaeus* (28 A.D.) to denote the model or pattern that the Demiurge (god) used to create the cosmos.

In a variation on that theme, the early 1990s found Michigan State University (MSU) AgBioResearch scientist William Taylor and then Michigan Department of Natural Resources (DNR) Fisheries chief John Robertson looking for an inspired

## Partnership for Ecosystems Research and Management (PERM)

### FACULTY MEMBERS

All PERM faculty members hold appointments in the MSU Department of Fisheries and Wildlife. Frank Lupi has a joint appointment in the MSU Department of Agriculture, Food and Resource Economics, and Dan Kramer has a joint appointment in James Madison College at MSU. Nine of the 11 PERM faculty members are also AgBioResearch scientists (\*), and nine of 11 have MSU Extension appointments (+).

<b>Jim Bence*+</b>	<b>Mary Bremigan*</b>	<b>Jordan Burroughs+</b>
<b>Dan Hayes*+</b>	<b>Dana Infante*+</b>	<b>Dan Kramer+</b>
<b>Weiming Li*+</b>	<b>Frank Lupi*+</b>	<b>Shawn Riley*</b>
<b>Kim Scribner*+</b>	<b>Michael Wagner*+</b>	

model to order their own universe — natural resources research and management.

MSU had a long history of providing research and educational information to the DNR, but most of it was done on a contract basis and was aimed at solving specific problems.

“In the 1990s, natural resources issues were becoming more complex,” said Taylor, professor of fisheries and wildlife and university distinguished professor in global fisheries systems. “There were new issues such as sea lamprey control and fish population dynamics that needed to be looked at from a systems level rather than at a species level. We needed an integrated, cooperative approach if we were going to tackle these challenges.”

“We were hurting a great deal for research,” Robertson recalled. “The DNR had a fundamental research program that looked at key parameters but didn’t consider the relationships between systems. The agency was having particular problems with its salmon program at the time — overstocking and bacterial kidney disease were thought to be causing a significant decline in the Lake Michigan salmon fishery — but because we hadn’t done a lot of research on the Great Lakes, there was no way to predict what was going to happen next.”

Taylor said that he and Robertson had been thinking about how they could create a formal partnership between the two organizations that would be seamless — very consistent and allowing for smooth transitions and continuity of the knowledge needed for sustainable resource governance.

“The idea was to merge the best of what MSU could offer from a scientific point of view and to deliver it directly to natural resource agencies for a quicker application to management problems,” Taylor explained. “With traditional methods — providing knowledge via students who then joined these agencies, or providing information through scientific literature — there is generally a significant lag time between research and implementation. We also wanted to create an environment where people would have an interest in working together, working across professional lines and having their

own culture as a research group. So we put our heads together and laid out a program.”

Though agreements between MSU and the DNR on research and fisheries and wildlife and subsequent management application began in 1984, the enterprise was formalized on Earth Day, April 23, 1993, when the leaders of the MSU College of Agriculture and Natural Resources and the DNR signed a joint operating agreement called the Partnership for Ecosystem Research and Management (PERM). Originally a partnership between MSU and the Fisheries and Wildlife divisions of the DNR, PERM expanded to include the DNR Forest Management Division in 1995, and the Great Lakes Fishery Commission (GLFC) and the Great Lakes Science Center — which is part of the U.S. Geological Survey (USGS) — in 1997.

PERM research is led by 11 scientists who are faculty members at MSU in the departments of Agriculture, Food and Resource Economics; Fisheries and Wildlife; Forestry; and Sociology (*see box this page*). Base funding for the positions is shared by MSU, the DNR and the GLFC. The research efforts of these scientists are augmented by undergraduate and graduate students, postdoctoral fellows and other faculty members.

“The idea was to merge the best of what MSU could offer from a scientific point of view and to deliver it directly to natural resource agencies for a quicker application to management problems.”

WILLIAM TAYLOR, AgBioResearch fisheries and wildlife scientist

Nine of these scientists are also affiliated with MSU AgBioResearch, which has a strong research focus in environmental stewardship, sustainability and natural resources management.

“The PERM program opened the door to a new brand of applied research and an enhanced capacity to make sustainable decisions about Michigan’s ecosystems,” said Steve Pueppke, AgBioResearch director. “The seamless integration of researchers





MIKE JONES  
chair, MSU Department of  
Fisheries and Wildlife

“It’s vitally important that we stay closely in touch with the sponsoring partners to ensure that we’re meeting their needs and that there are no issues bubbling along under the surface.”

and natural resource policymakers and managers in this program also makes the distribution of results quick and efficient — an element critical to the health and vitality of our natural resource base. We are pleased to help support such an important initiative.”

Though all who are associated with PERM consider it a strong and durable partnership, they are mindful that maintaining a vibrant, productive relationship requires constant attention and clear communication between the partners about their concerns and needs. MSU Department of Fisheries and Wildlife chairperson Mike Jones serves as the primary point of contact at MSU between the PERM partners and the university.

“Our department has always been the focal point for PERM because nearly all of the faculty members have appointments or historically had appointments in Fisheries and Wildlife — they might have joint appointments in other departments, but they are all in Fisheries and Wildlife,” he said. “The simplest way to describe my role is the care and feeding of the relationship. It’s vitally important that we stay closely in touch with the sponsoring partners to ensure that we’re meeting their needs and that there are no issues bubbling along under the surface.”

Jones was recruited to MSU by the PERM program in 1997 and held a PERM appointment until becoming chairperson of the Department of Fisheries and Wildlife in 2009, replacing Bill Taylor.

“MSU itself is a great institution, but it was the unusual and unique character of PERM that attracted me here,” he said. “So it was very easy for me to move from being a PERM faculty member into being more of a PERM ambassador when I became chairperson — I was completely sold on it from the get-go.”

### “Going public” to improve services

In addition to meeting regularly with the science program leaders in the participating DNR divisions and the Great Lakes Fishery Commission, Jones has frequent conversations with DNR director Rodney Stokes to make sure that PERM is in step with the agency’s applied research needs.

One area that Stokes is particularly interested in seeing further PERM involvement is in finding out more about the public that the DNR serves.

“We need to know more about people who hunt, people



DNR resource managers are using Michigan angler survey information collected over the past several years under the PERM program to help them answer questions about the who, what, when, where and how of the angling public.

who fish and people who use our state forests,” he said. “The past 10 to 15 years have seen a marked decline in these activities — we need to know why this is happening so that we can find ways to get more people outdoors. As an agency, we really depend on these individuals to buy hunting and fishing licenses, ORV stickers, and camping and park permits because the fees from these sales are what we use to manage our natural resources. If public participation in these activities continues to decline, it’s going to severely restrict our ability to manage our natural resources, so it’s extremely important to us to conduct research in this area.”

To help address this issue, AgBioResearch environmental and natural resource economics scientist and PERM faculty member Frank Lupi has been collaborating closely with Stokes and the DNR Fisheries Division to collect key data on Michigan anglers. Lupi said that when he arrived at MSU in 1999, there was a lack of information in the DNR Fisheries Division about its customers.

“There was no systematic data collection effort aimed at understanding people,” said Lupi, who holds joint appointments in the Fisheries and Wildlife and Agricultural, Food and Resource Economics departments at MSU. “The surveys were



RODNEY STOKES  
director, Michigan DNR

“ PERM has been a very good partnership for us, particularly related to providing scientific data that is critical to the management of Michigan’s natural resource base.”

primarily biological, so I began down the path of securing projects and doing research to fill that gap and ultimately was successful in establishing a monthly survey of people who fish in Michigan. It’s been going on for several years now, and it helps answer questions about the ‘who, what, when, where and how’ of angling. Now that this information is available, it’s easy to ask questions that people didn’t think about asking before or just weren’t in the position to answer, such as ‘If we need to change the way we manage a fishery, how many anglers will it affect?’”

Lupi added that access to this data not only provides



PHOTO: DAVE KENVON, DNR

Improved population assessment models will help fishery management agencies keep the Great Lakes fisheries adequately stocked.

resource managers with a sound basis for decision making but helps in interactions with interest groups because the decisions are being driven by systematic, representative data collection, not by opinions.

“The knowledge gleaned from this survey has the potential to bring a cultural change in the information brought to bear on resource management decisions,” he said. “If it weren’t for the PERM program, this research likely wouldn’t have hap-

pened. The dean of the MSU College of Agriculture and Natural Resources and the MSU provost have been talking about ‘big plays’ in advancing agriculture and natural resources management. PERM is a huge play for the university and for all of its partners.”

### Angling for optimum fish populations

In addition to Lupi’s research on the angling public, there are a number of other PERM projects targeted toward enhancing Great Lakes fisheries.

Kelley Smith, chief of the DNR Fisheries Division since 1997 and currently acting deputy director for resource management, was the Great Lakes research coordinator when the PERM program was created and was involved in the initial discussions on the program’s creation.

“PERM is unique,” he said. “We’ve been able to bring in expertise that we wouldn’t have access to otherwise. For example, we’ve long collaborated with Jim Bence, PERM faculty member and co-director [along with Mike Jones] of the Quantitative Fisheries Center at MSU, who has developed fisheries models for us so that we can better predict the effects of commercial fishing on the various Great Lakes stocks.”

Fish stocking is one of the main tools used by the DNR in fisheries management. About 40 percent of all recreational fishing in the state depends on stocked fish, including roughly 70 percent of trout and salmon caught in the Great Lakes. The DNR operates six fish hatcheries in the state that are capable of producing almost 1 million pounds of fish per year.

“It’s an ongoing partnership,” Bence said. “The fisheries management agencies monitor the stock, we build and apply the models, and they use the results to make better decisions.”

“We’ve also done extensive work with Kim Scribner, a fisheries and wildlife population geneticist with the PERM program, who has been invaluable in helping us establish and maintain appropriate genetics in our hatchery program,” Smith said. “A more diverse gene pool makes fish more likely to withstand disease and parasites, and provides more plentiful and healthy fish for both sport anglers and commercial operations.”

In addition to these examples, Smith said that his division has a couple of other important PERM projects on the front burner (see sidebar on pages 38-39).

The research conducted by PERM faculty members has



KELLEY SMITH  
chief, DNR Fisheries Division

“ We sometimes have a problem with credibility, just by virtue of being a government agency. Because the PERM scientists are with the university, they are seen as objective and neutral, which enhances our research integrity.”

another key benefit, Smith said.

“We sometimes have a problem with credibility, just by virtue of being a government agency,” he said. “Because the PERM scientists are with the university, they are seen as objective and neutral, which enhances our research integrity.”

While the MSU side of the PERM equation provides practical, world-class research, the DNR side brings a dose of reality, added Tammy Newcomb, who heads the DNR Fisheries Division research assessment section. Its duties include serving as PERM liaison for the division.

“Many times, when academics are looking for research dollars, they have to figure out the questions,” Newcomb said. “We provide the critical resource management questions that need to be answered. When you combine our demonstrated need and their expertise, it provides a very strong case for external funding. Further, the base funding put up for these PERM positions attracts significant amounts of money from the outside, so we’re getting more work done today than we would ever have achieved without the partnership.”

### An “about face” for wildlife management

In addition to fisheries management, PERM scientists also address challenges and issues related to Michigan’s wildlife resources.

DNR Wildlife Division chief Russ Mason works vigilantly with PERM administrator Mike Jones to make sure that research related to his division is aligned with DNR wildlife management needs.

“As with any cooperative agreement, PERM needs to be revisited and tuned periodically to keep it relevant to the issues that we confront,” Mason said. “We want to make sure that we continue to address topics that will advance conservation, meet public need and help us fulfill our mandate to the DNR Natural Resources Commission.”

Mason and his staff work most closely with PERM faculty member Shawn Riley, whose research explores human-wildlife interactions. Riley said that the work he and his team do is slightly different than what the DNR gets through conventional wildlife ecology.

“We focus on the human dimensions of wildlife management — everything that is involved in the management enterprise that is not directly about habitat and wildlife organisms,” he said. “We work to better understand how people interact

with wildlife, how those interactions affect their perceptions of wildlife, how they value wildlife, how these variables lead to people’s ability and willingness to live with wildlife in Michigan, and how that then affects the population objectives that are more typical of what an agency such as the DNR works with.”

During his 10 years with PERM, Riley’s work has included exploring the human dimensions of deer, wolf and Cormorant management. He and his team have just started to investigate suburban deer management to determine why certain communities have more deer-related problems than others.



PHOTO: ISTOCKPHOTO

Human-wildlife interactions are becoming increasingly important to manage as rural landscapes become more urbanized.

“Suburban environments are not traditionally an area that wildlife management agencies work in,” Riley explained. “The DNR, however, recognizes that this issue will only intensify over time as urbanization and suburbanization increase, so it has invested time, money and research to inform the development of a suburban deer management plan for southern Michigan that we hope is the precursor to a suburban wildlife management plan for the area.”



RUSS MASON  
chief, DNR Wildlife Division

“Thanks in large part to the PERM program, students come out of their fisheries and wildlife or forestry programs at MSU already knowing what we need because they’ve worked side-by-side with our folks.”

“There is a need to better understand the sociology of our user groups — why they do what they do,” Mason said. “We are more and more interested in building true partnerships with groups, and that kind of information is very important to us.”



**PERM research has provided the basis for changes in forest management practices, such as increasing the harvest gap size in northern hardwood stands to promote greater tree regeneration density and diversity.**

Mason said that another key benefit of PERM is the direct involvement of university students who work with PERM faculty members on DNR projects.

“Most universities today are moving more broadly into conservation biology — there are very few schools across the country that prepare students for what we’re looking for from a wildlife management perspective,” he said. “Thanks in large part to the PERM program, students come out of their fisheries and wildlife or forestry programs at MSU already knowing what we need because they’ve worked side-by-side with our

folks. They don’t need significant retooling. We don’t have to remake them in our own image. They understand what the game is and how it works. That’s really valuable.”

Though funding is more limited today than in the early days of PERM, Mason is hopeful that the partnership can weather the state’s current economic climate.

“We’re looking toward a future that undoubtedly will change,” he said. “As Michigan moves forward and certain things drop away, I hope that we, as a state, make every attempt to preserve the unique and the special because that’s what will carry us successfully into the future. Michigan’s natural resource base and the PERM partnership are certainly two of those special, unique things.”

### **Branching out: Managing Michigan’s forests**

With trees covering 19.3 million acres in Michigan — more than half of the state’s land base — effectively managing this important resource is no small feat. DNR Forest Management Division chief Lynne Boyd looks to PERM to provide her division with the practical science needed to keep the state’s woodlands and commercial timberlands sustainable and productive.

“The partnership provides a research capacity that we just can’t maintain inside the department,” Boyd said. “It provides us with access to top-notch scientists and the academic rigor that is very important to us. MSU is the research arm for the state and MSU Extension is the outreach arm, so it really doesn’t make sense for us to replicate that system when those resources are available and more robust than anything we could develop. Further, the research generated by PERM/MSU gives the work more credibility and a higher level of acceptance than it would receive if it came from the state.”

Boyd said that most of the forestry projects funded under PERM deal with forest regeneration challenges, particularly those related to the effects of wildlife management on forest management.

“We’re looking at the forest resource from the perspective of managing timber and timber sales; at the same time, it’s important to have a healthy and vibrant wildlife population,” Boyd said. “There are some competing interests between the two, and we need to figure out how to balance them — or if it’s even possible to balance them — so this type of research is very important.”



LYNNE BOYD  
chief, DNR Forest  
Management Division

“The partnership provides a research capacity that we just can’t maintain inside the department.”

To address this issue, Boyd’s division works closely with AgBioResearch forestry scientist Mike Walters, who receives PERM project support from the DNR to address forest ecology issues of management concern. Walters is particularly interested in studying tree harvesting practices and the link between deer density and regeneration failure of commercially valuable tree species.

“Most of my work has been focused on the sustainability of forest ecosystems,” Walters said. “I’ve done a lot of work on northern hardwood forests and how limitations to regeneration — deer browse, low light and competition from other plants — can ultimately result in their unsustainability. For examples, our research shows that, in some situations, the type of partial harvesting done in these forests needs to be changed — instead of cutting small groups of trees, larger patches of trees need to be removed to get a greater diversity of tree regeneration, and to get any regeneration at all in areas with large deer populations. This knowledge should ultimately lead to a more informed wildlife-forest co-management.”

Cara Boucher, assistant DNR Forest Management Division chief and State Forester, works closely with Boyd and Walters and would like to see PERM pursue other forest management research priorities.

“There are a lot of social issues related to people’s attitudes and feelings about certain forest management practices such as clear cutting, so we’d like to see more PERM dollars dedicated to that area of study,” she said. “We’d also like to use PERM to look at the effects of invasive species on the productivity and function of forest systems, and how at climate change affects forest insects and disease. PERM is the perfect vehicle to address these issues.”

### Advancing Great Lakes fisheries research

Another key PERM partner is the Great Lakes Fishery Commission (GLFC). Established in 1955 by the Canada/U.S. Convention on Great Lakes Fisheries, the GLFC coordinates fishery research, controls the invasive sea lamprey and facilitates cooperative fishery management among state, provincial, tribal and federal management agencies in the Great Lakes basin.

“The PERM program helps us conduct and communicate about our research and is a central means by which we fulfill our duties as defined by the convention, so it plays a critically

PHOTO: BRENDAN WALSH, GREAT LAKES MEDIA



**Native to the Atlantic Ocean, the parasitic sea lamprey was accidentally introduced into the Great Lakes during the past century. One sea lamprey can kill 40 or more pounds of fish, and only one of seven fish attacked by a sea lamprey will survive.**

important role for us,” said GLFC science director Charles Krueger. “For our part, we contribute funding for individual research projects and positions. We currently are providing salary support for two PERM scientists — Weiming Li [100 percent] and Michael Wagner [50 percent]. We also assist in their administration and fund many of their projects. Further, we provide research direction for projects of interest to us and have research boards that make recommendations about GLFC priorities. PERM scientists typically are members of these boards, so they play an integral role in deciding which research projects we fund and the research directions we pursue.”

A key GLFC focus is protecting the Great Lakes fisheries from aquatic invasives. On average, a new invasive enters the Great Lakes every eight months. Of particular concern over the past two decades is the serious damage caused to the lake trout, whitefish and salmon fisheries by invasive species, particularly the sea lamprey — a destructive pest that stays alive by attaching itself to other fish and then sucking out the fish’s blood and body fluids. The U.S. and Canadian governments spend about \$19 million per year on lamprey control using a chemical compound — known as TFM — that kills sea lamprey larvae.

Li and Wagner, both MSU fisheries and wildlife researchers

## DNR FISHERIES DIVISION:

# Shoring up fisheries in Michigan's inland lakes and streams

In addition to managing the state's Great Lakes resources, the DNR — working with partnering organizations — is responsible for monitoring Michigan's 36,000 miles of streams and more than 11,000 lakes and ponds.

To help with this enormous task, the DNR Fisheries Division works closely with a number of MSU fisheries and wildlife researchers who are faculty members under the Partnership for Ecosystems Research and Management (PERM) program. Two of the division's current projects are being buoyed by the expertise of fisheries and wildlife researchers Dan Hayes and Mary Bremigan.

A PERM scientist since 1994, Hayes conducts research focused on relating fish habitat to fish populations. Hayes and members of his laboratory have participated in many DNR-related fishery projects, including the effects of human-related activities such as dams and dam removal on fish populations, the effect of fishing on fish populations, and the general ecology of fishes.

The newest phase of Hayes' work is taking place on a large set of interconnected inland lakes — Crooked, Pickerel, Burton and Mullett — that extend across the northern tip of Michigan's Lower Peninsula, just south of the Straits of Mackinac. The genesis of this four-year project was the result of a conversation between Hayes and DNR Fisheries Division PERM liaison Tammy Newcomb and Fisheries Division chief Kelley Smith, who were concerned about the lakes' walleye population and the management of this enormous resource.

"These lakes are very important to the state, and they're also within a tribal area where there is a consent decree that regulates and manages how the fishery resources are allocated," Hayes

under PERM, are exploring the potential to enhance sea lamprey control efforts through natural means.

Li led groundbreaking research that identified the pheromone that male lampreys use to attract females to their nests to mate. A synthetic version of the pheromone has been developed and its effectiveness is currently being tested as a control for the destructive parasites.

"The commission considers regulating spawning and migratory behavior with pheromones the most promising

control method for implementation, so we're excited about the possibilities," Li said.

While Li's research is exploring how to attract lampreys to a certain area, Wagner is working with pheromones related to a different type of signaling that could potentially be used to repel lampreys in search of good spawning habitat. These compounds, known as alarm substances, are released from decaying sea lampreys, alerting the animals that the area they are approaching is likely a dangerous and an undesir-

PHOTO: DAVE KENYON, DNR



**PERM research on a large set of interconnected inland lakes located across the northern tip of Michigan's Lower Peninsula is under way to document fish movement between the lakes and to estimate walleye population abundance.**

explained. "Because the lakes are interconnected, fish populations move between them. This creates the potential for conflict when decree allocations are determined, because the consent decree is set up lake by lake, not across the whole system."

To begin to address this challenge, Hayes said one of the biggest tasks was tagging fish.

"A project of this magnitude requires cooperation from all of the involved groups, so DNR staff members, the tribes and the MSU/PERM crew — including students — were all out tackling that job this spring," he said. "The fish are tagged for multiple purposes. One of the key things is to document fish movement between these lakes. For example, anglers may

harvest in one lake, but the young are produced elsewhere, or they're somewhere else in the lake system during another part of the year. Tagging and recapturing fish also helps us estimate population abundance. We're hopeful that it will allow us to better estimate angler harvest rates over the course of the year."

Maintaining effective fishing regulations is another area where the DNR calls on the expertise of PERM scientists to help it strike a balance between angler desires and expectations and assuring the sustainability of the fish populations. PERM scientist Mary Bremigan has been working with the DNR Fisheries Division to take a closer look at one of the state's most popular fisheries — bass.



**Bass fishing is one of the few areas of fishing that is growing in Michigan. PERM scientists and DNR Fisheries Division staff are working together to meet the needs and desires of bass anglers while assuring the sustainability of the fish populations.**

Michigan is home to numerous bass fishing waters. Perhaps America's top game fish, bass are highly prized for their spirited fight. Traditionally, bass have been protected by a closed season from Jan. 1 until the Saturday before Memorial Day. Asked by anglers to extend this season, the DNR put a catch-and-immediate-release season in place (the last Saturday in April in the Lower Peninsula, and May 15 in the Upper Peninsula) in 2006 and committed to evaluating its effects over five years. Bremigan was asked to help the DNR assess how the longer season might affect spawning success.

"Bass are fun to catch in the spring, and anglers tend to catch relatively large bass during this part of the year because that's when the

fish are reproducing, and the males tend to be more aggressive because they are protecting their nests," said Bremigan, who has been with the PERM program since 1997. "However, there is a fair amount of controversy around extending the season because of the unknown potential effects.

"For example," she said, "one view is that if some of these bass are removed from their nests by fishing — even for a short time — their nests may fail. Although other nests may have really high success rates, we don't really know how many nests we can lose to fishing before there aren't enough nests

left behind to compensate. In addition, some research has shown that bass aggressiveness and vulnerability to angling is a heritable trait — their genetics make some of them more vulnerable to being caught by anglers than others. So there is the potential that, in the long term, we may unintentionally be altering the genetic composition and traits of these populations by reducing the reproductive success of certain individual fish."

Bremigan and members of her laboratory have spent the past few years comparing spawning success rates on heavily fished lakes and lightly fished lakes to find out if prespawn angling pressure has an effect on spawning success. In addition, Bremigan teamed up with

PERM scientist Kim Scribner to add some genetics work.

"The idea is that we can sample eggs and genetically fingerprint a bass nest in the spring and then go back in the fall, sample the young-of-the-year — 3- to 4-month-old fish — that lived to the fall, and genetically fingerprint them, too. This should tell us how many of the nests that we found in a lake in May and June actually contributed to the population we have in the fall. We're trying to get at the longer term effects on the population from fishing. If they're not serious, we should definitely keep allowing the fishing. If they are serious, then we might need to revisit things."

Bremigan, who co-chairs the DNR Fisheries Division Smallmouth and Largemouth Bass Regulations Committee — the body overseeing this research — said that the project ends in October and that the committee will then have a year to write its final report.

"Right now, the committee is writing a summary report for the DNR Fisheries Division management team," she said. "At this point, I feel comfortable saying that the study shows no catastrophic effects from this May catch-and-immediate-release season on our bass population. However, we want to go beyond just confirming that we're not driving bass populations into extinction. It's the more detailed research provided through PERM that can address the subtle, long-term effects that management agencies often don't, so to speak, have the luxury to worry about." 🌱

VAL OSOWSKI

able place to deposit future offspring.

"This odor could provide us with an exciting opportunity to better manage sea lamprey because, as they are moving up through any watershed, a lamprey will encounter junctions where two streams come together," Wagner explained. "When the animal reaches that point, it has to decide which direction to go. Our goal is to make the choice an easy one. If we activate one tributary with a repellent and the other with the migratory pheromone, it becomes a very simple choice from

the lamprey's perspective — a noxious choice versus a good one. This is known as a 'push-pull' behavioral manipulation."

Concentrating the run into a much smaller area and letting them reproduce as they normally would means the GLFC can then treat and eliminate the offspring with a far smaller quantity of TFM, Wagner said.

"This approach affords two important benefits to the sea lamprey control program," he said. "First, by treating a smaller area, they save a lot of effort that can be reapplied to



CHARLES KRUEGER  
science director, GLFC

“The PERM program helps us conduct and communicate about our research and is a central means by which we fulfill our duties as defined by the convention, so it plays a critically important role for us.”

other systems, thereby increasing the total amount of control achieved without upping the amount of pesticide and human resource effort that is being used now,” he said. “Ecologically, it’s very valuable as well, because now we can get into the true business of ecosystem management. We could direct the lamprey spawning run away from the streams that we want

### Building the case for centralized research

Rounding out the PERM lineup is the USGS Great Lakes Science Center. Its mission is to provide scientific information for restoring, enhancing, managing and protecting living resources and their habitats in the Great Lakes basin ecosystem.

“We are unique among the four partners because our participation in PERM is providing access to our Hammond Bay Research Facility in northeastern Michigan, where we conduct international sea lamprey research with MSU, the DNR and the GLFC,” said GLSC director Russ Strach. “It’s a wonderful field station where we get a rich collaboration among researchers. MSU also sponsors graduate students and postdoctoral fellows at the facility, who benefit from the training, insights and guidance provided by our federal scientists and PERM researchers. Conversely, we have employees, scientists and junior scientists who end up going to MSU for graduate degrees.”

The Hammond Bay facility — a site for U.S./Canadian sea lamprey research — houses the oldest collaborative exotic species program in the Great Lakes and the only one that deals with eradication, population monitoring and basic biology.

“There’s just no way for each agency to replicate these types of facilities, and there’s no need to because, under an agreement like PERM, we’re able to make them available to the cooperating parties,” Strach said. “It’s mutually nourishing to have the research capabilities of MSU and guidance from faculty members to provide oversight to graduate students, who then return to Hammond Bay to carry out their research projects. And ultimately, some of them become federal employees.”

Strach added that PERM greatly simplifies the pooling of talent across the four agencies.

“PERM is really a novel way to foster collaboration among these entities to share information, research and facilities,” he said. “Without it, you’d have to do individual agreements for people and it would end up being a paperwork nightmare with time and processing delays. PERM has really cut down on the bureaucracy and helps to bridge the working relationships that are good for natural resource research and management across the Great Lakes.”



PHOTO: COURTESY OF GREAT LAKES FISHERY COMMISSION

Research activities at the Hammond Bay Biological Station, a U.S. Geological Survey facility located in Millersburg, Mich. (above), focus almost exclusively on the study and control of the parasitic sea lamprey.

to protect and into streams that either are already experiencing degradation or where lampricide application is highly effective.”

Krueger said that this “push-pull” approach of using an attractant and a repellent is similar to behavior modification strategies that have been used successfully in integrated pest management practices for insect control.

“You push the lampreys out of an area with the repellent and then pull them into the adjacent stream with an attractant — either a migratory or a sex pheromone,” he said. “It’s the combined action of these two tools that we hope will lead to high control efficacy.”





RUSS STRACH  
director, GLSC

“There’s just no way for each agency to replicate these types of facilities, and there’s no need to because, under an agreement like PERM, we’re able to make them available to the cooperating parties.”

## A PERManent future for natural resources

Despite the pressures of tough economic times and the ups and downs inherent in any long-term relationship, all of the partners see PERM continuing to grow and evolve in beneficial ways.

“The people we’ve hired have been outstanding,” Taylor said. “They’re bright individuals who are competitive worldwide for grants and have raised our program stature. They’re also giving skills to our students — skills that no one else has. MSU has one of the top fisheries and wildlife programs in the country. Besides the access to long-term researchers, the agencies also have access to a better, more diverse workforce because the students are better educated and more holistic in their thinking.”

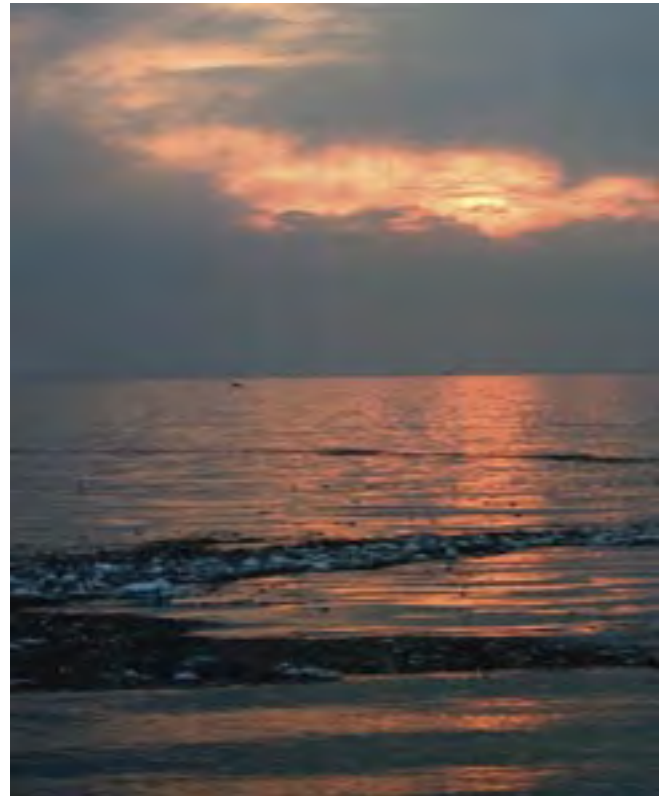
Though Stokes wants to see more PERM research on the human dimension of natural resources management, he continues to see great value in the DNR-MSU connection and all it offers.

“This partnership enhances our department because through it we have access to some of the top talent in the country in fish and wildlife research,” Stokes said. “On the other side of the coin, we provide the researchers with opportunities to work on some unique situations and issues that pique their academic interest and, at the same time, address real-life challenges. We also have a number of employees who teach classes at MSU — it keeps them current and they’re able to work with future talent and attract this talent to the DNR. It’s a win-win — it works for both of us.”

Krueger said that PERM is an excellent strategy for getting research done.

“We see this as a very productive, valuable program,” he said. “It is very foundational to complementing our research mission. In addition to PERM, we have some directed research programs that we do through the USGS Upper Mississippi Environmental Science Center and the Great Lakes Science Center, and have also started a PERM program at the University of Guelph in Ontario. When you put all of these initiatives together, we can nimbly go back and forth and get all sorts of things done using these different organizational research strategies than if we were simply operating with a narrow, one-agency research program.”

Strach doesn’t see the changing economic climate adversely affecting PERM’s durability.



Michigan is known for its scenic beauty and recreational resources. The PERM program provides natural resource managers and policy-makers with the research expertise and information they need to ensure that the state’s resources remain vital and sustainable.

“Despite the recent ups and downs in budgets, PERM may actually be a way to bring the parties even closer together and make even better use of limited staff, facilities and publication opportunities,” he said. “We’re active users of the agreement. Even if our budgets were cut substantially, I would still turn to this agreement to get work done and to foster the collaboration you need on such a vast resource as the Great Lakes.”

“It’s easy to take things for granted and forget that these successes and accomplishments were built on trust and relationships, and that you have to continue to prepare for transitions,” Taylor said. “And these transitions are not only about PERM — they are about how society has changed from when I grew up to what it is now, and how we can better help Michigan’s economy, Michigan’s job outlook and Michigan’s quality of life by working together more effectively, both now and for the long haul.”

VAL OSOWSKI

## In the race of life, better an adaptable tortoise than a fit hare

In the survival of the fittest, it's sometimes better to be an adaptable tortoise than a fitness-oriented hare, according to MSU AgBioResearch scientist **Richard Lenski**.



In the March 18 edition of *Science*, Lenski, MSU Hannah distinguished professor of microbiology and molecular genetics, and colleagues show that more adaptable bacteria oriented toward long-term improvement prevailed over competitors that held a short-term advantage.

The discovery that the less fit organisms overtook their in-shape counterparts surprised the researchers at first, but it turns out to work something like a game of chess.

"In games it makes sense to sacrifice some pieces for an eventual winning move," said Lenski, co-principal investigator of BEACON, MSU's National Science Foundation-funded Science and Technology Center. "The eventual winners were able to overcome their short-term disadvantage over the course of several evolutionary moves by producing more beneficial mutations."

Lenski is recognized as a leading evolutionary experimentalist, recording evolutionary change over 52,000 generations of bacteria grown during nearly 25 years. He and his team recently revived a frozen population of *E. coli* and compared the fitness and ultimate fates of four clones representing two genetically distinct lineages. One lineage eventually

took over the population, even though it had significantly lower competitive fitness than the other lineage that later went extinct.

By replaying evolution over and over with the clones, the researchers showed that the eventual winners likely prevailed because they had greater potential for further adaptation.

Though Darwin's theory of natural selection has been confirmed by a great deal of other research, it has never before been observed directly for so many generations and in such detail as Lenski's long-term experiment has afforded.

In addition to AgBioResearch, Lenski's research is supported by the National Science Foundation and the Defense Advanced Research Projects Agency.

## USDA grant funds study aimed at reducing food-borne illness caused by *E. coli*



Michigan State University (MSU) has received a \$2.5 million grant from the U.S. Department of Agriculture (USDA) to develop strategies to reduce the amount of *E. coli* released by cattle and, in effect, decrease the amount of foodborne illness in humans. The grant was awarded through the USDA National Institute of Food and Agriculture (NIFA), which supports research that promotes and enhances the scientific discipline of food safety.

The project is being led by MSU AgBioResearch scientist **Shannon Manning**, who will work to reduce cattle's fecal "shedding" of shiga toxin-producing *E. coli* (STEC).

"These infections are a national concern, particularly during outbreaks when public health agencies are rapidly trying to identify the sources to prevent additional infections," said Manning, an assistant professor of microbiology and molecular genetics at MSU. "The data generated through this project will aid in the development of STEC control methods that can be used to improve food safety."

STEC is a leading cause of food-borne and waterborne infections, and most outbreaks are caused by contact with fecal material from cattle and other ruminant animals. Little is known, however, about the factors that affect shedding from these animals.

"More than 70,000 people become ill because of shiga toxin-producing *E. coli* every year," said Roger Beachy, director of the USDA National Institute of Food and Agriculture (NIFA), who visited MSU in March to make the grant award announcement. "Understanding how the bacteria contaminate water and food supplies will help prevent thousands of illnesses and improve the safety of the nation's food."

Manning and her team of researchers will examine the host, genetic, microbial and environmental factors associated with STEC shedding. Multidisciplinary studies of this scope are required to improve understanding of shedding of *E. coli* from cattle and to enhance detection methods and control strategies. The research team expects to develop new ideas for direct-fed antimicrobials, vaccines, therapies and other control strategies that can reduce the frequency and level of STEC shedding. It is anticipated that this will lead to a reduction in food contamination, transmission to humans and STEC-related illnesses.

## AgBioResearch scientist heads new Clean Air Research Center

To explore one of the most critical health/environment intersections —

how the very air we breathe can cause heart disease and diabetes and contribute to the problems of obesity — Michigan State University (MSU) has been named a Clean Air Research Center by the Environmental Protection Agency (EPA).



A five-year, \$8 million EPA grant will fund three major research projects with the creation of the Great Lakes Air Center for Integrative Environmental Research, led by MSU AgBioResearch scientist **Jack Harkema**. The research team will study the exact role that air pollutants, most notably fine particles and ozone, play in cardiometabolic syndrome, a collection of interrelated risk factors leading to cardiovascular and metabolic diseases that affect about one-third of adult Americans.

Signs of cardiometabolic syndrome include high blood pressure and blood sugar levels, abnormal triglycerides and cholesterol as well as obesity — all warning signs for the development of chronic diseases such as diabetes and atherosclerosis.

"In tandem, the cardiometabolic syndrome and air pollution threaten human health worldwide," said Harkema, who is a university distinguished professor of pathobiology and diagnostic investigation in the MSU College of Veterinary Medicine. "We propose that not only are individuals with preexisting abnormalities at greater risk for the health effects of air pollution exposure but that air pollution itself may promote

## Research IN THE NEWS

the development of cardiometabolic syndrome.”

MSU is one of four Clean Air Research Centers named by the EPA — Harvard University, the University of Washington in Seattle and Emory University/Georgia Institute of Technology in Atlanta are the other recipients. The \$32 million federal effort aims to study a range of exposures to air pollution sources and their health effects across various life stages, among susceptible and vulnerable populations, and across communities where exposures may pose a significant health risk.

“Air pollution in the Great Lakes region is complex because of a large diversity of multipollutant ‘airsheds’ [the atmospheric equivalent of watersheds],” said Harkema, whose research team includes investigators from MSU, the University of Michigan and Ohio State University. “This complexity is due to a large assortment of emission sources, including heavy industry, dense motor vehicle traffic and high concentrations of coal-fired power plants. The health effects of these multipollutant airsheds are complex and understudied.”

### Overfertilizing corn undermines ethanol production



When growing corn crops for ethanol, more means less.

A team of researchers from Michigan State University (MSU) and Rice University, including MSU AgBioResearch scientist **Sieglinde Snapp**, has shown how farmers can

save money on fertilizer while they improve their production of feedstock for ethanol and alleviate damage to the environment.

The research results are featured in a recent issue of the American Chemical Society’s journal, *Environmental Science and Technology*. Snapp, an associate professor of crop and soil sciences, who does research at the MSU Kellogg Biological Station, said that the research has implications for an industry that has grown dramatically in recent years to satisfy America’s need for energy while trying to cut the nation’s reliance on fossil fuels.

“In an era of increasing reliance on corn production for food and fuel, it is important to quantify the full impact of corn nitrogen management on the environment and on the crop biochemistry,” she said.

The team discovered that corn grain — one source of ethanol — and the stalks and leaves — the source of cellulosic ethanol — respond differently to nitrogen fertilization. Liberal use of nitrogen fertilizer to maximize grain yields from corn crops resulted in only marginally more usable cellulose from leaves and stems. Further, when the grain is used for food and the cellulose is processed for biofuel, pumping up the rate of nitrogen fertilization actually makes it more difficult to extract ethanol from corn leaves and stems.

This happens, they learned, because surplus nitrogen fertilizer accelerates the production of lignin, a molecule that must be removed before cellulosic ethanol can be produced from corn stems and leaves.

Fertilization also increases the decomposability of corn residue. This finding implies that soil carbon sequestration becomes less efficient with increased fertilizer use. Research results suggested that even when corn is grown for grain, benefits of fertilization decline rapidly after the ecosystem’s nitrogen demands are met. Heavy application of fertilizer yields minimal grain benefits and almost no benefits in residue

carbohydrates, and it degrades the cellulosic ethanol feedstock quality and soil carbon sequestration (storage) effectiveness.

“These findings are an important next step in building a sustainable biofuel economy,” Snapp said. “Though farmers have a clear incentive to maximize grain yields, the research shows a path to even greater benefits when corn residues are harvested for cellulosic ethanol production.”

In addition to support from MSU AgBioResearch, this research is funded in part by the National Science Foundation.

### MSU scientists receive \$2.9 million to boost biofuel research

Michigan State University (MSU) scientists will use three 5-year grants totaling \$2.9 million to focus on various aspects of producing biofuels, which are made from renewable plant materials instead of petroleum.

Awarded by the U.S. Department of Agriculture (USDA), the grants are part of \$36.3 million in competitive funding allocated to advance sustainable bioenergy research.



MSU microbiology and molecular genetics assistant professor **Claire Vieille**, MSU plant biology associate professor and AgBioResearch scientist **Carolyn Malmstrom**, and MSU forestry associate professor and AgBioResearch scientist **David Rothstein** received \$957,582, \$991,219 and \$998,630, respectively, from the USDA to support their research efforts.

The Energy Independence and Security Act of 2007 mandates the use of 1 billion gallons of biodiesel by 2012. The production of the biodiesel will also entail the production of 100 million gallons of glycerol, its direct byproduct. The overall goal of Vieille’s grant is to develop a microbial process that converts glycerol into succinate (an organic salt), which can be used in everything from noncorrosive airport deicers to food and drug additives, and as a precursor to nontoxic solvents, plastics and polyesters.



“Succinate as a co-product of biodiesel production would have several environmental benefits,” Vieille said. “For example, biobased succinate could replace petroleum-based maleic anhydride [colorless crystals used to form polyester resins] as a feedstock in a bulk chemical market for the production of various polymers. Succinate production would also consume carbon dioxide, a major greenhouse gas. Further, succinate production would increase the economic sustainability of biodiesel production by finding a high-value application for glycerol.”

Deployment of perennial grass-based bioenergy systems offers opportunities for American agriculture to produce crops while enhancing wildlife habitat and protecting soil resources. However, perennial grass cropping systems may also harbor insects and pathogens that damage other crops.

Malmstrom, along with entomology professors Doug Landis and

Rufus Isaacs — both AgBioResearch scientists — will work to develop strategies to mitigate crop risks and enhance the benefits of perennial grass cropping systems.

“Biofuel research is moving away from food resources such as corn in favor of agricultural waste products or non-food crops such as switchgrass,” Malmstrom said. “These new biofuel crops have potential to provide both fuel and numerous ecological benefits, such as soil development and bird habitat. Our aim is to minimize risks and maximize benefits by identifying the most pest-suppressive cropping strategies.”

Soil carbon loss and greenhouse gas (GHG) emissions associated with intensive biomass production have the potential to undermine the perceived benefits of bioenergy. Rothstein will look at the conversion of large areas of herbaceous open lands to short-rotation woody biomass crops, which is seen as a key component of the developing bioeconomy of the northern Great Lakes region.

“We want to quantify the soil impacts, GHG emissions and biomass production associated with short-rotation woody cropping systems across a wide range of site conditions,” Rothstein said. “This information can then be used in predictive models to assess the true environmental impacts and benefits of expanded bioenergy plantations and assist in the sustainable deployment of short-rotation woody biomass crops across Great Lakes landscapes.”

MSU is among 27 universities, one college and two USDA research arms to share the USDA funding.

## MSU lands a \$4.1 million grant to unlock plants' biochemistry secrets

Michigan State University (MSU) will use a \$4.1 million grant from the National Science Foundation (NSF) to unlock plants' biochemistry secrets.

Using cultivated and wild tomato species from the Andes Mountains,

MSU AgBioResearch scientist **Robert Last** will lead a team of plant scientists to uncover how plants evolve to make compounds necessary for their survival.

Last and collaborators, who study functional genomics and how plants produce diverse chemicals and metabolites, will work to determine the specific genes that control chemical evolution and plant metabolism. By focusing on related plants from a particular region in South America, the researchers will be able to see how the plants' chemistry evolved for protection from the effects of their environment.

“Plants are amazing biochemists as they make hundreds of thousands of compounds, yet we don't know how most of these chemical compounds are produced by the plant or the role of these metabolites in the natural history of species across the kingdom,” said Last, who also holds the MSU Barnett Rosenberg Chair of Biochemistry in the MSU Department of Biochemistry and Molecular Biology. “We hope to tie together the chemical phenotypes with selective pressures, including climate, insects and pathogens, to see how their reactions have evolved in the wild.”



The grant furthers Last's long-time research on the function of trichomes — the fine hairs on plants that are keys to their smell and taste.

“Secreting glandular trichomes are little chemical factories in the plants,” he said. “They are important to smell and taste, and they play a key role in plant survival.”

Insight into these plants' mechanisms can help develop strategies to make plants more resistant to disease and insect damage, and help to increase the productivity of cultivated crops.

The grant will also fund a summer outreach program, which will give undergraduate students experience in biochemistry, genetics, metabolomics and the scientific method. Last said that the program, which recently became an official NSF Research Experience for Undergraduates site, excels at attracting minority students and connecting them with the labs and resources available only at MSU.

## Human rules may determine environmental 'tipping points'

People, governments and institutions that shape the way people interact may be just as important in determining environmental conditions as the environmental processes themselves, according to a new paper in the Proceedings of the National Academy of Sciences.

Tipping points, or qualitative changes in an ecosystem that often result in reduced ecosystem health and are difficult and costly to reverse, increasingly concern environmental scientists. The prevailing assumption among scientists has been that tipping points are fixed values.

Research results showed, however, that tipping points in human-influenced ecosystems are affected by regulatory choices that influence human behavior.

“This gives us reason for optimism,” said MSU AgBioResearch scientist **Richard Horan**, who is a professor of environmental and natural resource economics in the MSU Department of Agricultural, Food and Resource Economics and lead author of the paper. “If we give regulators sufficient flexibility, it may be possible and cost-effective to manage ecological systems so that only desirable ecological outcomes arise and tipping points are eliminated.”

Research results indicate that these tipping points are not fixed in human-influenced ecological systems but depend instead on human responses to a changing environment.

“For example,” Horan said, “if natural resource managers' policy choices are overly restricted, then it might be too difficult or costly to avoid tipping points.”



In particular, the researchers emphasize that their results highlight the importance of giving strong institutional support to regulatory agencies that aim to enhance societal well-being. They also point out many instances where tipping points resulted in catastrophic changes in ecosystems, such as climate change, collapsed freshwater and marine fisheries, and changes wrought by invasive species.

For example, the invasive species sea lamprey changed the Great Lakes from an environment that produced lake trout and whitefish to a collapsed fishery. If not for the \$17 million spent annually by the United States and Canada to control it, sea lamprey would continue to devastate Great Lakes fisheries.

Another example is the invasive rusty crayfish, which has transformed many Michigan and Wisconsin lakes from underwater forests inhabited by many smaller animals that supported sport fish to clear-cut forests with diminished sport fish production. This outcome occurred despite the fact that many fish, such as smallmouth bass, readily consume crayfish.

Institutional rules shape the relationships among managers, users and ecological systems. If the system

is mapped using only ecological characteristics, then managers may not account for human responses to change, such as changing decisions about whether or how much to fish as fishing quality changes.

“Without strong institutional support, tipping points might disappear but not in a good way,” Horan said. “Suppose lake managers invest in crayfish removal but do not properly alter the behavior of anglers, who may overharvest fish. Why would we invest to protect the system from crayfish if we are unable, or unwilling, to protect the system from humans?”

### Circadian rhythms spark plants' ability to survive freezing weather

Just as monarch butterflies depend on circadian cues to begin their annual migration, plants do so to survive freezing temperatures.



All living things — humans, animals, plants, microbes — are influenced by circadian rhythms, which are physical, mental and behavioral changes that follow a 24-hour cycle. In a recent issue of the Proceedings of the National Academy of Sciences, AgBioResearch scientist **Michael Thomashow**, along with Michigan State University (MSU) colleagues Malia Dong and Eva Farré, explains that the circadian clock provides key input required for plants to attain maximum freezing tolerance.

“The integration of cold-signaling pathways with the circadian clock may have been an important evolutionary event that has contributed to plant adaptation to cold environments,” Thomashow said.

Thomashow, who is also an MSU university distinguished professor of molecular genetics and an elected member of the National Academy of Sciences for his contributions to the field of plant biology, has focused his research on the identification of stress response pathways involved in freezing and drought tolerance. Stresses, including extreme temperatures and water deficit, are major factors that limit the geographical locations where food and potential bioenergy crops can be grown.

His research led to the identification of the C-repeat binding factor, or CBF response pathway, a stress pathway that can be found in many plants and plays a major role in freezing and drought tolerance. Reducing abiotic stresses, such as extremes caused by temperature and drought, can help expand where crops can be grown and increase annual yields, Thomashow said.

“Increasing the abiotic stress tolerance of crops is integral to keeping food production apace with the increasing world population and to the national vision of replacing a significant proportion of petroleum-based transportation fuels with renewable biofuels,” he said.

Identifying the circadian clock's influence helps answer a major question that had been puzzling researchers regarding the CBF pathway and how plants sense changes in temperature and other environmental conditions that regulate the activity of the pathway.

Knowing that input from the circadian clock is required for plants to attain maximum freezing tolerance will be a key factor for researchers to develop “designer plants,” ones that have modified CBF pathways that improve abiotic stress tolerance, Thomashow said.

In addition to funding from AgBioResearch, Thomashow's research is supported in part by the U.S. Department of Energy (Division of Chemical Sciences, Geosciences and Biosciences, Office of Basic Energy Sciences) and the National Science Foundation (Plant Genome Project).

### Major changes necessary to sustain U.S. farming's future

To provide abundant and affordable food, feed, fiber and fuel, U.S. agriculture needs to change its approach, according to research appearing in the May 6 issue of Science magazine.

MSU AgBioResearch scientist **Sandra Batie** and MSU colleague Richard Harwood, professor emeritus of crop and soil sciences, were among a team of scientists and farmers who wrote a report published by the National Research Council. The report, which was expanded as a policy forum in Science, identifies policy and practice reforms that could place agriculture in the United States and abroad on a more sustainable trajectory that includes improved natural environments and food security for the future.

The report stated that, although farmers in the United States continue to provide growing supplies of food and other products, such as fiber and ethanol, these efforts have been accompanied by the unintended consequences of greenhouse gas emissions, biodiversity loss, natural resource degradation and public health problems.

“Agricultural efforts also are vulnerable to resource scarcity, climate change and market vulnerability,” said Batie, who is the Elton R. Smith professor of food and agricultural policy. “Further, society continues to ask that agriculture better address not only these sustainability issues and challenges but also issues involving the welfare of rural communities, farm workers and farm animals.”

To improve the sustainability of

farming in the United States and worldwide, the team recommended that farmers, policymakers and scientists continue to expand current sustainability efforts to address whole-systems redesign.

“There are many examples of such redesign that address and balance sustainability goals, including the goal of enhancing farming productivity and financial viability,” Batie said.

The team, which also included farmers and researchers from Washington State University, Utah State University, is recommending both incremental and transformative changes. Incremental changes include adopting two-year crop rotations and employing precision agriculture practices using geospatial technologies that track field variation, classically bred or genetically engineered crops, and reduced- or no-tillage practices.

Though the small-scale changes are important, the researchers stated they are not enough to address larger sustainability concerns that could impair farming's future. These changes come from a whole-system redesign approach rather than focus on individual technological improvements. They include:

- Employing more organic farming.
- Embracing alternative livestock production (e.g., grass-fed/low-confinement animals).
- Incorporating mixed crop and livestock systems.
- Developing perennial grains.

“These approaches integrate the critical components of production, environmental and socioeconomic objectives,” Harwood said. “They also reflect greater awareness of ecosystem services and capitalize on complementary farm enterprises, such as crop and livestock production.”

Greater scientific validation could speed adoption of these successful examples of improved systems now in use by thousands of farmers, he added.

## Spurring Sweet Success



Thanks to Michigan State University (MSU) and AgBioResearch, a sweet partnership has helped revitalize Michigan's \$444 million sugar beet industry.

In 1996, the industry was in peril. Yields hit an all-time low because of pest, disease and production issues that greatly reduced crop health. Farmers were looking to get out of sugar beet farming and switch to more profitable crops. Industry representatives reached out to MSU for help.

Working with the Michigan Sugar Co., MSU spearheaded the creation of the Michigan Sugar Beet Advancement program, an interdisciplinary team of scientists, industry representatives and farmers. Together, they have resurrected the state's sugar beet industry, boosting production more than 80 percent in 15 years, establishing Michigan as the nation's fourth-leading sugar beet producer and giving the state an indirect economic boost of \$1 billion.

"Fifteen years ago, the sugar beet industry in Michigan was struggling to survive," said Steve Poindexter, an MSU Extension educator in Saginaw County, who works with the Saginaw Valley Research and Extension Center, one of 14 AgBioResearch centers across the state. "Industry representatives came to MSU seeking a way to fund a position to do research and education outreach to help improve the sugar beet crop. This is a great success story that was definitely a team approach."

When the research started, 30 issues or problems needed to be addressed. These primarily centered on poor emergence of the plants, various diseases and nematodes, and the sugar quality of the beet. A grant from MSU's Project GREEN (Generating Research and Extension to Meet Economic and Environmental Needs) was used to begin addressing these issues.

"Through our research, we've been able to improve sugar content from 16 percent to 18 percent, which increases farmers' profits without them having to farm any additional acreage," said Paul Pfenninger, Michigan Sugar Co.'s vice president of agriculture. "Our goal is to continually improve this percentage and eventually reach 19 percent in the near future."

Advancements have allowed Michigan growers to produce 4 million tons of sugar beets, which translate to 1 billion pounds of white sugar. There are now 1,100 farm families raising sugar beets and 2,300 full- and part-time employees working at Michigan Sugar Co.

"We've improved sugar content and nutrient management, which has vastly increased yields and enhanced crop quality," Poindexter said. "Essentially, we've made sugar beets the crop of choice in this region."

## Research maps out trade-offs between deer and timber

Since the 1950s, sustainability in northern hardwood forests has been achieved by chopping down trees in small clumps to make room for new ones to spring up naturally. Early experiments with single-tree and group selection logging found that desirable species such as sugar maples did a great job of regenerating in the sunny, rain-drenched harvest gaps – theoretically eliminating the need to replant.

But something has changed.

In a sweeping study of a huge swath of Michigan's Upper Peninsula, AgBioResearch forest ecologist

Michael Walters and other MSU researchers document that, in many places, the sugar maple saplings that should be thriving following harvesting are instead ending up as a deer buffet. This means the hardwood forests are not regenerating.

The results of the study, "Gap-, stand- and landscape-scale factors contribute to poor sugar maple regeneration after timber harvest," were published in the May online edition of *Forest Ecology and Management*. The research was funded by the U.S. Department of Agriculture and the Michigan Department of Natural Resources.



"Our goal was to determine what factors are affecting the regeneration of sugar maple," said Walters, an MSU associate professor of forestry. "Management paradigms for deer and northern hardwood forests have resulted not only in regeneration failure where deer populations are especially high but also in low tree regeneration diversity where they are not."

Forest conservation is a persistent push and pull between maintaining crops of hardwoods – especially sugar maple – for the timber industry, and herds of deer for hunters. The interplay between these conflicting resource uses can also affect bird habitat. So it came as no surprise that, when the researchers – Walters; Megan Matonis, a member of the research team who recently received a master's degree in forestry while a member of the Center for Systems Integration

and Sustainability at MSU; and James Millington, former post-doctoral researcher and now a Leverhulme Early Career Fellow at King's College in London – ventured into the U.P. forests for the study, they were peppered with questions by both hunters and loggers.

"It's amazing how differently these two groups generally view the situation," said Matonis, now a doctoral student in forest science at Colorado State University and an intern with the U.S. Forest Service in Washington, D.C. "Some hunters feel there aren't enough deer in the forests, whereas 'save a tree, kill a deer' is the sentiment of many loggers."

The study area stretches over some 3,000 square miles of public and private land from Crystal Falls to the west, east and south to Escanaba and north of Marquette. For two years, the group examined the harvest gaps left in forests when hardwoods are cut down, studying the amount of light in gaps of various sizes, competition from other plants on the forest floor, potential seed supply, and the relative richness and wetness of the soil.

What they found is that in the north, where heavy snows push deer populations south in search of food during the winter, sugar maple saplings generally are thriving in the harvested areas. Yet in the southern portion of the study area, there were areas where no saplings survive. Saplings are a tasty snack for hungry deer.

Although munching by deer seems to be the main cause of low sapling densities in the south, other factors also make it a tough life for saplings. Low light levels in small gaps and competition from other plants also play roles in poor regeneration.

"The results of this study fed into the development of a computer model designed to help balance those often-competing uses of the forests," Walters said. "These results and results from other projects by our research group are being com-

## Research IN THE NEWS

municated to forest managers and have resulted in the consideration of alternative management approaches for assuring the sustainability of this important resource.”

### New AgBioResearch faculty members

MSU AgBioResearch is pleased to welcome four new faculty members.



**John Kerr**, associate professor in the Department of Community, Agriculture, Recreation and Resource Studies, became affiliated with AgBioResearch in May. His research focuses on factors that influence individual and collective decisions about natural resource management, particularly in developing countries. Kerr has conducted research in Egypt, India, Indonesia, Mexico and the United States. He is interested in the economic and social aspects of incentive-based policies to promote improved natural resource management.

Before joining MSU in 1999, Kerr spent four years with the International Food Policy Research Institute in Washington, D.C., and five years with the International Crops Research Institute for the Semi-Arid Tropics in Hyderabad, India. These two research institutes are part of the Consultative Group for International Agricultural Research. In these posts, Kerr conducted research on watershed management, agricultural technology adoption and rural development in India. He received his doctoral and master's degrees in applied economics from the Food Research Institute at Stanford Universi-

ty in 1990 and 1987, respectively, and his bachelor's degree in economics from Swarthmore College in 1983.

**Shannon Manning**, assistant professor in the Department of Microbiology and Molecular Genetics, became affiliated with AgBioResearch in January. Her research focuses on applying molecular and evolutionary approaches to study the virulence, epidemiology and evolution of bacterial pathogens to better understand pathogenesis, emergence, and transmission in human and animal populations. She works primarily with shiga toxin-producing *Escherichia coli* (STEC) and group B Streptococcus. She is also examining how enteric infections alter intestinal microbial communities, and identifying factors important for STEC shedding in cattle.



Manning has been a member of the research faculty at MSU since 2004 and worked closely with the late Thomas Whittam and H. Dele Davies in the Department of Pediatrics and Human Development. Before coming to MSU, she was awarded an emerging infectious diseases research fellowship through the Centers for Disease Control and Prevention and the Association of Public Health Laboratories, and she worked at the Michigan Department of Community Health, Bureau of Laboratories. Manning received her doctorate in molecular epidemiology, her master's degree in public health and her bachelor's degree in biology from the University of Michigan in 2001, 1998 and 1993, respectively.



**Bo Norby**, associate professor of dairy health and well-being, became affiliated with AgBioResearch in March. His overall research focus is on the ecology of antimicrobial resistance in enteric bacteria, and how antimicrobial-resistant bacteria develop, spread and persist in cattle and human populations.

His research interests are in understanding risk factors for preharvest food safety issues in dairy cattle and developing intervention strategies to mitigate these risks. Additionally, Norby has conducted research to understand cattle producers' behavior in the face of foreign animal disease outbreaks.

Before coming to MSU, Norby spent seven years at Texas A&M University, where he established a well-funded research program focused primarily on the study of antimicrobial resistance in beef and dairy cattle. He also taught epidemiology and food safety and security to veterinary and graduate students. Norby received his veterinary degree from the Royal Veterinary and Agricultural University in Copenhagen, Denmark, in 1995 and his master's degree in veterinary preventive medicine at the University of California-Davis in 1998. In 1998, Norby came to MSU, where he completed a doctoral program under the direction of Paul Bartlett with a focus on the epidemiology of bovine tuberculosis.

Kurt Steinke, assistant professor of soil fertility and nutrient management in the Department of Crop and Soil Sciences, became affiliated with

AgBioResearch in January. His research interests include evaluating the environmental effects of managed ecosystems, improving ecological efficiency and nutrient management across a broad array of production agricultural systems, managing phosphorus-enriched stormwater runoff, environmental stress physiology and management, and drought and water management. Steinke has completed a long-term ecological research study evaluating the effects of turfgrass and prairie buffer strips in reducing stormwater runoff and phosphorus loading. Other projects include comparing water use between alternative types of urban vegetation and investigating the influence of mandatory municipal water restrictions on the drought survival of warm-season turfgrass.



Steinke came to the MSU crop and soil science program in 2009 from Texas A&M University, where he held a similar faculty position since 2006. He received his bachelor's degree in soil science at the University of Wisconsin-Stevens Point in 1999, and his master's degree in horticulture and his doctorate in horticulture and soil science from the University of Wisconsin-Madison in 2002 and 2006, respectively. 🌱

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