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LOUISIANA Agriculture

Assuring Our Future Through Scientific Research and Education

Asian carp seize La. waters

Research abates termite takeover

Holding invasive species at bay

LSU AgCenter Research & Extension

The value of earmarks

For the past few months, the institutions of higher education in Louisiana, including the LSU AgCenter, have been under the threat of deep budget cuts as high as 32 percent. Such severe cuts would be catastrophic. The current word, however, is that a 32 percent cut is not likely to materialize, according to LSU AgCenter Chancellor Bill Richardson. He is working closely with the Board of Regents and the governor's office to ascertain the funding levels for the AgCenter and higher education. He says many factors are at play to minimize the impact of the state budget deficit expected for the 2011-12 fiscal year on higher education and health care.

What is certain, though, is there will be cuts in state funding. And no matter what size, they will cause pain. The pending budget reduction comes on top of a steady stream of cuts since 2008, which have reduced the state appropriation to the AgCenter by 16 percent and caused the loss of more than 200 positions. The AgCenter stands today operating at bare bones without a tuition model to soften the effects.

Funds immensely helpful to the AgCenter are the so-called federal "earmarks." These are noncompetitive grants that provide sustained funding for projects that benefit individual states. These earmarked funds are currently under fire by the current Congress eager to reduce the federal deficit.

Here are some highlights of what earmarks have done and do for Louisiana.

The production of wetland plants for coastal restoration. Unfortunately, plant varieties that are salt-tolerant and have prodigious root systems that grasp onto land in marshes and beaches do not propagate well. AgCenter researchers are developing varieties of plants that can proliferate more rapidly. This plant production effort will help save the Louisiana coast.

The development of conservation tillage practices in farming. Researchers have developed and extension agents have taught best management practices so farmers can grow their crops and raise their livestock in ways that will stem soil erosion and improve water quality.

The establishment of the Master Farmer program. This joint program grew out of the need for increased voluntary adoption of environmental stewardship best management practices for farm and ranch lands. The program has gained nationwide attention and has been copied by other states. Farmers who learn and adopt BMPs gain Master Farmer certification from the Louisiana Department of Agriculture and Forestry. The other partners in the project are the Natural Resources Conservation Service, Louisiana Farm Bureau and the Louisiana Cattlemen's Association.

The expansion of the crawfish industry. No other state grows the quality and quantity of crawfish Louisiana does. That's because of the AgCenter's research and extension program, which enables the crawfish industry to improve and expand. A viable crawfish industry benefits the state's economic development. Earmarked funds go into our aquaculture research program.

The control of the Formosan subterranean termite in New Orleans. Four of the articles in this issue of *Louisiana Agriculture* tell about the success of the Operation Full Stop program in New Orleans. This invasive termite was destroying the historic French Quarter before the AgCenter in partnership with the U.S. Department of Agriculture and the New Orleans Mosquito and Termite Control Board developed an areawide management effort.

The federal earmarks are being portrayed as pure "pork" that benefits only a narrow group of people. But in Louisiana they have provided funding for discoveries and programs that have helped a broad swath of Americans. Eradicating earmarks will have a negligible effect on the federal deficit. This year, earmarks make up less than 1 percent of federal discretionary spending, which is nearly $1.4 trillion. But their elimination would be one more blow to the LSU AgCenter and its services to Louisiana. ■ **Linda Foster Benedict**

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Assuring Our Future Through Scientific Research and Education

ON THE COVER: Fisherman Rusty Kimball caught this Asian carp near Butte LaRose. Read more about Asian carp starting on page 12. Photo by Bruce Schultz.

What's New?

What's New?

3 new rice varieties ready for 2011

The LSU AgCenter has released three new varieties of rice. The varieties include a new medium-grain, a long-grain Clearfield and an aromatic Jasmine-type. Seed from the three releases will provide limited seed production in 2011.

The medium-grain variety has been named Caffey, to recognize the work of Rouse Caffey, retired LSU AgCenter chancellor who had been a director of the Rice Research Station.

Steve Linscombe, director of the station and a rice breeder, said this medium-grain variety has consistently out-yielded Neptune and Jupiter varieties in testing for the past three years. Its grain is bolder and similar to Calrose, a quality preferred by many end users.

Photo by Bruce Schultz

Xueyan Sha, rice breeder at the Rice Research Station, is responsible for the development of both versions of Jazzman rice.

The new Clearfield variety has been designated CL152. Its grain quality is superior to CL151, and it has more resistance to lodging – or falling over – and to straighthead and blast diseases, according to Linscombe, who developed this variety.

The new aromatic variety has been named Jazzman II. It has increased aroma compared with its predecessor Jazzman, which was released last year to compete with imports of Jasmine rice from Thailand, according to Xueyan Sha, the LSU AgCenter rice breeder responsible for both versions of Jazzman. ■ **Bruce Schultz**

Freshwater plants invade Louisiana coast

An unintended consequence of the Deepwater Horizon oil spill, which occurred on April 20, 2010, has been the expansion of invasive freshwater plants into the intertidal zone along Louisiana's Gulf Coast.

"In the course of my regular salvinia survey work, I have noted and documented to the Louisiana Department of Wildlife and Fisheries a huge environmental change," said Dearl Sanders, LSU AgCenter weed scientist.

To keep the oil at bay, the U.S. Army Corps of Engineers has operated the freshwater diversions at maximum capacity since shortly after the spill, said Sanders, who has been instrumental in the AgCenter's program to control invasive plants in Louisiana's freshwater lakes, rivers and bayous.

What was normally brackish water became fresh as a result of the diversions, which kept the oil at bay, Sanders said. But that apparently has allowed normally freshwater plants to move south 20 miles farther than normal.

This year, the Corps ran the Davis Pond Diversion at maximum or near maximum capacity from May until September, a time that it usually operates at minimum to low capacity, Sanders said.

"An explosion of freshwater invasive plants has occurred," he said. "Hydrilla, salvinia and water hyacinth have taken over areas where minimal saltwater levels have kept them in check for decades."

For example, Sanders has documented the movement of hydrilla from the fringes of lakes Des Allemands, Salvador, Catawatche and others so that the plants now cover hundreds of acres of what had been clear, brackish waters.

"Unless this is reversed, we may lose these lakes – or parts of them – like we have lost lakes Boeuf and Henderson," Sanders said. "I have discussed this with the Department of Wildlife and Fisheries, and they, too, are aware of the problem." ■ **Rick Bogren**

Friend of Extension Award goes to Angelle

Scott Angelle, secretary of the Louisiana Department of Natural Resources (DNR) and former Louisiana lieutenant governor, has received the national Epsilon Sigma Phi (ESP) Friend of Extension Award for his support and promotion of the LSU AgCenter's 4-H program.

This national ESP honor goes to a nonextension individual, business or organization to recognize truly outstanding support and personal involvement in extension efforts, said Diane Sasser, professor of human ecology and awards chairman of ESP's Alpha Alpha Chapter in the AgCenter.

From his early years of public service as president of a parish policy jury to lieutenant governor and twice secretary of DNR, Angelle carries with him an appreciation for Louisiana 4-H, Sasser said.

At 30, Angelle was elected president of the St. Martin Parish Police Jury, making him the youngest person in parish history to hold that title. It was at that time Angelle began his involvement with the Extension Service and 4-H, Sasser said.

Angelle developed a special affinity for the 4-H program and its efforts in wetlands protection and conservation, Sasser said.

During his first stint as secretary of DNR, Angelle was instrumental in securing funds to initiate the 4-H Youth Wetlands Program. A three-year grant of $500,000 a year provides opportunities for 4-H'ers throughout Louisiana to learn firsthand about conserving Louisiana's coast and becoming good stewards of the state's natural resources.

Angelle saw the promise of 4-H youth and how they could extend DNR's work through being good citizens and conservators of Louisiana, Sasser said. ■ **Mary Ann Van Osdell**

What's New?

LSU AgCenter receives $1.26 million in federal grants

The LSU AgCenter has received grants totaling nearly $1.26 million during the past few months.

"These grants are examples of the type of funds and the importance of the research our faculty members undertake," said Chancellor Bill Richardson. "They also indicate how the state's investment in the LSU AgCenter can be leveraged into additional funds that benefit the state of Louisiana."

The recent grants include:

– $117,400 for three grants from the Louisiana Department of Agriculture and Forestry as part of a U.S. Department of Agriculture program to support research in specialty crops, which include fruits, vegetables, nuts and nursery and horticultural crops. Pecan scab disease research received a two-year grant for $22,400 to study a new control for the disease. It will be conducted by Charlie Graham, a plant physiologist at the Pecan Research and Extension Station in Shreveport. Sweet potato weed management options in commercial sweet potato production are being funded by a three-year grant for $67,000. The research will be conducted by Donnie Miller, weed scientist, and Tara Smith, sweet potato specialist. Youth outreach programs received a two-year grant for $28,000 to educational materials for children intended to increase their awareness of agriculture, particularly specialty crops. Frankie Gould, communications director, will oversee production of these materials.

– $600,000 from the National Science Foundation to make upgrades in the biotechnology laboratories in Harry D. Wilson Laboratory building on the LSU campus. This grant is from a $300 million fund of federal stimulus dollars called the Academic Research Infrastructure Program Recovery and Reinvestment being distributed to research institutions across the country to enhance their capacity to conduct research, according to John Russin, associate vice chancellor of the LSU AgCenter.

– $13,750 from the USDA to screen for one year the AgCenter citrus variety collection for several potentially destructive diseases. The grant was awarded by the USDA's Plant Protection and Quarantine program in the Animal and Plant Health Inspection Service to support the AgCenter's involvement in the national Citrus Clean Plant Network. The research will be conducted by Don Ferrin, plant pathologist.

– $424,000 from the National Science Foundation to support developing a database and image library at the Louisiana State Arthropod Museum. Victoria Bayless, curator, and Chris Carlton, director of the arthropod museum, will produce an online database of entomological diversity that will serve as a taxonomic identification tool useful throughout the South.

– $21,350 from the U.S. Department of Agriculture's Farmers Market Promotion Program to support a one-day conference for farmers markets in Louisiana. The grant will enhance and broaden the skills and information network of market managers and key vendors at Louisiana farmers markets, said Carl Motsenbocker, horticulturist. LSU AgCenter economist Roger Hinson is assisting with this project.

– $79,000 is the AgCenter's share of a grant to study dispersant toxicity to organisms critical to the ecosystem of the Gulf of Mexico. The funding comes from the National Science Foundcation. Other participants include Modular Genetics Inc., Columbia University and Iowa State University. The grant supports work on the production and testing of biodispersants that might be used to replace the chemical dispersants used for oil spill management, according to Andy Nyman in the School of Renewable Natural Resources. ■ **Rick Bogren**

Mexican rice borer extends reach into Louisiana

The Mexican rice borer, a threat to sugarcane and rice, has moved eastward from Texas extending farther into Louisiana.

The insect was first found in Louisiana in December 2008 north of Vinton.

On Nov. 22, 2010, four male adults were found in a pheromone trap about six miles southwest of Sulphur, according to Gene Reagan, LSU AgCenter entomologist. Chris Carlton, director of the Louisiana State Arthropod Museum, confirmed that these trap catches were Mexican rice borers.

"This trap location is adjacent to a grassy area where no crops are grown, and it is within 15 to 18 miles of commercial sugarcane fields south of Lake Charles," Reagan said.

Reagan's graduate student, Julien Beuzelin, said the traps are set out by the Louisiana Department of Agriculture and Forestry. "Without their work, it would have not been possible to detect this insect's movement," Beuzelin said.

He said the LDAF had planned to end the monitoring program in early December, but after the Nov. 22 samples were found, the department has decided to continue the program into the spring.

Beuzelin said the discovery is a reliable indicator that the pest is continuing to move eastward in Louisiana.

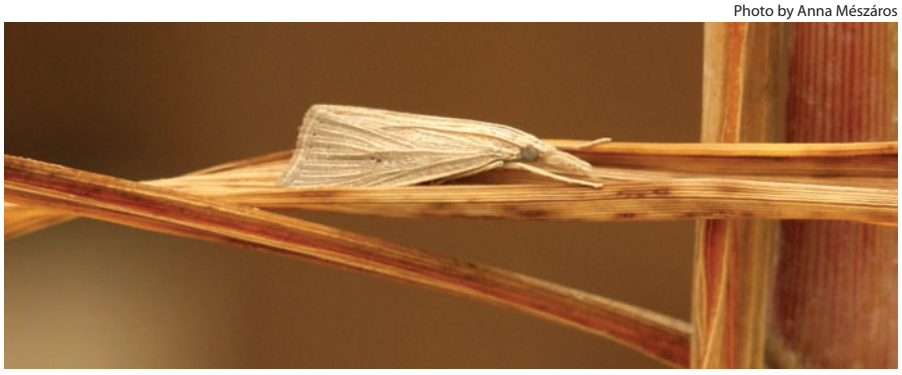
"Since first being found in south Texas in 1980, they have consistently expanded their range along the Gulf Coast," Beuzelin said.

In 2006, the Mexican rice borer was found in east Texas just one county away from Louisiana, and it was anticipated that it would be found in Louisiana in 2008. Only two weeks before the end of 2008, borers showed up in two pheromone traps five miles apart on the Louisiana-Texas line north of Vinton.

A 2007 study by LSU and Texas A&M projected an annual $45 million loss of revenue for Louisiana rice farmers once the entire state is infested.

The estimated damage for sugarcane is projected at up to $220 million

Photo by Anna Mészáros



The Mexican rice borer moth rests on Johnsongrass foliage.

What's New?

in the next few years. Mexican rice borers are not obvious pests in rice until the crop is in the boot stage. But by the time it is found within rice plants, Reagan said, studies with Texas colleagues show that the population jumps rapidly. Reagan said that prompted the question to arise regarding the pest's overwintering habitat.

Between growing seasons, the insect is found in high numbers in grasses such as Johnsongrass and vaseygrass.

Once the insect bores into sugarcane, insecticides don't work well because the cavity created by the borer is filled with chewed plant material, frass, blocking a chemical's entry, he said.

Insecticides work better on the pest in rice, Reagan said. However, three applications may be required in some east Texas areas.

A new seed treatment, Dermacor, appears to help control the pest in rice. Originally, Dermacor was developed as a seed treatment for drill-seeded rice against the rice water weevil. ■ **Bruce Schultz**

Rice farming sustainability program starts

The Kellogg Company of Battle Creek, Mich., recently announced a partnership with the LSU AgCenter to develop a sustainability program for Louisiana rice producers who grow rice for Kellogg's products.

The program will rely on expertise within the LSU AgCenter and with Louisiana rice millers to help develop a master grower program that focuses on environmentally sound and profitable rice production, according to Diane Holdorf, Kellogg vice president of environmental stewardship.

The program will be based on the AgCenter's Master Farmer program, said Steve Linscombe, director of the LSU AgCenter Rice Research Station and rice breeder.

"The ultimate goal of the program will be to ensure this rice is produced in a sustainable and profitable manner," Linscombe said.

Kellogg has become concerned about sustainability within its own corporate operations, as well as its suppliers, Holdorf said. The company has set a series of goals of waste reduction, decreased energy and water usage, and generating less greenhouse gas. The company also will apply sustainability principles to other key cereal ingredients, including corn, wheat and palm oil. ■ **Bruce Schultz**

Rice insect guide now online

Solving the whodunit mystery of insect damage in a rice crop will be easier with a new online program developed by the LSU AgCenter.

Using the process is as easy as playing the board game "Clue" because it uses a simple process of elimination, according to LSU AgCenter experts. But instead of guessing if the perpetrator was Col. Mustard armed with a lead pipe, the usual suspects will be arthropods (insects and mites) such as the rice water weevil, billbug, chinch bug or spider mites.

The program originated from a conversation with Evangeline Parish farmer Richard Fontenot, said LSU AgCenter entomologist Natalie Hummel. "The whole project was his idea."

Anyone with access to the Internet through a smart phone can get to the guide in the field and through process of elimination, click on a list of symptoms and narrow down the pest and suggested treatments.

"It doesn't require you to be an entomologist to use it," Hummel said.

The website starts by asking users to identify the location of visible damage, then lists descriptions of different types of damage with photographs to illustrate the feeding signs so the user can identify the likely culprit.

For example, feeding on the lower part of the plant brings the user to the options of feeding signs on the leaf blade or another part of the plant. If the feeding is on the surface of the leaf blade, the next step is to choose between the first option of feeding on "narrow strips of leaf material removed between veins" or "other type of feeding damage or leaf dehydration."

The first option would identify the suspect as Public Enemy No. 1 in rice farming, the notorious rice water weevil, or the lesser-known rice leaf miner. The second choice, "Other type of feeding damage or leaf dehydration," asks the user to further identify the damage, choosing between broken leaf tips, which could be caused by the Southern green stinkbug, or dehydrated leaf tips, which is probably the work of aphids.

"At the final step, you will see a picture of the arthropod and some information about scouting and management," Hummel said. The guide also has links to videos that show how scouting should be done for rice water weevils and colaspis, a small beetle. ■ **Bruce Schultz**

Photo by Bruce Schultz

Natalie Hummel, extension rice entomologist, shows an example of a rice insect pest, the colaspis beetle.

Officials thank LSU AgCenter at sweet potato plant opening

Gov. Bobby Jindal, state legislators and ConAgra Food officials thanked the LSU AgCenter during the Nov. 5 grand opening of ConAgra's new sweet potato processing plant near Delhi.

Amid a sea of orange-clad ConAgra employees, state Sen. Francis Thompson quoted Jackie Gleason with "How sweet it is."

ConAgra's Lamb Weston division, which is based in Washington state, built the state-of-the-art facility in northeast Louisiana to take advantage of Louisiana's bountiful sweet potato crop.

Company officials said they chose the location to be in close collaboration with the researchers and extension specialists at the nearby LSU AgCenter Sweet Potato Research Station in Chase, which is the only facility of its kind in the United States.

Lamb Weston markets frozen sweet potato products – wedges, puffs, mashed – to restaurants through its Sweet Things brand and to grocery stores through its Alexia brand. It operates frozen-food processing plants in the Pacific Northwest, Minnesota and Canada.

Jindal said the plant had a capital investment of $156 million and provided 275 direct jobs and 780 indirect jobs. A second phase will be completed by 2014.

"This is a great win for the workers and farmers," he said, adding that he looks forward to eating the sweet potato fries the plant will process.

"The acknowledgement that the Sweet Potato Research Station contributed to the decision of ConAgra's Lamb Weston to locate in Louisiana is an example of an institution of higher education – the LSU AgCenter – fueling economic development in our state," said David Boethel, LSU AgCenter vice chancellor.

"Gov. Jindal, in his remarks, indicated we needed to develop more value-added products from our raw materials," Boethel said. "Certainly, this processing plant will do that for the sweet potato industry."

Boethel said LSU AgCenter research and extension scientists working on sweet potatoes have achieved worldwide recognition. "I want to thank the LSU AgCenter researchers and all of our ag partners," said Jeff DeLapp, president of Lamb Weston. "Great quality food requires great quality ingredients. The northeast Louisiana region has the best sweet potato products in the world."

Gary Rodkin, president and CEO of ConAgra, said he appreciated everyone who played a role in the opening, including the LSU AgCenter.

"This is sweet potato country, the perfect place to extend our leadership in sweet potatoes," Rodkin said.

Louisiana has about 13,000 acres in sweet potato production, and this will grow over the next few years.

■ **Mary Ann Van Osdell**

Youth Wetlands program wins national award

An LSU AgCenter 4-H program has been chosen for a national award by the U.S. Fish and Wildlife Service.

The Youth Wetlands education and outreach program was selected to receive the U.S. Fish and Wildlife-4-H 2011 Connecting Youth with Nature Through Natural Resources Conservation Education Award.

The award consists of a $10,000 grant to the LSU AgCenter 4-H Youth Development Department plus travel for five program representatives to attend an awards reception at the North American Wildlife and Natural Resource Conference March 16, 2011, in Kansas City, Mo.

"We're thrilled to receive this recognition," said Mark Tassin, state director of 4-H. "It's a testament to the strong work of a whole lot of people."

The Youth Wetlands Education and Outreach program is a statewide initiative by the Louisiana Office of Coastal Protection and Restoration, Tassin said. It's designed to heighten students' awareness of Louisiana's wetland loss.

Louisiana 4-H provides participating teachers with lessons and activities at no cost, said Ashley Mullens, youth wetlands program manager.

Teachers present the lessons throughout the academic year, and the program culminates during Youth Wetlands Week, which is in April, Mullens said. The program curriculum is endorsed by the Louisiana Science Teachers Association, and lessons are designed to follow Louisiana's Grade Level Expectations. Students complete pre- and post-tests, and the results reflect increased knowledge of main science concepts.

During the summer, 4-H offers four camps that use the program curriculum and provide wetland-related, hands-on learning activities. ■ **Rick Bogren**

Photo by Bruce Schultz

Students at Meaux Elementary School in Vermilion Parish build a wood duck nesting box as part of Youth Wetlands Week activities.

OVERVIEW

On Guard for Invasive Species

Natalie A. Hummel, Krishna Paudel, Craig Roussel, Tad Hardy and William Spitzer

Louisiana is a beautiful state with a unique blend of cultures and habitats. Positioned on the Gulf of Mexico and at the mouth of the Mississippi River, the state benefits economically from international trade and interstate commerce. Unfortunately, these factors also make the state vulnerable to invasive species introductions. The spread of invasive species threatens economic and ecological stability by decreasing biodiversity, displacing native species and increasing agricultural production costs.

Natalie A. Hummel, Assistant Professor, Department of Entomology, LSU AgCenter, Baton Rouge, La.; Krishna Paudel, Associate Professor, Department of Agricultural Economics & Agribusiness, LSU AgCenter, Baton Rouge, La.; Craig Roussel and Tad Hardy, Louisiana Department of Agriculture and Forestry; William Spitzer, U.S. Department of Agriculture, Animal Plant Health Inspection Service, Baton Rouge, La.

For this issue of Louisiana Agriculture, we define invasive species as any non-native species that has entered and spread aggressively causing damage to agricultural production, human habitation, forestland, wetlands or native species. Although not all non-native species are invasive, those that are cause an estimated $120 billion in damage in the United States each year. In a 2009 U.S. Department of Agriculture report ranking the relative risk exotic pests pose to the 50 states, Louisiana was ranked ninth. Within the past 12 years alone, 33 new invasive plant pest species have been detected in Louisiana. Realizing the threats to the Louisiana economy and ecosystem, LSU AgCenter scientists conduct research and extension programs aimed at prevention, control and eradication of invasive species.

Economic Impact

The economic impact of invasive species is difficult to calculate but is significant. The damage caused by the Formosan subterranean termite, for example, is estimated to exceed $1 billion per year in the United States with the portion accrued in Louisiana alone exceeding $500 million per year. AgCenter economists have completed an extensive cost analysis of control choice options in Louisiana. For the past 20 years, AgCenter researchers have used traps to monitor Formosan termite populations in the French Quarter and greater New Orleans area. Within the past few years, AgCenter researchers have begun using DNA profiling to monitor individual colonies, which are genetically distinct from each other. The data generated by monitoring through trapping and DNA techniques have been used to garner federal funding for a project known as Operation Full Stop. Because of this project, Formosan termite numbers in New Orleans have been significantly reduced.

Another economically important invasive species – the red imported fire ant – was discovered in Louisiana in the 1950s. These ants infest lawns and pastures and can attack humans and live-

Photo by Natalie Hummel

Once infected with citrus greening disease, a citrus tree is lost. There is no cure.

Photo by Michael A. Seymour

A queen fire ant is protected and groomed by workers.

Photo by John Chaney

LSU AgCenter scientists have begun using DNA profiling to identify the movement and growth of Formosan subterranean termite colonies.

stock resulting in death in some cases. AgCenter researchers are developing sustainable control methods. One such approach is the release of parasitic flies as a biological control agent, which is proving to reduce populations of fire ants to manageable levels.

Recently, the stability of the citrus fruit and nursery tree production industries has been threatened by the introduction of many invasive insects and diseases. The value of the Louisiana citrus industry is estimated at $10 million annually. AgCenter scientists have worked with state and federal agencies to rapidly respond to these detections. They have developed educational materials and provided management recommendations in response to invasive species detections. Without these interventions, Louisiana's citrus industry could face extinction.

The sugarcane and rice industries are under threat of infestation by the Mexican rice borer. Once established, this pest may cost Louisiana sugarcane producers $220 million and rice producers $45 million in the first few years. AgCenter scientists have been working cooperatively with Texas scientists to stem the movement of the borer and buy time to develop effective management and control methods. This cooperative program resulted in early detection of this pest in December 2008 by Louisiana Department of Agriculture and Forestry (LDAF) specialists.

Animal species that have invaded Louisiana include the feral hog, which has recently begun to cause major damage to agricultural and forestland. Nationwide, the damage is believed to exceed $1.5 billion annually. In 2008, AgCenter and LDAF scientists surveyed landowners to obtain an estimate of the severity of feral hog infestations. Eighty percent of survey respondents in 50 parishes reported the presence of feral hogs with 95 percent reporting damage to property, crops or forests. AgCenter scientists also have measured the impact of feral hogs in aquatic environments and have found that they are responsible for introducing significant levels of biological contaminants into freshwater supplies.

Another animal invader is the nutria, which causes damage to Louisiana's marshland. The most effective method for management of this pest is trapping for fur and consumption. Demand for fur has declined significantly in the past 50 years, and Louisiana has an aggressive campaign to encourage consumption of nutria meat.

The waterways of Louisiana are threatened by the Asian carp. This fish causes harm not only to the environment and other fish, but also injury to property and people with its tendency to leap from the water and hit boats.

Regulatory Efforts

As soon as an invasive species is discovered, the LSU AgCenter works closely with state and federal regulatory agencies. As a rule, port inspection authority for invasive pests lies with the federal government through the USDA Animal and Plant Health Inspection Service (APHIS). State activities are accomplished by LDAF Plant Quarantine Programs. The AgCenter supports regulatory efforts through education programs

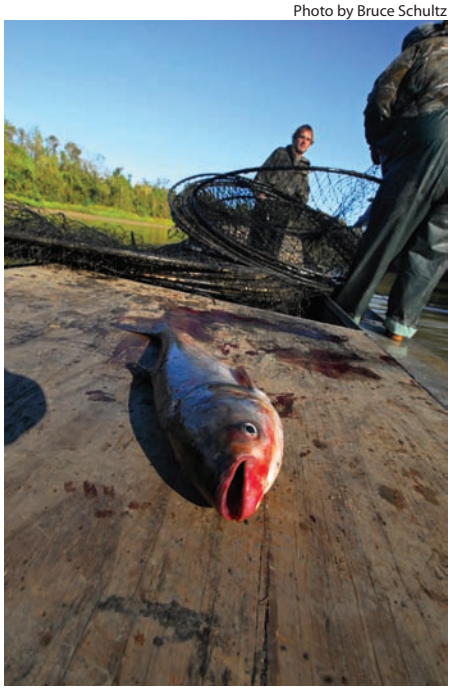
The response to discovery of an invasive species involves prevention and preparedness. Strategies for prevention include monitoring and control activities carried out in foreign countries, at U.S. ports of entry and within the United States. The USDA inspects imported shipments and monitors for federal pests of concern. LDAF conducts pest surveys and inspections on many commodities statewide, facilitating early pest detection and pest-free certification for export to other states or countries. Commodities may include nursery stock, grains, citrus, sweet potatoes, sugarcane, honeybees and forest products. Agricultural equipment also may be included.

One important prevention strategy is an analysis of the characteristics of the plant or animal species to develop a cost-sensitive decision support tool. The decision support tool helps to identify effective control strategies against introduced invasive species. LSU AgCenter faculty assist regulatory agencies when they are developing these tools.

Preparation activities may include development of a risk analysis to assess loss or injury to a crop or ecosystem. An invasive pest not only causes crop damage, but can affect commodity markets, human health, food safety and the environment. For example, financial markets worldwide may be adversely affected with the introduction of a new pest into a major commodity such as rice.

State response to invasive species may be separated into two categories, routine and targeted. Routine response consists of ongoing surveillance at sites with regulated materials, such as plant nurseries. The goal of routine survey

Photo by Bruce Schultz



The Asian carp is here to stay in Louisiana waters, and about the only way to get rid of it is to eat it. Though it has a complex bone structure and is more difficult to filet, it is an excellent-eating fish.

Photo by Johnny Morgan

Don Ferrin, LSU AgCenter plant pathologist, inspects a citrus tree for citrus greening disease, a major threat to the citrus industry.

These feral hogs were captured on camera foraging for food.

Photo by Bruce Schultz

The Mexican rice borer is now in Louisiana causing a major threat to the sugarcane industry.

Photo by Hallie Dozier

The Chinese privet tree can dominate a landscape.

is early detection of pest problems and safeguarding of agricultural products. Discovery of an invasive species during routine surveys may trigger stop- sales, treatments, return to origin or destruction. In some cases, sites may need follow-up inspection or remediation. LSU AgCenter scientists develop educational materials featuring the species being monitored.

Targeted response also requires action tailored to the invasive organism. The goal of targeted response is to prevent the spread, reduce harm, and manage or eradicate the problem. The annual tropical soda apple weed survey, for example, relies on visual survey of pastures and rodeo arenas with subsequent property restrictions and herbicide treatments when the weed is found. Cattle cannot re-enter until fruiting plants are eliminated. Cactus moth – a federally-regulated pest – is monitored using pheromone trapping and visual survey for the prickly pear host. Teams of inspectors across Louisiana coastal lands search for moth-infested cactus. When found, the cactus is destroyed. Moth locations are tracked with GPS, and teams map their progress. When the pink hibiscus mealybug was found in southeastern Louisiana, LDAF conducted surveys to determine how widespread this ornamental pest was in residential settings. Parasitoid wasps for biological control were released weekly. Sentinel sites still monitored confirm a high success rate of this control program, which helps prevent spread to major agricultural crops in Louisiana. Giant salvinia weed management is another biocontrol success story in Louisiana, using natural organisms to recover from invasive pest damage.

Pest mitigation measures may be straightforward, such as conducting surveys and inspections or applying treatments. Others may require restrictions on high-risk plants. Quarantines represent the most restrictive response and are enforced on pests with high impact potential. Strategies may be devised using multiple mitigation methods. Regulatory response should be reasonable, uniform, science-based, transparent and limited in scope so that benefits outweigh risks.

In some cases the risk posed by an invasive species is so great that attempts are made to eradicate it. Eradication is difficult and costly and effective only if initiated immediately after the first detection. It may require one or a combination of methods such as chemical, mechanical, vaccination or even release of sterile males into the ecosystem. An eradication effort may not be successful, such as the failed attempt to eliminate fire ants in the South. Furthermore, eradication of invasive species may result in secondary effects such as emergence of a new species that may dominate the ecosystem.

In a few cases, however, eradication can be successful and worth the investment. Examples of successful eradication programs in Louisiana include the pink bollworm, sudden oak death and southern bacterial wilt disease. The financial investment to prevent the spread of these invasive species has decreased the long-term cost to industry.

The Boll Weevil Eradication Program represents the ultimate targeted response: a cooperative, long-term strategy to eliminate an organism through survey, treatment, quarantine and maintenance. The cotton boll weevil first appeared in Louisiana in 1903. Boll weevil damage to developing cotton bolls was a major yield-limiting factor in cotton production in Louisiana. Nationally, the boll weevil is estimated to have cost cotton farmers more than $15 billion in yield loss and additional costs to control the pest. An eradication program was initiated in Louisiana in 1997, and since then approximately $167 million has been spent on boll weevil eradication ($77.6 million by the state, $25 million by USDA, $64.3 million by the cotton growers) in a unified eradication program. In 2010, one weevil was trapped in the third week of May in Louisiana. At this time there is no evidence of boll weevil reproduction in Louisiana.

Ultimately, management of invasive species through containment or control may be the only way to overcome economic and environmental damages. In containment, an effort is made to confine the invasive species within a limited geographical area. Control aims at keeping invasive species below a certain threshold level – a level in which economic and environmental cost can be tolerated.

We hope you find this issue of Louisiana Agriculture helpful. Please do not hesitate to contact any of the authors of these articles for more information about invasive species. ■

Pest	Year Discovered	Impacts / Response Actions
Salvinia molesta, Giant Salvinia – aquatic weed	1998	First found at Toledo Bend Reservoir, this weed is widespread in at least 35 water bodies in 15 parishes. LDWF and LSU AgCenter coordinated efforts to distribute a biological control agent, the salvinia weevil, into lakes infested with giant salvinia. Giant salvinia has a major negative impact on Caddo Lake. LDAF prohibits nursery production and sales of giant salvinia.
Aethina tumida, Small Hive Beetle	2000	First detection in Orleans Parish. Beetle has now spread into all 64 parishes. Healthy hives with large bee populations are able to keep the pest in check. Weak hives allow beetle populations to multiply, resulting in serious damage to brood and stored honey. LSU AgCenter faculty worked with LDAF to develop management options.
Puccinia hemerocallidis, Daylily Rust	2001	First found in U.S. in 2000. First Louisiana detection was in Iberia Parish. This disease is easily spread by the wind and through the nursery trade. Severity of injury depends upon variety. LSU AgCenter developed outreach information on resistant or tolerant varieties.
Diaprepes abbreviatus, West Indian Sugarcane Rootborer	2004	First found in U.S. (Florida) in 1964. New Orleans Audubon Zoo personnel reported finding a few adult beetles in 2004 and 2007. In 2008, the beetle was found infesting a commercial citrus grove near Buras, Plaquemines Parish. Possibly entered Louisiana as a hitchhiker on plant material. LSU AgCenter worked with LDAF to develop management recommendations also extension educational programs about this beetle.
Phakospora pachyrhizi, Soybean Rust	2004	First detection of this disease in North America was in East Baton Rouge Parish. Rust spores were carried here by wind from South America. Rapid survey response in 2004 indicated disease was widely scattered in the South. LSU AgCenter has developed management plans and tracks rust movement each year.
Apis mellifera scutellata, Africanized Honeybee (AHB)	2005	AHB spread into Louisiana by natural migration from Mexico through Texas. LDAF considers the entire state to be infested with confirmed finds in Caddo, Winn, LaSalle, Cameron, Evangeline, Vermilion and St. Bernard parishes. No stinging incidents from AHB have been confirmed. LSU AgCenter cooperated with LDAF to develop response plans for parish governments.
Maconellicoccus hirsutus, Pink Hibiscus Mealybug (PHMB)	2006	First established populations of PHMB were found in Jefferson Parish. Biological control agents supplied by USDA were released by LDAF in 2007 and 2008. This is a pest of hibiscus, other ornamentals and several crops produced in Louisiana and is under control.
Pomacea canaliculata, Channeled Apple Snail	2006	First established populations of this snail were found in Gretna, Jefferson Parish. Snail may have been placed into the environment when someone dumped an aquarium into a canal. This pest of rice has now spread throughout Orleans, Jefferson and Plaquemines parishes. There are populations found on the north shore of Lake Pontchartrain and in Terrebonne Parish. Egg masses found in a pond in Lafayette were removed, and monitoring of the pond is ongoing. Surveys by LDAF continue in rice-producing areas of the state.
Aleurocanthus woglumi, Citrus Blackfly (CBF)	2007	This citrus pest is widespread throughout southern Louisiana. Another pest that growers and homeowners need to watch for and control if citrus trees become heavily infected. LSU AgCenter has released parasitoids for biological control of CBF.
Steneotarsonemus spinki, Panicle Rice Mite	2007	Found in Acadia Parish. This is a federally regulated pest, resulting in infested fields and greenhouses being placed under quarantine by USDA and treatment options given to the grower.
Diaphorina citri, Asian Citrus Psyllid (ACP)	2008	First find in Louisiana was in Orleans Parish. This citrus pest was possibly carried into the state on plant material. ACP is widespread across southeast Louisiana. Parishwide spray program is conducted biannually in Plaquemines Parish. Entire state is federally quarantined for this pest, and all shipments of citrus plants out of Louisiana require treatment and certification. LSU AgCenter has published control options for growers and produced a scouting video. USDA surveys continue.
Candidatus Liberibacter asiaticus, Citrus greening Asiatic strain	2008	First infected citrus tree was found in Orleans Parish. This disease is vectored by the Asian citrus psyllid. Over the past two years only five infected trees have been found infected, and all have been destroyed voluntarily by LDAF. Orleans and Washington parishes are quarantined for this disease. USDA surveys continue.
Eoreuma loftini, Mexican Rice Borer (MRB)	2008	LSU AgCenter collaboration with LDAF found two moths spaced five miles apart near the Texas border in Calcasieu Parish (December 2008). The most recent collection included four moths in November 2010 southwest of Sulphur, 15-18 miles from commercial sugarcane. AgCenter continues developing proactive management approaches with ongoing training of stakeholders.
Cactoblastis cactorum, South American Cactus Moth	2009	Natural spread of this moth into Louisiana from the Mississippi Gulf Coast. USDA is attempting to stop the westward movement to keep this pest of prickly pear cacti out of the desert Southwest and Mexico. Infested cacti are destroyed when they are found.
Scirtothrips dorsalis, Chilli Thrips	2009	This pest of ornamentals and vegetable crops was hand-collected from roses by LSU personnel in Jefferson Parish. No additional reports have been received and no damage concerns expressed. LSU AgCenter faculty have informed citizens of the threat posed by this pest.
Paratrechina sp. nr. pubens, Crazy Rasberry Ant	2009	Nuisance pest for homeowners was first found in West Baton Rouge and St. Tammany parishes by LSU AgCenter personnel. Control options are under development.
Drosophila suzukii, Spotted Wing Drosophila	2010	This pest of strawberry, blueberry and blackberry was collected in a fruit fly trap by USDA in Allen Parish in August 2010. LSU AgCenter is developing pest management options.
Elsinoe australis, Sweet Orange Scab	2010	This citrus disease was first isolated from a Persian lime tree in Orleans Parish in August 2010. It has now has been found in 15 parishes from Calcasieu to Plaquemines. Because this disease is newly confirmed in the U.S. , the USDA is determining response actions. The AgCenter has educational programs.

Fishermen set hoop nets near Butte LaRose to catch fish, including Asian carp, at left. The fishermen are Preston Terrell, left, and Rusty Kimball.

Photos by Bruce Schultz

Asian Carp

Unwelcome Guest for Dinner

Julie Anderson, Michael D. Kaller and R. Glenn Thomas

There is an invasive species in town that might not be welcome, but at least this one we would like to invite to dinner. Commercial fishers across Louisiana have been reporting increasing populations of both bighead carp and silver carp, known collectively as Asian carp, beginning in the early 1980s.

Subsequently, the invasive population of both species has been increasing in the Mississippi River Basin. Along the Gulf of Mexico, bighead carp have invaded states from Texas to Florida. While silver carp are only observed in Louisiana, Mississippi and Alabama, there is the potential for them to invade farther along the Gulf of Mexico coast similar to the bighead carp. The Asian carps can reach extremely high population densities with harmful effects on the environment, native species and safety. Silver carp often jump out of the water when disturbed, causing damage to property and injury to people in boats.

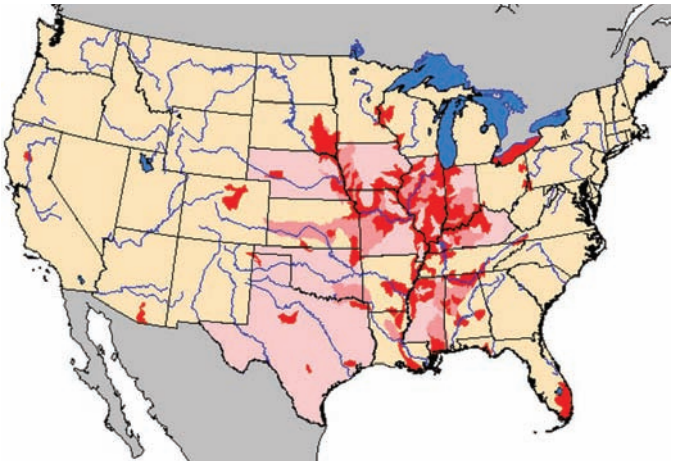
Commercial fisherman Preston Terrell with a silver carp. Asian carp have a tendency to bleed when caught.

The bighead carp is native to east Asia, ranging from eastern China through Siberia to North Korea, but it has become an invasive species across Asia. It can tolerate a wide range of temperatures from 25 to 75 degrees mean annual air temperature. Silver carp have a similar native range and are endemic to the large rivers of southern Asia. Like the bighead carp, the silver carp's territory has spread. It is documented in at least 88 countries.

These two species of Asian carp were originally imported to the United States for use in wastewater treatment lagoons as well as in aquaculture ponds in the 1970s to control nuisance algae and improve water quality. Bighead carp primarily eat zooplankton, but will also eat phytoplankton if available. Silver carp can consume smaller particles and consume primarily plankton. Consequently, Asian carp were purported to be biological controls of excess plankton preventing excessive, periodic plankton blooms and the resulting decline in water quality.

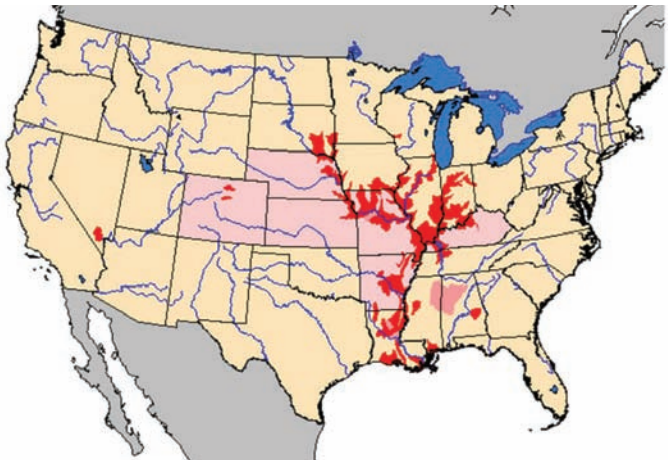
Julie Anderson, Assistant Professor and Fisheries Specialist; Michael D. Kaller, Assistant Professor, both with the School of Renewable Natural Resources, LSU AgCenter; and R. Glenn Thomas, Director of Marine Extension, Louisiana Sea Grant, Baton Rouge, La.

Bighead carp, *Hypophthalmichthys nobilis*, distribution in the United States, April 2010. The red areas indicate where the species is known to exist and the pink areas indicate belief of statewide distribution.



Map created on 4/22/10. United States Geological Survey

Silver carp, *Hypophthalmichthys molitrix*, distribution in the United States, April 2010. The red areas indicate where the species is known to exist and the pink areas indicate belief of statewide distribution.



Map created on 4/22/10. United States Geological Survey

Eventually, the Asian carp escaped from holding facilities into nearby wetlands, streams, rivers and ponds. The first bighead carp in natural waters in the United States was found in 1981 in the Ohio River in Kentucky. Later, reproduction was documented in natural waters in 1989 with the discovery of a young bighead carp in Missouri, and postlarval fish were found in southern Illinois in 1992. The bighead carp population has been increasing ever since, ranking fourth in total commercial harvest on the Missouri portion of the Mississippi River Basin by 1998. Today, the bighead carp has been recorded in 23 states.

Silver carp have a similar history of invasion. The first specimens were found in Bayou Metro and in the White River in Arkansas between 1974 and 1975. By 1981, silver carp had reached the Mississippi River and began their spread throughout the Mississippi River Basin. Today, silver carp have been recorded in 16 states, including Louisiana where 1,600 larval Asian carp were collected from a backwater outlet of the Black River in 1996. Asian carp commercial landings increased from 4,700 pounds to 26,691 pounds annually between 2000 and 2005.

Both bighead and silver carp can tolerate a wide range of temperatures and salinity, making these unlikely factors to halt their invasive range within the United States. Bighead carp are known to actively spawn from 57 to 86 degrees. Additionally, fingerlings have survived 41 degrees, and adults are inactive only below 36 degrees water temperature. Silver carp also are active in the winter, and they may be more cold tolerant than bighead carp. Silver carp have been known to overwinter in Alberta, Canada, in ponds close to freezing from November to April. Because of their tolerance to salt water, Asian carp could compete with marine and estuarine fishes, not just freshwater species, further exacerbating an already precarious situation for coastal fishes.

Another trait that makes Asian carp a successful invasive species is their fecundity. With both bighead and silver carp, fertility increases with age and size. Newly mature females have an average of 280,000 eggs, and older spawners can have up to 549,000 eggs. Sexual maturity in their native range is three to four years with males maturing about one year before females. However, this varies by environment, and female maturity can be in as little as two years.

Spawning generally is initiated by rising water levels in the spring. Bighead carp migrate upstream and spawn in high-flow water that is turbid. Flow rates may be important for the eggs. Viable eggs are semibuoyant and hatch in 24 hours at 82 degrees. Turbulent water keeps the eggs buoyant until they hatch. However, in laboratory experiments, eggs resting on the bottom of still dishes also hatched. Therefore, flow may reduce predation or settling into mud, but may not be a requirement.

Rapid growth rates are another trait that increases the invasive threat of Asian carp. In waters above 55 degrees with plentiful food, bighead carp can reach 6 pounds in less than a year, and they can reach more than 80 pounds. Silver carp can grow to a size of 2.2 pounds in less than a year, and adults can reach more than 80 pounds over a 15-year lifespan.

Eradication of Asian carp in the Mississippi River basin is impractical, if not impossible. Attempts to limit their movement have been taken in Illinois to limit their access to the Great Lakes. However, even with electric and physical barriers, evidence of Asian carp has been found in Lake Michigan. A better alternative would be to utilize this resource and at the same time attempt to control their numbers and spread to minimize ecosystem disruption.

A regional commercial fishery has developed in Louisiana, but far more Asian carps are captured than are sold. Both species of carp are already captured and cultured as a human food product in Asia. Increased demand for the Asian carp, which are highly palatable, would improve profitability and would reduce the standing stock of these invasive species. While assumed to be a fish relatively low in potential contaminants due to its feeding behavior and low placement on the food chain, little data are currently available, although research is beginning. ■

EAT Asian Carp

Help rid Louisiana of this invasive species by consuming it.

Asian carp have become a huge environmental problem in waterways throughout the Mississippi and Missouri river basins.

These fish, which are comprised of the "silver" and "bighead" species, were originally introduced into private U.S. ponds in the 1970s. Some of them escaped into the wild and multiplied, practically taking over water systems as an invasive species. They have been adversely affecting these ecosystems ever since by voraciously eating vegetation and robbing many native fish of their food supply.

These relatively large fish, called silverfin, also jump into boats causing serious injury and damage to property. Hence, they have been nicknamed "flying fish."

Often confused with common carp, which is considered a trash or rough fish, Asian carp are a completely different fish. Asian carp taste excellent and can be successfully cooked numerous ways. These plant-eating fish are also nutritious, low in fat and a good source of omega-3 fatty acids.

To help promote the eating of Asian carp, which is one of the best ways to control their numbers, Glenn Thomas, extension director of Sea Grant at LSU and the LSU AgCenter, teamed up with Duane Chapman, a research fisheries biologist with the U.S. Geological Survey in Columbia, Mo., to produce the instructional video "Flying Fish, Great Dish!" This video, which is available free on YouTube, demonstrates methods of cleaning Asian carp. Chapman is one of the world's foremost authorities on Asian carp.

"Chapman suggested their use as table fare but was having trouble developing a teaching tool on how to clean them," Thomas said.

"Asian carp have excellent flesh but a very unusual bone structure. Duane developed some unique cleaning methods that will put them on the table. We need to develop a market for these things because the breeding populations are already established," Thomas said.

In many states, there's no catch limit on Asian carp. But these flying fish are herbivores, so they can't be caught with traditional bait.

"You can go bowfishing or wait for them to jump in the boat," Chapman said. "Commercial fishermen catch them in hoop and gill nets in Illinois."

Thousands of DVDs of "Flying Fish, Great Dish!" are being distributed nationwide to help encourage the expansion of this fishery in Louisiana and other states in the Mississippi and Missouri River regions. To order a DVD, contact Jessica Schexnayder at jschel5@lsu.edu. The cost is $6 to cover postage and handling.

To view the segments on YouTube, search for the title. The video has three segments:

Part 1 – Introduction & Removing Filets
Part 2 – Making Flying Carp Wings
Part 3 – Deboning Filets

DVD duplications of this program were funded by the U.S. Fish and Wildlife Service and Illinois-Indiana Sea Grant. The Mississippi River Basin Panel on aquatic invasive species (MRBP) was also involved in the project. ■ **Randy LaBauve**

Photos by Bruce Schultz

Asian carp are more difficult to filet than other fish because of their complex bone structure. But, if fileted correctly they yield more good meat for eating than other fish. Craig Gautreaux, avid fisherman and LSU AgCenter communication specialist, demonstrates the fileting process.

Asian carp taste nothing like the common carp, or grass carp, which are referred to as trash or rough fish. The Asian carp is delicious.

Invasive Feral Swine in Louisiana

These creatures of the night cause havoc to agriculture, wildlife and the environment.

Michael D. Kaller and Don Reed

In the eyes of many conservationists, feral swine are among the most damaging invasive species around the world. Farmers, ranchers, foresters and landowners consider the feral swine to be a nuisance, at best, and, more commonly, a grave threat. However, feral swine also may be culturally and economically important to hunters and other enthusiasts. Consequently, the invasive feral swine is one of the most controversial animals on the landscape.

Michael D. Kaller, Assistant Professor, School of Renewable Natural Resources, LSU AgCenter, Baton Rouge, La.; and Don Reed, Professor, Bob R. Jones-Idlewild Research Station, Clinton, La.

The first documented introductions of swine into what would become the United States occurred in 1539 in Florida by Spanish explorer Hernando de Soto. In early settlements, it was common practice to allow domestic swine to range freely on public or common lands to be recovered for slaughter. This practice was extensive across the United States until the 1930s, with some exceptions that exist today.

In addition to domestic swine, the European boar was introduced into the United States by sport hunters. Although the European boar is in the same species as domestic swine, it has a number of characteristics different from domestic swine, including a more distinctive hair pattern and a tendency toward larger tusks that make it a more desirable hunting quarry. The bloodlines of these various swine have joined over the years, creating individuals with mixed genetic makeup. Therefore, feral swine in a given area may be descendents of domestic stocks, pure wild boar or a mixture of the two strains. As a result of these introductions, feral swine are believed to be present in 40 of 50 states. Although the genetic composition of Louisiana feral swine has not been investigated, the introduction of European boar in Louisiana is believed to be limited, and most Louisiana feral hogs are likely descended from domestic stocks.

Photo by Bruce Schultz

Farmer Troy Fruge of Basile shows how wild pigs have damaged areas of his grain sorghum crop. Fruge said the hogs also feed on his rice crop and fields of his sweet potatoes.

In Louisiana, feral hogs can be found in a wide variety of habitats ranging from tidal marshes to timbered areas. They prefer hardwood forests that produce mast, such as acorns, but will frequent pine forests. In remote areas or where human disturbance is minimal, they can often be found in open ranges or pastures. Although feral swine generally prefer less interaction with humans, feral swine are adaptable and have successfully colonized parks in large cities, including Dallas and New Orleans.

Feral hogs seek areas with access to water, cover and a dependable food supply. They are omnivorous in their feeding habits, consuming anything from grain to carrion. Heavy mast crops will often hold them in smaller areas during the fall and winter, but human disturbance and lack of food are the two greatest factors in causing nomadic behavior. Areas in Louisiana that may never have had populations of feral hogs will suddenly begin to see the rooting, wallowing and other telling signs of their presence. Other areas, where feral hogs have occurred in the past, may go for years without a sighting

when suddenly individuals begin to be seen once more.

Feral hogs are the most prolific large mammal in North America, and given adequate nutrition, populations can double in only four months. Sexual maturity is reached as early as six months, with sows producing two litters per year. Litter size varies with age and nutritional intake but five to six young are produced on average. Estimates from Australia suggest that based on reproductive capacity, feral hog populations can rebound from a 70 percent cull in only two and a half years. Other studies suggest that reductions of adult females greater than 90 percent may be ineffective because of the ability for juvenile females (6-12 months old) to reproduce. Therefore, where food and cover are available, feral hog populations can explode and spread quickly.

Beyond their remarkable reproductive capacity, feral hogs have had assistance in their spread. Legal and illegal introductions have extended the range of invasive feral hogs beyond the historic southern and western distribution (North Carolina, South Carolina, Florida, Georgia, Alabama, Mississippi, Louisiana, Arkansas, Missouri, Texas, New Mexico, Arizona, California and Hawaii). West Virginia introduced the European boar to supplement whitetail deer hunting opportunities, and legally permitted introductions have occurred in other states. More frequently, however, introductions for hunting purposes have been illegal and clandestine. Because these introductions are unauthorized, they sometimes go unnoticed by state and federal agents until problems occur. For example, the first reports of escaped feral hogs from hunting reserves in Michigan occurred in 2004. By 2008, hogs were reported in 61 of 83 counties, including counties in the snowy Upper Peninsula heretofore thought to be too cold for feral hogs.

This photo was taken by trail cameras mounted about 50 yards in front of a deer hunting stand and aimed at an automatic deer feeder. The feeder is set to release corn 10 seconds in the morning and evening. The pictures are downloaded once a week to determine which stand the hunter will use.

Feral hogs seek areas with access to water, cover and a dependable food supply. They are omnivorous in their feeding habits.

Because feral hogs can expand rapidly, it is likely that they were present but not actively being sought by state wildlife agents. Consequently, the seemingly rapid expansion was more probably a matter of finally documenting existing populations. Similar illegal introductions associated with game ranches and private hunting groups have occurred in Colorado, Illinois, Iowa, Ohio, Kansas, Kentucky, New Hampshire, New York, Oregon, Pennsylvania, Tennessee, Virginia, Vermont and Wisconsin. These states are implementing eradication and educational programs aimed at halting the spread of feral hogs.

Nationwide damage from feral hogs has been estimated to be more than $1.5 billion dollars annually. These estimates include damage to agriculture and forestry operations and public health and control costs. They do not include the damage effects to other wildlife, including predation and displacement of irreplaceable endangered species, aesthetically important species and recreationally important wildlife. The damage estimates also do not include impairments to aquatic ecosystems and water quality or property damage to vehicles from collisions, home gardens and other personal property.

Feral hogs have been documented to destroy shrub-nesting and ground-nesting bird nests and to consume turkey poults, white-tailed deer fawns, small mammals, turtles and their eggs, fish, snakes, frogs, and salamanders, oysters and other mollusks. Further, feral hogs displace and out-compete adult wildlife, such as white-tailed deer and wild turkey, from desirable habitats because of their more aggressive nature. Wildlife-related effects are difficult to quantify, and the real monetary damage from feral hogs is probably far greater than official estimates.

Feral hog damage to agricultural and forested lands is better documented. Recent estimates of damage in east Texas range from $3 million to $6 million per year. In 2008 and 2009, the LSU AgCenter conducted surveys along with the Louisiana Department of Wildlife and Fisheries to determine the extent of the distribution and damage from feral pigs. In 2008, 80 percent of survey respondents in 50 parishes reported feral hogs. Of those respondents, 95 percent reported damage to their property, crops or forests. Results from the 2009 survey have not been completely tallied, but the trends are similar to 2008.

Feral pigs will travel extensively for food, including hay, small grains, corn and peanuts. Similarly, tree seedlings are an attractive food resource, possibly for saps and starches. Vegetables, watermelons, soybeans, cotton and tree fruits are reported to be less attractive.

Beyond direct consumption of agricultural crops and seedlings, feral hogs can be highly destructive to roads, ditches, levees, outbuildings and other

physical structures, as well as agricultural infrastructure, such as airplane landing strips and irrigation systems.

Adult livestock are sometimes preyed upon by feral hogs. Feral hogs are attracted to birthing grounds, and young goats, lambs and cattle, as well as the occasional livestock giving birth may be killed. Feral hog depredation is difficult to document because the hogs completely consume the carcass. Further, pigs scavenge animals killed accidentally by disease or from other predators. Lastly, rooting and wallowing behaviors destabilize the ground and can lead to accidental livestock death and injury, reductions of beneficial soil insects and microbes, and compaction of soils reducing agricultural and forest productivity.

Disease is another critical issue associated with feral hogs. Feral hogs carry diseases that may infect humans including brucellosis, leptospirosis, salmonellosis, toxoplasmosis, sarcoptic mange, *Escherichia coli*-related illness and trichinosis. Most human infections from feral pigs occur among hunters, and precautions such as wearing rubber gloves and masks while cleaning feral hogs are important to adopt by hunters and landowners removing feral swine. Humans also may contract diseases from feral pigs from contact with water that feral pigs frequent. More commonly, feral hogs infect livestock they encounter at watering sites and feeding areas with pseudorabies, swine brucellosis, tuberculosis, vesicular stomatis and classical swine fever.

Feral hogs carry diseases that may infect humans including brucellosis, leptospirosis, salmonellosis, E. coli-related illness and trichinosis.

Because feral pigs cannot be vaccinated or readily destroyed when disease is detected, they often act as disease reservoirs re-infecting livestock in a cyclic pattern. Further, feral pigs in Mexico and Central America are known to carry foot-and-mouth disease, which has been eradicated in the United States since 1929. Estimates suggest a loss of $14 billion to $21 billion to the U.S. agricultural

Photo by Bruce Schultz

Tony Fruge stands in an area of rice damaged by wild pigs. He said in another field the feral hogs had damaged six acres out of a total of 30 acres. "There goes my profit on that field," he said.

Management of feral hogs is another important aspect to conserving Louisiana's wetlands and aquatic resources.

Photo by Bruce Schultz

Tony Fruge with the head of a hog killed on his farm that weighed 450 pounds. Fruge sets snares and traps for the pests and also hunts for them at night. "It's hard to cut rice in the day and hunt hogs at night," he said.

industry if feral hogs were to become infected or carry foot-and-mouth disease into the country. The U.S. Department of Agriculture Animal and Plant Health Inspection Service, Louisiana Department of Wildlife and Fisheries, and Louisiana Department of Agriculture and Forestry conduct disease surveillance on feral hog populations in the wild and on feral hogs brought to livestock sales. These agencies also respond to hunter concerns about harvested feral pigs.

Because of Louisiana's extensive and ecologically and economically important wetlands and aquatic resources, it is the ideal location to study the impact of feral pigs on wetlands and waters. Feral pigs have an affinity for wet areas and are well-known for their wallowing in wet soils and shallow waters. Further, in warm climates feral hogs spend most of their time in close proximity to water sources. In a 1998 study, scientists at the U.S. Geological Survey National Wetlands Center in Lafayette concluded that feral pigs had similar negative impacts to marshes and wetlands as nutria.

More recently, LSU AgCenter scientists studied the effects of feral swine on aquatic ecosystems and concluded that feral swine introduce pathogenic bacteria *Aeromonas*, *Staphylococcus aureus* and *Shigella* and reduce beneficial aquatic insects and mussels. In another study conducted in cooperation with the U.S. Army at Fort Polk, AgCenter scientists concluded through use of DNA source tracking that the excessive E. coli levels in a stream in western Louisiana were from local feral pigs. Feral swine impacts to small streams and rivers, specifically the reductions in beneficial insects and mussels, have important implications downstream with reductions in the appropriate nutrients for coastal estuaries and wetlands that may further threaten coastal ecosystems. Therefore, management of feral hogs is another important aspect to conserving Louisiana's wetlands and aquatic resources.

Control and management of feral pigs is difficult. There are no repellents or toxicants registered for control of feral hogs. Fencing is generally impractical because of the large areas that often must be protected and the persistent nature of feral hogs in their rooting and feeding habits. Trapping and shooting are the most effective control measures. Where feral hog densities are high, trapping is the most effective control method. Stationary corral-type traps and moveable box traps are two designs that can be used. Research suggests that large corral-type traps that are baited to habituate the feral hogs are more effective than box traps. Corn is the preferred bait to use with either trapping method.

Feral hogs are classified as outlaw quadrupeds in Louisiana, and until new laws were passed in 2010, they could be hunted at any time of the year during daylight hours on private lands and during legal hunting seasons on public land. Because many landowners requested night hunting opportunities, which are allowed in other states, the Louisiana Legislature passed a law in 2010 allowing nighttime hunting from March 1 to Sept. 1.

In 2008, surveyed landowners reported that a combination of daytime shooting and trapping was the more effective management activity. Unfortunately, 25 percent reported no success in managing their hog populations with any method. Nevertheless, landowners should continue management efforts. A Texas study indicated that every dollar invested in technical assistance to landowners returned $11.42 in increased revenue for the landowner.

In another law passed in 2010, the Louisiana Legislature removed the exception to the free ranging of feral hogs where the practice is still allowed. In no area of Louisiana is it legal for swine to run at large upon public property or the property of others.

Feral hogs have been in Louisiana since the earliest settlements. They were a source of meat for the region's emblematic gumbos, sausages and cochon de lait and remain a popular sporting animal among some Louisianans. However, despite their historical and cultural significance, the feral hog of today is a threat to productive farms, livestock operations and forests. Further, feral hogs have tremendous negative ecological impacts to wildlife, aquatic life and wetlands. Therefore, despite a few benefits to some people, the invasion of feral hogs into Louisiana has been a loss to the state. ■

Management of the Invasive *in the New Orleans*

Dennis R. Ring, Alan Morgan, Frank S. Guillot,

The Formosan subterranean termite is considered the most important structural pest of the new millennium. It is more aggressive than native subterranean termites, and colonies may be greater in numbers reaching millions of termites. The Formosan subterranean termite builds above-ground carton nests and eats the centers of live trees. These characteristics contribute to the destructive potential of this invasive pest.

The Formosan subterranean termite was first discovered in Louisiana in 1966. Specimens of this termite were identified from Lake Charles in 1966 and from New Orleans in 1967. Taiwan is the native home of the Formosan subterranean termite. Two entry points were reported for the Formosan subterranean termite in the New Orleans area – the Algiers area across the Mississippi River from the French Quarter and near Camp Leroy Johnson on Lake Pontchartrain. Once the Formosan subterranean termite was introduced to the New Orleans area, it expanded its range, and the numbers of termites increased. The problem coincidentally increased in the French Quarter including historical buildings.

Management of Formosan subterranean termites became so difficult in the French Quarter that some pest management companies stopped treating for termites. The New Orleans Mosquito and Termite Control Board would receive 20 to 30 calls about swarming termites per swarm season from people in the Upper Pontalba Apartments near Jackson Square. One person reported sleeping in a pup tent inside his structure during swarm season to prevent termite alates from falling on him at night and waking him up. Buildings in the French Quarter experienced structural damage on an ongoing basis resulting in a continuous cycle of damage and repair. The situation was bleak.

In response to this problem, an areawide integrated pest management program was begun in the French Quarter with an objective of reducing the numbers of Formosan subterranean termites and potential for damage. This federally funded areawide program is a partnership among the LSU AgCenter, the U.S. Department of Agriculture's Agricultural Research Service, the New Orleans Mosquito and Termite Control Board, area pest management professionals, and the Audubon Nature Institute.

In 1998, the program began with treatment of a 15-block area of the French Quarter. The strategy was to reduce damage caused by the Formosan subterranean termite by decreasing the numbers of termites through population management, eliminating colonies and reducing termite pressure. Treatments by pest control companies included nonrepellent liquid termiticides and baits. The remaining area of the French Quarter outside of the treated area was monitored to provide a comparison to the treated area. Monitoring methods included sticky traps strategically placed on light poles within 2 meters of all corners in the French Quarter. These traps collected swarming reproductive alates and helped determine the annual alate numbers in the area.

A second monitoring method was the use of in-ground monitoring stations. These stations, which were used to monitor termite foraging activity, were placed in contact with the soil in holes drilled through the sidewalks. Twelve stations were placed at regular intervals around

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Formosan Subterranean Termite *French Quarter*

Alan R. Lax and Charles McCown

each block in the initial 15-block area, and 44 additional stations were placed in the French Quarter outside of the test area.

In January 2002, this was supplemented with an additional 300 stations placed within the French Quarter outside of the test area. Stations were checked monthly and the presence or absence of termites was recorded. The treated area was expanded each year in 2002, 2003, 2006 and 2007. Inspections were also conducted on properties in the test areas. Aimed at determining the presence of Formosan subterranean termites, the inspections of these properties consisted of visual inspections and the use of infrared cameras. A pest management professional was contacted to treat any infestations located during the inspections.

Data collected showed that areawide management reduced termite numbers and activity in the initial 15-block area by 75 percent. A 50 percent reduction in the number of alates was also observed in other areas of the test within two years after treatment. In addition, a 50 percent reduction in the number of in-ground monitoring stations with termites was observed in the initial 15-block area. A similar 50 percent reduction in the number of in-ground stations with termites was observed in other areas after treatment.

In 2003, about 23 percent of the properties in the initial test area were found to be infested with termites. This percentage declined in each subsequent year, but increased in 2007 and decreased to zero in 2008. Declines in the percentage of properties found to be infested with termites were observed in other areas after treatment.

The number of complaints about swarming termites from people in the Upper Pontalba Apartments has dropped dramatically to about one per year. This further shows that the program has reduced the numbers of termites in the French Quarter. Visual inspections of trees and courtyards on these properties are being conducted to detect any termite infestations outside of the structures. Infested trees were treated by pest management professionals, and termites were not found infesting treated trees in subsequent inspections.

Results of the French Quarter program have shown a reduction in the numbers of Formosan subterranean termites using areawide integrated pest management. Reductions have been seen in the numbers of alates captured, percentages of in-ground stations with termites, infestations in trees, and numbers of swarms in buildings. Some isolated areas still exhibit high termite activity. These areas are being examined for termites through intensive inspections of structures and trees. Continued inspections, treatments and evaluations are needed to further reduce the numbers of Formosan subterranean termites.

The emphasis of the program has been on killing termites and management of termites throughout the landscape rather than simply applying insecticide barriers around structures. The program has shown that areawide management can be successful in reducing the numbers of Formosan subterranean termites. This program should be transferred to and adopted by other neighborhoods and cities. ■

Acknowledgements
Rose Broggi, Chris Morel, Chris Dunnaway and Rita Riggio – LSU AgCenter; Ed Freytag, Barry Yokum, Perry Ponseti, Berry Lyons, Carrie Owens, Jamie Ward and especially Ed Bordes for the many hours of personal communication – New Orleans Mosquito and Termite Control Board; Pedro Levy, Ryan Solhjoo, Chris Florane, Ronnika Allen and Elena Khoutorova – USDA-ARS; pest management professionals for treating properties and cooperating in the program and property owners, tenants and property managers for allowing inspections and treatment of properties in the French Quarter.

Photos by John Wozniak

Under Attack by Termites

Gregg Henderson

I remember watching a science fiction television program as a child where the residents of a house were being attacked by giant termites the size of small cars from an alien world. The termites ate slowly through the house, horrifying the couple inside. A similar fear occurs in some residents of Louisiana when they find out they are under siege by the invasive and highly destructive Formosan subterranean termite.

Although not much smaller than a rice grain and similar in color, the Formosan subterranean termite worker may have several million brothers and sisters with the same mindset – find and eat wood. A single colony's foraging area has been documented to encompass the area of an entire football field. The cellulose they pursue may be a 600-year-old live oak or a modest, not-as-old home. In time, both can be destroyed by the colony.

Originally hopping a ride to the United States on military ships returning from the Pacific after World War II, the Formosan subterranean termite became widespread in the state within the past 10 years. Boasting the highest populations of Formosan subterranean termites in the continental United States, Louisiana has been dealing with the destructive tendencies of these termites for 65 years now. They truly are the alien giants of the termite world.

The unusually large flights of males and females flying in the early evening near light posts were the first signs that something new was in town. The winged termites, known as alates, that emerge from numerous colony nests in the ground, tree or home around Mother's Day every year can shut down outside evening events any day they choose between April and end of June. People out and about on the nights of these alate flights are at risk of gagging from inhaling a bunch of alates. There are that many flying at a time. The alates are attracted to lights, which serve as the meeting place between the sexes that will result in a monogamous relationship between king and queen that can last for decades.

Starting in 1989, when Formosan populations in the French Quarter were considered at crisis levels by residents and pest control operators alike, LSU AgCenter scientists deployed 15 light-traps to collect alates in the French Quarter and Greater New Orleans. Originally, the idea was just to see how widespread they were in the Quarter. However, it was soon determined that yearly counts were one of the few measures (indirect as they may be) that could be used to determine growth or decline of the infestation.

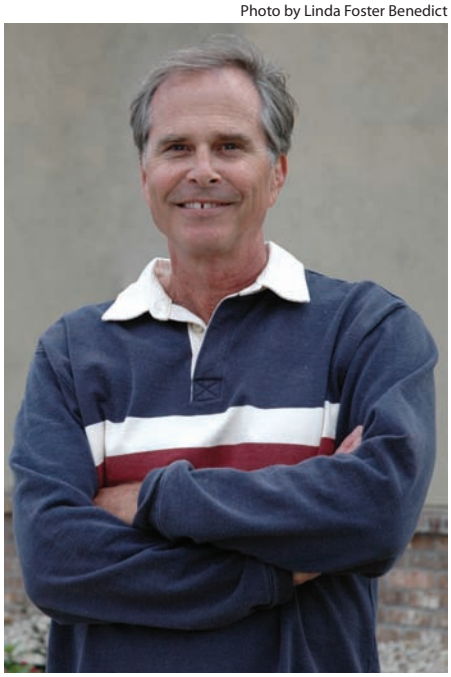
The use of alates to measure the health and size of these underground

Gregg Henderson, Paul K. Adams Professor of Urban Entomology, Department of Entomology, LSU AgCenter, Baton Rouge, La.

Illustration by Elma Sue McCallum

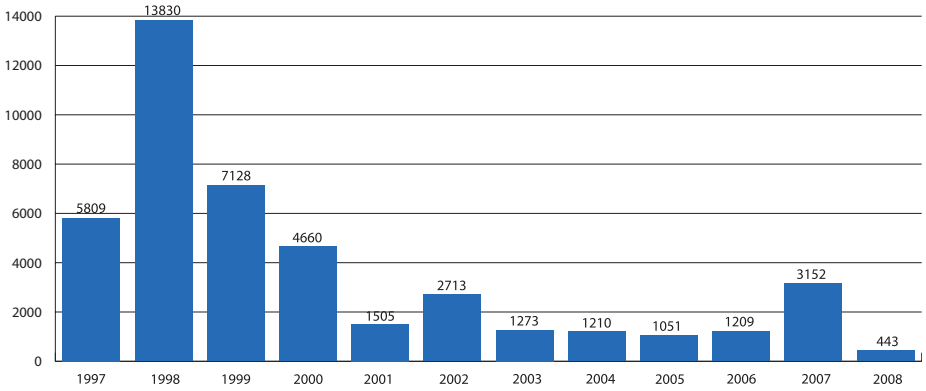
Although not much smaller than a rice grain, the Formosan subterranean termite worker may have millions of siblings, all with the same mindset to find and eat wood.

Photo by Linda Foster Benedict



Gregg Henderson started his entomology career with an interest in ant behavior, but switched to termites. His termite research has led to 17 patents regarding termite control agents and devices.

Figure 2. Mean alates per trap in the French Quarter of New Orleans



aliens is an imperfect science because we don't understand many of the intrinsic and environmental factors that control their numbers in a colony. While we know the colony must be large, having developed for at least seven years if it is to produce alates, we don't really know how various stresses can affect their output. From the 20-year census we have gained some insight into these questions.

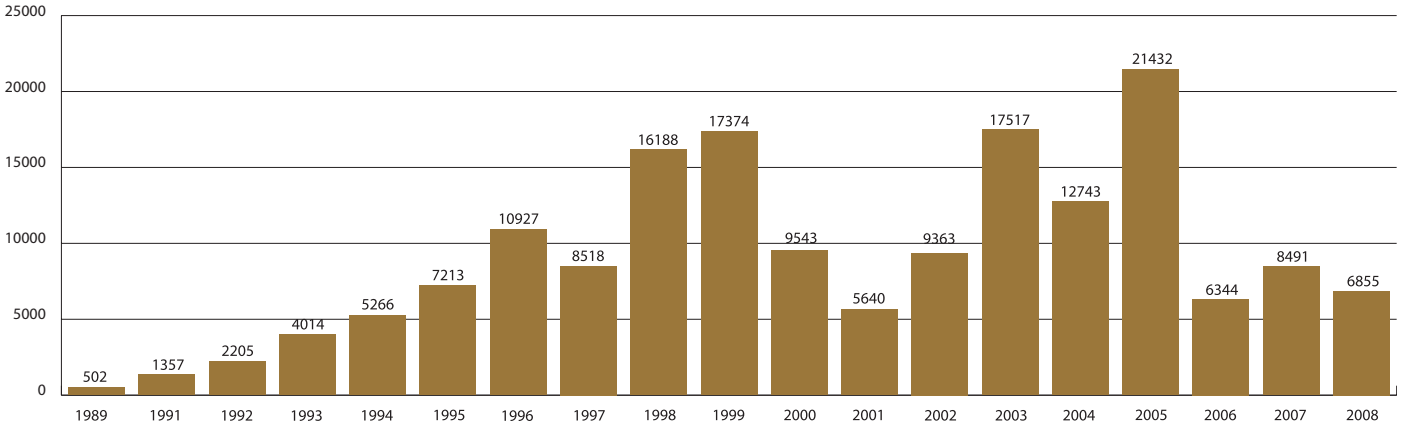
From 1989 through 1996, growth in the number of alates was recorded. These data were invaluable to Rep. Bob Livingston, who at that time was chair of the House Appropriations Committee, as justification for funding a major initiative to control Formosan subterranean termites. Operation Full Stop, as the effort was named, has since garnered more than $28 million in federal funding to study and demonstrate control methods since then. Over the 20 years, three drops in alate catches stand out. Two were linked to major droughts and one to Hurricane Katrina.

Both in the mid-1990s and again starting in 2000, major droughts were recorded in Louisiana. Dry conditions make it difficult for Formosan subterranean termites to persist in above-ground carton nests for long because they require a constant source of water. In addition, dry soil is harder to tunnel through to get to food sources without major desiccation casualties among the soft-bodied workers. Alate production becomes too costly to the colony.

Meanwhile, the floods caused by levee failures in 2005 in the aftermath of Hurricane Katrina kept much of New Orleans under water for close to one month. This resulted in the highest percentage drop in numbers from the previous year over the 20-year census. More than a 70 percent drop in numbers was seen from the pre-Katrina 2005 count to the post-Katrina 2006 count. However, climate is not the only reason that alate numbers dropped in New Orleans, especially in the French Quarter. The proposed research project, which was funded by Congress, was directed at using only colony reduction products. Nonrepellent termiticides and baits were just coming onto the market, and both represented a new paradigm in termite control – whole colony kill. Figure 2 shows the total alate catch in the French Quarter for a condensed set of years. A clear and persistent decline is evident that almost certainly was due to the efforts of the LSU AgCenter, the U.S. Department of Agriculture's Agricultural Research Service, the Louisiana Department of Agriculture and Forestry, New Orleans Mosquito and Termite Control Board and local pest control operators – all partners in Operation Full Stop. The 2008 alate catches were more in line with 1989 numbers.

While success is clear, and using alates to measure changes in populations appears useful, we must keep in mind that in 1989 we were thought to be in crisis mode with this termite giant. ■

Figure 1. Mean alates per trap in Greater New Orleans (1989-2008)



ECONOMICS of Formosan Subterranean Termite Control Options in Louisiana

Krishna P. Paudel, Mahesh Pandit and Michael A. Dunn

Experts estimate the damage from Formosan subterranean termite infestations in the United States exceeds $1 billion per year. In Louisiana alone, the most affected state in the continental United States, they estimate damage at almost $500 million a year.

The Formosan subterranean termite, a species native to China, was introduced to Louisiana, South Carolina and Texas by ships returning from World War II. As of 2010, this invasive species is present in Alabama, California (an isolated infestation in San Diego County), Florida, Georgia, Hawaii, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee and Texas. These termites are known as super termites because a single colony can consist of as many as 10 million individuals.

The Formosan termite attacks living trees as well as structural wood. Colonies are established both in the ground and above ground as long as they have a source of water. To control Formosan termites, researchers are attempting to identify the best options to minimize economic damage. Additionally, if needed, subsidized treatment programs can be implemented based on homeowners' preference rankings. Decisions based on homeowners' responses provide a basis for urgency of the situation and perceived cost/benefit of a proposed control method.

The U.S. Department of Agriculture has subsidized a treatment program in the New Orleans French Quarter since 2000 through which a subsidy is paid to participating homeowners. Because Formosan subterranean termites can move easily during the breeding season from other areas into the subsidized zone, the subsidy may need to be expanded to a larger area.

A survey was conducted in 2002 to identify the termite control option preferred by Louisiana homeowners. The survey population consisted of all Louisiana homeowners occupying single-family homes in four metropolitan areas – New Orleans, Baton Rouge, Monroe and Alexandria. A total of 5,641 homeowners were contacted through a mail survey: 1,490 from Monroe, 1,305 from Alexandria, 1,395 from Baton Rouge and 1,451 from New Orleans metropolitan areas.

Four termite treatment options were offered for each individual homeowner to rank from the most preferred to the least preferred. The treatment choices provided were:

No control. Do not engage in any sort of activities, such as contracting with a pest control operator, to protect against termites. This option costs no money. With no form of termite protection or control, however, the chance that your home will be attacked by termites over the next five years is significant.

Liquid. Contract with a pest control operator to install a liquid termite prevention solution, which is an insecticide applied in a trench dug around your home. The cost of this option is, based on a 2,000-square-foot home, $750 for the initial inspection and installation fee and $113 in annual renewal fees, including the first year. This equates to an average cost over the next five years of 13 cents per square foot per year. With this service you will receive one home inspection per year. The contract lasts for five years.

Photo by Chris Dunaway

A carton nest has been extracted from a fallen tree infested by Formosan subterranean termites.

Krishna P. Paudel, Associate Professor; Mahesh Pandit, Graduate Student; and Michael A. Dunn, Professor, Department of Agricultural Economics & Agribusiness, LSU AgCenter, Baton Rouge, La.

Bait. Contract with a pest control operator to install a termite baiting system around the exterior of your home. The cost of this option is, based on a 2,000-square-foot home, $2,000 for the initial inspection and installation fee and $450 in annual renewal fees, including the first year. This equates to an average cost over the next five years of 43 cents per square foot per year. With this service you will receive a minimum of one inspection per month. The contract lasts for five years.

Liquid+Bait. Contract with a pest control operator to install a liquid termite prevention solution around the exterior of your house plus a termite bait system. The cost of this option is, based on a 2,000-square-foot home, $2,750 for the initial inspection and installation fee with an annual renewal fee of $563 per year, including the first year. This equates to an average cost over the next five years of 56 cents per square foot per year. With this service you will receive a minimum of one inspection per month. The contract lasts for five years.

The 747 respondents who completed the survey ranked four termite control options. The liquid treatment was preferred by 52 percent of the respondents, followed by the no-control option at 23 percent, bait treatment at 13 percent and liquid-plus-bait at 12 percent. Seventy percent of the respondents preferred some form of treatment. Further statistical analysis of the data indicates that if liquid is the first choice, bait is the second choice for termite control.

The analysis also showed that a treatment choice differs by socio-economic characteristics. Respondents with incomes less than $125,000 preferred the liquid treatment option whereas respondents with incomes greater than $125,000 prefer the bait treatment. At this income point, there is an apparent change in perceived risk versus value. Homeowners with incomes greater than $125,000 perceive they can afford to pay more for termite control because the extra cost is worth the protection. The less-than-$125,000 group appears to believe the extra cost is not worth the perceived extra protection.

Likewise, if a home's market value was less than $300,000, respondents preferred the liquid treatment option, while respondents preferred the bait treatment if their homes' market values were equal to or greater than $300,000. In addition, respondents who considered termites to be a problem in their neighborhoods preferred the bait treatment option, whereas the liquid treatment option was preferred by those who did not consider termites to be a problem in their neighborhoods. Finally, respondents from New Orleans preferred the bait treatment option, and respondents from outside New Orleans preferred liquid as a treatment option.

The study indicated that Louisiana homeowners chose the liquid treatment as the single most preferred option to control Formosan subterranean termites, and the liquid-treatment option and bait-treatment option are the two most preferred options. This study also revealed that New Orleans respondents preferred the more expensive termite treatment options. This could be due to several factors, including a "subsidy effect" that occurs because some areas in that city were already under subsidized termite control and an "information effect" resulting from heavy termite damage that has occurred in New Orleans during the past 20 years.

State and federal agencies can provide the public with support in terms of information, knowledge and education on Formosan subterranean termite control. This study indicates that information should be targeted to different groups according to where they live, their experience with termites and other demographic categories that relate to termite control preferences and risk tolerances. ■

Using DNA profiling to assess the success of controlling Formosan subterranean termites *in the New Orleans French Quarter*

Claudia Husseneder and Frank Guillot

Because of the persistent infestation of the Formosan subterranean termite that has threatened to destroy historical buildings in the French Quarter of New Orleans, a federally funded program called Operation Full Stop was initiated in 1998 to apply areawide treatments to suppress the termite and limit further damage.

The success of Operation Full Stop is assessed in two ways. First, the foraging activity of colonies is measured using nontreated, in-ground monitoring stations in the French Quarter throughout the year. Second, swarming activity of alates – winged, reproductive termites – is measured using traps under street lamps during the swarming season in late spring and early summer.

The number of infested monitoring stations and the number of alates caught in traps do not necessarily reflect the number of active termite colonies because a colony's foraging area can extend over hundreds of yards. A single mature colony can produce thousands of alates. Infestations of foraging workers

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Photo by Linda Foster Benedict

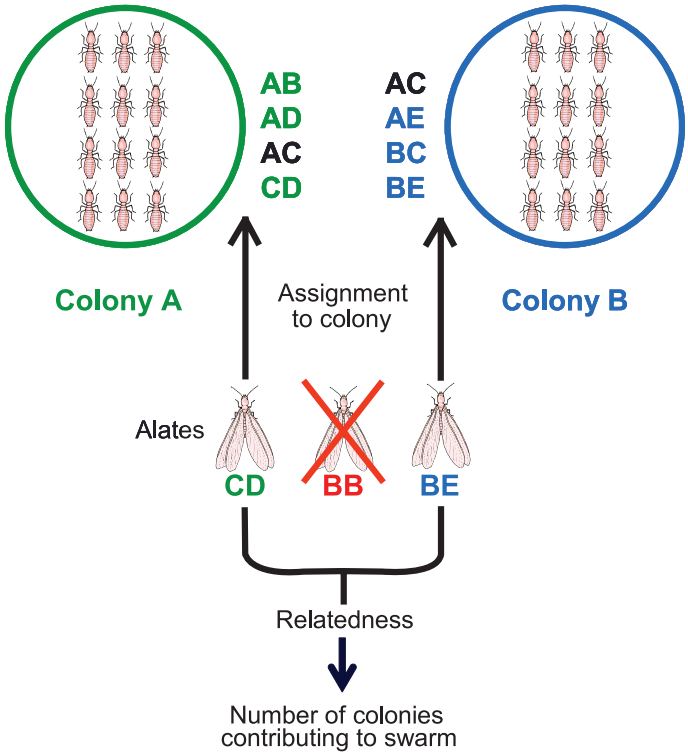
Claudia Husseneder analyzes the DNA of termites to determine which colonies they belong to. This aids in the evaluation of the effectiveness of the treatment programs.

and swarms of alates need to be assigned to their colony of origin. This is not an easy task for two reasons. First, subterranean termites forage and nest mainly underground. Therefore, direct observation of termite activity is almost impossible. Second, even if foraging workers or swarming alates are captured, they cannot be physically distinguished to identify from which colony they come.

To solve this problem, researchers in the LSU AgCenter Department of Entomology analyze DNA profiles of termites. DNA profiling identifies genotypes – or hereditary factors – visible as a specific banding pattern – or fingerprint – of each individual and each colony. These DNA fingerprints can be used like barcodes to tag each colony with its genetic profile.

Because colony offspring share a subset of bands of their mother colony's barcode, foraging workers can be assigned to colonies, and the actual numbers of termite colonies infesting an area can be determined. Swarming alates can be assigned to their colony of origin following the same principle. Because colonies are families and genotypes are inherited from the king and the queen that originally started the colony, relatedness among alates can be calculated and used to estimate how many colonies contribute to a particular swarm. For example, if a swarm is made up of only one colony, all individuals are highly related. The more colonies mix in swarms, the lower the average relatedness becomes (Figure 1).

Figure 1. How alates are assigned to colonies and how the number of colonies contributing to alate swarms can be estimated.



Letter combinations represent genotypic profiles – profiles of hereditary markers – for two groups of workers found at infestation sites. The genotypic profiles of the two groups contain many different genotypes (different colors) and are, therefore, genetically distinct colonies. Because colony offspring always have a subset of the genotypes of the mother colony, two of the alates could be assigned to their colony of origin, and one is from a different colony. Relatedness among alates can be used to estimate from how many different colonies they originated from.

Areawide treatment was expected to kill the majority of termite colonies in the French Quarter and lead to a decline and eventual disappearance of their swarming and foraging activities. By using mark-and-release recapture and DNA profiling to "tag" colonies before treatment, researchers have shown that proper treatment successfully eliminates termite colonies.

In a study along the Riverfront Railroad in New Orleans, all colonies – regardless of their size and the number of kings and queens in them – treated with baits containing insect growth regulators disappeared and did not come back after treatment. This indicates that many hundreds of colonies were eliminated during the 12-year course of treatment by Operation Full Stop. As a result of reducing the number of colonies, alate numbers decreased during the first years of the program. Since then, however, alate numbers have reached a steady level, and despite continued treatment efforts, no further reduction was observed. At the same time, a small percentage of in-ground monitoring stations have remained infested, and some residual infestations remain in trees and structures. This leads to the question: Do colonies foraging in these monitoring stations, trees and structures serve as a major source for persisting alate swarms in the vicinity?

AgCenter research has shown that the in-ground monitoring stations within the program area contribute less than five percent of alates caught in the traps. The research team is investigating how many alates are originating from nearby infestations in trees and structures. Preliminary data suggest that only a small percentage of alates can be assigned to infestations close to each trap. This can be explained by two scenarios: 1) many hidden colonies are missed by treatment and monitoring efforts and contribute to the alate swarms; and 2) a few remaining colonies still produce a considerable number of

alates. Therefore, alate counts have not been reduced as much as expected.

To find out which of the alternatives would explain the residual alate swarms and the difficulties of finding their colonies of origin, AgCenter researchers used DNA profiles to determine relatedness of alates in swarms and calculate how many colonies contributed alates to each swarm. The number of colonies contributing to swarms caught in traps has dropped from an average of 13 in 2003 to seven in 2007 and only two per trap in 2008. This proves the number of colonies has been significantly reduced because of the persistent treatment effort. Because alates don't always fly to the closest trap, however, the originating colonies cannot be pinpointed easily.

These studies show the effectiveness of the treatment provided by Operation Full Stop on termite infestations of the French Quarter. The results are encouraging for combating Formosan termites and other invasive and native termite species. To sustain the treatment success and avoid repopulation by alates from outside the treatment area, areawide treatment not only should continue but also should be expanded, even though federal funds are likely to subside. It is in the vital interest of Louisiana to carry on the "second battle for New Orleans" against the Formosan subterranean termite. ■

Acknowledgement
The U.S. Department of Agriculture's Agriculture Research Service and the City of New Orleans Mosquito and Termite Control Board are cooperating partners with the LSU AgCenter in Operation Full Stop.

Apple snails pose threat to Louisiana's rice industry

Don Reed

Plants and animals introduced into Louisiana cause a wide range of ecological problems. Notable examples include water hyacinth, Chinese tallow tree, nutria, English sparrows and European starlings. Unfortunately, another animal can be added to the list that could pose problems for us in the future, the apple snail.

Apple snails are tropical or subtropical freshwater snails that occur naturally in Africa, South and Central America, and Southern Asia. They can reach sizes up to 6 inches in diameter and are well-adapted to regions with periods of drought alternated with periods of excessive rainfall. They possess gills similar to fish on one side of their body and lungs on the opposite side. This lung/gill combination greatly aids their mobility when searching for food.

Most species of apple snails lay brightly colored egg masses above the normal water line. This strategy prevents egg predation from fish and other aquatic invertebrates.

Apple snails reached the United States by way of the aquarium pet trade. Their attractive appearance and size have made them a popular addition to many home aquariums. In other parts of the world, apple snails have been introduced in an attempt to start an escargot industry. It was believed that this type of food culture could provide protein for local populations who were lacking this essential component in their diets. These introductions primarily made in Taiwan quickly spread to Indonesia, Thailand, Cambodia, Hong King, southern China, Japan and the Philippines. In none of these areas has the food value of apple snails been realized. Introductions into Hawaii in 1989 have also failed to serve as a food source.

Apple snails are not selective in their eating habits and will consume almost any type of vegetation. They do, however, tend to prefer soft succulent plants. When food supplies are lacking in their aquatic environment, apple snails take advantage of their amphibian life style and leave the water in search of food.

Apple snails can live from three months to three years, depending on the species of apple snail, food availability and water temperatures. Species with shorter life cycles will reproduce throughout the entire year, while those with longer life cycles reproduce mainly in the spring and early summer.

When depositing their eggs, female apple snails climb from the water, usually during the night or early morning. They deposit their eggs on a stem of emergent aquatic vegetation, tree trunk, rock or other structure. They lay a new egg approximately every 30 seconds until an egg mass of anywhere from 100 to 1,000 brightly colored orange, pink or green eggs appears. The time from egg deposition to hatching varies from two to four weeks, depending on temperature and species.

Apple snails have been found in significant-enough numbers in Louisiana to cause concern. The discoveries so far have been along the ditches and streams of the north shore of Lake Pontchartrain. Releases from aquariums are believed to be the source of these invaders. The biggest concern at this point is the effect that large numbers could have on the rice industry. In many countries where they now occur, significant damages are reported on rice fields. They feed on young succulent rice plants. The LSU AgCenter has tested several insecticides labeled for use on rice fields in Louisiana, but none has been found effective in controlling apple snails. At present, the best control measure is to knock the brightly colored egg masses back into the water any time they are spotted. ■

Don Reed, Professor, Bob R. Jones Idlewild Research Station, Clinton, La.

Nutria

More Than a Nuisance

Brian D. LeBlanc

A semi-aquatic rodent, the nutria live as far west as Texas, east to the Florida panhandle and southward toward Tampa Bay, Fla.

The nutria is possibly the most well-known of the non-native species introduced into the environment of south Louisiana. Over the past 90 years, they have spread as far west as the hill country of Texas, east to the Florida panhandle and southward into the Tampa Bay, Fla., region. A semi-aquatic rodent, the nutria's original range includes most of South America.

Nutria adults range in size from 12 to 18 pounds with some individuals reported as large as 37 pounds. The nutria's fur is yellowish brown to dark brown, except on the belly, which is a pale yellow. The head is proportionally large with large orange incisor teeth perfect for gnawing plant materials of any density and strength. The rodent's tail is long, round, scaly and thinly haired except at the base. The digits of the hind legs are partially webbed, while those of the front feet are not. Although nutria eat mostly vegetation, they also consume small mollusks, insects and even nestling birds if they encounter them while foraging.

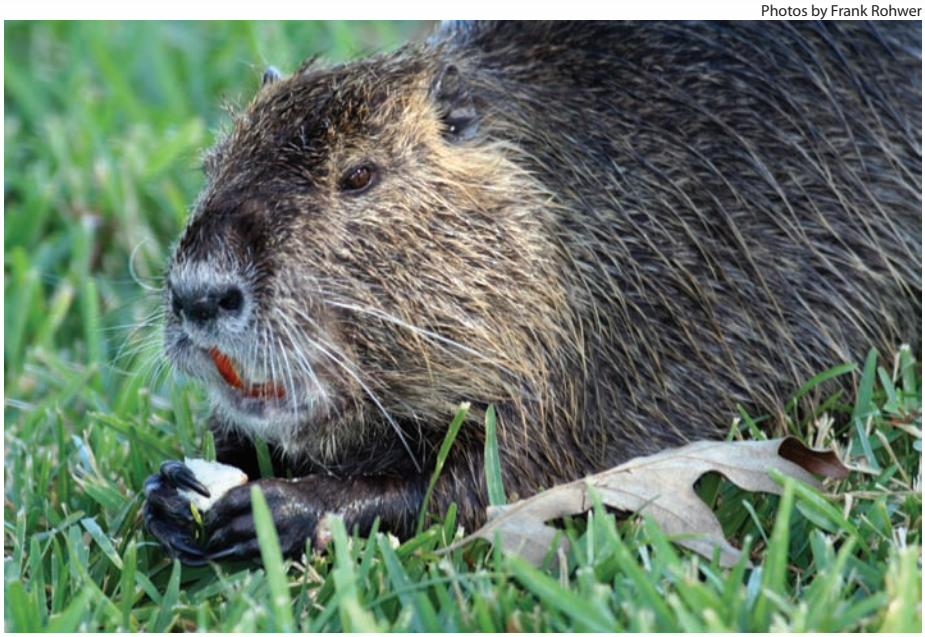
Early in its history in Louisiana, the nutria was considered not only a source of pelts for the fur trade but also an effective method of aquatic plant control in canals and bayous. It has been debated whether the introduction of the nutria from South America into Louisiana was accidental or intentional. Most believe, however, that nutria were released intentionally in the early 1930s for their fur and their potential to clear waterways of unwanted, clogging plants. A small number of nutria farms became part of the coastal economy during these times. Unfortunately, the nutria preferred the native wetland vegetation over invasive non-native vegetation. As the nutria numbers increased, so did the damage they inflicted on the native plant life and natural environment.

Trapping the nutria for their fur was initially the control method. But as demand for fur worldwide has decreased, nutria numbers have increased as has their damage to the wetlands and marshes of Louisiana.

Nutria can eat on average about 3 to 4 pounds of plants per day. They can reproduce any month of the year and generally produce two to three litters of young per year with each litter consisting of three to five offspring. The animals live for about 12 years. The only predators the rodents have are alligators and people.

Louisiana is trying to control the numbers of nutria to minimize the continued degradation of the marsh. In 2002, the state implemented an incentive payment or "bounty" to be paid to hunters properly licensed to kill nutria for their pelts and meat. Louisiana continues an aggressive campaign to encourage the consumption of nutria meat. Nutria can be prepared for consumption in many different ways and can be quite good and nutritious. State efforts to encourage the widespread use of nutria meat, however, have been met with limited results, and scientists continue to seek innovative ways to protect the fragile wetlands from this troublesome creature. ■

Photos by Frank Rohwer



Nutria have large orange incisor teeth, which are perfect for gnawing plant materials of any density and strength. They eat mostly vegetation, but they will eat small mollusks, insects and nestling birds.

Brian D. LeBlanc, Roy and Karen Pickren Associate Professor of Water Resources, LSU AgCenter and Sea Grant, Callegari Environmetal Center, Baton Rouge, La.

Zombie Fire Ants

Biological Control of the Red Imported Fire Ant in Louisiana with Decapitating Phorid Flies

Seth Johnson, Don Henne, Anna Mészáros and Lee Eisenberg

The red imported fire ant invaded the United States from South America more than 75 years ago. It was first discovered in Louisiana in the early 1950s. Because of its aggressive behavior and lack of natural enemies, the red imported fire ant has expanded its range into at least 13 states and Puerto Rico. It is present throughout most of the southeastern United States, where it is considered an economically important pest.

Early efforts to eradicate fire ants with chemical controls were met with limited success, and it was eventually recognized that alternative control tactics were required for effective management. Because the red imported fire ant invaded the United States without its natural enemies, attention has recently focused on the potential for biological control by importing specialist parasitoids in the phorid fly genus, *Pseudacteon*.

In South America, where fire ant populations are one-fifth of those in the United States, at least 24 species of *Pseudacteon* attack fire ants. These parasitic flies locate their host by detecting alarm pheromones that worker ants release when the mound is disturbed or when the ants are fighting with other ants or among themselves. These tiny flies, which are less than 1.5 millimeters in length, are known as decapitating flies. They attack fire ants exclusively. These include red and black fire ants and their hybrids. The female phorid fly lays a single egg in the thorax of a worker ant. When the egg hatches, the maggot moves into the head and consumes the head contents. The maggot releases a specific enzyme that eventually causes the decapitation of the ant, and the larva uses the empty head capsule as a pupal case.

Different species of phorids attack host ants at different times of day in different locations and prefer different host fire ant worker sizes. *Pseudacteon* flies are effective in disrupting foraging activity of fire ants, allowing for more balanced competition among ant species. These decapitating flies will not eradicate fire ants completely, but they could theoretically reduce the red imported fire ant competitive dominance in ant communities and allow native ant species to better compete for resources. If this happens, North American red imported fire ant populations could drop up to 90 percent to levels more similar to those found in South America. In Louisiana, so far, we have released four phorid species: *P. tricuspis*, *P. curvatus*, *P. litoralis* and *P. obtusus* (Figure 1).

The first successful release of *P. tricuspis* in the U.S. was by the U.S. Department of Agriculture Agricultural Research Service in Florida in 1997. The first successful release with *P. tricuspis* by LSU AgCenter scientists was northeast of Covington in 1999. Releases with *P. tricuspis* were made at seven locations (twice at the same site in Natchitoches Parish) around the state from 1999-2006, with establishment confirmed in St. Tammany, East Feliciana, Natchitoches and Vernon parishes (Figure 2).

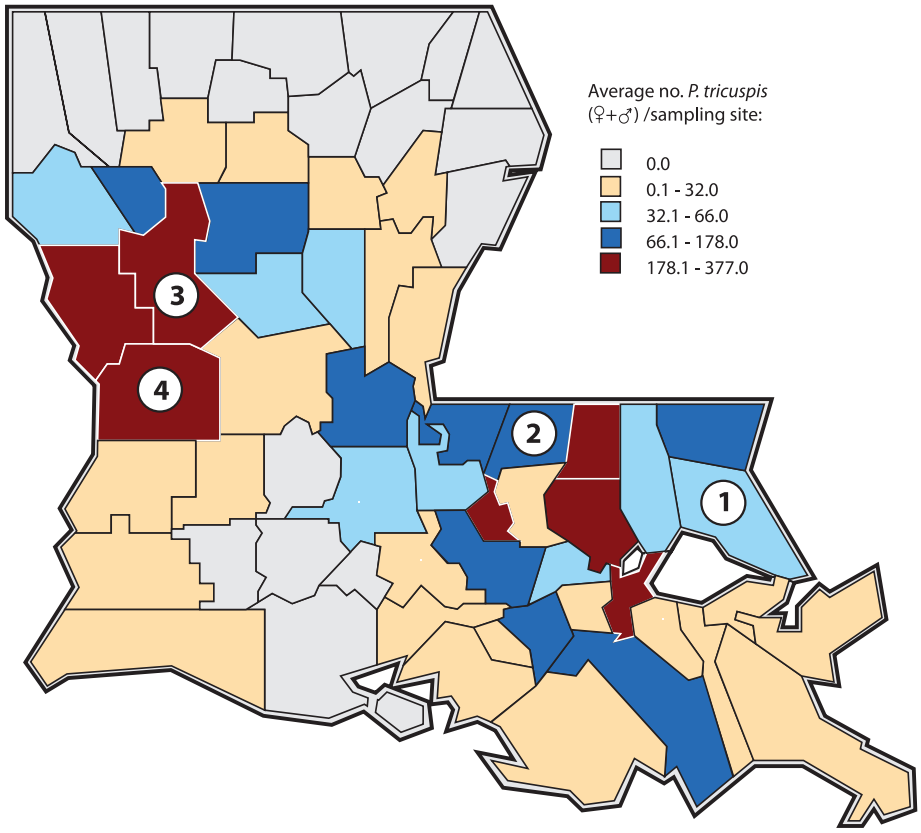
The flies for the first five *P. tricuspis* releases were provided by the USDA-ARS lab-

Figure 1. Females of three of the four phorids released in Louisiana, left to right, *Pseudacteon curvatus, P. tricuspis, P. obtusus* and a small red imported fire ant worker.

Photo by Anna Mészáros

Seth J. Johnson, Professor, Department of Entomology, LSU AgCenter; Donald C. Henne, Assistant Professor, Texas A&M AgriLife Research-Weslaco, Texas; Anna Mészáros and Lee J. Eisenberg, Research Associates, Department of Entomology, LSU AgCenter, Baton Rouge, La.

Figure 2. Distribution of *P. tricuspis* in Louisiana, 2009. The average number of flies per 10 disturbed mounds was calculated for each parish and compiled into 5 categories represented on the Louisiana map using Arc GIS. The successful release sites and date of releases are also reported: 1. St. Tammany parish (1999); 2. East Feliciana parish (2000); 3. Natchitoches parish (2005); 4. Vernon parish (2006)



oratory in Gainesville, Fla. Flies for the sixth release came from the USDA's Animal, Plant, Health Inspection Service and the Florida Department of Plant Industry rearing program. Flies for the successful seventh and eight releases came from the LSU AgCenter's own small-scale rearing program from 2003-2006. The founding flies for the AgCenter colony came from the USDA-APHIS and FL-DPI rearing program. Successful *P. tricuspis* releases were made by releasing 30-40 flies at each of 10 disturbed mounds daily for two weeks. Mounds were continually disturbed for two hours to keep the worker ants on the surface and available for parasitization.

AgCenter scientists made three successful releases with *P. curvatus* in Madison, East Feliciana and Natchitoches parishes (Figure 3). A single unsuccessful release of *P. litoralis* was made in East Feliciana (2006) with flies from the USDA-ARS lab in Gainesville, Fla. *P. obtusus* was released in Natchitoches (2009) and Iberville (2010) parishes. Establishment has not been confirmed for the 2009 release. The *P. curvatus* and *P. obtusus* releases were conducted in cooperation with the USDA-APHIS and FL-DPI rearing program. Colony fragments of worker ants were collected from Louisiana release sites, shipped to Gainesville, Fla., exposed to attacking flies for several days and shipped back for release into the mound where they originated. The colony fragment method was also used for the *P. litoralis* release, but only the largest workers were shipped to Florida for exposure to attacking flies because of the preference for this worker size class.

Field and laboratory studies were conducted on the ecology of *P. tricuspis* in Louisiana. AgCenter scientists found the pattern of range expansion by *P. tricuspis* involved both neighborhood diffusion and a long-distance dispersal pattern, known as stratified or jump dispersal. The annual rates of spread were a few miles in the first two years. The rates increased rapidly in years 3 to 4 and slowed down or leveled off by years 5 to 6 at 9-15 miles per year, with northward spread being about 40 percent greater than the spread in the other directions.

Hourly fly abundance gradually increased through the morning to a peak at midday and gradually declined in the evening. Hourly fly abundance was positively correlated with wind speed and negatively correlated with relative humidity and dew point temperature. Peak seasonal abundance occurred in the late summer and early autumn. Mass-release resighting experiments found a dispersal pattern in the short-term consistent with a simple diffusion model. Within two hours of release 50 percent of the flies dispersed less than 10 yards and 95 percent dispersed less than 30 yards. The distribution of this species at a location over time was largely random. However, high *P. tricuspsis* counts were associated with areas of polygyne (multiple queens) host colonies, and there were occasional aggregations into discrete patches with distribution gaps between these patches. Thus, population surveys of *P. tricuspis* should be conducted in several areas at a location to account for patchiness in fly populations and varying densities and social forms of fire ant colonies.

The most fascinating discovery involved the fate of the parasitized fire ant worker. AgCenter scientists found through intensive observation that parasitized workers remained inside the nest during parasitoid larval development and left the nest 8-10 hours before decapitation. Parasitized ants were highly mobile after they left the nest and ultimately entered the thatch layer at the soil surface where they were decapitated, and the fly maggot pupated. The term "zombie" fire ant workers was coined to characterize the behavior while under parasitoid control.

In 2009, AgCenter scientists conducted a survey of phorid fly distribution in Louisiana. All 64 parishes were sampled at a total of 137 sites. At each sampling site, 10 fire ant mounds were selected and sampled by disturbing the mound, crushing ants with a shovel to allow release of alarm pheromone, and collecting the phorid flies that showed up with an aspirator for two to three minutes at each mound (Figure 4). Scientists found *P. tricuspis* in 46 out of 64 parishes. It was not found in a tier of 13 northern parishes or in five parishes in the south central part of the state including Vermilion, Acadia, Evangeline, Lafayette and Allen. The parishes with the highest counts were Vernon, Natchitoches, Sabine, St. Helena, Livingston, St. John the Baptist and West Baton Rouge (Figure 2).

Scientists found *P. curvatus* in 57 of the 64 parishes. It was not found in Avoyelles, Evangeline, Allen, Acadia, Vermilion, Assumption and St. James. The parishes with the highest counts were in the north central part of the state – Union, Lincoln, Jackson and Caldwell – and Washington in the southeast (Figure 3). Even though the first *P. curvatus* release occurred six years after the first *P. tricuspis* release, *P. curvatus* was already more widely distributed. This is due to a reported dispersal rate of twice that of *P. tricuspis*, and spread from Texas and Mississippi releases. Populations in southwest Louisiana probably came from releases in Texas, and the southeast and northeast Louisiana populations were aided by releases in Mississippi. Although dispersal was slowed by the cold this past winter, every parish in the state is expected to have at least one of the fly species by the end of 2010. The successful establishment and spread of *P. tricuspis* and *P. curvatus* in Louisiana warrants further research on additional phorid species, pathogens and other natural enemies that can be safely released for biological control against the red imported fire ant in the United States.

A previous study in Florida attempted to measure the effect of phorid fly releases on the red imported fire ant after *P. tricuspis* was established there. The study showed that *P. tricuspis* alone exerted no significant impact on fire ant populations. It was concluded that multiple species of phorids would be required, as naturally occurs in South America, before fire ant populations would be reduced.

AgCenter scientists are in the second year of attempting to evaluate the impact of two established species of phorids on fire ant populations in Louisiana. However, the study may be ended early because the control area, Vermilion Parish, may be overrun with one or both phorid fly species in 2010. Regardless of the results of this study, additional species of phorid flies will soon be available for release in Louisiana. *Pseudacteon cutellatus* is currently in quarantine in Gainesville, Fla., awaiting approval for release, and *P. nocens* is being reared and released in Austin, Texas. In addition to the established phorid species, *P. cutellatus* and *P. nocens* are expected to increasingly reduce red imported fire ant populations in Louisiana and help mitigate their negative effects on humans, livestock and wildlife. ■

Figure 3. Distribution of *P. curvatus* in Louisiana, 2009. The average number of flies per 10 disturbed mounds was calculated for each parish and compiled into 5 categories represented on the Louisiana map using Arc GIS. The successful release sites and date of releases are also reported: 1. Madison (2005); 2. East Feliciana parish (2006); 3. Natchitoches parish (2007).

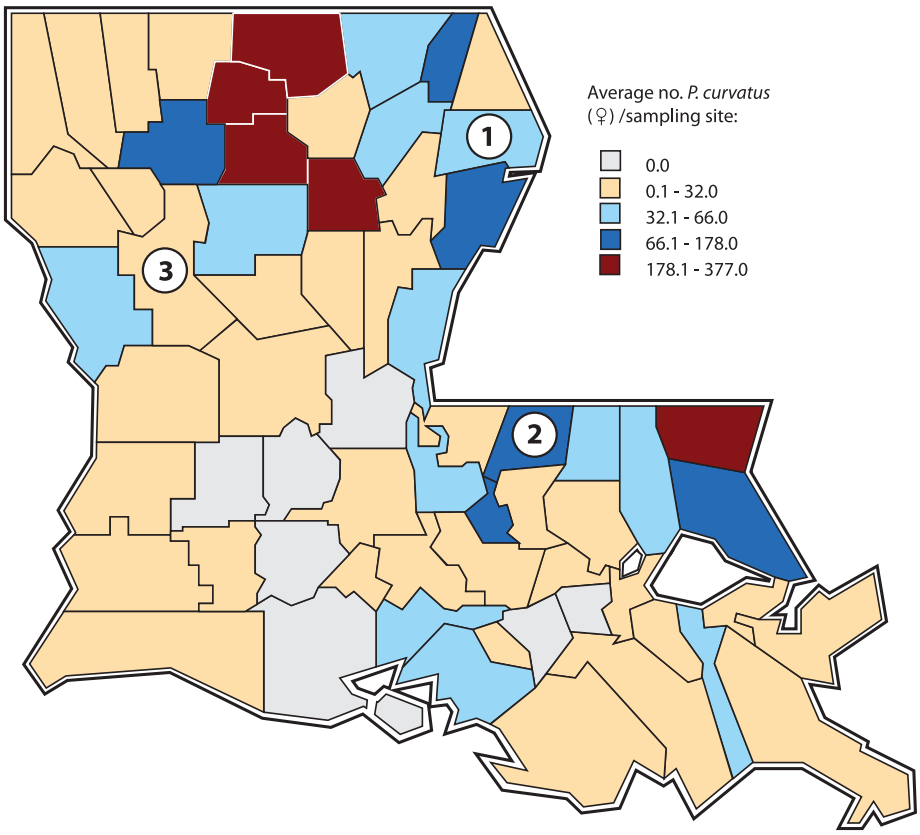


Figure 4. Anna Mészáros sampling phorids at a disturbed red imported fire ant mound in East Feliciana Parish during the 2009 statewide survey.

Photo by Julien Beuzelin

Photo by Michael A. Seymour

Red imported fire ants, *Solenopsis invicta*, are a major pest species around the world and an exotic species from South America.

Balancing benefits and damage from fire ants in pastures

Lane D. Foil, Linda Hooper-Bui, Deanna Colby, Glen Gentry, William "Van" Hilbun, Claudia Husseneder, Lacy M. Inmon and Seth Johnson

Red imported fire ants were introduced into the United States more than 75 years ago. Since then, fire ants have invaded more than 320 million acres in 12 southeastern states, and they continue to spread despite eradication and quarantine efforts. The most notable fire ant control program was conducted by the U.S. Department of Agriculture in the 1960s and 1970s in a failed attempt to eradicate fire ants by treating 140 million acres with bait by ground and aerial equipment. It is now generally accepted that eradicating fire ants from the Southeast is not feasible and that integrated pest management systems approaches are better suited.

Fire ants have a potent sting, and they are known to contribute to reduction in native insect and other animal populations. Fire ant mounds in hay fields reduce hay production, and in pastures they reduce the area for grazing. Farmers report increased costs from damaged machinery, unclogging cutters and worker injury. Fire ants also cause direct injury to livestock. Although fire ants must be managed to increase profits in livestock production, few economically viable control strategies are available.

Despite the problems they cause, fire ants also provide benefits as predators of agricultural pests. For example, researchers have observed a gradual decline in tick populations as fire ants numbers have increased. Field studies conducted in Louisiana in 1972 clearly demonstrated significant fire ant predation on ticks. Since then, ticks have not been considered to be a major problem for livestock. Fire ants also were identified predators of the immature forms of the horn fly, which is one of the major economic pests of livestock in the United States. As such, it would be practical to accept the inevitable presence of fire ants in pastures, maintain their beneficial aspects and manage their populations below economic impact levels.

Chemical treatments are available for temporary suppression of fire ants in pastures, but producers rarely apply these treatments because they are cost-prohibitive. The estimated cost of broadcast applications of fire ant baits approved for use in pastures is $10-$15 per acre. The cost of the products alone is commonly $10 per pound, and recommended application rates vary from 1 to 1.5 pounds per acre. The average profit for a Louisiana cow-calf pair at a stocking rate of one cow per 2.6 acres is $80. If fire ant control costs $12.50 per acre, the average cattle producer would spend 40 percent of his annual profit on chemical treatments.

In 1981, LSU AgCenter scientists found that dragging pastures with a one-ton metal harrow during February significantly reduced the number and size of fire ant mounds for up to 15 months, but they found no benefit from dragging fields in summer. The pastures were dragged just before a freeze, and the effects on the ants were attributed to temperature. A similar study conducted in Oklahoma in 2001 showed no post-treatment differences the next spring. The contrast in the results of these two studies brought into question whether timing cultivation with freezing temperatures was important for controlling fire ants.

At the LSU AgCenter Reproductive Biology Center in St. Gabriel, pastures are often plowed and planted with ryegrass every other fall. The effect of the fall techniques on the appearance of fire ant mounds in the following spring is easily observed and is consistent from year to year. Prior interpretation of the observed effects of plowing would have been that the ants merely moved to the undisturbed fence and moved back or that the mounds were new colonies. This study revisited the use of a routine

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farm practice – plowing – as a potential control strategy to reduce fire ants in pastures. In addition to documenting structural mound changes, Trial 1 incorporated microsatellite molecular markers to determine how the sample population moved in response to plowing.

In Trial 1 at the Reproductive Biology Center, three sites were each divided into three 480-square-yard plots. One plot at each site was randomly selected for plowing, and the remaining two plots were left undisturbed for comparison. The one undisturbed plot served as a buffer between the plowed plot and the control plot.

Active fire ant mounds were measured (length, width and height), mapped and sampled once per month from pretreatment in November 2003 through April 2004. A mound was considered active if ants appeared on the surface within a few seconds of disturbing it. All active mounds were recorded regardless of size, and the coordinates were mapped.

Plowed plots were disked on Nov. 7, 2003, and a harrow pulverized any large chunks of soil. Plots were observed during and immediately after plowing to confirm that above-ground mounds were removed from their bases and dragged several yards, while the below-ground portions of mounds were sliced and turned. Samples of fire ants were taken from each mound and were assigned to colonies based on their DNA profiles.

In Trial 2, six study plots were established at the Reproductive Biology Center in May 2009. Three plots were in pastures that had been plowed in October 2008, and three plots were in pastures that had not been plowed in October 2008. Fire ant mounds were measured in each sampling area in May and August 2009 and May 2010. The mean height, area and volume of the mounds in plowed and unplowed pastures were compared to determine how plowing affected mound size.

In Trial 1, differences in mound area, volume and height before treatment and five months after treatment showed that plowing significantly reduced the above-ground height and volume of mounds. At one month after treatment, the mounds in the plowed plots were reduced by 61 percent in area, 85 percent in volume and 83 percent in height. Five months after treatment, the undisturbed mounds had increased by 138 percent in area, 380 percent in volume and 363 percent in height while the disturbed mounds were still smaller than they were before treatment.

Researchers observed a gradual decline in tick populations as fire ant numbers increased.

Comparisons of genetic markers revealed that 95 percent of the original colonies on control plots in November 2003 remained in April 2004, compared with 79 percent on plowed plots. The decrease in number of original colonies was not significantly different between treatments. The genetic profiles of colonies that disappeared from plots were not seen in adjacent colonies, indicating they had not moved to new locations.

In Trial 2, the height, area and volume of the mounds in plowed areas were significantly different from those in undisturbed areas six months after plowing, and the height was significantly different nine months after treatment. In the plowed areas, the mounds were 67 percent smaller in area, 69 percent smaller in volume and 48 percent smaller in height than those in the unplowed nine months after treatment, and the volume of mounds in plowed areas was 42 percent less than in plowed areas 18 months after plowing.

As in 1981, this study found that destroying fire ant mounds in the fall by plowing led to significantly less growth in mound height by the following spring when compared with undisturbed mounds. The effect of plowing on mound height contributed to significantly reduced mound volume during a time of year when mounds are crucial to colony functions, such as rearing young. Above-ground mounds allow colonies to maintain optimal temperatures by moving in and out of the mound and producing young year-round. The energy lost to mound rebuilding or significantly smaller mounds could potentially decrease and delay reproductive flights in early spring, influencing the successful establishment of new colonies. The physical cost to a colony to rebuild a mound during winter months may be too high because metabolic reserves are mostly spent on colony maintenance. Regardless of the biological reasons for the apparent benefits of fall cultivation, reducing the effects of fire ant mounds in spring when forage availability is critical for growing and lactating cattle is a goal that can be obtained using standard farm practices.

The primary economic losses in cattle production associated with fire ants are due to reduced forage available for grazing and damage to equipment used for hay production. These losses are directly proportional to the size of mounds rather than the number of ants. The recent studies have shown that tillage associated with normal farm practices can significantly reduce fire ant mound size in pastures for more than six months, and that timing these practices for fall or winter is needed for sustained benefits. These studies also show that timing tillage with hard freezes is not critical.

One outcome of the molecular study was that plowed plots did not lead to greater numbers of new colonies compared with controls. Because this was not the case, it appears that disrupted colonies maintained their territories while rebuilding their mounds. Furthermore, the observations of large mounds along fence lines apparently does not mean that fire ant colonies move from disturbed areas to the fence lines but rather that the colonies along the fence lines continue to grow while the colonies in disturbed areas do not.

Maintenance of stable fire ant populations should prevent invasion by new colonies and sustain beneficial predation of fire ants on cattle pests, such as ticks and horn flies. Therefore, controlling fire ants likely will both conserve their predatory benefits and decrease their economic effects.

The best application of fire ant management may be by combining control measures in an integrated pest management approach. The benefits of mechanical control are as good as or better than chemical control. For example, a previous study tested methoprene broadcast bait treatments for fire ant control in pastures at the Rosepine Research Station in Rosepine, La. The number of fire ant mounds was reduced at six months after treatment but returned to pretreatment levels within a year.

The effects of whole-farm treatments with methoprene in areas where phorid flies are established are effective for six months longer than the in areas devoid of phorid flies. Therefore, as established phorid fly populations spread and new phorid species are established, the benefits of mechanical control may be extended by biological control agents.

Ultimately, the use of conventional farming practices in combination with biological techniques will provide sustainable, economically feasible control of fire ants in pastures, and chemical control can be used to augment these techniques. ■

Photo by Johnny Morgan

Giant salvinia was taking over Lake Bistineau in north Louisiana. Camp owners were not able to take out boats for fear of burning engines while trying to traverse the noxious weed.

Invasive Aquatic Weeds in Louisiana

Dearl Sanders, Seth Johnson and Bill Kelso

Over the past 120 years, many individuals have released aquatic plants into state and private waters in Louisiana with the best of intentions, only to find out that the seemingly innocuous and often very attractive plants have completely upset the ecology of the receiving water bodies. When released far from natural predators and diseases that regulate their numbers in their native lands, a number of these plants have displaced native aquatic vegetation in many water bodies throughout the state. Uncontrolled, these plants can eliminate access for anglers and other water users, degrade fisheries and waterfowl habitat, severely reduce water quality and cause the expenditure of millions of dollars annually in control costs.

The history of invasive aquatic plants in Louisiana can be traced to the World's Industrial and Cotton Centennial Exposition of 1884 in New Orleans. Although difficult to document, numerous sources state water hyacinth was imported from Brazil and distributed at the exposition in decorative glass containers as mementos. Infestations of water hyacinth were reported across the

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Photos by Johnny Morgan

Seth Johnson monitors these holding pens at Gheens, which are infested with the salvinia weevils to determine their rate of destruction of the weed.

southeast and as far west as California by 1890. Alligator weed was introduced into the Mobile, Ala., area in the late 1890s, probably in ship ballast water, and by 1920 was reported in Louisiana and other southern states. Hydrilla was introduced into Florida from Asia in the aquarium trade in the late 1950s. By 1969 hydrilla had infested several lakes in north Louisiana and by 1980 had spread throughout the state.

The most recent invader, giant salvinia, was reported in Toledo Bend Reservoir in 1999, in Cameron Parish in 2000 and in the Atchafalaya Basin in 2006. Investigation by the Louisiana Department of Agriculture and Forestry discovered that the plant was being sold for water gardens. Sales were immediately stopped, and all new plants were confiscated and destroyed. But by 2008, most lakes in northwest Louisiana had a severe infestation, and the freshwater marsh from Lafitte to Morgan City had unmanageable infestations.

Other invaders have made their way into the state over the past 100 years. Common salvinia, water lettuce, torpedo grass, Peruvian water grass, parrot feather, egeria and Eurasian water-milfoil have all established populations in the state but have not reached a level of economic importance.

Water hyacinth, alligator weed, hydrilla and giant salvinia all share the traits common to invasive plants. They are rapid colonizers and competitively superior to most native plants. Once established, they quickly dominate the aquatic plant community. These species can spread extremely quickly (giant salvinia can reach an 80 percent daily growth rate under ideal conditions), and all are capable of vegetative reproduction, either through fragmentation, budding or in the case of hydrilla, tubers and axilary buds. Because of their growth potential and their ability to adapt to wide-ranging water conditions, these plants are difficult and expensive to control.

Mechanical control

Early attempts to combat aquatic weeds centered on such equipment as mechanical harvesters, shredders, dredgers and cutters. By 1910, the U.S. Army Corps of Engineers was operating specially constructed, steam-powered saw boats in Louisiana's navigable waters. The use of mechanical harvesters continues today. They also can be effective in small water bodies with little or no environmental concerns, assuming plants are removed from the water – if not, decomposed plant material can reduce dissolved oxygen levels in the water.

For larger infestations on larger water bodies, mechanical control has proven ineffective mainly because limited areas can be harvested each day and target weeds grow rapidly. In addition, trees, stumps and other obstructions common in Louisiana make harvesters difficult to operate efficiently, and disposal of large amounts of harvested vegetation can be difficult and expensive.

Physical control

A common control method for aquatic plants is the use of water level manipulation, called a drawdown, to strand and expose both floating and submerged vegetation. Historically conduct-

Dearl Sanders, at right, helps load salvinia infested with weevils at Gheens into coolers that will be transported to waters with salvinia problems around the state to monitor the effect of the weevils in different water bodies.

Photos by Johnny Morgan

Seth Johnson determines the sex of the weevils at Gheens as part of his research to show reproduction patterns and overwintering rates.

ed in late summer or fall to expose plants to winter temperatures, this control method has been used effectively on a number of weeds. Drawbacks include the inability to use a drawdown on water bodies without dams or control structures, as well as the loss of commercial and recreational opportunities while a lake is drained. A less-common technique is the use of dyes, which cause the water to become opaque and limit sunlight to the submerged plants. Water dyes are not effective on floating or emergent plants and must be replenished as needed.

Another physical control technique is the use of screens placed on the water bottom to block sunlight to plant roots. Although they can be effective in small ponds, screening material can be expensive. If sediment is a problem, the screens will become covered, and new plants will simply root above the screen.

Chemical control

Early attempts at chemical control involved the use of extremely toxic compounds such as sulfuric acid, sodium arsenate and peroxides. Used primarily on water hyacinth, they often were effective, but they were extremely hazardous to people, aquatic animals and the environment in general. Discoveries in the early 1950s showed copper-based compounds were effective on some aquatic plants and most algae, and copper-based herbicides are still common today.

About a dozen of the more-than-300 synthetic herbicides on the market in the United States are registered for use in water. The rest are either not effective in water, too toxic to nontarget aquatic life or not economically practical to register as aquatic-use herbicides.

The contact herbicides diquat and endothall came into widespread use in the 1960s and are still widely used today, primarily for spot treatment of both emerged and submerged weeds. Herbicides such as 2,4-D that mimic the plant hormone auxin came into widespread use for controlling emerged and floating broadleaf weeds in 1959. Today, 2,4-D is used to treat between 75,000 and 150,000 acres of water hyacinth and alligator weed in Louisiana annually. The herbicide glyphosate received aquatic registration in 1977 and remains one of the few aquatic herbicides with both grass and broadleaf weed control capability.

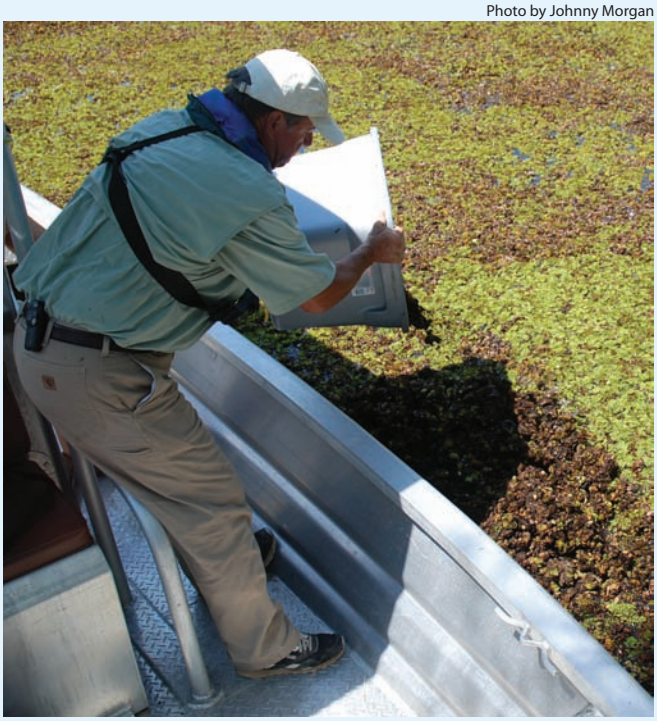
The first herbicide dispersed in an entire water body for controlling submerged weeds like hydrilla was fluridone, which was registered in 1986. Since 2000, several new herbicides have been registered to control fluridone-resistant hydrilla. Repeated use of fluridone as the sole, effective, lakewide treatment for hydrilla in Florida has resulted in most Florida lakes being infested with fluridone-resistant hydrilla, rendering fluridone ineffective for its primary target plant.

Since 1999 more than 20 potential aquatic herbicides have been screened for efficacy at the AgCenter's Bob R. Jones-Idlewild Research Station. Trials typically are conducted in 30-gallon containers stocked with water hyacinth, water lettuce, duckweed, common salvinia and hydrilla. Herbicide screening on giant salvinia has been conducted off-station to prevent unintentional infestation into area river systems.

The Bob R. Jones-Idlewild Research Station is one of only five or six facilities in the United States that routinely screen herbicides for aquatic use. Data obtained from trials conducted at the research station have provided support for the registration of imazapyr, imazamox and carfentrazone – all registered for use in Louisiana since 2002. Additional herbicide registrations are in the pipeline, with registration for flumioxazin (excellent on giant salvinia) and bispyrabac (excellent on water hyacinth) expected in late 2010.

Note the tiny brown weevil atop the plant, which it has killed.

Photo by Johnny Morgan



Dearl Sanders pours giant salvinia that has been infested with weevils into Lake Bistineau as a way to slow the progress of the noxious weed.

Biological control

Biological control programs have been implemented against invasive aquatic weeds in the Southeast and Louisiana with mixed results. There is no evidence that biological control agents have had any effect on hydrilla. Partial success has been achieved with biological control agents against alligator weed and water hyacinth in Louisiana. Control of giant salvinia with the salvinia weevil appears possible.

The first use of an insect as an aquatic weed control agent was against alligator weed. The alligator weed flea beetle was introduced from 1964-1970 by the U.S. Department of Agriculture-Agricultural Research Service from waterways near Buenos Aires, Argentina, and established in the southeastern United States, including Louisiana. Feeding by larval and adult beetles destroys both leaves and stems, which become waterlogged and sink. This is still considered a successful example of biological control of an invasive weed, especially in Florida, Louisiana and Texas where it was most successful. However, control is sporadic and depends on maintaining a large population of the flea beetle in Louisiana. Unfortunately, thousands of acres of alligator weed are untouched by the flea beetle each year.

Two weevils and a moth from Argentina were introduced by the U.S. Army Corps of Engineers into the Gulf Coast states, including Louisiana, in the 1970s against water hyacinth. The weevil *N. eichhorinae* was probably the major contributor to the level of control that was reported in the 1980s when the area infested by water hyacinth was reduced to one-third of its former acreage in the Gulf States. Feeding by these insects destroys stem tissue, and plants loose buoyancy and sink. But often the plants only stop growing. Hundreds of thousands of acres of Louisiana lakes, bayous and canals continue to be infested with water hyacinth. The weevil life cycle takes 90 days, which limits its ability to respond to water hyacinth growth, especially if the winter is severe and insect populations are greatly reduced.

Relief may be on the way. In 2010, the LSU AgCenter, in cooperation with the U.S. Department of Agriculture-Agricultural Research Service and U.S. Army Corps of Engineers, began releasing a new agent for the biological control of water hyacinth. The plant hopper, which was collected in Argentina by the USDA, was cleared for release in spring 2010. The first Louisiana releases were in Gramercy in July and August. Additional releases are planned in other areas of the state. Time will tell what impact the plant hopper will have, but it is hoped that, combined with the weevils, it will help control water hyacinth in Louisiana.

Several biological control agents have been released against hydrilla in the Southeast. They include the Asian hydrilla leaf miners, the hydrilla tuber weevil and the stem-feeding weevil. The only one of these agents suspected of having any real impact is the Asian hydrilla leaf miner. Long-term monitoring for results has been limited, but direct effects have been observed in several locations in northern Alabama and Texas, Lake Seminole in the Florida panhandle and southern Georgia. In these areas, hydrilla populations declined and were replaced by other submerged species that hydrilla normally outcompetes. The Asian hydrilla leaf miner was introduced in Louisiana and has been collected by the U.S. Army Corps of Engineers in Lake Henderson in south Louisiana and a lake in north central Louisiana north of Interstate 20.

The most successful use of an insect to control an aquatic weed is the salvinia weevil against giant salvinia. This aquatic weevil, which is native to Brazil, Bolivia and Paraguay, has been used successfully for the biological control of giant salvinia in a number of countries around the world. The weevil is a specialist whose larvae burrow into the rhizomes of the plant. Adults consume leaves and buds, inhibiting plant growth. Larval feeding causes the leaves to first darken and then drop off. The combined feeding of larvae and adults kills the plant.

The LSU AgCenter has had tremendous success establishing nurseries for the Brazilian salvinia weevil in Lafourche Parish. The initial weevil nursery on the Golden Ranch Plantation in Gheens was used to develop the protocol for salvinia and weevil production, the timeline for weevil population growth and the optimum times for weevil harvest and distribution. The south Louisiana nursery required 12-15 months from weevil seeding to weevil distribution in salvinia-infested water bodies. The weevil population builds rapidly in the spring, and harvest begins when the population reaches three weevils per pound of giant salvinia. The weevil population reaches a peak of 24 per pound in mid-June.

A highly successful partnership with the Louisiana Department of Wildlife & Fisheries facilitated collection and transport of more than 30 tons of weevil-infested salvinia with approximately 2.3 million weevils to Lake Bistineau near Bossier City and four other north Louisiana lakes in 2009. Several weevil nurseries now have been established in Lafourche and Terrebonne parishes for continued distribution of weevils to areas with giant salvinia problems.

In addition, a population of Brazilian weevils has adapted to feed on common salvinia and is capable of reaching populations of 80 weevils per pound. This is sufficient to control this smaller salvinia species. A nursery with this weevil strain has been established in St. Charles Parish, and weevils will be available in 2011 for distribution to areas where common salvinia is a problem. ■

Chinese Privet

a biological invader in Louisiana's forests

Hallie Dozier and Metha Klock

Since the arrival of Europeans in North America, thousands of plants have been introduced intentionally for agricultural, fiber or ornamental purposes. Others have been introduced accidentally. And although most have not become a problem, some 300 or so have escaped their intended uses and populated natural areas. This phenomenon, commonly known as biological invasion, may threaten endangered plants, alter the food chain, change natural fire patterns or displace native species when these non-native populations expand and dominate the systems where they grow. Biological invasion is recognized as one of the greatest threats to the preservation of biodiversity and as a vehicle of accelerated global change.

Hallie Dozier, Associate Professor, and Metha Klock, Graduate Student, School of Renewable Natural Resources, LSU AgCenter, Baton Rouge, La.

In Louisiana, as elsewhere, ornamental gardening and landscaping with aggressive non-native species are part of the threat to native ecosystems – one that may be reduced by more environmentally conscientious practices, such as selecting native plants over non-native species. The heavy use of non-native plants in human-inhabited landscapes – and most ornamental plants are non-native – promotes invasion by virtue of proximity and the availability of sprouting fragments, seeds or spores that find their way into adjacent wild lands. The case of Chinese privet is a classic example of what can go wrong when certain species are introduced into the landscape.

Chinese privet was first introduced as an ornamental shrub from China in 1852. By the 1930s it had escaped cultivation, and by the 1970s it was widespread in the forests of the southeastern United States. Currently, Chinese privet is considered one of the most common invasive plants in humid southeastern forests. It also is recognized as a weed in New Zealand, Australia and Argentina. Growing in moist, well-drained soils such as stream bank areas, Chinese privet commonly develops into single-species stands and outcompetes native species.

Photo by Hallie Dozier

Under ideal growing conditions, such as this stream bank where water and sunlight are plentiful, Chinese privet can completely dominate all other plant growth.

As an ornamental shrub, Chinese privet makes a perfect landscape plant. Easy to grow and difficult to kill, Chinese privet thrives in most soil types. It does well in full sun and in shadier sites. It flowers heavily and reliably, and it fruits well. It attracts birds and other wildlife, making it desirable to homeowners. It also tolerates repeated aboveground damage such as heavy pruning and mower/trimmer damage. All of these characteristics are common across the group of privets, making them some of the most widely grown shrubs in the world.

In natural landscapes, the characteristics that make Chinese privet a popular choice for landscaping contribute to its ability to compete successfully against native species in forested lands – prolific fruiting, high germination rates and vegetative reproduction. Being shade-tolerant allows Chinese privet to proliferate both along forest edges and interiors. Attractiveness to animals, especially birds, ensures its seeds are dispersed far and wide. These attributes, especially its ability to tolerate repeated above-ground damage, including browsing by animals, and its high reproductive capacity, make the spread of Chinese privet difficult to control. In Louisiana, Chinese privet has been documented in every parish.

Various management techniques have yet to control Chinese privet and stop its spread. Land managers have attempted control through prolonged flooding, prescribed fire and herbicide application. They also have tried using prescribed fire followed by herbicide application.

Mechanical removal of individual small plants in small areas can be successful as a control method, but this approach is less effective with larger plants because of the plant's ability to re-sprout from stumps and root fragments. Where infestations cover a larger area and include larger plants, successful manage-

ment requires the use of herbicides, although this may be questionable because of heavy labor requirements and risk to non-target plants. In some cases, broad-scale use of heavy equipment to remove the above-ground portions of plants may be necessary. Normally, though, such aggressive treatment is last resort and must be combined with subsequent herbicide treatments.

Glyphosate herbicides are among the most commonly recommended and can be effective when used correctly. Soil disturbance should be minimized before and after herbicide treatment. Applying the herbicide to the leaves is best on actively growing plants and where non-target plants are few. This foliar application may cause rapid defoliation, slowing movement of the herbicide to roots and retarding control. Applying the herbicide to the trunk, usually in an oil-based carrier, is effective, though labor-intensive and expensive. Removing the above-ground portions of the plants through cutting, mowing, chopping or burning makes herbicide application easier, though not necessarily more effective. Traditional trial-and-error testing of herbicides with mechanical control has not yielded reliable treatments for controlling this plant in natural areas.

The LSU AgCenter has approached Chinese privet from a different perspective, using basic life history information to build population models to help identify best approaches to effective management. Knowledge of a species' life history is useful for developing projection models that estimate population growth. These models have enhanced the study of invasive-plant demographics; they can be used for examining population growth of the same organism in response to different site conditions, as well as the response of organisms to different management techniques.

LSU AgCenter researchers are refining population growth models based on analysis of Chinese privet life-history characteristics that will indicate how populations grow under natural conditions. These models will help describe population growth of Chinese privet, and projection models will help evaluate different management techniques. The AgCenter models will aid in evaluating management methods for Chinese privet, reducing the need for ineffective trial-and-error testing. ■

Photo by Hallie Dozier

Opposite leaves distinguish Chinese privet from another common forest understory plant, yaupon holly.

Plant invaders pose problems in state

Chinese privet is not the only plant that has invaded the Louisiana landscape and created problems for farmers, forest owners and homeowners.

Hallie Dozier, an assistant professor in the School of Renewable Natural Resources, says the introduction of foreign plants often causes problems because these plants don't have natural enemies to control their spread.

One of the top invasive plants in Louisiana is the Chinese tallow tree, often called popcorn or chicken tree, she said.

"Characteristics that make a plant a good ornamental can help make a plant a good invader," Dozier said. "It flowers and fruits and produces lots of seeds."

Flowering plants are attractive to pollinators, and plants that produce fruit attract "dispersers" – primarily birds, she says. "So people who like bees and birds in their yards like these plants."

In addition to flowering profusely and producing fruits and seeds, other characteristics of invasive plants include the ability to thrive under a wide variety of growing conditions and tolerate significant above-ground damage.

Left unchecked, Chinese tallow trees began growing in wet prairie soils in southeast Louisiana, where they transformed the ecosystem from a grassland environment to a woodland environment. "That changed all the rules for all the animals that used that system," Dozier said.

Dozier said insect and disease resistance are common among invasive species. These traits not only make them hardy in the wild but also allow them to thrive in cultivated locations.

Kudzu was planted extensively for erosion control in Georgia and Alabama woodlands and is now in northeast Louisiana, Tunica Hills and south Louisiana, Dozier said. "It is tough to manage, growing as much as a foot a day, and takes a minimum of six to seven years of repeated mechanical and herbicide treatment before a site can successfully be re-planted and restored."

Cogongrass is a new forest problem in Louisiana, primarily in the Florida parishes, where conditions are conducive for its growth, Dozier said. It is moving west from Florida and Alabama, where it was introduced as forage for grazing cattle.

"Unfortunately, it's only good for grazing when it's small," Dozier said. "When it grows taller than a few inches, it becomes rough and unpalatable. If managed while in small clumps, there might be some success in preventing its spread and the problems they have faced in neighboring states and elsewhere in the South." ■ **Mary Ann Van Osdell**

Advanced Management Research and the Mexican Rice Borer

LSU AgCenter scientists in collaboration with scientists in Texas continue their battle to protect the sugarcane and rice crops from this invasive species.

T. Eugene Reagan, Julien Beuzelin, Blake Wilson, Allan Showler and M.O. Way

From an entomology integrated pest management perspective, invasive species have several characteristics that make them difficult to control. As the insect is brought in or migrates into new areas, only rarely does the new pest bring along its natural enemies, which can include parasites, predators and diseases. The Mexican rice borer's move into the Lower Rio Grande Valley of Texas sugarcane area in 1980 is a prime example. Within a year of its discovery in the Valley, some farmers found damage so severe that they were unable to successfully harvest their sugarcane fields. As the insect moved out of the Valley and through the Texas Rice Belt toward Louisiana, rice farmers began using three insecticide applications directed mostly to stem borer control. Economic loss projections for this "alien" pest are expected to reach as high as $220 million for sugarcane and $45 million for rice industries in Louisiana in the next few years.

Scientists in Louisiana and Texas are studying two fundamentally different approaches. The first approach uses certain aspects of Mexican rice borer biology to help farmers better protect their sugarcane crop on an individual field basis. The second approach to pest management involves a "landscape ecology" perspective understanding that several grass weeds serve as important hosts to the perpetuation of this insect.

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Many years of entomology research with Texas A&M scientists on insecticidal control of the Mexican rice borer have often shown inconsistent results on sugarcane. Much of this earlier work was modeled after the successful sugarcane borer scouting program in Louisiana. More recently, LSU AgCenter scientists in collaboration with those in Texas have been studying pheromone trap monitoring of adult Mexican rice borer moths to help predict treatable larval infestations.

Experiments in the summer of 2010 involved greenhouse studies at the U.S. Department of Agriculture research facility in Weslaco, Texas, and large field aerial application studies in the Lower Rio Grande Valley near Santa Rosa. Scientists found that in comparing Mexican rice borer larval feeding immediately after egg hatch (neonate larvae), the data show that more than three quarters of the new larvae on susceptible Louisiana variety HoCP 00-950 bore into the plant within one day, where they are mostly protected from insecticides. The remaining 24 percent of the larvae bore into the plant within six days on average. On the Mexican rice borer-resistant HoCP 85-845 variety, more than 41 percent of the neonates escaped potential insecticidal exposure one day after hatching out of the egg masses. See Table 1.

Table 1. Mexican rice borer larval exposure on sugarcane during a greenhouse study on neonate behavior, Weslaco, Texas, 2010.

Variety	*% Boring in Midrib 1 Day After Hatch*	*Sheath Feeding Exposure*	
HoCP 85-845	41%	59%	7.3 days
HoCP 00-950	76%	24%	5.8 days

Using weekly pheromone trap collections of the Mexican rice borer to help improve the timing of insecticidal control of larvae, researchers treated five fields, ranging in size from 35 to 78 acres with insecticides. The treatments were made on Aug. 21, 2009 (Figure 1). Each field was divided into three separate plots for aerial spraying of labeled rates of Baythroid (beta-cyfluthrin) and Diamond (novaluron) at a time when plant infestations averaged 14 percent. The data on insect damage show substantial control – 6.8 percent bored internodes (Diamond) versus 20.4 percent on the nontreated sites. See Table 2. The study was repeated in 2010.

Early studies conducted in Mexico during the 1920s found that virtually any large grass could host the Mexican rice borer. However, the role of noncrop hosts in Mexican rice borer population changes has only recently received consideration for pest management. LSU AgCenter scientists have conducted studies for two years to determine Mexican

Figure 1. Mexican rice borer moth catches per trap in five commercial fields of the 2009 insecticide aerial application study near Santa Rosa, Texas (1 trap adjacent to each field).

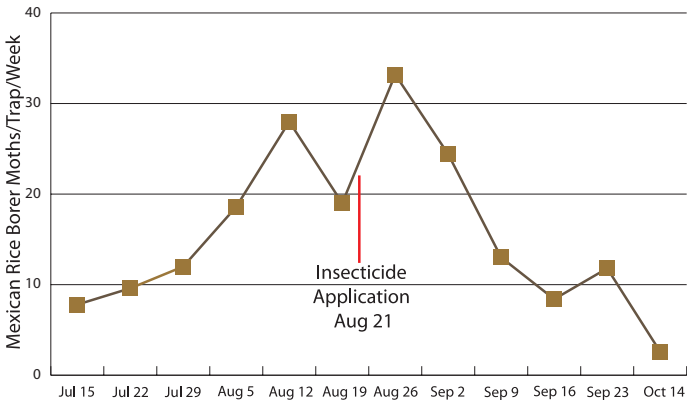


Figure 2. Graduate student Julien Beuzelin samples weedy habitats to assess Mexican rice borer infestations in noncrop hosts.

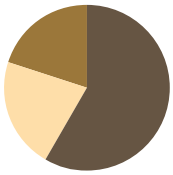
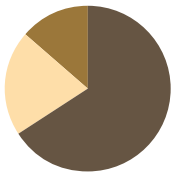
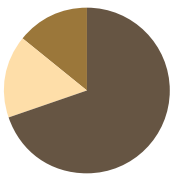
Photo by Anna Meszaros

Table 2. End of season Mexican rice borer injury and adult emergence (completion of life cycle) in the 2009 insecticide aerial application study near Santa Rosa, TX.

*Treatment**	*Rate (oz/a)*	*% MRB Bored Joints*	*MRB Moth Emergence Holes per Stalk*
Untreated check	NA	20.42	0.83
Baythroid XL 1C	2.8	12.63	0.46
Diamond 0.83 EC	12.0	6.80	0.31

** One application 8/21/2009 following MRB infestations averaging 14%*

Table 3. Mexican rice borer densities and noncrop grass relative abundance in weedy rice field margins, Southeast Texas, 2007-2008.

Sampling time	Densities (borers/m²)	Plant relative abundance: Johnsongrass, Vaseygrass, Other grasses	% of total Mexican rice borers collected in Johnsongrass	% of total Mexican rice borers collected in Vaseygrass
May	2.9		60.6	33.1
August	2.4		65.3	26.4
December	4.0		38.2	51.2

rice borer infestations in noncrop hosts under natural conditions. Three farms were selected in the upper, middle and lower Texas rice production area. On each farm, noncultivated habitats adjacent to rice fields were sampled year-round on a six-to-eight-week basis. Average densities of the Mexican rice borer ranged from 0.3 to 5.7 borers per square meter throughout the year. Early annual grasses such as ryegrass, brome and canarygrass were infested during the spring, whereas the perennial johnsongrass and vaseygrass were infested throughout the year. See Figure 2 and Table 3. Johnsongrass was the most prevalent host (41 percent to 78 percent relative abundance), but vaseygrass (13 percent to 40 percent relative abundance) harbored up to 70 percent of all borer infestations during the 2007-2008 winter.

These studies confirm that noncrop hosts play a role in Mexican rice borer population overwintering and build-up during the spring. In addition, the relative importance of these noncrop hosts changes at different times of the year, with vaseygrass representing a major overwintering host. The manipulation of noncrop hosts may decrease a significant proportion of Mexican rice borer populations, thus decreasing infestations in crop fields. Ongoing research involves simulations of different landscape weed management strategies (mowing, insecticide applications, other cultural practices) to predict their effect on the Mexican rice borer populations.

Even though this alien invasive species has been in the extreme southwestern portion of Louisiana since December 2008, it has not yet caused detectable losses to the state sugarcane and rice industries. Successful management of Mexican rice borer infestations will have to rely on a comprehensive strategy that includes protecting individual crop fields, but also decreasing areawide pest populations. Improved crop production practices involve using irrigation because plants are more vulnerable in droughty conditions, planting resistant varieties and better timing of insecticides using pheromone trap-assisted scouting. Decreasing areawide populations involves managing Mexican rice borer noncrop hosts and resistant crop varieties. ■

Value of Research Partnerships

Since 2002, the LSU AgCenter has partnered with other agencies for the success of this Mexican rice borer initiative. These partners include the U.S. Department of Agriculture Agricultural Research Service, the U.S. Environmental Protection Agency, Texas A&M AgriLife Research Centers in Beaumont and Weslaco, the Louisiana Department of Agriculture and Forestry, the Texas Department of Agriculture, the American Sugar Cane League, Rio Grande Valley Sugar Growers Inc. and the Texas Rice Growers Association. Conducting research over such a wide area has helped:

- Develop readily available and unique solutions for pest management (cultural practices, pest resistant varieties, proven new insecticides and improved scouting procedures).
- More effectively use valuable and limited resources.
- Use available expertise of colleagues in other states.
- More effectively interest competitive grant sources.

Since 2002, Louisiana sugarcane and rice research studies on invasive species including the Mexican rice borer have brought in more than $2.5 million in competitive grants to the LSU AgCenter. ■

Acknowlegements
Lower Rio Grande Valley farmers whose land was used in this study; Rio Grande Valley Sugar Growers Association presidents Jack Nelson and Steve Bearden and field manager Tony Prado. Grant support was provided by the American Sugar Cane League, the USDA NIFA IPM crops-at-risk program, and the EPA Strategic Agricultural Initiative program.

Invasive insects and diseases threaten Louisiana citrus

Natalie A. Hummel, Donald M. Ferrin and James Boudreaux

Photo by Keith Weller, Bugwood.org

The diaprepes root weevil was first found in Louisiana in 2004. This is an adult on a citrus leaf.

The Louisiana citrus industry includes 250 growers who produce on average $9 million worth of fruit on 800 acres per year. The majority of the commercial citrus acreage, 550 acres, is in Plaquemines Parish, the narrow strip of land just south of New Orleans next to the Mississippi River. The Louisiana citrus industry comprises mostly small orchards whose owners maintain full-time jobs and produce fruit as extra income.

Satsumas and navel oranges make up the majority of Louisiana citrus along with a limited amount of grapefruit, kumquats, sweet oranges, mandarins and tangerines. All fruit is picked tree-ripe and sold at farm stands, in gift boxes, at farmers markets, by roadside peddlers and in supermarkets.

The production of citrus nursery trees also is in Plaquemines Parish, where 20 nurseries produce $1 million worth of budded citrus tree stock annually. The trees are sold to chain stores, nursery and garden centers, hardware stores, fruit stands and commercial orchards.

Freezes and hurricanes periodically destroy Louisiana citrus orchards, so growers typically have to reestablish an orchard every 10 years on average. In addition to weather-related threats, the Louisiana citrus industry has been affected by a number of invasive insects and diseases, which has led to more regulation, increased production costs and decreased yields. Insect and disease introductions include citrus blackfly, West Indian sugarcane stalk borer, Asian citrus psyllid and citrus greening.

Citrus pests can be introduced into Louisiana through tropical storms and hurricanes as well as by humans. Federal and state restrictions prohibit moving citrus plant material among citrus-producing states without proper approval.

One of the most potentially devastating pest/disease complexes that has recently been detected in Louisiana is the Asian citrus psyllid and huanglongbing – also known as citrus greening. The Asian citrus psyllid is an extremely destructive citrus pest because it spreads citrus greening, a bacterial disease for which there is no control. This disease has caused the loss of hundreds of thousands of acres of citrus production in Florida.

The presence of the Asian citrus psyllid in Louisiana was originally reported by a homeowner in Algiers, La., in late May 2008. The homeowner discovered an insect she did not recognize and found a picture of Asian citrus psyllid on the LSU AgCenter website. This identification was confirmed by the U.S. Department of Agriculture in early June, and the lime tree from which the psyllid was first collected was confirmed to be infected with the bacterium that causes citrus greening disease.

All species of citrus are susceptible to this disease, and other members of the citrus family may serve as hosts, particularly orange jessamine. Infected trees decline in vigor and eventually die. Detection in the early stages is difficult. Currently, DNA identification is the only means of detecting the pathogen.

Initially, symptoms may appear in only one tree branch, but the disease eventually will spread throughout the tree. The detection of Asian citrus psyllid/citrus greening prompted the USDA and Louisiana Department of Agriculture and Forestry to conduct a comprehensive survey of all citrus-producing regions of the state. The AgCenter published educational materials, conducted meetings with producers and homeowners, distributed information to the media, produced a video on how to scout for Asian citrus

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Photo by Craig Roussel

The Plaquemines Parish government conducts spraying of citrus orchards throughout the parish to control the Asian citrus psyllid and help prevent the citrus greening disease.

psyllid and greening, and developed recommendations for control in commercial orchards, nurseries and backyards. AgCenter specialists also worked with the Plaquemines Parish government to implement an areawide management plan that has prevented an outbreak in the parish.

Citrus also has been plagued by other invasive insect pests. The citrus blackfly was first reported in Plaquemines Parish in high populations in 2007. Possibly introduced on winds from Hurricane Katrina, citrus blackfly is relatively easy to identify because it deposits its eggs in a distinct, spiral-shaped pattern on the undersurface of the leaf. Citrus blackfly is a piercing, sucking insect, and both adult and immature nymph stages feed on vegetation.

The damage from citrus blackfly alone does not cause substantial reductions in crop yield, but the production of a sugary waste substance called honeydew makes a good medium for the growth of sooty mold. This sooty mold makes a black film on leaf surfaces and can reduce a tree's ability to photosynthesize effectively.

Soon after detection in Louisiana, the citrus blackfly infestation increased to the point that many trees were covered with these insects, and initial efforts to manage this pest with insecticides were not successful. Recently, a parasitoid wasp has been released across the state. It attacks the larval stage of citrus blackfly and can quickly reduce a population to nondamaging levels.

Another pest that has invaded Louisiana is the West Indian sugarcane stalk borer, generally referred to as diaprepes. Native to the Caribbean islands, it is a significant pest of citrus and sugarcane production in Puerto Rico. Diaprepes are now widespread in Florida and cost millions of dollars annually to control. Diaprepes was detected at Audubon Park in New Orleans in 2004, on food brought in for zoo animals.

Diaprepes have a broad range of hosts that include citrus, sugarcane, sweet potatoes and at least 270 ornamental plants. Vigilant monitoring will be critical to maintain this insect at a manageable population in Louisiana. Any insect that looks like diaprepes should be collected and reported to an AgCenter or LDAF office.

Photo by Natalie Hummel

The citrus blackfly deposits its eggs in a spiral-shaped pattern, making it easy to identify.

Photo by Natalie Hummel

Asian citrus psyllid nymphs are about 1 millimeter wide and 2 millimeters long.

In 1995, the citrus tristeza virus was detected in citrus trees in Louisiana. The most important citrus virus worldwide, a number of strains of citrus tristeza virus cause mild to severe symptoms depending on the host. Mixtures of strains further complicate the situation. Mild strains of citrus tristeza virus are common in Florida and were found in navel orange and satsuma trees in Plaquemines Parish in the mid-1990s.

Strains of citrus tristeza virus that cause decline of sweet orange, grapefruit and tangerine grafted onto sour orange rootstocks are prevalent in Florida and have been managed successfully by the use of resistant rootstocks. Because sour orange is not commonly used as a rootstock in Louisiana, this strain of citrus tristeza virus has not been a major concern here. Whereas decline-causing strains can be managed by changing rootstocks, stem-pitting strains cannot. Because of this, preventing the introduction of new strains and using virus-free propagation material available through certified budwood programs are the primary strategies for managing this disease. Louisiana does not have a certified budwood program, but through the newly created Citrus Clean Plant Network, the state's citrus industry has access to certified budwood produced in other states.

A few citrus insects and diseases now being watched for in Louisiana include the brown citrus aphid, citrus canker and citrus black spot.

The example of the detection of Asian citrus psyllid and greening disease by a homeowner demonstrates that everyone has the ability to detect an invasive species and report it to the proper authorities. If this is done in a timely manner, it is possible to stop, or at least slow, the spread of an invasive species. ■

Photo by Johnny Morgan

Don Ferrin, center in the yellow shirt, helps train people in Plaquemines Parish on how to detect the Asian citrus psyllid and greening disease.

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