# 2014 International


# PIG CONFERENCE
## SCIENCE & MANAGEMENT

April 13-16, 2014

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Conference Center

Montgomery, Alabama

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*Welcome to Montgomery and the 2014 International Wild Pig Conference!*

Conference Co-Chairs, Dr. Steve Ditchkoff and Dr. Mark Smith have been busy at work since San Antonio! They endeavored to make the Wild Pig Conference a venue for learning, networking, and training. This year, the organizing committee is pleased to present the first ever all-day Technical Training Session designed to critically examine the issues surrounding wild pigs, and then identify the best tools, techniques, management strategies, and collaborations to move forward in controlling the problem.

We have a full agenda of speakers again this year, including a panel of experts who will assess the pros and cons of wild pig hunting as a management tool for control. In addition, efforts will be made to move forward on a consolidated National Wild Pig Task Force and your input is needed in the forum!

Please welcome Kevin Shea, Administrator of the USDA Animal and Plant Health Inspection Service as our plenary. Mr. Shea brings exciting news regarding the Feral Hog Initiative, a federal effort to conduct research, outreach, and management on issues surrounding wild pigs.

We invite you to enjoy the fantastic educational and professional resources from the many presenters and sponsors at the conference. Explore downtown Montgomery and all that the Capital city has to offer! If at any time you have a need or special request, one of the organizing committee members will be glad to assist you.

## 2014 International Wild Pig Conference Organizing Committee:

Dr. Steve Ditchkoff, School of Forestry and Wildlife, Auburn University
Dr. Mark Smith, Alabama Cooperative Extension System, Auburn University
Dr. Jessica Tegt, Mississippi State University Extension Service
Mr. Bill Hamrick, Mississippi State University Extension Service
Dr. John “Jack” Mayer, Savannah River National Laboratory
Dr. Ben West, Western Region Director, University of TN Extension
Dr. Billy Higginbotham, Texas AgriLife Extension Service, Texas A&M
Mr. Robert Denkhaus, Fort Worth Nature Center and Refuge, Texas
Dr. Fred Cunningham, USDA/APHIS/WS/National Wildlife Research Center

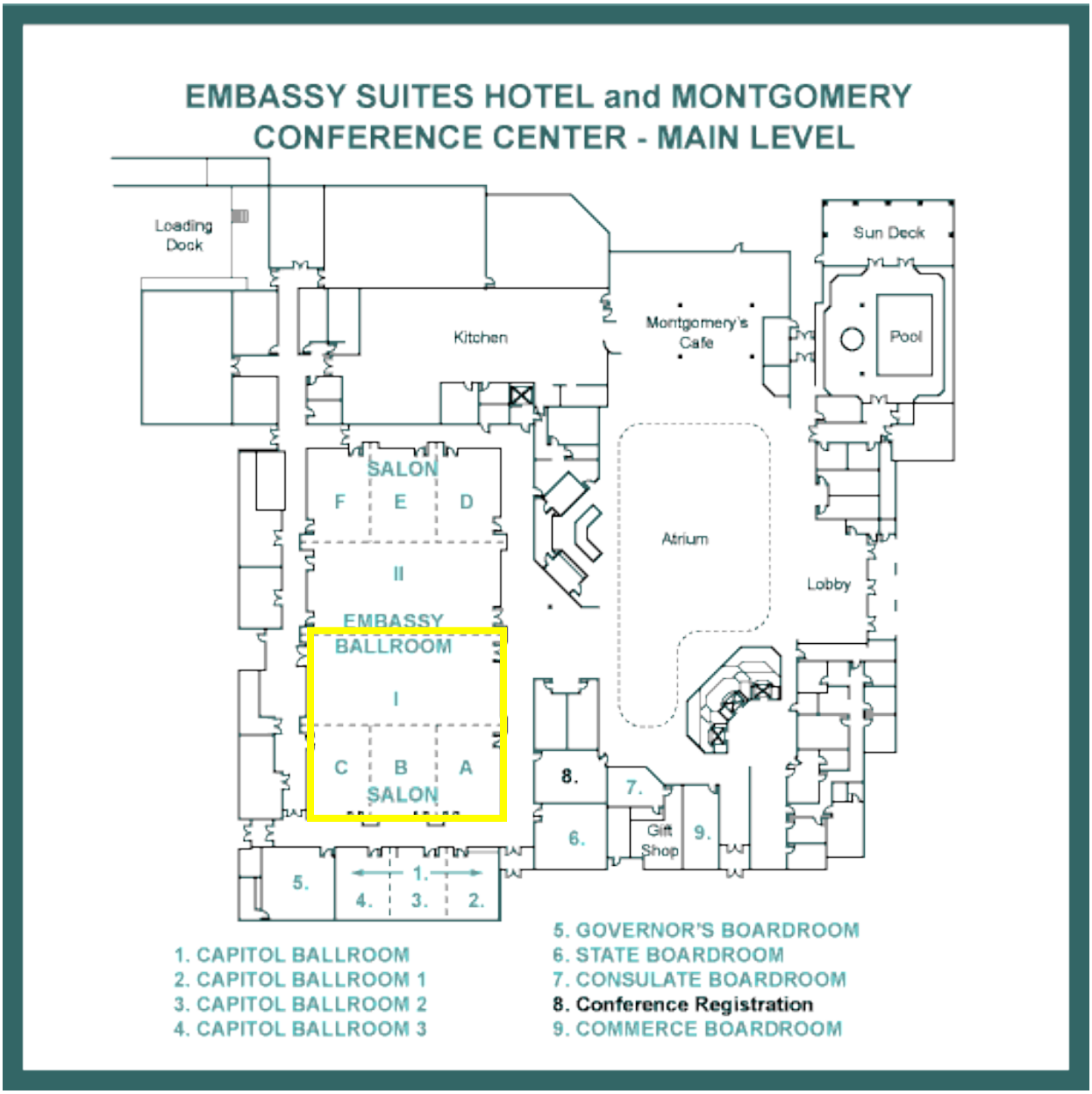
# 2014 International Wild Pig Conference Agenda

| Sunday, April 13, 2014 | |
|---|---|
| 6:00-10:00 pm | Registration<br>Informal "Meet and Greet" at Fountain Court Bar, Embassy Suites Hotel |

| Monday, April 14, 2014 | |
|---|---|
| 7:00 am to 5:00 pm | Registration |
| 8:00 am to 5:00 pm | Technical Training (Salons ABC) **SPONSORED BY USDA/APHIS Wildlife Services** |
| 1:00 pm to 5:00 pm | National Wild Pig Task Force Discussion, (by invite please) |
| 6:00 pm to 9:00 pm | Welcome Reception (Snacks and Drinks) (Salon ABC and Ballroom 1)<br>**SPONSORED BY ALABAMA FARMERS FEDERATION** |

| Tuesday, April 15, 2014 | |
|---|---|
| 7:30 am to 8:30 am | Registration |
| 8:30 am to 8:40 am | Conference Introductions, Mark Smith, Alabama Cooperative Extension System, Auburn University |
| 8:40 am to 9:40 am | **Plenary, Kevin Shea, "APHIS National Feral Swine Damage Management Program"**<br>**Administrator of the USDA Animal and Plant Health Inspection Service** *(Salon ABC)* |
| 9:40 am to 10:00 am | Break/ Poster Session |
| 10:00 am to 12:00 pm | Technical Session 1: *Human Dimensions of Wild Pig Management (Salon ABC)*<br>**SPONSORED BY WESTERVELT** |
| 12:00 pm to 1:20 pm | LUNCH ON YOUR OWN |
| 1:30 pm to 3:10 pm | Technical Session 2: *Biology, Genetics, and Behavior (Salon ABC)*<br>**SPONSORED BY ALABAMA WILDLIFE FEDERATION** |
| 3:10 pm to 3:30 pm | Break/Poster Session |
| 3:30 pm to 5:10 pm | Technical Session 3: *Disease (Salon ABC)* **SPONSORED BY ALABAMA CHAPTER OF NWTF** |
| 5:20 pm to 7:00 pm | DINNER ON YOUR OWN |
| 7:00 pm to 8:30 pm | Shoot from the Hip Session: Legalities surrounding wild pig hunting (Salons ABC and Ballroom 1)<br>**SPONSORED BY CENTER FOR FOREST SUSTAINABILITY, AUBURN SCHOOL OF FORESTRY AND WILDLIFE SCIENCES** |

| Wednesday, April 16, 2014 | |
|---|---|
| 8:00 am to 9:00 am | State Agency Reports *(Salons ABC and Ballroom 1)* |
| 9:00 am to 9:40 am | National Wild Pig Task Force Forum *(Salons ABC and Ballroom 1)* |
| 9:45 am to 10:00 am | Break/Poster Session |
| 10:00 am to 12:00 pm | **CONCURRENT TECHNICAL SESSIONS-** **SPONSORED BY JAGER PRO™**<br>Technical Session 4: *Distribution (Ballroom 1)*<br>Technical Session 5: *Control Measures (Salon ABC)* |
| 12:00 pm to 1:20 pm | LUNCH ON YOUR OWN |
| 1:30 pm to 3:10 pm | **CONCURRENT TECHNICAL SESSIONS-** **SPONSORED BY USDA NRCS**<br>Technical Session 6: *Management and Economics (Ballroom 1)*<br>Technical Session 7: *Ecological Impacts and Control (Salon ABC)* |
| 3:10 pm to 3:30 pm | Break |
| 3:30 pm to 5:10 pm | Technical Session 8: *Baits, Toxicants, and Contraceptives (Ballroom 1)*<br>**SPONSORED BY WILDLIFE MANAGEMENT SERVICES LLC** |
| 5:10 pm to 5:30 pm | Conference Wrap-up, Closing Remarks |




**Wild Pig Conference Activities will take place in Ballroom 1 and Salons ABC.**
**Please check your program for room assignments**

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# Technical Training Program Agenda
**Monday, April 14, 2014**

| | |
|---|---|
| **8:00-8:45am** | **Framing the Problem** *Jack Mayer, Savannah River Nuclear Solutions, LLC* |
| **8:45-9:30am** | **Wild Pig Biology and Ecology** *Jack Mayer, Savannah River Nuclear Solutions, LLC* |
| **9:30-9:45am** | **Break** |
| **9:45-10:30am** | **Wild Pig Diseases, Parasites, and Implications to Humans, Livestock, and Wildlife** *Fred Cunningham, USDA-APHIS Wildlife Services, National Wildlife Research Center* |
| **10:30-11:30am** | **Overview of Wild Pig Control Methods** *Billy Higginbotham, Texas A&M AgriLife Extension* |
| **11:30-1:00pm** | **Lunch on your own** |
| **1:00-2:00pm** | **Trapping Wild Pigs** *Stephen S. Ditchkoff, School of Forestry and Wildlife Sciences, Auburn University* |
| **2:00-2:45pm** | **Using Technology in Wild Pig Removal** *Steve Smith, USDA-APHIS Wildlife Services-Georgia* |
| **2:45-3:00pm** | **Break** |
| **3:00-3:30pm** | **Toxicants and Contraceptives—Real Potential or Pie in the Sky?** *Kurt VerCauteren, USDA-APHIS Wildlife Services, National Wildlife Research Center* |
| **3:30-4:00pm** | **How State and Federal Agencies are Grappling with the Problem** *Chad Soard, Kentucky Department of Fish and Wildlife Resources, MAFWA and SEAFWA Wild Hog Working Groups* |
| **4:00-4:30pm** | **Current and Future Research Needs** *Stephen S. Ditchkoff, School of Forestry and Wildlife Sciences, Auburn University* |
| **4:30-5:00pm** | **Open Q&A Session (all speakers present)** |

# Plenary Speaker

## Mr. Kevin Shea

**Administrator of the U.S. Department of Agriculture's Animal and Plant Health Inspection Service**

## "APHIS National Feral Swine Damage Management Program"

**Tuesday, April 15th, 8:40 am**
**Salon ABC**

**Kevin Shea** was appointed **Administrator of the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS)** on June 18, 2013, after serving as Acting Administrator since June 2012. As Administrator, Mr. Shea carries out the agency's broad mission of protecting and promoting American agriculture, regulating genetically engineered organisms, administering the Animal Welfare Act and carrying out wildlife damage management activities. In addition to his regular duties, Mr. Shea serves on the Secretary's Executive Resources Board and the Secretary's Management Council.

Before becoming Administrator, Mr. Shea served as Associate Administrator since September 2004, ensuring the smooth functioning of the Agency and championing APHIS' unprecedented business process improvement efforts. Starting in 2000, Mr. Shea served as Deputy Administrator for Policy and Program Development, providing leadership for the overall planning and direction of policies, programs and activities at APHIS, as well as being responsible for the Agency's budget, regulation development and environmental compliance programs. From 1992 to 2000 he served as APHIS' Director of Budget and Accounting. Earlier in his career he worked as a budget analyst, Chief of the Program Analysis Branch, and Chief of the Policy Analysis and Development Staff. He also spent one year practicing law in the litigation department of Frank, Bernstein, Conaway and Goldman in Baltimore, MD.

Mr. Shea graduated from DeMatha Catholic High School in Hyattsville, MD and the University of Maryland in College Park. He earned a law degree, summa cum laude, from the University of Baltimore School of Law.

A native Washingtonian, Mr. Shea now resides in Crofton, MD.

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# Schedule of Oral Presentations

**Tuesday, April 15, 2014**

**10:00am-noon , Ballroom 1** ***Sponsored by Westervelt***
**Technical Session 1: Human Dimensions of Wild Pig Management**
**Moderator: Billy Higginbotham, Texas Agrilife Extension Service**

**10:00am** *Landowner attitudes towards feral swine management in Illinois*
Erin Harper, Illinois Natural History Survey

**10:20am** *Feral wild boar in western Canada: ecological train wreck or red herring?*
Ryan Brook, University of Saskatchewan

**10:40am** *Examining the risk and rewards for the anthropogenic spread of wild hogs*
Joe Caudell, Murray State University

**11:00am** *2011 Georgia wild pig survey*
Michael Mengak, University of Georgia

**11:20am** *Bridging the gap: taking wild pig education to the people*
Daniel Gaskins, Texas A&M Wildlife and Fisheries Extension

**11:40am** *Perceptions of County Extension Agents and "Acres for Wildlife" participants about feral hogs in Arkansas*
Rebecca McPeake, University of Arkansas

**1:30-3:10pm, Ballroom 1** ***Sponsored by Alabama Wildlife Federation***
**Technical Session 2: Biology, Genetics, and Behavior**
**Moderator: Bronson Strickland, Mississippi State University Extension Service**

**1:30pm** *Investigation into gut contents of feral swine (Sus scrofa) across different habitat types in Louisiana*
A. Nikki Anderson, Louisiana State University Agricultural Center

**1:50pm** *Feral swine movements in response to control in southern Missouri*
Justin Fischer, USDA/APHIS/WS/National Wildlife Research Center

**2:10pm** *Movement patterns of feral hogs in Louisiana and Mississippi*
Steve Hartley, National Wetlands Research Center

**2:30pm** *Pennsylvania's feral swine- where did they come from and where do we go from here?*
Kyle Van Why, USDA/APHIS/Wildlife Services

**2:50pm** *A new Ophiostoma species found in association with soil collected from wild pig snouts trapped at Fort Benning, Georgia*
Lori Eckhardt, Auburn University

**3:30-5:10pm, Ballroom 1** ***Sponsored by Alabama Chapter of NWTF***
**Technical Session 3: Disease**
**Moderator: Fred Cunningham, USDA/APHIS/WS/NWRC**

**3:30pm** *Disease surveillance in feral swine*
Sarah Bevins, USDA/APHIS/WS/NWRC

**3:50pm** *Identification of risk factors associated with bovine tuberculosis in feral swine populations: implications for mitigation of risk in North America*
Ryan Miller, USDA/APHIS Center for Epidemiology and Animal Health

**4:10pm** *Duration of H3N2 influenza virus shedding and antibody detection in feral swine*
Fred Cunningham, USDA/APHIS/WS/NWRC

**4:30pm** *Pathologic findings in feral swine from Macon County, Alabama*
Ebony Gilbreath, Tuskegee University

**4:50pm** *B. Suis in the United States- A Growing Public Health Concern?*
Marta Guerra, Centers for Disease Control and Prevention

**7:00-8:30pm, Ballroom 1 and Salons ABC**
***Sponsored by Center for Forest Sustainability, Auburn School of Forestry and Wildlife Sciences***
**Shoot From the Hip Session: Legalities surrounding wild pig hunting**
**Moderator: Steve Ditchkoff, Auburn University**

**Panel Experts:**
**Curran Salter**, USDA/APHIS Wildlife Services – Kansas
**Mike Bodenchuck** , USDA/APHIS Wildlife Services – Texas
**Chuck Sykes, Director** – Alabama Division of Wildlife and Freshwater Fisheries

**Wednesday April 16, 2014**

**8:00-9:00am**
**State Agency Reports, Ballroom 1**

*Tennessee Wildlife Resources Agency*- Chuck Yoest and Gray Anderson
*New Jersey Division of Fish and Wildlife/New Jersey USDA WS*- Adam Randall
*Indiana Division of Fish and Wildlife, IDNR*- Steve Backs
*Missouri Department of Natural Resources*- Debra Burns
*Michigan Department of Natural Resources/Michigan USDA WS*- Nathan Newman
*Arkansas Game and Fish Commission*- JP Fairhead
*Alabama Department of Conservation and Natural Resources*- Chris Jaworowski
*South Carolina Department of Natural Resources*- Charles Ruth (Jack Mayer presenting)

**10:00am-12:00pm- CONCURRENT SESSIONS *Sponsored by Jager Pro™***
**Ballroom 1**
**Technical Session 4: Distribution**
**Moderator: Jack Mayer, Savannah National River Laboratory**

**10:00am** *Species distribution modeling for feral swine across the conterminous United States*
Matthew Farnsworth, Conservation Science Partners

**10:20am** *Home range estimates, habitat preference, and supplemental food use of feral swine in sub-tropical rangelands of Florida, USA*
Raoul Boughton

**10:40am** *Estimating wild boar population size: camera traps or distance sampling*
Giovanna Massei, Animal Health and Veterinary Laboratories Agency

**11:00am** *Characterization of microsatellite markers in Tennessee's feral pig population*
Kathryn Breidenstein and Rachel Chamberlin, Lipscomb University

**11:20am** *Expansion of feral swine in the United States*
Joseph Corn, Southeastern Cooperative Wildlife Disease Study

**11:40am** *Mapping the distribution of wild pigs in Alabama*
Rachel Conley, Auburn University

**10:00am-12:00pm- CONCURRENT SESSIONS**
**Salon ABC**
**Technical Session 5: Control Measures**
**Moderator: Jessica Tegt, Mississippi State University Extension Service**

**10:00am** *Method specific costs of feral swine removal in a large metapopulation: the Texas experience*
Mike Bodenchuk, USDA/APHIS-Wildlife Services

**10:20am** *Attaching GPS and radio telemetry devices to feral hogs*
Dan McMurtry, USDA/APHIS- Wildlife Services

**10:40am** *Feral swine in New Mexico- an eradication effort in year one with disease information*
Dallas Virchow, USDA/APHIS-Wildlife Services

**11:00am** *Integrated Wild Pig Control™ results from the EPD Pennahatchee Creek project*
Rod Pinkston, JagerPro™ Hog Control Systems

**11:20am** *Novel Techniques for wild pig capture*
Joshua Gaskamp, Samuel Roberts Noble Foundation Inc.

**11:40am** *Seeing the forest despite the trees, Tennessee wild hog management*
Chuck Yoest, Tennessee Wildlife Resource Agency

**1:30-3:10pm –CONCURRENT SESSIONS *Sponsored by USDA NRCS***
**Ballroom 1**
**Technical Session 6: Management and Economics**
**Moderator: Bill Hamrick, Mississippi State University Extension Service**

**1:30pm** *An attempt to mitigate potential impacts on two candidate species: feral swine control in southeast New Mexico*
Randy Howard, US Department of the Interior, BLM

**1:50pm** *Feral pig management at Tejon Ranch, California*
Michael White, Tejon Ranch Conservancy

**2:10pm** *Using ecological research to reduce barriers to achieve effective feral pig management*
Darren Marshall, Queensland Murray Darling Committee, Australia

**2:30pm** *The economics of feral swine damage and its control*
Stephanie Shwiff, USDA/APHIS/WS/NWRC

**1:30-3:10pm –CONCURRENT SESSIONS**
**Salons ABC**
**Technical Session 7: Ecological impacts and control**
**Moderator: Jessica Tegt, Mississippi State University Extension Service**

**1:30pm** *Feral hog management plan and environmental assessment, Big Thicket National Preserve, Texas*
John Williamson, Atkins

**1:50pm** *Eradication versus control*
David Pauli, The Humane Society of the United States

**2:10pm** *Mallee recovery: a landscape predator control project for the conservation of endangered malleefowl (Leipoa ocellata) in New South Wales, Australia*
Jason Wishart, Invasive Animals Cooperative Research Centre

**2:30pm** *Developing tools for detecting feral swine and their impacts to wildlife and agriculture*
Antoinette Piaggio, USDA/APHIS/WS/NWRC

**2:50pm** *Environmental impacts of feral swine in rangelands of South Florida*
Samantha Wisely, University of Florida

**3:30-5:10pm , Ballroom 1** ***Sponsored by Wildlife Management Services LLC***
**Technical Session 8: Baits, Toxicants, and Contraceptives**
**Moderator: Bill Hamrick, Mississippi State University Extension Service**

**3:30pm** *Effectiveness of Wildgranix$^{TM}$as a deterrent for wild pigs*
Gregory Brooks, Fort Benning Environmental Branch

**3:50pm** *Controlling feral hogs with species specific feeders*
Harold Monk, Wildlife Management Services LLC

**4:10pm** *Phage-based vaccines: two approaches to species-specific contraception of wild pigs*
Tatiana Samoylova, Auburn University

**4:30pm** *Development of sodium nitrite as a toxicant for the control of wild pigs*
Kurt VerCauteren, USDA/APHIS/WS/NWRC

**4:50pm** *Understanding the carpal gland of wild pigs*
Brandon Schmit, USDA/APHIS/WS


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# Technical Session 1: Human Dimensions of Wild Pig Management

**Landowner attitudes towards feral swine management in Illinois**

**Erin E. Harper**, Illinois Natural History Survey, Craig A. Miller, Illinois Natural History Survey
1816 South Oak Street, Champaign, IL 61820, eeharper@gmail.com

Feral swine were first found in western Illinois during the 1990s. In response to the spread of the feral hog population throughout the state, the Illinois Department of Natural Resources (IDNR) is working to find the best management approaches for population control. To better understand landowner attitudes toward feral hogs and preferences for management approaches, we conducted a mail survey of 5,320 landowners who possess greater than one acre (.4 ha) of land from the twenty-three counties in which feral hogs had previously been reported to the IDNR and an additional twenty-two counties within close proximity of the afore mentioned. We received 3,061 completed questionnaires, of which 3,035 were usable for a response rate of 58%. Survey participants were categorized into landowner type by response to a question on who farms their land. These land use types were then used as an independent variable with statements investigating preference for management action, perceived risks from and attitudes toward feral hogs. We found a significant difference using Pearson's Chi-squared test ($p < 0.001$) between landowner type and acceptance of targeted sharpshooting in both in the county where the respondents' land was located and on the respondents' land specifically. Landowners who indicated having hogs on their land were asked if they took action to remove the hogs (65% "Yes"), reported any damage (10% "Yes"), and to whom they reported the damage. Several statements addressing attitudes toward feral hogs on a 7-point Likert-type scale (1="Strongly Disagree", 7="Strongly Agree) were included (e.g., "Feral hogs are an important part of the environment," and, "Feral hogs destroy native wildlife."). All of these questions and responses to the statements were analyzed in comparison with the management actions. Discussion will focus on implications for management of feral hogs based on beliefs and attitudes towards feral hogs.

**Feral wild boar in western Canada: ecological train wreck or red herring?**

**Ryan Brook**[1], and Floris Van Beest[2], [1]University of Saskatchewan Department of Animal and Poultry Science, College of Agriculture and Bioresources, University of Saskatchewan, 51 Campus Drive, Saskatoon, Saskatchewan, S7N 5A8, CANADA phone: 306-966-4120 ryan.brook@usask.ca, [2]Department of Bioscience, Aarhus University

Although feral wild boar are globally recognized as an important invasive species, they have largely been ignored in Western Canada. As such, there has been virtually no research and even less active management. In this presentation we provide an overview of the history of feral boar in Western Canada, from their introduction as a domestic species aimed at diversifying agriculture through their on-going escapes and releases. We used trail-cameras, social surveys, and social media reports to map feral boar in Saskatchewan. We surveyed all 296 rural municipalities that comprise the entire agricultural region of Saskatchewan to determine the distribution of feral boar in the province and characterize community leader perceptions of risk. Of the respondents, over the last three years 49% never saw feral boar, 48% saw them at least occasionally, and 2% did not know. The majority of respondents (ranging from 59% to 70% by type of damage) indicated that damage to bales, standing crop, pasture and fences was 'never serious'. The levels of concern expressed by respondents regarding feral wild boar impacts were consistently moderate for all impacts on crops, livestock, humans, and the environment. At the scale of the individual municipalities, responses about management actions were positively associated with frequency of feral boar observations, whereas questions about the province as a whole were consistently positive regardless of frequency of feral boar observations. Rural municipal complaints to provincial agencies about impacts of feral boar remain low and claims for crop damage compensation to Saskatchewan Crop Insurance Corporation are similarly low. Control efforts in Canada are sporadic and very limited in scope and scale. However, the current distribution of feral boar in Saskatchewan, in combination with the life-history strategy of the species, indicates that aggressive and coordinated action is required but is unlikely to occur in the near future.

**Examining the risk and rewards for the anthropogenic spread of wild hogs**

**Joe N. Caudell**, Emily Dowell, and Katelyn Welch, Murray State University, 2112 Biology Building, Murray, KY 42071. jcaudell@MurrayState.edu

Wild hogs (*Sus scrofa*) are an invasive, exotic species that have spread through much of the US through anthropogenic means. Many states have laws and regulations aimed at reducing legal important of wild swine. Federal regulation also prohibit the movement of undocumented swine. However, in many cases, these laws have been ineffectual for stopping the anthropogenic spread of wild swine. Current efforts at eradication will only be hampered if there is a continual influx of illegally imported and released wild hog. We are currently examining various wild hog-related laws throughout the US for definitions of wild hogs; restrictiveness for wild hog-related activities; enforcement potential; and the potential for current laws and penalties associated with those laws to provide a disincentive for the illegal importation and release of wild hogs. We also discuss methods that may be developed and used to enhance efforts to reduce the anthropogenic spread of wild hogs.

**2011 Georgia wild pig survey**

**Michael T. Mengak**, Warnell School of Forestry & Natural Resources, University of Georgia, Warnell School of Forestry & Natural Resources, University of Georgia, Athens, GA 30602, 706.583.8096; mmengak@uga.edu

I developed a 6-page questionnaire with input from members of the Georgia Feral Hog Working Group. A total of 1200 surveys were delivered to randomly selected recipients in 41 counties of southwest Georgia. A total of 471 useable surveys were returned (response rate = 39.25%). Most respondents reported having wild hog damage to land they farm and that the damage was first noticed more than 5 years ago. The cumulative impact of multiple years of damage has taken a financial and emotional toll on these agricultural producers and landowners. The most common type of damage was from rooting and grubbing. Peanuts, corn, and cotton were the crops most frequently reported damaged. Respondents self-reported a dollar amount of damage to corps or items other than crops. Expanding this damage estimate to the southwest Extension District results in an estimated amount of wild pig damage to crops and/or crop related damage was in excess of 57 million dollars in 2011. Damage to non-crop items (timber, fences, food plots, lease values, etc.) were in excess of 24 million dollars in 2011. Total estimated loss exceeded 84 million dollars. Respondents felt that most control measures were not highly effective and that state and federal agencies should provide more assistance with wild pig control. Questions related to knowledge, opinions and attitudes about wild pigs revealed that survey participants differed in their knowledge of wild pigs but generally opinions were negative and the perceived need for control was widespread. Many respondents perceived a decline in white-tail deer, wild turkey, and northern bobwhite and attributed this decline, at least partially, to wild pigs. In addition to other negative attitudes, 90% of respondents did not enjoy seeing wild pigs around their property and 81% worried about problems wild pigs might cause to their property.

**Bridging the Gap: taking wild pig education to the people**

**Mark A. Tyson**, Daniel G. Gaskins, and James C. Cathey, Texas A&M Wildlife and Fisheries Extension 111 Nagle Hall, 2258 TAMU, College Station, TX 7784, Phone: (979) 574-6818, Mark.Tyson@ag.tamu.edu

Interest in information concerning wild pigs (*Sus scrofa*) is widespread across the United States. When dealing with topics that can assist the public, most Universities rely on a system of Extension agencies to take the scientific research and translate it to landowners, producers, and the general public. This model works well, but changes in the way people get their information are presenting a communication gap, consistent with a generational one. Extension efforts must incorporate the use of web-based tools to continue disseminating research-based educational and technical content to a growing population of web-based learners that are interested in wild pigs. The Wildlife and Fisheries Extension Unit has incorporated the use of internet-based tools such as websites, blogs, social media, videos, and iPhone applications in addition to face to face programs, 45 over the last two years, to deliver information on wild pigs. We link many of these tools with the eXtension.org Feral Hog Community of Practice and colleagues benefit from the collaborative effort from 23 states. These online tools allow us to reach members of the public who would not typically receive this information otherwise. As wild pig populations continue to increase the need for the widespread distribution of research–based information will become a vital component in improving the public's ability to address wild pig related issues. Since incorporating these outlets, the Wildlife and Fisheries Extension Unit has seen a significant increase in the reach of information and audience engagement. The Feral Hogs

CoP Facebook page has 1820 “likes” and has had total reach of over 7,000 on some posts. The feral hog blog articles on Wild Wonderings have a total of 49,215 views and the feral hog videos on the WFSCAgrilife YouTube channel have a combined total of 35,626 views. Many of these individuals would not have been reached by traditional, face to face programming.

**Perceptions of County Extension Agents and “Acres for Wildlife” participants about feral hogs in Arkansas**
**Rebecca McPeake**, Jaret Rushing, Sayeed Mehmood, Alexandra Locher, University of Arkansas Division of Agriculture, Cooperative Extension Service, and Arkansas Forest Resources Center , 2301 South University Avenue, Little Rock, AR 72204; 501-671-2285, RMcPeake@uaex.edu

Feral hogs are present in every county in Arkansas; however, they are more abundant in some areas of the state. Unlike white-tailed deer, not every rural Arkansas landowner sees a feral hog, or evidence of a feral hog, on their property in a given year. Two questionnaires were implemented asking different audiences their perceptions of feral hogs: Acres for Wildlife program participants in 2010 (n = 389), and University of Arkansas County Extension Agents in 2013 (n = 75). Most program participants reported Arkansas has too many wild pigs (76%) and agreed or strongly agreed wild pigs are a nuisance (85%). A little less than half (43%) reported hunting wild pigs for enjoyment and one-third harvested them for food (34%). Very few respondents agreed (9%) wild pigs were beneficial to have in the state. A little less than half (44%) reported seeing wild pigs on their land the past year. Most county Extension agents reported feral hogs caused problems in their county the past year (72%), with 12% reporting feral hogs were a major agriculture issue. Program participants reported problems with rooting (59%) and equipment damage (33%) by wild pigs on their property. Almost one in four County agents reported “a lot” of pasture damage (23%) in their county compared to forest (16%) or crop (11%) damage. One-fifth (20%) of program participants indicated they knew “a lot” about wild pigs, with the majority knowing “some” (58%) about them. Almost half the county agents reported being very (12%) or somewhat (39%) knowledgeable about recent legislation in Arkansas regarding feral hogs. Early intervention in reducing hog numbers is often recommended, but where agricultural problems with feral hogs were perceived as minor, county agents tended to be slightly (27%) or not at all (9%) interested in educational efforts regarding feral hogs.

## Technical Session 2: Biology, Genetics, and Behavior

**Investigation into gut contents of feral swine (*Sus scrofa*) across different habitat types in Louisiana**
**A. Nikki Anderson**, and Michael D. Kaller, School of Renewable Natural Resources, Louisiana State University Agricultural Center, 324 A RNR Building, Baton Rouge, LA 70803, 225-578-2627, aande18@lsu.edu

Feral swine (*Sus scrofa*) are considered one the worst invasive species on a global scale and negatively impact terrestrial and aquatic flora and fauna. They compete with native wildlife for food, cause habitat damage, and serve as reservoirs for wildlife diseases. The feeding activities of feral swine cause damage to forests, wetlands, and streams. Growing numbers of feral swine in Louisiana increases damage to local flora and fauna. Given the potential negative impacts, we are examining the diet characteristics of feral swine by habitat type in order to aid in future management decisions. Feral swine are generally believed to be opportunistic feeders with diet differences arising from differences in food availability among habitats. We are currently analyzing the gut contents of more than 50 individuals opportunistically collected during culling events in multiple habitat types in Louisiana over a four year time period. Contents are being identified and sorted into one of seven categories: 1) mast; 2) vegetation; 3) avian; 4) mammal; 5) reptile/amphibian; 6) invertebrate; and 7) bait. Data will be analyzed with a multicategory logit model to test differences in the composition of stomach contents within and among habitats. We propose to determine whether differences in diet may be attributable to differences in habitat, suggesting opportunistic feeding. Failure to correlate diet with habitat would suggest targeted feeding. Evidence of non-opportunistic feeding would help guide targeted removal and increase options for feral hog control.

**Feral swine movements in response to control in southern Missouri**

**Justin Fischer**[1], Dan McMurty[2], Jeff Beringer[3], and Kurt VerCauteren[1]
[1]United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center, 4101 LaPorte Avenue, Fort Collins, CO 80521, 970-266-6174; Justin.W.Fischer@aphis.usda.gov, [2] United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, 1714 Commerce Ct Suite C., Columbia, MO 65202. [3]Missouri Department of Conservation, 1110 S. College Ave, Columbia, MO 65201.

Feral swine (*Sus scrofa*) are among the most widely-distributed mammals in the world and can have devastating impacts to personal property, agricultural crops, natural resources, native ecosystems, and shed or harbor numerous parasites and disease. Reducing human-wildlife conflict due to increased feral swine populations and distributions is currently a high priority for numerous federal, state, and local government agencies. Currently in Missouri, feral swine can be found in at least 28 counties with estimated populations of 10,000 to 15,000 individuals. The Missouri Department of Conservation (MDC) began a three year research project in 2009 to evaluate feral swine movements, fecundity and survival, habitat use, and various control techniques. Wildlife Services partnered with MDC to extend this project an additional 18 months in an effort to more thoroughly assess feral swine movements related to control measures. We analyzed location data from 25 feral swine that were captured and fitted with global positioning system collars. Various control techniques were tested before lethally removing feral hogs. Daily movement patterns, space-use estimation, and habitat use were evaluated pre- and post-control technique. We will present preliminary estimates of feral swine space use and movement patterns pre- and post-control technique.

**Movement patterns of feral hogs in Louisiana and Mississippi**

**Steve Hartley**[1], and Buddy Goatcher[2], [1]National Wetlands Research Center, National Wetlands Research Center, 700 Cajundome Blvd., Lafayette, LA, 70506, steve_hartley@usgs.gov, [2]Wildlife Biologist Environmental Risk Assessment Branch Chief, Environmental LabBldg. 3270, Rm.2803 Engineer Research and Development Center, US Army Engineer Corps of Engineers 3909 Halls Ferry Road, Vicksburg, MS 39180 Buddy.L.Goatcher@usace.army.mil

Wild swine (feral hogs [*Sus scrofa domestica*]) are arguably the most serious mammalian invasive species on the landscape. Wild swine are in direct conflict with goals to manage lands for natural and healthy ecosystems. Throughout the southern United States, their foraging activities have been documented to adversely affect wetlands, restoration plantings, and endangered and threatened species, and significantly alter plant community composition. Louisiana feral swine populations have existed since the 1500s when explorer Hernando De Soto brought swine with his expeditions. However, little is known about their movement patterns, populations, and habitat destruction within Louisiana and Mississippi. This study used hybrid radio and satellite GPS tracking collars on feral hogs to track their movement patterns on the landscape. Twenty-two electronic tracking collars (GPS-satellite telemetry) were installed on boar, sow, and barrow hogs captured and released on seven sites considered to have substantial feral hog impact in Louisiana and Mississippi. The GPS coordinates of their movements from one point to another were recorded on an hourly basis. This allowed us to monitor feral hog movements daily in the office. The results of this research will provide natural resource managers with knowledge of how to better manage and respond to invasive species. The research will also allow managers to predict the encroachment of feral hogs on adjacent lands.

**Pennsylvania's feral swine - where did they come from and where do we go from here?**

**Kyle Van Why**, Harris Glass, and Matt Rice, USDA-APHIS-Wildlife Services, PO Box 60827, Harrisburg, PA 17106, 717-236-9451, Kyle.r.vanwhy@aphis.usda.gov

Awareness and documentation of feral swine has increased nationwide. Pennsylvania is no exception, with feral swine presence historically unknown on the landscape but emerging as diverse and widely distributed in recent years. Pennsylvania is now a prime example of how feral swine have begun to populate areas not historically known and how management problems have emerged. Many of the initial populations were believed to have originated from escapes or releases from shooting facilities. These facilities either bred or imported hogs for hunting purposes with little regulation due to classification of hogs as livestock, and monitoring and management of these sites was limited. Records of feral swine hunting facilities are now being tracked, but valuable information is still lacking. Additionally, feral swine have been documented in areas where no known hunting facilities are located, or where

stock at known facilities does not match free roaming animals. Likely sources include illegal importation to undocumented facilities, sale of stock to farmers with insufficient facilities to contain feral breeds, or release of animals by sportsmen in an attempt to establish a wild hunting resource. Changes in farming practices are also a potential source of feral swine in Pennsylvania, with the increase of heritage breeds of swine or free-range stock. Many of these breeds are better suited to being outdoors and possess classic feral swine characteristics. The increase in these breeds, combined with unregulated sale and housing of pasture raised swine, pose issues when animals escape and quickly become feral. The diversity of potential sources creates problems with conducting management and crafting regulations to reduce feral swine populations. Increased pressure from sportsmen's groups, agricultural produces, businesses, and the public related to feral swine management cause significant problems for agencies attempting to stem the tide of the feral swine invasion.

**A new *Ophiostoma* species found in association with soil collected from wild pig snouts trapped at Fort Benning, Georgia**

**Eckhardt, L.G.** [1], Duong, T., [2] Ditchkoff[1], S.S., Wingfield, M.J. [2], and de Beer, Z.W. [2]
[1] School of Forestry and Wildlife Sciences, Auburn University, Alabama, 36849; [2] Department of Microbiology and Plant Pathology, Forestry and Agricultural Biotechnology Institute (FABI), University of Pretoria, Pretoria, South Africa

During an investigation into the possibility of wild pigs moving around pathogenic fungi during rooting activity in *Pinus palustris* and *P. taeda* stands, a new *Ophiostoma* and *Leptographium* species were isolated along with *Ophiostoma sparsiannulatum*. To describe the new *Ophiostoma* and *Leptographium*, morphological and DNA sequence analysis were employed. Morphology of this fungus was found to be different to previously described *Ophiostoma* and *Leptographium* spp. Comparisons of DNA sequences for the part of the ITS ribosomal DNA region and the β-tubulin gene regions also showed that this fungus represents an undescribed taxon. The fungus is thus described as *Ophiostoma culverii* sp. nov. In addition, this study shows that wild pigs may reduce tree vigor by causing wounds for soil-borne or insect vectored pathogen infection, predisposing trees to bark beetle attack and perhaps incidentally vectoring phytopathogens during rooting activity.

## Technical Session 3: Disease

**Disease surveillance in feral swine**

**Sarah Bevins**, John Baroch, Mark Lutman, and Kerri Pedersen, USDA-APHIS Wildlife Services National Wildlife Research Center, 4101 Laporte Ave., Fort Collins, CO 80521, 970-266-6211, Sarah.N.Bevins@aphis.usda.gov

Feral swine can carry a multitude of pathogens, and although this is one of the least discussed effects that they have as an invasive species, it is a significant issue. In the United States, feral swine have been documented as actively infected with, and having contributed to the transmission of, a wide variety of diseases that can infect humans, species of conservation concern, and domestic livestock. Ongoing surveillance efforts have documented both substantial pathogen exposure and active infection in feral swine throughout the United States. Here, we present a multi-year disease surveillance dataset that includes results on swine brucellosis, hepatitis E virus, pseudorabies, influenza A, *Trichinella spiralis*, leptospirosis, and porcine reproductive and respiratory syndrome in feral swine. In addition, given the recent introduction of porcine epidemic diarrhea virus in the United States, we discuss the need to understand newly introduced diseases and foreign animal diseases. Feral swine could serve as a reservoir for diseases that are not currently found in the United States but that would bring with them devastating consequences if they were accidently or intentionally introduced. We also highlight future pathogen surveillance efforts in feral swine.

**Identification of risk factors associated with bovine tuberculosis in feral swine populations: implications for mitigation of risk in North America**

**Ryan S. Miller**, Steven J. Sweeney, and Jennifer L. Malmberg, USDA-APHIS Center for Epidemiology and Animal Health 2150 Centre Avenue; Fort Collins, CO. 80521, 970-494-7327 (office) Ryan.S.Miller@aphis.usda.gov

Bovine tuberculosis (bTB), caused by Mycobacterium bovis, occurring in free ranging swine has been reported in fourteen countries and is considered endemic in five. Recent evidence supports the role of wild boar as competent maintenance hosts for bTB, posing a serious risk for livestock, human health and recreational hunting industry in North America. The goal of this study was to identify potential risk factors associated with the maintenance of bTB in free ranging swine and determine if risk factors are present in North America. A systematic structured literature review was conducted to identify scientific peer reviewed publications related to bTB in feral or free ranging swine. The review procedure involved three processes: 1) identification of keywords, 2) systematic review of PubMed, Scopus, and Web of Science 3) review and identification of risk factors associated with bTB. Searches identified 236 scientific publications with 107 relevant to the topic, explicitly addressing M. bovis in free ranging swine. The majority of publications (53%) addressed issues related to surveillance and epidemiology. The remaining publications addressed pathology (31%) and disease control tools (16%). Risk factors identified included concentration of swine for hunting, supplemental feeding, congregation at watering or feeding sites, and interactions with cattle or other wildlife. While bTB has not been identified in North American feral swine, risks for disease emergence are present – high densities, robust hunting industry, and significant baiting and feeding. Development of a robust program of feral swine control together with surveillance for bTB may help mitigate risks.

**Duration of H3N2 influenza virus shedding and antibody detection in feral swine**

**Fred L. Cunningham**[1], Hailiang Sun2 Katie Hanson-Dorr1, Paul Fioranelli1 , Jillian Harris2, Yifei Xu2, Li- Ping Long2, John A. Baroch3, Mark W. Lutman3, Kerri Pedersen3, Brandon S. Schmit3, Jim Cooley4, Thomas J. DeLiberto3, and Xiu-Feng Wan2*, 1Mississippi Field Station, National Wildlife Research Center, Wildlife Services, Animal and Plant Health Inspection Service, U.S. Department of Agriculture, Mississippi State, Mississippi, USA; 2Department of Basic Sciences, College of V eterinary Medicine, Mississippi State University, Mississippi State, Mississippi, USA; 3National Wildlife Research Center, Wildlife Services, Animal and Plant Health Inspection Service, U.S. Department of Agriculture, Fort Collins, Colorado, USA;4Department of Population and Pathobiology, College of Veterinary Medicine, Mississippi State University, Mississippi State, Mississippi, USA.

The objectives of this project were to understand the duration of viral shedding and antibody dynamics after experimental H3N2 influenza A virus infection in feral swine. Twelve (12) feral swine were trapped in Mississippi and transported under special permit to Mississippi State University for testing. Feral swine tested negative for pseudorabies and brucellosis. The feral pigs were infected with a low pathogenic influenza A virus, (A/swine/Texas/A01104013/2012(H3N2)) antigenically and genetically similar to the contemporary H3N2 swine influenza viruses circulating in domestic swine. On day 0 10^6 TCID50 virus in 0.5 mL was inoculated into each side of the nasal passage in the experimental infected feral pigs (EI) group (n=8) through intranasal administration. A 0.5 mL sterile PBS was used in a group of 4 sentinel pigs (S) which were housed in pens at least 5 ft away from EI pigs but in the same air space. The sentinel pigs were used to see how quickly aerosol transmission of the virus would occur. The EI pigs seroconverted at 8 DPI and the S pigs 11 DPI. Their antibody titers peaked 14 DPI (from 1:1280 to 1:2560), began to drop at 28 DPI, reached the lowest level (from 1:80 to 1:320) at 56 DPI, and remained similar. All pigs had detectable titers through 104 DPI with 4 of 8 pigs having titers until 110 DPI. Virus shedding started day 1 post inoculation and continued until day 6 in the experimentally infected group and from day 3 through day 11 in the sentinel pigs. The EI pigs shed viruses until 6 DPI, and the viral titers peaked at 4 DPI; in the S group, one pig shed virus from 1 to 10 DPI whereas the other three shed viruses on 7 or 8 DPI and lasted from 1 to 4 days.

**Pathogenic findings in feral swine from Macon County, Alabama**

**Ebony Gilbreath**, Tuskegee University, College of Veterinary Medicine, Nursing and Allied Health, Clinical Anatomy Building Room P130, 1200 W. Montgomery Road, Tuskegee, AL 36088
(334) 724-4103; egilbreath@mytu.tuskegee.edu

Feral swine (a.k.a. feral boar, wild boar, wild hogs) (*Sus scrofa*) can cause a significant economic problem as they are an agricultural nuisance and they can harbor various zoonotic diseases as well as diseases that are transmissible to other animals—particularly domestic swine. Feral swine were submitted to the TUSVM Pathobiology Diagnostic Laboratory for post-mortem evaluation. All of the animals had numerous ectoparasites (ticks and/or lice) on their external surface. They also had various parasitic infections that were macroscopically and/or microscopically evident within various organs, including pulmonary trematodiasis, pulmonary nematodiasis, and lingual nematodiasis. The pathologic findings present in three porcine species will be showcased in this presentation.

***B. Suis* in the United States- a growing public health concern?**

**Marta Guerra**, G. Kharod[1], R. Tiller[1], P. Kache[1], and A. Smee[2]. [1]Centers for Disease Control and Prevention, 1600 Clifton Rd, Atlanta, GA 30333, (404) 639-3951, [2]Pennsylvania Health Department

Brucellosis, caused by *Brucella* species, is a zoonotic disease that can cause acute febrile illness in humans that can lead to chronic disease and relapses if not treated appropriately. *B.suis*, associated with swine, has been eliminated from domestic swine in the U.S., but is still present in feral swine populations. As these populations increase and expand throughout the U.S., the risk of transmission of brucellosis can also increase for persons recreationally and occupationally exposed to feral swine. We describe a recent investigation of brucellosis in a feral swine hunter and present a summary of human *B. suis* cases in the U.S. In November 2013 the PA Dept. of Health investigated a report of a febrile illness in a 54-year-old Pennsylvania resident. After a diagnosis of brucellosis was obtained, human brucellosis cases reported to Centers for Disease Control and Prevention (CDC) and attributed to *B. suis* were reviewed. The investigation determined that the likely source of exposure was butchering a feral swine, without wearing appropriate personal protective equipment (PPE). Specimens from the patient were confirmed to be culture positive for *B. suis* by the PA Dept. of Health's Bureau of Laboratories. Lack of suspicion of brucellosis as a diagnosis led to laboratory exposures at local clinical laboratory. Culture and PCR results of pork from the feral swine also identified *B. suis.* The review of cases from 2008-12 found 370 cases of brucellosis reported to CDC, with 65 cases infected by *B. suis*. Animal exposure was reported in 40 (62%) cases; 48 (74%) cases had associated laboratory exposures Results of the investigation indicated that the patient was not wearing recommended PPE. Prevention can be emphasized through education of appropriate PPE and food safety practices, and by increasing physician awareness to enable more rapid diagnoses and reduction of laboratory exposures.

## Technical Session 4: Distribution

**Species distribution modeling for feral swine across the conterminous United States**

**Matthew L. Farnsworth**, Meredith McClure, Christopher Burdett, Ryan Miller, Mark Lutman, David Theobald, and Daniel Grear, Conservation Science Partners, 11 Old Town Square, Suite 270, Fort Collins, CO. 80524, 970-484-2898, matt@csp-inc.org

Wild pigs (*Sus scrofa*), or feral swine, are highly invasive generalists that continue to spread across the U.S. from historic strongholds in the southeast, adapting to a broad range of habitat conditions. We sought to predict patterns of future spread based on occupancy data assembled by the Southeastern Cooperative Wildlife Disease Study and Federal partners. We distinguished the natural spread of pig populations from likely introductions to novel areas by humans and fit logistic discrimination functions to identify habitat conditions and human factors linked to natural and human-mediated spread processes, respectively. We show that habitat characteristics associated with pig occupancy patterns vary geographically, and that demographic characteristics of human communities may serve as a rough guide as to where pigs are most likely to be introduced. These findings are expected to guide future efforts to reduce further spread of wild pigs by informing targeted surveillance and removal efforts.

**Home range estimates, habitat preference, and supplemental food use of feral swine in sub-tropical rangelands of Florida, USA**

**Raoul Boughton**, S. Andrew Satterlee, Brittany Bankovich, Tyler A Campbell, Eric A Tillman, Michael P. Milleson, Elizabeth H. Boughton, and Samantha M. Wisely, University of Florida, IFAS, Range Cattle Research and Education Center, 3401 Experiment Station, Ona, Florida 33865,863 735 1314, rboughton@ufl.edu

Rangeland productivity in Florida subtropical environments is predominantly driven by monsoonal seasons with a dry winter/spring and a wet summer/fall. The "wet" runs from early July until the middle of October and during the harsher dry winter ranchers provide supplemental food to livestock. Feral swine are also attracted to the supplemental feed. To understand fine scale landscape use, daily activity patterns, and home range size of feral swine during the dry season we deployed 20 GPS fitted collars to collect location data from January 10 – May 15 2013 on 10 sows and 10 boars trapped at dispersed locations on the 10400 acre MacArthur Agro-Ecology Research Center. On average >5000 points were recorded for the 18 collars retrieved, with 15 minute resolution during high activity periods from 1600-1000 and hourly during middle of the day from 1000-1600. We estimated home range based on the utilization distribution of 95% of kernels with a bivariate normal kernel estimator and reference bandwidth smoother. During the dry season home ranges for females were 161± 106 ha and for males 337 ± 242 ha and home range size increased with individual estimated mass. Habitat preference analyses suggest that feral swine preferentially select wetlands over all other habitats and often returned to the same wetland over consecutive days. Using cameras we also measured number of visits swine made to supplemental feed and ongoing work will estimate amount of feed consumed. Home ranges of feral swine in subtropical Florida are relatively small suggesting ample local food during the dry period, which may be inadvertently supplied by ranchers. Knowledge of home range and activity patterns is important for understanding feral swine use of rangelands and how ranching practices influence swine behavior.

**Estimating wild boar population size: camera traps or distance sampling**

**Giovanna Massei,** Alienor Chauvenet, Alastair Ward, and Robin Gill, National Wildlife Management Centre, Animal Health and Veterinary Laboratories Agency, Sand Hutton, York,YO41 1LZ, UK, +44 (0)1904 406141, giovanna.massei@ahvla.gsi.gov.uk

Wild boar in Europe are increasing in numbers and range and they also occur in many suburban areas. Wild boar can have a significant impact on crops, livestock, plant and animal communities and are involved in disease transmission to livestock or humans. Assessing wild boar local densities is important to monitor population trends and to quantify the impact of population control methods. However, counting wild boar is notoriously difficult, particularly in areas where animals are regularly hunted. This is particularly relevant to the UK, where wild boar went extinct and recently recolonized parts of the country as a result of escapes from farms and illegal introductions. We present preliminary results on the theoretical and empirical use of camera trapping and distance sampling to monitor wild boar numbers in England. We built a spatially-explicit individual based model to investigate the accuracy and precision of both monitoring techniques in estimating known densities and we trialled both methods in the Forest of Dean in England. The model showed that both distance sampling and camera trapping produced reasonably accurate estimates of the true population. Camera trapping estimates had narrow confidence intervals and were not affected by population size, but the estimates obtained through this method were highly sensitive to mean group size. Distance sampling estimates were more accurate but less precise than those from camera trapping. In addition, distance sampling consistently underestimated wild boar numbers and was sensitive to population size. Field applications of both methods resulted in very similar estimates of densities, thus increasing the credibility of the conclusions drawn from the model. We will present these data together with considerations of the relative merits and disadvantages of using other methods to monitor population trends as well as range expansion of wild boar.

**Characterization of microsatellite markers in Tennessee's feral pig population**

**Kathryn Breidenstein** and Rachel Chamberlin, Lipscomb University,1 University Park Drive. Nashville, TN 37204, 513-739-0533 kmbreidenstein@mail.lipscomb.edu

The use of microsatellite markers has been beneficial for revealing population structure in feral pigs. The use of microsatellite markers is advantageous because they are highly polymorphic and provide highly accurate levels of heterozygosity. To our knowledge, this study represents the first use of microsatellite markers in Tennessee's feral pig populations. As such, it is important to evaluate the microsatellite markers for their ability to document the genetic characteristics of this population. Microsatellites selected for use in this study were chosen because they were highly polymorphic in other feral pig studies and are genetically unlinked. DNA will be extracted from serum using a commercially available kit. Microsatellite markers will be amplified by Polymerase Chain Reaction (PCR) and separated using capillary electrophoresis. Microsatellite data will be analyzed using the computer programs POPGENE 1.32 and FSTAT 2.9.3.2, which will calculate allelic richness, observed and expected heterozygosity and inbreeding coefficient (Fis.). Understanding the genetic characteristics of the populations such as migration habits and mating patterns can lead to better management of feral pigs.

**Expansion of feral swine in the United States**

**Joseph Corn**[1], Thomas Jordan[2]. [1] Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine, University of Georgia, Athens, Georgia 30602, 706-542-1741, jcorn@uga.edu, [2] Center For Geospatial Research, Department of Geography, University of Georgia, Athens, GA 30602

The Southeastern Cooperative Wildlife Disease Study (SCWDS) began producing nationwide feral swine distribution maps in 1982 by working directly with state and territorial natural resources agencies. In 1982, 17 states reported feral swine; by 2004, 28 states were reporting feral swine. In 2008, SCWDS implemented the National Feral Swine Mapping System (NFSMS). The NFSMS is an internet-based data collection system used to collect and display current data on the distribution of feral swine in the United States. These maps are produced using data collected from state and territorial natural resources agencies, USDA-APHIS-Wildlife Services, and other state/federal wildlife and agriculture agencies; over 240 agency representatives have passwords for access to submit data into the system. The map is available to be viewed by the public on the NFSMS home page. Distribution data submitted by agency personnel are evaluated by SCWDS on a continual basis, and the map is updated with verified additions on a monthly basis. Feral swine populations and/or sightings are designated either as established breeding populations, or as sightings, but only established breeding populations are included on the map and in the total of the number of states with feral swine. Over 600 additions have been made to the national map through the NFSMS since January 2008. The NFSMS is accessed via the internet at http://www.feralswinemap.org/. Although the distribution of feral swine continues to increase in the United States, the number of states reporting established populations dropped from 37 in 2011 to 36 in 2013 as feral swine were eradicated from Nebraska. Expansion of feral swine is due to several factors including intentional release of feral swine into new areas, escape of penned feral swine, and natural expansion of extant populations. Implications of expansion have included increases in the distribution of diseases including brucellosis and pseudorabies in feral swine.

**Mapping the distribution of wild pigs in Alabama**

**Rachel E. Conley,** Mark D. Smith, and James B. Armstrong**,** School of Forestry and Wildlife Sciences, 3301 Forestry and Wildlife Sciences Building, Auburn University, AL 36849, (336)403-4004, rec0004@auburn.edu

Wild pigs are a non-native wildlife species causing >$1.5 billion/year in agricultural damage in the United States and >$55 million/year in crop and forest damage in Alabama. Effective management of wild pigs in Alabama will require a determination of their distribution and relative abundance, characterization of the extent and breadth of damage, and development of practical management techniques, extension programming, and policies. A 2001 mail survey conducted by Auburn University and the Alabama Cooperative Extension System of agriculture and natural resources extension agents and conservation officers and wildlife biologists of the Alabama Department of Conservation and Natural Resources (ADCNR) reported wild pig occurrence in 52 counties with abundant populations in 31 counties. However, given the substantial increase in the number of wild pig damage complaints and anecdotal data during the last 10 years, wild pig populations have increased dramatically since this survey. Therefore, we conducted a statewide mail survey of ADCNR law enforcement officers to develop an updated map

depicting current wild pig distribution and relative abundance. We also measured the number of wild pig damage complaints received by law enforcement officers within each county using a one-page questionnaire. In the past five years, wildlife law enforcement officers received >6,000 wild pig complaints with 1,460 complaints reported in the past year alone. In 2012, 962 wild pig damage management permits were issued in Alabama. Wild pigs were present in 64 of 67 counties with 36 counties reporting a population increase over the last 5 years. Currently, wild pigs occupy approximately 38.3% of the land base in Alabama. Given this updated distribution, we will be able to better characterize future growth and spread of wild pig populations throughout Alabama and to more effectively target extension programs to address wild pig damage issues.

## Technical Session 5: Control Measures

**Method specific costs of feral swine removal in a large metapopulation: the Texas experience**
**Mike Bodenchuck**, State Director, USDA-APHIS Wildlife Services Cooperative Texas WS program, P.O. Box 690170, San Antonio, TX 78249, michael.j.bodenchuk@aphis.usda.gov

The methods used to remove feral swine include aerial shooting, trapping in large "corral" traps, drop nets, snaring, shooting in the daylight hours and night shooting with specialized equipment. Each method has its utility as well as limitations. In areas with large connected populations, method selection may be based on the amount of land available for control, attitudes of neighbors towards control, time necessary to successfully implement control and access to the habitat. Costs of control may be a secondary consideration. However, recognizing the relative cost of control in a metapopulation may assist managers when deciding between two or more equally appropriate methods. Texas WS data were examined to determine the success rates and cost per animal removed by the various methods. Utility of each method and implementation strategies are also discussed.

**Attaching GPS and radio telemetry devices to feral hogs**
**Dan McMurtry** and Parker T. Hall, USDA Wildlife Services, Columbia, MO, United States Department of Agriculture, Animal and Plant Health Inspection Services, Wildlife Services, 1714 Commerce Ct. Suite C., Columbia, MO 65202, 573-449-3033 x13 dan.w.mcmurtry@aphis.usda.gov

From 2009 to 2012, the Missouri Wildlife Services program took part in a research project that involved attaching GPS and radio telemetry devices to feral hogs. During that time, Wildlife Services developed several methods, procedures, and philosophies that led to an increased success rate of collar attachment. This presentation will highlight a number of considerations for wildlife professionals to keep in mind when attaching GPS/radio telemetry devices to feral hogs. 1) Attaching GPS/ radio telemetry devices to feral swine is something that should be taken seriously, with appropriated time, funding, and manpower to adequately monitor, troubleshoot and recover devices once in the field. 2) Large boars are very hard on GPS equipment, they can be very solitary, they have the ability to cover great distances in a short period of time and at other times simply don't move. Large boars can also be very elusive if the animal is not removed during the first encounter, making equipment recovery time consuming and difficult. 3) The use of Telazol for immobilization is very forgiving, sedating most hogs in three minutes with recovery in 90 minutes. 4) Horse halters can be converted into an effective hog harness which can then be attached to the GPS/ radio telemetry devices. These harnesses provide more surface area and are more forgiving to the animal as compared to nylon straps. 5) Know your equipment and be creative in the field. The ability to assemble and re-make harnesses and collars in the field with a wide variety of components and specialty tools can mean the difference between success and failure. 6) Do not leave GPS/ radio telemetry devices /harnesses on hogs more than three months. Any longer and equipment failures and issues with hog growth can have negative effects on the hog and data.

**Feral swine in New Mexico- and eradication effort in year one with disease information**

**Dallas Virchow**, Wildlife Disease Biologist, USDA-APHIS Wildlife Services, Albuquerque, NM 87113, 505 346 2640, Dallas.R.Virchow@aphis.usda.gov

Feral swine (*Sus scrofa*) have been on New Mexico landscapes for an unknown time. Because most landscapes in NM are either high desert or mountains, feral swine populations have remained relatively sparse and disjunct, compared to other states with more suitable habitat. During 2012, New Mexico state and federal agencies organized and devised a mid-range plan with a goal to eradicate this invasive species. Both federal and state monies were acquired to ensure a successful start to this project. USDA APHIS Wildlife Services, spear-headed operations with aerial and ground methods. Priority areas were designated where feral swine had been most often observed historically. A reconnaissance team of Wildlife Services wildlife disease biologists initially contacted landowners, managers, and others who had observed or heard of feral swine sightings. NM-WS operations personnel continued use of ground techniques (box traps, corral traps, bait stations with trail cameras, snares, and opportunistic use of firearms) throughout 2013. Aerial techniques used trained helicopter personnel and gunners. Both GPS and VHS radio transmitters were attached in tandem to young sows for them to return and locate a sounder. Aerial and ground tactics were to take all swine within a sounder, with the exception of such "Judas pigs" if there was a chance of another sounder being present in the general area. Aerial operations took the majority of feral swine during year one. Aerial operations were useful as follow-up to successful trapping efforts where the remaining swine may not be coming to bait. Helicopters were also useful in locating lone boars that were miles from a sounder and travelling through desert habitat. Samples from swine were collected to test among ten diseases. Apparent prevalence for swine brucellosis and pseudorabies exposure were at comparatively low levels.

**Integrated Wild Pig Control™ results from the EPD Pennahatchee Creek project**

**Rod Pinkston**, JAGER PRO™ Hog Control Systems, PO Box 4006, Columbus, Georgia 31914-0006, 706-905-8245, Rod@jagerpro.com

In October 2011, the River Valley Regional Commission submitted a 319(h) Clean Water Act grant application to the Georgia Environmental Protection Division (EPD) with efforts to address the fecal coliform levels in Pennahatchee Creek (Dooly County, Georgia). It was the overall consensus of the stakeholders that wild pigs were the source of the pollutant. After one year of targeted monitoring, the source was tracked to an isolated area within the watershed. A private wildlife control company (JAGER PROTM) was hired to remove the total wild pig population within the 4,000+ acre target area by employing their Integrated Wild Pig ControlTM (IWPC) model. IWPC is a strategic approach using a series of innovative control methods and technologies implemented in a specific sequence based on seasonal food sources. Emphasis is placed on efficient removal of entire sounders at one time to eliminate escapes and education. The JAGER PROTM IWPC model was adapted to wild pigs from the Integrated Pest Management (IPM) model developed for termite, rat and cockroach eradication. This presentation will provide detailed results (capture percentages, camera to kill ratios, etc) and video documentation of the intel gathering strategies and control sequences used (during the first 16 months of the project) to eliminate the total wild pig population within the target area.

**Novel techniques for wild pig capture**

**Joshua Gaskamp,** Samuel Roberts Noble Foundation Inc. 2510 Sam Noble Parkway, Ardmore, OK, 73401, 580-222-9017, jagaskamp@noble.org.

Numerous trap designs have been used in efforts to capture wild pigs (*Sus scrofa);* however, drop-nets had never been examined as a potential tool for wild pig control. We implemented a two-year study to compare the efficacy of an 18.3 x 18.3 meter drop-net and a traditional corral trap for trapping wild pigs. In spring 2010, treatment units were randomly selected and multiple trap sites were identified on 4,047 hectares in Love County, OK. Trap sites were baited with whole corn and monitored with infrared-triggered cameras during pre-construction and capture periods. Unique pigs using trap sites were identified five days prior to trap construction and used in mark-recapture calculations to determine trap effectiveness. Three hundred fifty-six pigs were captured in spring of 2010 and 2011. We documented maximum captures of 27 and 15 pigs with drop-nets and corral traps, respectively. Our findings indicate that 86 and 49 percent of the unique pigs were removed from treatment units using drop-nets and corral

traps, respectively. Catch per unit effort was 1.9 and 2.3 hours per pig for drop-nets and corral traps, respectively. Advantageous elements of both systems were combined to produce the BoarBuster® suspended corral trap. Preliminary testing of this novel system has yielded maximum capture of 39 pigs, capture rate of 88 percent, and catch per unit effort of 0.65 hours per pig. BoarBuster® technology demonstrates how adaptive and innovative methodologies can achieve greater results in wild pig control.

**Seeing the forest despite the trees, Tennessee wild hog management**

**Chuck Yoest** and Gray Anderson, Tennessee Wildlife Resources Agency (TWRA), P.O. Box 40747 Nashville, TN 37204, (615) 781-6615, Chuck.yoest@tn.gov

In 2011, the Tennessee Wildlife Resources Agency (TWRA) shifted focus from harvest based management to a more aggressive statewide wild hog control program. TWRA's three year old program is based on three tenants: eliminating incentives to illegally transport and release wild hogs; creating practical means of control for landowners; and outreach. The TWRA is experiencing great success with its redirection of management, but pressure to revert back to traditional harvest management continues. This pressure endures despite evidence that the TWRA is accomplishing great feats including: aiding in the elimination of over 10,000 wild hogs; eradicating wild hog populations in three of Tennessee's 95 counties; eliminating small pockets of wild hogs in 11 counties; and noticeably reducing populations in five counties. TWRA's success is very apparent to program administrators and recent University of Tennessee at Martin (UTM) research has confirmed their belief that past harvest based management exacerbated wild hog problems in Tennessee. UTM research found that the number of counties with wild hogs present quadrupled during the time that Tennessee had a statewide feral hog hunting season. Amidst all the success and supportive research findings, TWRA's wild hog management continues to be challenged. TWRA personnel outside of wildlife management and a very vocal minority of the general public remain skeptical threatening the integrity of the control program. These groups fail to see the "big picture" and dwell on issues outside of TWRA's control indicating that TWRA's message is flawed. Outreach tools including population distribution projections have been developed and used, but overall outreach efforts have been inadequate. As a result, TWRA is conducting a self-evaluation and reconsidering its message and outreach regarding wild hogs. Improving messaging and outreach should aid in removing two major obstacles challenging TWRA's wild hog management program: lack of sufficient public support and apathetic management partners.

## Technical Session 6: Management and Economics

**An attempt to mitigate potential impacts on two candidate species: feral swine control in southeast New Mexico**

**Randy Howard**[1], Brian Archuleta[2], and Alan May[3], [1]USDI BLM, 1717 W. 2nd Street, Roswell, NM, 88201, (575) 627-0266, rhoward@blm.gov, [2] USDA/APHIS/WS, 500 N. Richardson Ave, Fed Bldg Rm 127, Roswell, NM 88201, brian.v.archuleta@aphis.usda.gov ,3USDA/APHIS/WS, 8441 Washington Ave, NE, Albq, NM 87113. alan.may@aphis.usda.gov

Feral Swine (*Sus scrofa*) have been increasing in number and geographical distribution in New Mexico over the last 8 years. In 2010, feral swine sign was found in Lesser Prairie Chicken (*Tympanuchus pallidicinctus*) and dunes sagebrush lizard (*Sceloporus arnicolus*) habitat in southeastern New Mexico by a Bureau of Land Management Wildlife Biologist. BLM and USDA/APHIS/Wildlife Services responded to the sighting by placing additional trail camera and bait tubes in the area. Over the next 3 years BLM and USDA continued to monitor and remove feral swine as they were located. During FY12 & 13, BLM was able to secure funding dedicated to removing feral swine and coyotes in the Lesser Prairie Chicken and dunes sagebrush lizard habitat to reduce the potential for predation by this non-native introduced species. A total of 78 feral swine have been removed from this area, and an additional 1,260 coyotes were removed between 2005-2013 with cage, corral traps, aerial hunting and firearms. Anecdotal data from selected study areas showed the least amount of predation on LPC in this area. New Mexico Department of Game and Fish pronghorn surveys in the same area showed the highest fawn to doe ratio in the state. This paper summarizes the joint efforts between BLM and USDA to reduce predation to the Lesser Prairie Chicken and dunes sagebrush lizard and increase their nesting/clutch success.

**Feral pig management at Tejon Ranch, California**

**Michael White**[1], Kyran Kunkel[2], [1] Tejon Ranch Conservancy, PO Box 216, Frazier Park, CA 93225 (661) 248-2400, mwhite@tejonconservancy.org, ,[2]Mountain Thinking Conservation Science Collaborative.

Feral swine damage is a serious management issue for natural resource managers, farmers, ranchers, and increasingly even suburban, private property owners. The 270,000-acre, privately owned Tejon Ranch in the Tehachapi Mountains of California, the subject of a conservation and land use agreement that conserved 90% of the property, supports a population of feral pigs that produces extensive ecological and economic damages. However, pigs are an important revenue source to the landowner's hunting program. The Tejon Ranch Conservancy serves as steward of the conserved lands, and is evaluating management options to reduce feral pig damages while respecting the landowner's right to maintain a for-profit hunting operation. To inform our management, the Conservancy has initiated field monitoring to obtain habitat- and season-specific indices of population size and associated rooting damage and has modeled pig population responses to age- and sex- specific harvest scenarios. Preliminary monitoring results show that pigs prefer mesic habitats during the dry season and move into more xeric habitats during the wet season. Consistent with previous studies, our model results show that >70% of the population must be harvested annually to maintain or reduce the population, and that harvesting juveniles can be valuable to population control. Density-dependent reproduction and immigration do not fully offset high mortality rates suggesting that high adult female and juvenile harvest is a potential way to reduce the impacts of pigs at Tejon. Our analysis shows that population growth rates are most sensitive to reproductive rates, but we have no site-specific data to estimate these or mortality rates. This talk will present background on the Tejon Ranch conservation and land use agreement, the historic harvest of pigs on the Ranch, our analysis of population size, damage and harvest rates necessary to control the population, and objectives and strategies for pig management at Tejon Ranch.

**Using ecological research to reduce barriers to achieve effective feral pig management**

**Darren Marshall**[1], Matthew Gentle[2], Ted Alter[3], [1]Queensland Murray Darling Committee, PO Box 6243 Toowoomba, Qld 4350 Australia, [2] Robert Wicks Pest Animal Research Centre, Biosecurity Queensland, Department of Agriculture, Fisheries and Forestry, Queensland, 203 Tor Street, Toowoomba, Qld 4350, Australia. [3]Penn State University, 204 Armsby, University Park, PA USA, 16802

Feral animal control in southern Queensland is an ongoing challenge to land managers. While there are significant resources being invested in this issue, there is often little measurable reduction in feral animal numbers or the impact they have on the environment, production or human and domestic livestock health. Effective and practical tools are available to land managers to control feral animals in the landscape, but these tools often remain under or poorly utilized. The major challenge is to engage citizens and communities to enable these tools and knowledge to be used, to effectively control feral animals. It is generally advisable to employ multiple control methods to ensure that all animals are susceptible to control. Techniques should also be implemented in a coordinated manner, over a large enough area to minimize 'edge-effects' and therefore, potential for reinfestation through immigration from surrounding, uncontrolled areas. This approach is important for longer-term, effective control and represents an even larger challenge. How do we get a community to work together in a timely, coordinated manner to reduce feral animal numbers and the impact they have? The challenge is to effectively engage citizens and communities to enable these tools and knowledge to be utilized in a successful manner. In conjunction with Origin Energy, Santos GLNG, and the Queensland Murray Darling Committee in Southern Queensland, I aim to facilitate effective community action through applied research, to influence land managers to participate in coordinated control. I believe there is significant value in bridging the gap between research and extension to encourage greater participation in feral pig control. I will examine an innovative approach that aims to improve the participation of citizens and communities in coordinated feral pig management - using applied science to achieve social change. This project will use innovative research techniques to investigate feral pig movement ecology during control operations to gather scientific data whilst also create a strong interface for community ownership and change. This presentation will discuss an integrated scientific and community engagement approach, and discuss the implications for improved feral pig management in southern Queensland.

**The economics of feral swine damage and its control**

**Stephanie Shwiff**, Jason J. Holderieath, Aaron Anderson, Steven Shwiff, Fred Cunningham, and Ryan Miller, USDA-APHIS National Wildlife Research Center, 4101 LaPorte Avenue; Fort Collins, CO. 80521, 970.266.6150, Stephanie.A.Shwiff@aphis.usda.gov

Feral swine are known to cause extensive damage, and their range and population are growing. Estimates of population, range, damage (actual and potential), and control costs vary greatly and, in spite of decades of study, substantial gaps in knowledge still exist. Recent crop damage estimates range from $1.8 million of corn, cotton, peanuts, and soybeans in Northern Florida to $57 million in 41 Georgia counties. The tendency of most analyses of feral swine damage to focus on a very specific region or crop makes it difficult to understand the full impact of feral swine because feral swine densities and agricultural practices display considerable variation across the current range of feral swine. A commonly repeated estimate of total damage by feral swine in the US is $800 million per year, but the method of estimation was somewhat ad hoc and there is evidence that swine populations continue to expand. Improved estimates require better quality data. We will address this problem with a survey of producers across ten states with documented feral swine damage to corn, soybeans, wheat, rice, and peanuts. The survey will address the topics of crop, facility, and livestock damage, and it will include questions related to hunting and the attitudes of farmers and ranchers toward feral swine. By addressing a broad range of interests, we hope to help agencies involved in control efforts to garner the support of affected producers and improve the effectiveness of management.

## Technical Session 7: Ecological Impacts and Control

**Feral hog management plan and environmental assesssment, Big Thicket National Preserve, Texas**

**John Williamson**[1], Scott Zengel[2], Pedro Chavarria[1], Angela Bulger1, Stephanie Burgess[3], [1]Atkins,Suite 200, 6504 Bridge Point Parkway, Austin, Texas 78730, 512-342-3381, john.williamson@atkinsglobal.com , [2] Atkins, 2639 North Monroe Street, Building CTallahassee, Florida 32303 ,scott.zengel@atkinsglobal.com, [3]Oil and Gas Program Manager, National Park Service, Big Thicket National Preserve, 6044 FM 420Kountze, Texas 77625, stephanie_m_burgess@nps.gov

Within the United States, National Park Service (NPS) lands have been greatly affected by feral hog impacts, which degrade the natural resources for which the park units were established and the NPS has been charged to protect. To combat this issue, several NPS units have implemented, or plan to implement, feral hog management strategies. The Big Thicket National Preserve (BTNP), which encompasses over 108,208 acres in East Texas, has not been an exception to this management issue. Feral hogs have been estimated to affect up to 30,000 acres or more of Preserve lands, including sensitive and unique habitats, such as wetlands and pine savannahs, and rare and endangered species occurrences. Problematic has been the rapid population growth of feral hogs in BTNP, with the population estimated to have doubled in density over roughly the past 25 years. To address this concern, the NPS, in compliance with the National Environmental Policy Act, prepared a Feral Hog Management Plan / Environmental Assessment (EA) for the BTNP. The plan describes how feral hog populations will be managed to prevent or mitigate impacts on Preserve resources and values. The EA provides the decision-making framework that identifies significant issues and concerns facing Preserve management, a description and analysis of a reasonable range of management alternatives and their effects, and a strategy to determine long-term management of feral hog populations at BTNP. Topics addressed in this presentation will be a general background on feral hog management issues in BTNP, development and details of the approved management plan, and a discussion of the NEPA process, its role in the formation of the Feral Hog Management Plan/EA, and applicability and implications for future management plans on Federal lands.

**Eradication versus control**

**David Pauli,** Senior Advisor Wildlife Response & Policy, The Humane Society of the United States, 4235 Zephyr Lane, Billings, MT 59106, 406-698-1167, dpauli@humanesociety.org

Vertebrae Wildlife eradication programs have deep historic roots. Some species like bison and wolves were eradicated almost to extinction for economic, corporate, cultural or agricultural reasons. Modern day eradication attempts on species like coyotes and starlings have shown eradication may not be possible across a large landscape. States with high densities of wild pigs have had whispers, and promotion of eradication for many years. Recently the potential addition of a lethal toxicant, that might be conditionally acceptable, has increased the volume and intensity of the eradication discussion. But many factors including public opinion; carcass disposal; uncooperative private landowners; unsuitable urban settings, and unknown long terms effects of rapid depopulation suggest that state and federal land and wildlife managers should proceed cautiously. Review of other species control programs; public opinion surveys to toxic bait programs; long term observation of sounder behaviors/compensations; and overall environmental impact of large scale poisoning programs must be completed before states actively conduct large scale toxic control projects. Yet inappropriate use of toxic baits on an isolated property level could establish cycle of killing going forever without accomplishing overall population reduction goals. Managers should have reasonable expectations and recognize that there will be areas where toxic bait programs will be politically, socially and legally impossible to conduct. Liability, public pushback to large scale kill projects and issues like killing full term pregnant sows or allowing non-lethal but toxicant affected pigs to move to a non supporter's property will generate even more pushback. (Who will be liable when a car or school bus hits a sub-lethal dosed wild pig?) Toxic bait programs should be tested, refined and be a tool in the wild pig toolbox. But all other options Including exclusion, built in colony trapping of entire sounders, Immunocontraception, and continued public education must also be part of the Solution. Community based "Wild Pig Task Forces" which garner input from all stake holders including urban residents, nonagricultural citizens and even wild pig advocates should become the model for community, private and governmental wild pig control efforts.

**Mallee recovery: a landscape predator control project for the conservation of endangered malleefowl (*Leipoa ocellata*) in New South Wales, Australia**

**Jason Wishart**, Paul Meek, and Simon Humphrys, Invasive Animals Cooperative Research Center, 33 Flemington Street, Glenside, South Australia 5065, +61 88207 7836, Email; jason.wishart@invasiveanimals.com

Malleefowl (*Leipoa ocellata*) are a medium sized ground dwelling bird species that occur in the arid zones of southern Australia. They build large mound nests from soil, and use leaf litter within the mound to incubate their eggs. Historically, malleefowl were relatively common throughout much of their range, although since European settlement their populations have declined considerably. They are now listed as vulnerable under both Commonwealth and state Legislation. Numerous factors have contributed to their current conservation status including; habitat clearing, competition, inappropriate fire regimes and predation. However, given they are a ground nesting, and largely ground dwelling, bird they are particularly susceptible to predation by exotic predators. This project aims to develop an integrated landscape scale exotic predator control program to conserve malleefowl populations in western New South Wales. Exotic predators targeted in the program include feral pigs (*Sus scrofa*), foxes (*Vulpes vulpes*), and feral cats (*Felis catus*). A series of traditional and modern control tools are being used to ensure maximum efficacy and target specificity. Camera trapping, sand padding and aerial survey are being used to gather predator and prey abundance indices, and thus measure program performance. The progress of the project to date will be discussed.

**Developing tools for detecting feral swine and their impacts to wildlife and agriculture**

**Antoinette Piaggio**, and Kelly Williams, USDA-APHIS Wildlife Services, National Wildlife Research Center, Fort Collins CO, Colorado State University, Department of Microbiology, Immunology, and Pathology, Fort Collins, CO 4101 LaPorte Ave, Fort Collins, CO 80521, 970-266-6142 toni.j.piaggio@aphis.usda.gov

Documenting the presence of invasive feral swine (*Sus scrofa*) and identifying their impacts is critical for successful management strategies. Control of feral swine can be costly and success can be rapidly reversed by remnant populations. In areas where control has been applied, it is critical to detect repopulation as soon as possible before the population rebounds. It is also critical to document the impact of control efforts on feral swine populations. Molecular tools can assist with such efforts. We are developing methods using whole genome sequencing (WGS) to document the impact of feral swine on water quality and subsequent pathogen transmission to livestock and agriculture. We will use WGS to detect pathogens known to be transmitted by swine in water. Pathogen detection will be examined before and after control efforts to test if control reduces swine related pathogens in water sources. Environmental DNA (eDNA) is a relatively new approach for detecting the presence of a target species through sampling water, soil, and even air. We are developing an eDNA assay where feral swine activity can be detected through water samples. Feral swine spend significant time wallowing in wet areas and thus allow a unique opportunity for eDNA detection. In areas where there is no concern about domestic swine having access to a water source or watershed, eDNA will allow managers to detect feral swine.

**Environmental impacts of feral swine in rangelands of South Florida**

**Samantha Wisely**, Brittany Bankovich, Andrew Satterlee, Elizabeth Boughton, Raoul Boughton, and Michael Avery, Department of Wildlife Ecology and Conservation, University of Florida, University of Florida,110 Newins-Ziegler Hall, Gainesville, FL 32611-0430, 352.846.0645, wisely@ufl.edu

Feral swine have increased dramatically in the last 15 years in South Florida. Behavior of feral swine such as rooting can result in significant damage to pastures and the abundance of feral swine increases the risk of disease to cattle. We studied the effects of feral swine on MacArthur Agro-Ecological Research Center, a 10,500-acre cow-calf operation in south-central Florida. We compared plant community composition and cover in 54-1m2 plots in rooted and unrooted patches of pasture once a month for a year. We estimated a loss of 50-70% of palatable forage in rooted pastures compared to unrooted pastures and we found a significant increase of the noxious native plant, Carolina redroot (*Lachnanthes caroliana*) which created dense monotypic stands of unpalatable forage in previously rooted patches of pasture. Pasture quality did not improve after the initial disturbance. Furthermore, it appears that there is a positive feedback loop between feral swine and redroot. 97% of patches that had Carolina redroot were rerooted by feral swine during the course of our study, yet none of the patches without redroot were rerooted. Feral swine appear to select patches with Carolina redroot for rooting which in turn increases the size and density of the redroot patch. In south Florida, this change in forage quality could impact the production of cattle and profit margins of ranchers.

## Technical Session 8: Baits, Toxicants, and Contraceptives

**Effectiveness of Wildgranix$^{TM}$ as a deterrent for wild pigs**

**Gregory B. Brooks**[1], and Robert W. Holtfreter[2], [1]Fort Benning Environmental Division, Environmental Programs Branch, NEPA Section, Fort Benning, GA 31905, 706-587-8276, brookgbjr@gmail.com, [2]Department of Natural Resource Ecology and Management, Connors State College, Warner, OK 74469 USA.

Wild pigs are a concern on Fort Benning Army Infantry Training Installation. In 2011, officials proposed the use of a repellent, WildgranixTM, as an aid to pig management on the installation. WildgranixTM is a biodegradable, lime-based repellent, manufactured by SeNaPro. SeNaPro claims the odor of WildgranixTM will deter wild pigs from sensitive areas for 21-35 days per application. We evaluated the effectiveness of WildgranixTM as a repellent by

observing wild pig usage of baited sites, prior to and following application of the repellent. We applied WildgranixTM, according to manufacturer's recommendations, over a ~2,000 m2 area surrounding game feeders. We used remote cameras to document pig usage of sites throughout the study. We additionally monitored the extent of pig damage observed at 6, 2m x 3m, test plots established in standing corn. Each plot was randomly assigned to 1 of 3 groups; WildgranixTM, Tripple-13 fertilizer, or Control (i.e. no treatment). We counted stalks of standing corn in each plot prior to treatment, and returned on a 2-day interval over 10 days in effort to document wild pig damage. On average, pigs were observed during 19.67 (1.33 SE) 24-hours periods prior to application of WildgranixTM. Pigs visited sites an average of 11.25 (4.24 SE) times per day during this period, spending an average of 2.45 (0.53 SE) hours on site per day. Following application of Wildgranix TM, pigs were observed during 20.33 (0.67 SE) 24-hours periods, on average, and visited sites an average of 10.43 (2.47 SE) times per day, for an average of 2.40 hours (0.52 SE). Additionally, we found that 21.45% of corn stalks at test plots treated with WildgranixTM were damaged by pigs during the study, versus 78.05% at plots treated with fertilizer, and 23.45% of corn stalks at control sites. Our results suggest WildgranixTM does not effectively deter wild pigs from areas of interest.

**Controlling feral hogs with species specific feeders**

**Harold Monk**, Wildlife Management Services LLC, 31321 Highland Drive, Denham Springs, Louisiana 70726, 225-664-0411, Cell 225-921-7070, hmonk1@cox.net

Wildlife Management Services LLC. has built a species specific feeder to deal with the out of control hog population. By using video or sound technology to identify our target, we can focus on the delivery of both toxins and birth control technology to feral hogs. The challenge we faced was delivering a toxin to a specific species, which in this case is feral hogs, without affecting any other non-targeted animal. Using challenges raised by Lowell Miller (retired USDA), we started on a 4 year quest to develop, test and deliver a machine we call HAM. Our main challenge was protecting bears from the toxin by not allowing them to get to the food/toxin inside the machine. Our machine was handled and tested by Eric Tillman (USDA) during an 8 month test outside Orlando, Florida. Locking and unlocking, opening and closing all 6 doors based on detecting only hogs was perfected after recording 4000 videos of field testing. Building a machine that is small enough and can be moved around to target hogs was also a major accomplishment. All these features are combined to make the machine we call HAM. Wildlife Management Services has created HAM to target feral hogs and to protect the large areas affected by these animals in a cost effective way. We will continue to pursue creating the most technological machine available for controlling feral hogs.

**Phage-based vaccines: Two approaches to species-specific contraception of wild pigs**

**Tatiana Samoylova**[1], TD Braden, AM Cochran, B. Schemera, R.R. Wilborn, S. Ditchkoff, V.A. Petrenko, N.R. Cox, [1]Scott-Ritchey Research Center, 1265 HC Morgan Drive, College of Veterinary Medicine, Auburn University, Auburn, AL 36849, USA, (334)844-5569, samoiti@auburn.edu

To be economically viable, a contraceptive vaccine for wild pigs should be delivered orally or nasally and be species-specific. Our group utilizes two novel approaches for development of contraceptive products for wild pigs based on filamentous phage as a delivery vector for immunogenic peptides with species-specific properties. Approach I develops peptides mimicking sperm surface proteins that bind to zona pellucida (ZP) at fertilization. Immunization with such ZP-binding peptides displayed on phage stimulates production of anti-peptide antibodies, which act as anti-sperm antibodies affecting sperm-ZP binding. Since sperm-ZP binding is suggested to occur via species-specific molecular recognitions, antibodies interfering with the binding could prevent fertilization in a species-specific manner. Multiple phage-peptide constructs with potential contraceptive properties for wild pigs were developed and tested. Administration of the antigens into pigs stimulated production of anti-sperm antibodies detected in blood as well as in oviducts (sites of fertilization). Staining of semen samples collected from different mammalian species with anti-sera from immunized pigs allowed identification of phage-peptide constructs with species-specificity. Approach II exploits the observations that: a) the pig is one of the few mammals that have both gonadotropin- releasing hormone II (GnRH II), and GnRH II functional receptor, and b) immunization of boars with GnRH II reduces circulating testosterone and impairs the ability of the testis to secrete testosterone. Species-specificity is possible because this hormone-receptor complex is not functional in representatives of several orders of mammals such as primate (i.e., human), rodentia (rat nor mouse), lagomorpha (rabbit), carnovira (cat nor dog),

perissadactyla (horse), or artiodactyla (sheep nor cattle), but is functional in pigs. Inactivation of this hormone-receptor complex via phage-GnRH II constructs is expected to block fertility in pigs of both sexes. Major advantages of phage-based vaccines include thermostability and low cost to produce since large quantities of phage can be easily obtained in bacterial cultures.

**Development of sodium nitrite as a toxicant for the control of wild pigs**

**Kurt VerCauteren**[1], and Justin Foster[2], [1]USDA-APHIS Wildlife Services National Wildlife Research Center, 4101 Laporte Ave, Fort Collins, CO 80521, 970-266-6093; kurt.c.vercauteren@aphis.usda.gov , [2]Texas Parks and Wildlife, 2625 FM 1340, Hunt, TX 78024, 830-238-4483; Justin.foster@tpwd.texas.gov

We are working to develop a formulation of sodium nitrite (SN) to function and be registered as a toxicant for wild pigs. Initial formulations have been tried with limited success, but there is potential. We are assessing and comparing the palatability and lethality of promising formulations of SN in a controlled, captive setting. For each candidate SN formulation, three independent groups of seven feral swine are offered treated baits following an acclimation period with non-toxic placebo baits. The number of baits consumed and feral swine killed across all formulations are being assessed and compared. Here, we provide an update and present our findings to date. We also lay out our path going forward toward the US and Australian registration of a SN-based toxicant for the control of wild pigs.

**Understanding the carpal gland of feral swine.**

**Brandon Schmit**[1], Tyler Campbell, Eric Tillman, Justin Foster, Bjorn Palm, Daniel Gray, Donnie Frels
[1]USDA/APHIS/Wildlife Services/NWRC/ National Wildlife Disease Program, 4101 LaPorte Avenue, Fort Collins, CO 80521, 970-266-6079, Brandon.S.Schmit@aphis.usda.gov

Invasive feral swine (*Sus scrofa*) are increasingly coming into conflict with agriculture, natural resources, and property owners and they threaten human health and safety. New methods or modification of existing methods are needed to control burgeoning feral swine populations and their associated damage. Little research has been directed toward the identification and development of repellents or attractants for feral swine in the United States. Investigations into the carpal glands of domestic swine, wild swine, and feral swine have used histology, histochemistry, and morphometrics to demonstrate that these glands likely play a role in intraspecific communication. However, behavioral trials involving feral swine and carpal gland secretions have not been reported. A captive pen study was conducted at Kerr WMA in Texas to gain a better understanding of the role the carpal gland serves in feral swine communication. Twelve feral swine were subjected to 4 solitary behavioral trials each for a total of 48 trials. The main objective was to describe and compare the behaviors of adult feral swine in the presence of control (distilled water) and treatment capsules (containing carpal gland secretions). Fresh carpal secretions were utilized randomly from 8 donor individuals unknown to the experimental group. The behavioral trials were recorded using video and results (still pending) will be discussed. Predictable behaviors tied to carpal gland communication could lead to new management tools for controlling feral swine.

# Poster Sessions

**The status of wild pig populations in the state of California and on Tejon Ranch**

**Elizabeth Hiroyasu**[1], Adam Kreger, Maxwell Ludington, Emily DeMarco, Jocelyn Christie, [1]Bren School of Environmental Science & Management, University of California, 2400 Bren Hall, Santa Barbara, CA 93106, (760) 937-4112; ehiroyasu@bren.ucsb.edu

Wild pigs have spread to 56 of the 58 counties in California since their introduction in the 1920's. This has resulted in significant ecological and economic impacts in the state. Despite wild pigs being listed as pest species in most states, California is one of three states that classifies them as large game species. This status creates unique challenges for managing wild pigs and reducing their damage. We present a brief analysis of statewide trends and the political context of wild pigs in the state. The sale of wild pig tags provides one of the largest sources of revenue for the California Department of Fish and Wildlife tag sales, greater than one million dollars in 2012. We conducted preliminary research on wild pigs at Tejon Ranch illustrating the challenges and tradeoffs of managing wild pigs in California. We conducted a pilot monitoring study to assess relative pig abundance in different vegetation classes and a cost benefit analysis to compare management strategies. We found the greatest relative abundance of pigs in riparian areas and conifer in summer, using camera traps placed along stream reaches and ranch roads. We found that damage was correlated with abundance of pigs only in riparian areas ($R^2=0.68$, $p=9.162 \times 10^{-5}$), however pig damage in other vegetation types was difficult to assess in the dry summer months. Based on our analysis we conclude that a strategic pig management plan for Tejon Ranch should focus on fencing high value areas to exclude pigs while engaging in strategic population reductions more widely through targeted trapping and increased hunting efforts.

**Elimination efforts of feral swine in New York State**

**Daniel Hojnacki** and Justin Gansowski, USDA-APHIS Wildlife Services, 5757 Sneller Road, Brewerton, NY 13029, 315-698-0940, dan.hojnacki@aphis.usda.gov

Feral swine are a non-native invasive species found throughout the United States, with an estimated population of 5 million individuals. Accidental and intentional releases from enclosed shooting facilities and domestic swine operations have allowed these animals to proliferate across the landscape. Feral swine cause large-scale ecological, agricultural, and property damage along with the threat of disease. First discovered breeding in New York State in 2008, four distinct populations of feral swine currently reside within the state. Although the population remains low within NY, the impacts of an expanding population could be enormous. WS estimated that feral swine have accounted for $1,002,677 in damage and management efforts combined, although much of the damage caused goes undocumented. Between 2008 and 2014, New York State Department of Environmental Conservation and USDA-APHIS Wildlife Services (WS) have removed 178 feral swine from the state. In 2013, WS personnel performed feral swine management on 26,399 acres of private and public lands. New York State recently passed new legislation immediately banning breeding, transporting, and intentionally releasing Eurasian Boars onto the landscape, while banning possession in 2015. With new legislation and utilizing aerial surveillance operations to assist in detecting feral swine, elimination in NY is a foreseeable goal. Population reduction is only one component to the WS feral swine program, which also involves public education and disease surveillance. The impacts of feral swine on the landscape, current efforts to eliminate feral swine, and future feral swine management in New York will be discussed.

**Recording and analyzing feral hog damage in Louisiana's southern marshes**

**Anthony Ballard[1],** Kim Tolson[1], James LaCour[2], [1] University of Louisiana at Monroe**,** 700 University Ave. Monroe, LA 71209**,** (601)260-3277, ballarra@warhawks.ulm.edu, [2] Louisiana Department of Wildlife and Fisheries Baton Rouge, LA 70898

Feral hogs (*Sus scrofa*) were first introduced along the coast of Florida, but have now established breeding populations in at least 36 states. In addition to competing with almost all native species, they are responsible for the

extensive aquatic and terrestrial degradation of every habitat type where they reside. The mosaic of different habitats present in Louisiana's marshes creates a unique and sensitive ecosystem that is suffering adverse effects by the encroachment of feral hogs. This project aims to record and analyze feral hog damage in Louisiana's marsh habitats. The study area is a 498,000 acre block of land in Terrebonne Parish in southern Louisiana that exhibits all four marsh types found in the coastal marshes of the southeastern United States (fresh, intermediate, brackish, and salt). Hog damage was identified by flying seventeen north-south transects in a helicopter equipped with floats. Transects were 1.77 miles apart and covered a total observation width of 0.5 mi (0.25 mi on each side). Once damage was detected from the air, ground-truthing was conducted to verify that all damage being recorded was correctly identified. Seventeen damage sites were concentrated in the northwestern quadrant of the study area and were restricted to freshwater marsh. Sites ranged from 3 to 76.2 acres. Of the 141,640 total acres observed along the transect lines, 227.5 acres of damage were detected. Extrapolation methods were used to estimate the total amount of damage occurring within the freshwater marsh. Assuming equal distribution and occupancy of hogs in this area, we estimate that damage could meet or exceed 796 total acres within the freshwater marsh. Since feral pigs have been documented in all four marsh types found in Louisiana, we hypothesize that total acres of damage within the study area could rise significantly as marsh encroachment progresses. A second year of data collection in 2014 will be used to assess our hypothesis.

**Identification of *Brucella suis* from feral swine in select states in the United States**

**Kerri Pedersen**[1], Christine R. Quance, Suelee Robbe-Austerman, Antoinette J. Piaggio, Sarah N. Bevins, Samuel M. Goldstein, Wesson D. Gaston and Thomas J. DeLiberto, [1]USDA APHIS-WS-NWRC, National Wildlife Disease Program, 4101 LaPorte Avenue, Fort Collins, CO 80521, kerri.pedersen@aphis.usda.gov

Serologic tests currently available for brucellosis diagnosis detect antibodies to *Brucella*, but do not distinguish between the various species of *Brucella*. Although *Brucella suis* is known to circulate within various feral swine (Sus scrofa) populations, our objective was to determine the primary species of *Brucella* circulating in populations of feral swine in the United States. We cultured lymph nodes from 183 feral swine. Twenty-two isolates from 21 animals were identified, and all isolates were genotyped as *B. suis*. Most of the isolates were identified as B. suis biovar 1, with the exception of two genetically distinct isolates from one feral swine in Hawaii which were both identified as *B. suis* biovar 3. Serum from each feral swine was also tested by the fluorescence polarization assay when possible, but only 52% (95% CL 29.8-74.3) of culture positive animals tested antibody positive. Our results indicate that brucellosis infections in feral swine within the United States are typically caused by *B. suis*. However, improved serological tests are needed to more accurately determine exposure to *Brucella* spp., and monitor disease trends in feral swine populations.

**Feral swine forest habitat and riparian area use in immediate response to prescribed burning**

**Patience Knight**, Alabama A&M University, 4900 Meridian Street N, Normal, AL, 35762, 806-317-6526, patience.knight@aamu.edu,

Feral swine are a serious threat to biodiversity, especially in forested and riparian habitats, due to their destructive behaviors (i.e. wallowing, rooting, etc.) and depredation on many native species of plants and wildlife. Therefore, it is important to explore how forest management activities affect their distribution and habitat use. Though little to no research has examined this relationship, the need to discover the link between forest management and feral swine is three-fold: for increased ecological knowledge of feral swine, for improved feral swine population management, and for more effective management of forest resources. In my study, I will investigate how feral swine forest habitat and riparian area use is influenced by prescribed burning performed by the USDA Forest Service in the William Bankhead National Forest, AL. I will use 1370-m long, modified "figure 8" line transects to sample 20 prescribed burn forest stands and 20 control stands for pig sign (i.e. wallows, rooting, rubs, scat, nests, tracks) before and after burning. Habitat surveys will also be performed at each vertex of the modified "figure 8" transects. I will use 150-m line transects to survey 20 streams each in the prescribed burn stands and in the unburned stands for pig sign before and after treatment. Forest stand surveys, habitat surveys, and riparian surveys will be conducted seasonally. Comparisons of control and burn sites before and after treatment will made through one-way analysis of variance or other appropriate statistical methods.

**Diet composition of wild hogs in northern Alabama using stomach contents analysis**

**William E. Stone**[1], and David Morrill[2], [1]Alabama A&M University, 4900 Meridian Street, PO Box 1927, Normal, AL 35762-1927, william.stone@aamu.edu, [2]Alabama A&M University, 4900 Meridian Street, Huntsville, AL 35810

We investigated the foraging ecology of wild mammals in northern Alabama to discover ecological strategies of food acquisition that are critical for animal survival. Following some initial studies of large mammal distribution using game cameras, we focused on foraging ecology of wild hogs (*Sus scrofa*) in the Bankhead National Forest. Wild hogs are feral animals that have the potential to negatively influence vegetation, soils, water, and wildlife. We trapped and dispatched 5 wild hogs during the late summer of 2011 and performed composition analysis on the contents of each stomach using percent frequency of diet items contacted with 5 passes of a 10-point sampling frame. Excluding some corn used for bait, the majority of the diets (91%) of these hogs were vegetation including tree fruits (44%), seeds (6%) roots (6%), grasses and sedges (33%), other herbaceous plants and some unknown fungi (2%). The remainder (9%) of the diet was composed of animal material including several taxonomic Families of insects (Insect=2%), two frog species and a small snake (Herps=2%), a least shrew (*Cryptotis parva*) and a white footed mouse (*Peromyscus leucopus*)(Mammals=5%). We did not discover any avian items in these stomachs, but the senior author discovered embryos of wild turkeys (*Meleagris gallopavo*) found in 3 of 16 hog stomachs taken in April of 2004 in the same forest. Additionally, we found large chunks of masticated muscle tissue in the stomach of one hog that we could not identify. However, photos from game cameras revealed that feral swine scavenged on the carcasses of sacrificed hogs that remained in the forest, leading us to speculate that these unidentified chunks of muscle may have been pork.

**A portable drop net for wild hog control in remote locations**

**Joe Yarkovich**, and Bill Stiver, National Park Service, Great Smoky Mountains National Park, 107 Park Headquarters Rd., Gatlinburg, TN 37738 USA, 828-497-1928, Joseph_Yarkovich@nps.gov

Great Smoky Mountains National Park (GRSM) is located on the border of western North Carolina and eastern Tennessee. Wild hogs (*Sus scrofa*) invaded GRSM in the late 1940s after escaping from a private hunting preserve in 1920. Wild hog control began in 1959 with nearly 13,000 animals having been removed through a combination of trapping and shooting. Historically, trapping methods consisted of using numerous single catch box traps. However, to improve effectiveness, efforts have been made to utilize a trap design that focuses on groups, rather than individuals. Corral-style traps catch larger groups, however because of their size and weight, trap locations are limited by access. In GRSM, most wild hog control activities occur in remote mountainous locations accessible only by foot. Thus, we have designed a cost-efficient drop net system that can be transported into remote locations and used in combination with shooting to removing larger groups of hogs. This system is advantageous over corral traps in that it is lighter and therefore easier to transport, and hogs show little hesitation feeding under the net allowing for shorter pre-baiting and fewer man hours of effort.

**Development of strategies to detect and address the risk factors associated with *Brucella suis* infection in dairy cattle**

**Cristopher A. Young**[1], Nelva Bryant[2], Marta Guerra[3], [1]USDA APHIS VS Georgia, 1498 Klondike Rd SW, STE 200, Conyers, GA 30094, Cristopher.A.Young@aphis.usda.gov, [2]CDC Atlanta Quarantine Station, 2600 Maynard H. Jackson Boulevard, Suite # 2425J, Atlanta, GA 30354, ncb3@cdc.gov, [3]Centers for Disease Control and Prevention, Afton Rd. MS A-30, Atlanta, GA 30333 , hzg4@cdc.gov

Brucellosis, a zoonotic infectious disease of the reproductive system of livestock; causes an undulating fever, headaches, chills, depression, profound weakness, arthralgia, myalgia, weight loss, orchitis/epididymitis in men and spontaneous abortion in pregnant woman. It is caused by several species of Brucella. Brucellosis in cattle, water buffalo, and bison is caused almost exclusively by B. abortus. B. suis causes brucellosis in swine; however it has been implicated in some cattle herds. Although eradicated in the cattle and swine production industries, brucellosis does exist in the feral swine population. As the feral swine populations expand and are able to comingle with cattle and other animals, there is increased potential for disease transmission which may impact humans. B. suis has been isolated from raw milk which demonstrates its ability to transfer from swine to cattle. This transfer increases the risk of infection for populations such as hunters, dog owners, dairy producers, dairy parlor workers, and consumers

of raw milk. Thus, an understanding of the prevalence and geographic distribution of brucellosis in feral swine populations is necessary for informing and guiding relevant management decisions that will help ensure the security of commercial swine and cattle industries. In order to address the consequences of the growing feral swine population and its potential impact on the US brucellosis status, APHIS Veterinary Services'(VS) Georgia Field Office partnered with multiple federal and state agencies to develop an integrated infrastructure for detecting and responding to brucellosis. The project focused on 4 areas of interest:

1. Identify the location of Grade A dairy cattle farms and their proximity to feral swine populations.
2. Testing of milk samples.
3. Determining the risk factors enabling the transmission of Brucella suis to dairy cattle.
4. Education of dairy producers, creamery workers, and consumers of raw milk.

**Molecular detection of feral swine in water samples using eDNA**

**Kelly Williams**, and Antoinette Piaggio, National Wildlife Research Center, Fort Collins CO, 211 East Mulberry Street Apt 5 Fort Collins CO, (716) 545-1654 , kellwill@rams.colostate.edu

Feral hogs have inhabited the United States since the late 1400's after being introduced to Florida as domesticated European pigs. However, due to their opportunistic behavior, omnivorous feeding habits and high reproductive capacity, the expansion of these animals has caused them to become a destructive invasive species throughout the country U.S. The ability of feral swine to vector to a wide range of diseases that can affect other wildlife, livestock, and humans, raises concern over their expanding geographical distributions. These pathogens include both viral and bacterial zoonoses along with zoonotic parasites. Based on concerns over the spread of disease and ecological damage caused by feral swine, it has been acknowledged that there is a need for management of feral swine populations. Developing methods for detecting the presence of feral swine DNA from environmental samples (EDNA) will provide a tool to assess effectiveness of management practices in addition to identifying locations that require management efforts.

**Social unit organization in three introduced wild pig populations**

**John J. Mayer**[1], and I. Lehr Brisbin, Jr[2], [1]Savannah River National Laboratory, Savannah River Nuclear Solutions LLC, Savannah River Site, Bldg. 773-42A, Aiken, SC 29808; (803) 725-5991, john.mayer@srnl.doe.gov, [2]Savannah River Ecology Laboratory, P. O. Drawer E, Aiken, SC 29802

Wild pig (*Sus scrofa*) social unit organization was compared in three introduced populations in the southeastern United States. Group size, age and sex composition and social unit category (10 types) were recorded from field observations. The number of observations (number of individuals observed) were: Immokalee Ranch, FL - 304 (1,109); Ossabaw Island, GA - 383 (974); and Savannah River Site, SC - 355 (1,163). The mean social unit size at each site was: Immokalee Ranch – 3.6 (1 to 19); Ossabaw Island – 2.5 (1 to 19); and Savannah River Site – 3.3 (1 to 22). All ten social unit categories were observed at each site. Groups of two of more animals were more frequent than solitary animals. Mixed adult/immature groups were the largest social unit of two or more individuals, followed by groups of immature animals and the various types of adult groups. In two of the populations, this same trend among these groups types was seen for the frequency of occurrence (i.e., with the adult/immature group being the most common). In the third population, the frequency of the adult/immature and immature-only groups was reversed. Size variation within all except the mixed-sex adult group type was similar among the three field sites. Adult males were the most frequently observed solitary category, followed by adult females and then immatures. Size and composition of the social units appeared to vary seasonally. Increased percentage of hardwood forest was significantly correlated with a decrease in the percent frequency of immature-only groups and an increase in adult/immature groups. Increasing annual harvest by man was significantly correlated with an increase in the frequency of immature-only groups and a decrease in those of adults/immatures. The biased removal of females through trapping would be consistent with this apparent shift from adult/immature groups to immature-only groups.

**Using microsatellites to determine genetic population structure of feral pigs in Tennessee**

**Rebecca Noel, Maddison Stanley**, John Lewis, Mary Sledge, Lipscomb University, Department of Biomolecular Sciences, 1 University Park Drive, Nashville, Tennessee 37204, 615-497-3742, rcnoel@mail.lipscomb.edu

Feral pigs (*Sus scrofa*) are identified as a triple threat to their environments due to their profound influence on local agriculture, public health, and biodiversity. Feral pig populations are present in 45 states, totaling more than 5 million pigs across the U.S. In the state of Tennessee, feral pigs are reported in greatest numbers on the Cumberland Plateau, around the Tennessee River in southwest Tennessee, and in the Appalachian region in eastern Tennessee. This wide distribution is partially attributed to illegal translocation for recreational hunting purposes. To better understand and manage feral pig populations, several groups have used microsatellite markers to understand their genetic distributions and interbreeding among subpopulations. The purpose of this study is to map the population structure of the feral pig population in Tennessee using microsatellite markers. DNA will be extracted from blood samples obtained from the Tennessee Wildlife Resources Agency (TWRA) and Polymerase Chain Reactions (PCR) will be carried out using 14 fluorescently labeled markers from the U.S. Pig Genome Coordination Program. Subsequent fragment analysis on the PCR products will allow us to compare allele frequencies among individuals and establish population clusters using STRUCTURE 2.3.4 and Bayesian Analysis of Population Structure (BAPS) 6.0. TWRA biologists, state veterinary officials, and landowners may use this information to determine the best method for management of feral pig populations in Tennessee to control population expansion, disease spread, and environmental and agricultural damage.

**Use of morphometrics for estimating the live weight of wild pigs**

**Korbin Reich**[1], Robert W. Holtfreter[1], Stephen S. Ditchkoff[2] , Brian L. Williams[2], Gregory B. Brooks[3] ,[1]Department of Natural Resource Ecology and Management, Connors State College, Warner, OK 74469, USA., [2]School of Forestry and Wildlife Sciences, Auburn University, Auburn, AL 36849, USA., [3]Fort Benning Environmental Division, Environmental Programs Branch, NEPA Section, Fort Benning, GA 31905 USA.

Successful control programs rely on an in-depth understanding of the basic biology of species of interest, including changes in productively (i.e. growth, reproduction). Knowledge of the live-weight of captured wild pigs (*Sus scrofa*) is a critical component in understanding the relationship between productivity and resource availability; however, researchers are often unable to weight captured animals due to the logistical constraints associated with handling large-bodied mammals in remote areas. Existing models for estimating the weight of pigs either pertain specifically to domestic pigs, or rely on precise skeletal measurement, which cannot be obtained without lethal removal. Our objective in this study was to use morphometrics (i.e. body measurements) to develop a predictive model for estimating the live-weight of wild pigs. In effort to do so, we captured 148 female, and 113 male wild pigs, as part of a larger study, between June of 2007 and August of 2010 within a 22,000 acre study area on Fort Benning Military Installation in Georgia, USA. We recorded 6 body measurements, in addition to weighing and aging each captured pig, including: neck circumference, skull, body, snout-to-vent, right-front shoulder, and right rear hoof length, respectively. Results from multiple regression analysis indicated sex, age, shoulder length and neck circumference were the primary factors in predicting the live weight of both male and female wild pigs. Our top model for boars, ($R^2_{adj}$ = 0.903), was able to predict live-weight to within an average difference (i.e. observed v. predicted) of 3.59 kg (0.29 kg SE, $N$ = 77) for males less than 12 months of age; 3.22 kg (0.71 kg SE, $N$ = 14) for males ranging from 12 to 15 months, and 12.64 kg (2.80 kg SE, $N$ = 18) for males older than 15 months. The average difference between observed and predicted live-weight in our top model for sows, ($R^2_{adj}$ = 0.961) ranged from 0.81 kg (0.11 kg SE, $N$ = 19), for sows 7 weeks of age or younger, to 8.87 kg (2.06 kg SE, $N$ = 10) for sows older than 26 months. These results suggest morphometrics can be used to accurately predict the live-weight of wild pigs.

**Spatial patterns in resource selection by feral wild boar in western Canada and overlap with domestic swine**

**Ryan Brook[1],** and Floris Van Beest[2], [1]Department of Animal and Poultry Science, College of Agriculture and Bioresources, University of Saskatchewan, 51 Campus Drive, Saskatoon, Saskatchewan, S7N 5A8, CANADA, 306-966-4120, ryan.brook@usask.ca, [2]Department of Bioscience, Aarhus University

The spatial distribution of feral wild boar in Western Canada is increasing rapidly, but distribution and resource selection has yet to be characterized quantitatively. We used the results of our survey of 296 rural municipalities in Saskatchewan, Canada to determine the distribution of feral boar in the province and used a Resource Selection Probability Function (RSPF) analysis to characterize habitat variables selected (i.e. positive *β-coefficient)* or avoided (i.e. negative *β-coefficient)* at the population level. Variables that determined the distribution of feral boar included % farmland ($\beta$ = +6.46), % flaxseed crop ($\beta$ = -8.63), density of paved roads ($\beta$ = -1.92), % deciduous forest ($\beta$ = +5.93), and % mustard seed crop ($\beta$ = *-12.63*). The areas under the ROC curve for the 3 top-ranked landscape-scale RSPF models were 0.798, 0.765, and 0.739 respectively indicating that the models had good predictive capacity. Mapping the Resource Selection Probability Function (RSPF) across the landscape of Saskatchewan predicted 70% of municipalities had RSPF > 0.7 (high probability of boar presence) and 12% had RSPF < 0.3 (low probability). Our results indicate that the large majority of the agricultural dominated landscape of Western Canada can likely support populations of feral boar. There are approximately 1.4 million domestic pigs on farms in Saskatchewan on 930 farms and several key areas currently have both high densities of domestic pigs and known presence of feral boar, providing maps of the areas of greatest concern. Our results, in the context of the known reproductive and dispersal rates of feral boar, suggest a likely ongoing increase in overall distribution and abundance in the absence of intensive control efforts, which are largely absent in Western Canada. Interactions between domestic pigs and feral boar carry significant risks, especially related to potential disease transmission.

**Mapping the Distribution of Feral Swine**

**Mark Lutman[1],** and Joe Corn[2], [1]USDA APHIS, 4101 Laporte Ave, Fort Collins, CO 80526, 970-266-6077 ,Mark.w.lutman@aphis.usda.gov, [2]University of Georgia – SCWDS, 589 DW Brooks Drive, Athens GA, 30602, jcorn@uga.edu

Feral swine are a destructive invasive species in the United States, causing at least 800 million dollars in damage to agriculture and personal property. In addition, these invasive species are reservoirs for diseases that have been eradicated from the commercial swine industry. The threat of reintroduction of certain diseases can jeopardize agricultural trade both locally and internationally. Feral swine distribution has expanded into new territories because of natural range expansion, intentional or accidental release of domestic pigs, and illegal transport. Historically, feral swine were limited to the southeastern U.S., but now feral swine exist in northern states like Idaho and Maine. Mapping feral swine distribution is a complex and challenging process because of the many ways that feral swine populations expand both naturally and from anthropogenic events. In order to map feral swine in the U.S., a multi-agency approach is needed. Wildlife Services (WS) is currently working with the Southeastern Cooperative Wildlife Disease Study (SCWDS), state game agencies, state agriculture agencies, and the public to identify and update feral swine locations across the nation. New mapping techniques such as ArcGIS online allow biologists and wildlife managers to access the most current feral swine distribution maps and document changes as they arise. This updated information may be used by WS operational programs to target areas for feral swine removal in order to minimize damage to agricultural and personal property.

**Battling Mississippi's Wild Pig Problem: The Cooperative Approach**

**Bill Hamrick**, Bronson Strickland & Jessica Tegt[1], Kris Godwin, Jay Cumbee & Scott Alls[2], Ricky Flynt[3] [1]Mississippi State University Extension Service-Department of Wildlife, Fisheries & Aquaculture**,** [2]USDA/APHIS-Wildlife Services**,** [3]Mississippi Department of Wildlife, Fisheries & Parks

In the last twenty years, wild pig populations have expanded greatly throughout Mississippi and much of the southeastern United States. As a result of this population expansion, wild pigs are a serious threat to agriculture, natural resources, and human health. The only long-term solution to these problems is reducing both the size and range of wild pig populations. Such a strategy of population reduction can only be achieved via awareness of the problems among natural resource policy makers and professionals and knowledge about the techniques for controlling wild pigs among land managers. As part of our outreach program to educate the public and assist

landowners with wild pig removal, Mississippi State University Extension Service has partnered with USDA/APHIS-Wildlife Services and Mississippi Department of Wildlife, Fisheries & Parks to conduct statewide workshops. Our workshops not only serve to provide attendees with the most effective methods for wild pig removal, but also educate attendees about wild pig behavior and biology, disease issues and risks, and regulations regarding wild pig removal and transportation. In turn, we believe this cooperative approach is essential in delivering a unified message and instruction on controlling wild pigs.

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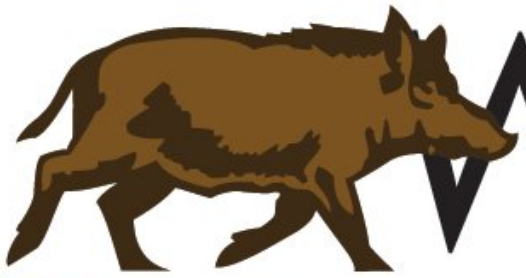

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