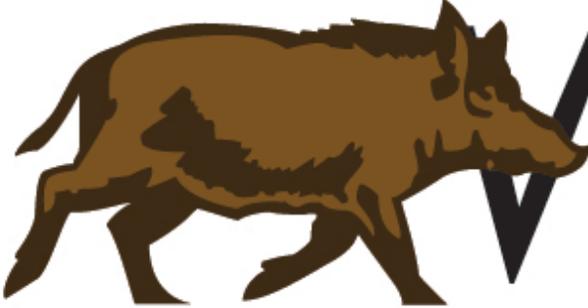


2010 International



WILD
PIG CONFERENCE
SCIENCE & MANAGEMENT

April 11-13, 2010

Crowne Plaza Grand Hotel

Pensacola, Florida

Hosted by:

BERRYMAN INSTITUTE

Resolving Human-Wildlife Conflicts



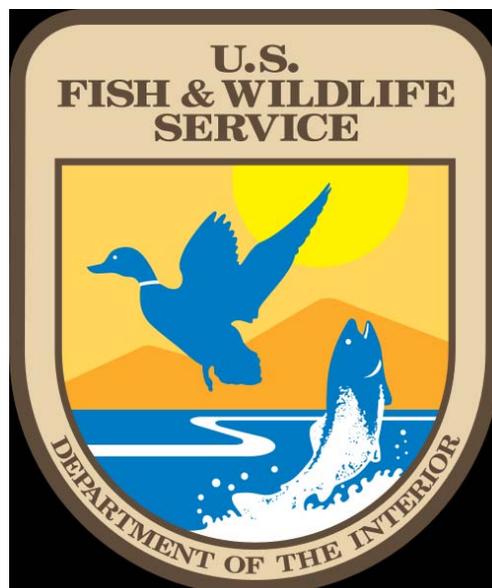
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Welcome From the Berryman Institute.....

The Berryman Institute is named for renowned wildlife biologist Jack H. Berryman and is dedicated to education and research surrounding human-wildlife conflicts. First established at Utah State University, growing requests for Berryman Institute training and education assistance expanded the organization south to Mississippi State University as well.

Personnel at both universities strive to offer educational, training, and internship opportunities for students and professionals in wildlife sciences. The Berryman Institute is particularly invested in creating venues for professionals to share management experiences and generate new dialogue to help mitigate conflicts between human and wildlife interests.

The nationwide scope of the Berryman Institute along with its mission to resolve human-wildlife conflicts fall perfectly in line with the purpose of the Wild Pig Conference creating the perfect partnership of research and education. The conference organizers at the Berryman Institute would like to welcome you to Pensacola Florida for the 2010 International Wild Pig Conference.

Please enjoy the fantastic educational and professional resources from the many presenters and sponsors at the conference. If at any time you have a need or special request, one of the organizing committee members will be glad to assist you.

2010 International Wild Pig Conference Organizing Committee:

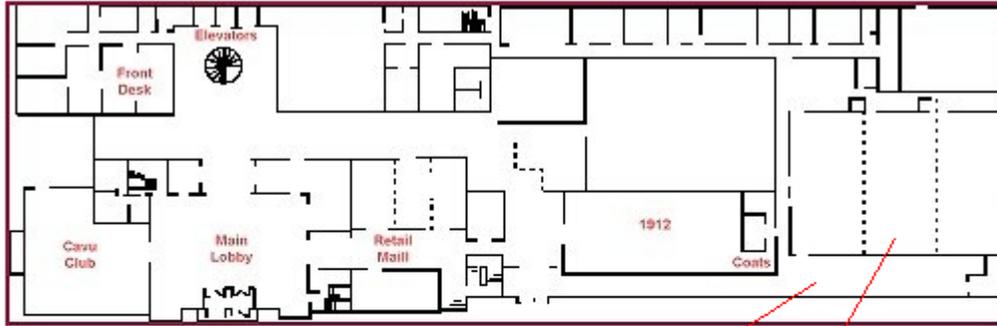
Jessica Tegt, Berryman Institute, Mississippi State University
Dr. Ben West, National Outreach Coordinator, Berryman Institute
Bill Hamrick, Extension Associate, Mississippi State University
Dr. Billy Higginbotham, Texas AgriLife Extension Service, Texas A&M
John Dunlap, USDA/APHIS/WS, North Florida District
Dr. John "Jack" Mayer, Savannah River National Laboratory
Rex Martensen, Private Land Services, Missouri Dept. of Conservation
Robert Denkhaus, Fort Worth Nature Center and Refuge, Texas
Dr. Steve Ditchkoff, School of Forestry and Wildlife, Auburn University
Dr. Tyler Campbell, USDA/APHIS/WS/NWRC, Texas A&M-Kingsville

Conference at a Glance

Sunday, April 11, 2010	
1:00 pm to 5:00 pm 6:00 pm to 10:00 pm Grand Central Station	Registration, Opening Social, Reception (food and drink will be served)
Monday, April 12, 2010	
7:00 am to 8:30 am Grand Ball Room Foyer	Registration and Continental Breakfast
8:30 am to 9:30 am Grand Ball Room	Introductions: Dr. Ben West, Berryman Institute Plenary Speakers: Dr. John Mayer, "Wild Pigs: America's Most Successful Large Invasive Species?" Dr. Skip Jack, "Pigs, pigs EVERYWHERE! What you don't know can HURT you."
9:30 am to 10:15 am	State Agency Reports
10:15 am to 10:30 am	Break
10:40 am to Noon	Technical Sessions: Disease
Noon to 1:20 pm	Lunch on own Grand Ball Room
1:20 pm to 3:00 pm	Technical Sessions: Damage Assessment
3:00 pm to 3:15 pm	Break
3:15 pm to 5:00 pm	Technical Sessions: Biology, Genetics, and Behavior
6:30 pm - until	Evening Reception: McGuire's Pub
Tuesday, April 13, 2010	
8:30 am to 9:45 am Grand Ball Room	Shoot From the Hip Session/Poster Session (9:15-9:45)
9:45 am to 10:00 am	Break
10:00 am to Noon Grand Ball Room	Technical Sessions: Bait Delivery Methods
Noon to 1:30 pm	Lunch on own
1:30 pm to 3:00 pm	Technical Sessions Topic 1: Disease Grand Ball Room Technical Sessions Topic 2: Control Measures Union Station Meeting Room
3:00 pm to 3:15 pm	Break
3:15 pm to 4:55 pm	Technical Sessions Topic 1: Control Measures Grand Ball Room Technical Sessions Topic 2: Human Dimensions and Distribution Union Station Meeting Room
5:00 pm to 5:30 pm	Closing Remarks

Pensacola Grand Hotel Floor Plan

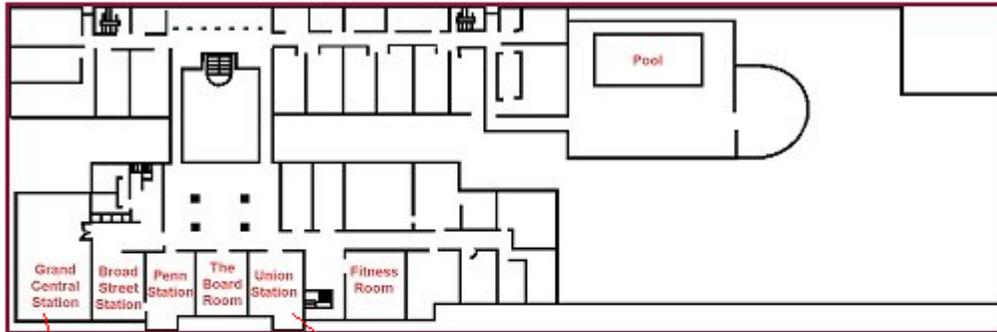
Ground Level Diagram



Foyer

Grand Ball Rooms

Second Level Diagram



Opening Reception

Concurrent Sessions

**Directions from
Pensacola Crowne Plaza (A) to
McGuires Pub (B)**



Why did we call it the “WILD PIG” conference: after all, a Pig is a Pig is a Pig... or is it?

John J. (“Jack”) Mayer

The use of common names in species identification can vary from straightforward simplicity to something that is about as clear as mud. It is difficult to say why some species are spared ending up on the murkier end of this spectrum while others are not.

Up until the late 1980s, the common names used to identify the wild *Sus scrofa* (i.e., Eurasian wild boar, feral pigs and hybrids between these two forms) found in the United States were both reasonably consistent and accurate. However, since then, the aforementioned logical state of affairs has seemingly come unglued with respect to what to call these introduced suids in the context of a scientific study/report. It appears that the use of common names for these animals has gotten about as confusing and challenging as trying to control these invasive animals themselves. Further, with each new journal article or report that is published, the situation just gets muddier and muddier. “Feral pigs” were “wild boar,” and “Eurasian wild boar” were “feral hogs;” one journal article even identified the species being studied in the title as “a feral pig species (collared peccary, *Tayassu tajacu*)” (Funny, the last time I checked, pigs and peccaries were in separate mammalian families; oh well, maybe I just need to get current with my mammalian taxonomy...). How things have gotten to such a befuddled state of nomenclatural affairs for *Sus scrofa*, I am at a complete loss to explain.

This evolving conundrum of common name usage even came into play as we were trying to decide on a standing name/title for the present conference. To that end, the committee tried to sort out this confusing morass from a scientific perspective. The various members opined, waxed expressively, “soapboxed” and even quoted organizational/agency taxonomic chapter and verse, and finally, a solution was reached (...albeit it by a majority but not unanimous vote). I will attempt to step through the associated thought process to that answer. To begin, illustrated in Fig. 1 below is a simplistic taxonomic phylogeny of the species *Sus scrofa*.

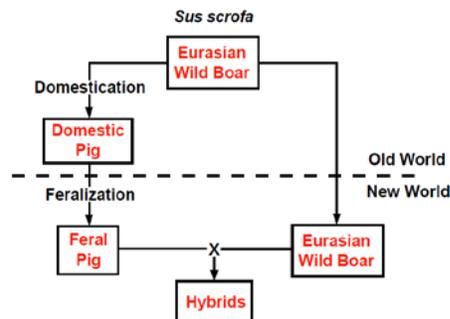


Figure 1. Taxonomic phylogeny of *Sus scrofa*.

The wild ancestral form, the Eurasian wild boar, was domesticated in the Old World 8-10,000+ years ago. Descendants of those domesticated stocks were brought to the New World and subsequently either released or escaped into unfenced lands. A number of these free-ranging domestic pigs went wild, a general process called feralization. Such pigs (i.e., wild pigs that are solely of domestic origin) are technically called “feral pigs” (or “feral hogs” or “feral swine,” whichever noun suits your fancy; the noun of choice is generally less troubling than the modifier). Such feral pig populations can vary from one to many generations removed from the domestic founding stock. Then, in the late 1800s, pure Eurasian wild boar were brought to the United States to provide a new huntable big game species. Being the same species, the wild boar hybridized with the feral pigs in areas where these two forms of wild *Sus scrofa* coexisted. Such hybrids are called wild boar x feral pig hybrids, hybrid *Sus scrofa* or simply hybrids. There are morphological, genetic and behavioral differences that support the separation of the aforementioned three general types of wild *Sus scrofa*. However, because so much hybridization has gone on in the wild *Sus scrofa* populations in this country since

the early 1900s, it may be difficult to be certain (short of doing a genetics workup) as to whether any one population in question is purely feral pig, purely Eurasian wild boar, or hybrid in origin. But the bottom line is, a Eurasian wild boar is not a feral pig, and conversely, a feral pig is not a Eurasian wild boar. Hybrids, being “hybrids,” are not either pure feral pigs or pure Eurasian wild boar. As an analogy, using the similar taxonomic phylogeny for *Canis lupus* (see Fig. 2 below), we don't refer to "gray wolves" as "feral dogs." We also don't refer to "feral dogs" as "gray wolves." Wolf-dog hybrids have been studied up in Alaska, and those wild canids were referred to as "wolf-dog hybrids." What a concept! So, then why is it that the situation with pigs has gotten so complicated?

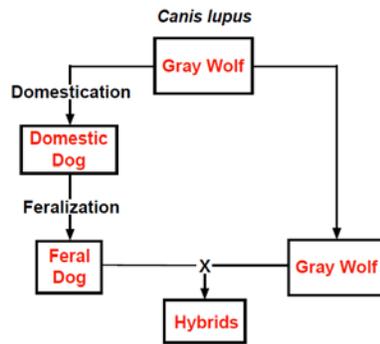


Figure 2. Taxonomic phylogeny of *Canis lupus*.

In any event, the solution arrived at by the committee was both simple and scientifically-accurate, and, as such, hopefully the best of all answers. The solution was to use the specific common name (i.e., Eurasian wild boar, feral pigs or hybrids) for a specific population if the researcher knows what the study animals in question are. However, if that answer was not known or if one was wanting to collectively refer to all three of the wild *Sus scrofa* types (as was the case with the conference), then the term "wild pig" (or "wild hog" or "wild swine") would be a good, accurate and general common name that can be used for any wild *Sus scrofa* (Fig. 3). Because it is "all encompassing," it is a "safe" term to use from a taxonomic perspective (e.g., when one does not know the specific genetic/ancestral makeup of the wild *Sus scrofa* population that one is working with).

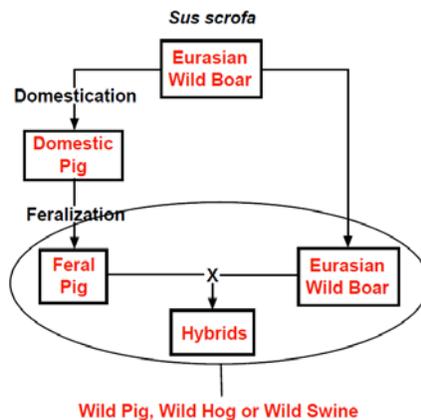


Figure 3. Collective common name solution for wild *Sus scrofa*.

Ergo, this conference became the “Wild Pig Conference” ... a simple naming solution that works from a scientific perspective. The use of common names, even within the scientific community, can be a frustrating and challenging endeavor. However, we, as researchers, have the responsibility to be as accurate as possible in identifying the animals that we are studying, and this is especially true with the use of common names.

Plenary Speakers



Dr. Jack Mayer

"Wild Pigs: America's Most Successful Large Invasive Species?"

Dr. Mayer received both his B.A. in biology and Ph.D. in zoology from the University of Connecticut. He is currently a research scientist and manager at the Savannah River National Laboratory in Aiken, South Carolina. Dr. Mayer has been conducting research on wild pigs for over 36 years. Although mostly focused on morphological work, it has also included research on wild pigs in the areas of systematics, behavior, population biology, reproductive biology, damage/impacts, and management/control techniques. He is the senior author of "Wild Pigs in the United States." Dr. Mayer's work with wild pigs has spanned three continents and included over 20,000 specimens examined/measured. He was also one of the National Geographic Society team of scientists who were unearched and examined the legendary, or perhaps infamous, "Hogzilla."



Dr. Skip Jack

"Pigs, Pigs, EVERYWHERE! What you don't know can HURT you."

Dr. Jack is a professor of veterinary pathology at Mississippi State University College of Veterinary Medicine for the past 20 years. Over the past 2 years, he also serves in the Berryman Institute housed at the College of Forest Resources Department of Wildlife, Fisheries and Aquaculture. His teaching and research interests include emerging infectious and zoonotic diseases, especially those involving wildlife.

Schedule of Oral Presentations

Monday April 12, 2010

9:30-10:15am

Technical Session 1: State Agency Reports

Grand Ball Room

Moderator: Bill Hamrick, Extension Service, Mississippi State University

Missouri-Rex Martensen, Missouri Department of Conservation

New Mexico-Justin Stevensen, USDA/APHIS/Wildlife Services

Louisiana- Dr. James LaCour, Louisiana Department of Wildlife and Fisheries

South Carolina- Charles Ruth, South Carolina Department of Natural Resources

Kansas- Chad Richardson, Nebraska Wildlife Services

Mississippi- Kris Godwin, USDA/APHIS/Wildlife Services

Texas- Justin Foster, Texas Parks & Wildlife Department

California- Craig Coolahan, USDA/APHIS/Wildlife Services

North Carolina- Carl Betsill, USDA/APHIS/Wildlife Services

Kentucky- Steven Dobey, Kentucky Dept. of Fish and Wildlife Resources

10:40am-noon

Technical Session 3: Disease

Grand Ball Room

Moderator: Rob Denkhaus, Fort Worth Nature Center and Refuge

10:40am *Foot-and-mouth disease in feral swine: susceptibility and transmission*
Brandon Schmit, USDA/APHIS/WS National Wildlife Disease Program

11:00am *Select bacterial zoonoses from feral swine and public health concerns*
Kendra Stauffer, D.V.M., Centers for Disease Control and Prevention

11:20am *Trichinella spiralis and Toxoplasma gondii surveillance in feral swine*
John Baroch, USDA/APHIS/WS National Wildlife Disease Program

11:40am *Avian disease surveillance as a model for improved feral swine disease surveillance in Florida*
Michael Milleson, USDA/APHIS/Wildlife Services

Monday, April 12, 2010

1:20-3pm

Technical Session 4: Damage Assessment

Grand Ball Room

Moderator: Steve Ditchkoff, Associate Professor, School of Forestry & Wildlife Sciences, Auburn University

1:20pm *Quantifying feral pig rooting in ecologically-sensitive plant communities at Avon Park Air Force Range in Florida*
Eric Tillman, USDA/APHIS/WS National Wildlife Research Center

1:40pm *Preliminary results from a rapid assessment monitoring technique for wild pigs on public lands*
Buddy Goatcher, US Fish and Wildlife Services, Ecological Services

2:00pm *Texas feral swine control: project results and the development of a statewide strategy*
Michael Bodenchuk, USDA/APHIS/WS, Texas Wildlife Services Program

2:20pm *Evaluation of feral hog removal to reduce damage to sensitive plant sites at Avon Park Air Force Range in Florida; preliminary results and challenges*
Gary Killian, USDA/APHIS/WS National Wildlife Research Center

2:40pm *Florida's natural lands and feral hogs: a domestic disturbance*
Camille Brescacin, University of Central Florida

3:15-5pm

Technical Session 5: Biology, Genetics, and Behavior

Grand Ball Room

Moderator: Bronson Strickland, Assistant Professor, Department of Wildlife, Fisheries & Aquaculture, Mississippi State University

3:15pm *Genetic relatedness of feral pigs in the United States: national and regional perspectives with implications for management*
Blake McCann, Department of Biology, University of North Dakota

3:35pm *Phage display: opportunities for development of species-specific contraceptive vaccines for feral swine*
Tatiana Samoylova, Scott-Ritchey Research Center, College of Veterinary Medicine, Auburn University

- 3:55pm** *Habitat selection of feral pigs on Fort Benning, Georgia*
Bill Sparklin, USDA/APHIS/Wildlife Services
- 4:15pm** *Ground cover and understory vegetation in relation to habitat type and wild pig rooting at Congaree National Park, South Carolina*
Scott Zengel, PBS&J Ecological Sciences, Tallahassee Florida
- 4:35pm** *Reproductive biology of an introduced wild pig population over four decades*
John Mayer, Savannah River National Laboratory, Aiken South Carolina

Tuesday April 13, 2010

8:30-9:45 **Shoot From the Hip Session**
Grand Ball Room
Moderator: Billy Higginbotham, AgriLife Extension Service, Texas A&M

9:15-9:45 **Poster Sessions**
Grand Ball Room

10am-noon

Technical Session 6: Bait Delivery Systems

Grand Ball Room

Moderator: Tyler Campbell, USDA/APHIS/Wildlife Services, Texas A&M

10:00am *The development of HOGGONE®, a new lethal control option for the management of feral pigs in Australia*
Steven Lapidge, Invasive Animals Cooperative Research Centre, Australia

10:20am *Development of the Boar Buffet®: a feral pig specific bait delivery device*
Jason Wishart, Invasive Animals Cooperative Research Centre, Australia

10:40am *The development of PIGOUT®- a case study in commercialisation of scientific research*
Michelle Smith, Invasive Animals Cooperative Research Centre, Australia

- 11:00am** *The development of the ultimate feral hog bait hopper - are we heading in the right direction?*
Steven Lapidge, Invasive Animals Cooperative Research Centre,
Australia
- 11:20am** *Utility of simple baits for camera surveys of wild pigs*
Brian Williams, School of Forestry and Wildlife Sciences, Auburn
University
- 11:40am** *Adapting hog control methods and technology to agricultural crop cycles*
Rod Pinkston, Jager Pro™ Hog Control Systems



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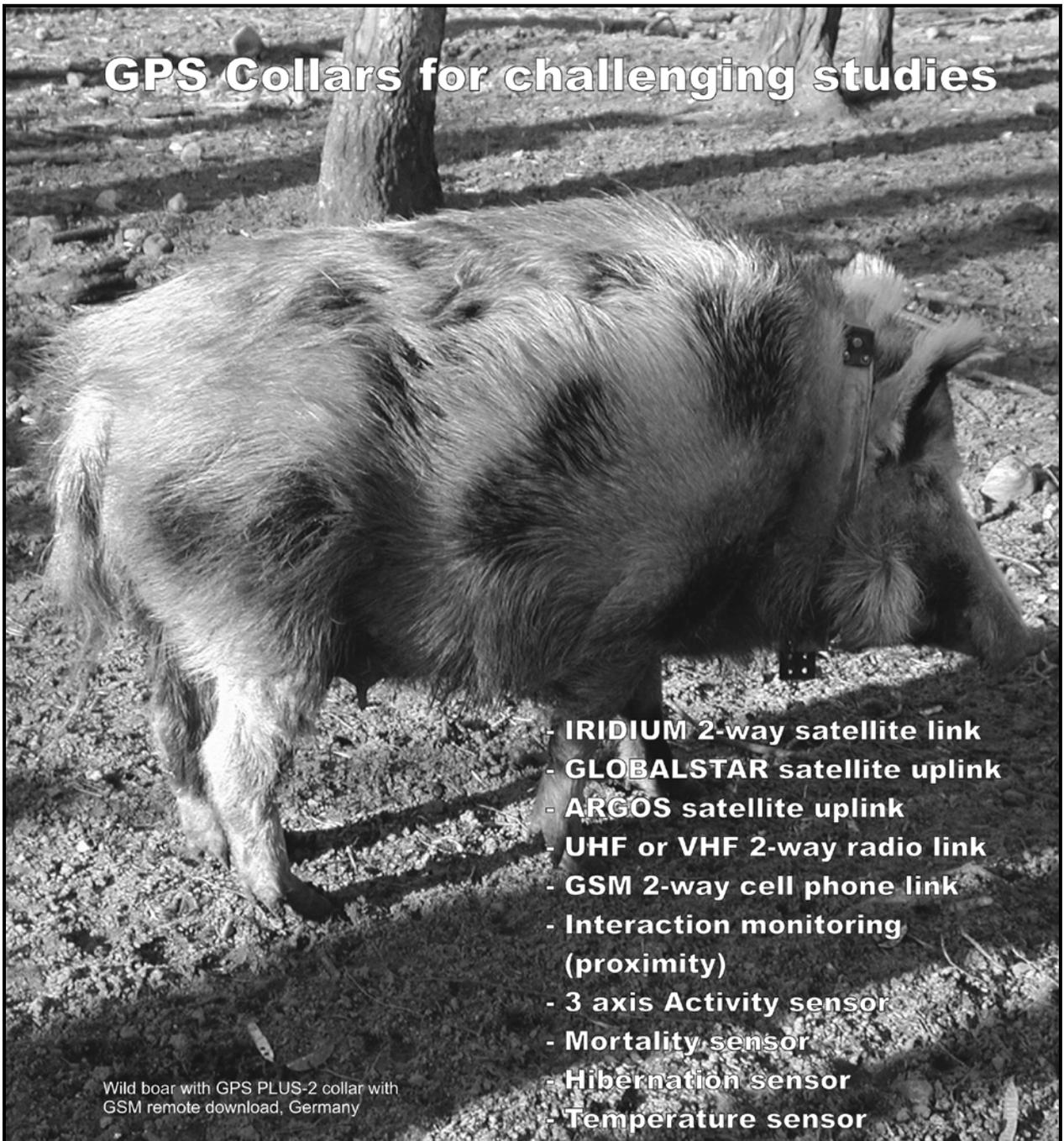
Concurrent Sessions
1:30-3:00 pm

	Technical Session 7: Disease Grand Ball Room Moderator: Billy Higginbotham, Texas AgriLife Extension Service, Texas A&M	Technical Session 8: Control Measures Union Station Meeting Room Moderator: Rex Martensen, Missouri Department of Conservation
1:30pm	<i>Evaluation of a National classical swine fever disease surveillance program in feral swine</i> Richard Minnis, USDA/APHIS/Wildlife Services	<i>Aerial hunting feral hogs in non-traditional areas</i> Chad Richardson, USDA/APHIS/Wildlife Services
1:50pm	<i>Feral swine disease surveillance and human health in Florida</i> Danielle Stanek, DVM, Florida Department of Health	<i>A recipe for successful pig control: lessons learned from the third largest island pig eradication</i> John Knapp, Native Range Incorporated, Ventura California
2:10pm	<i>Economic benefit of feral swine disease surveillance: foot and mouth disease</i> Tyler Cozzens, USDA/APHIS/WS National Wildlife Research Center	<i>State regulations pertaining to feral swine in the United States and implications for management</i> Bill Sparklin, USDA/APHIS/Wildlife Services
2:30pm	<i>Age and gender analyses of pseudorabies virus in feral swine</i> Mark Lutman, USDA/APHIS/WS National Wildlife Disease Program	<i>Trained dogs and nuisance wild pig management</i> Buddy Goatcher, US Fish and Wildlife Services, Ecological Services
2:50pm	<i>Classical swine fever surveillance in feral swine throughout the United States</i> Kerri Pedersen, USDA/APHIS/WS National Wildlife Disease Program	<i>Effectiveness of the pilot bounty program on wild pigs at Fort Benning, GA</i> Robert Holtfreter, School of Forestry and Wildlife Science, Auburn University

Concurrent Sessions
3:15 – 4:55 pm

	Technical Session 9: Control Measures Grand Ball Room Moderator: Jack Mayer, Savannah River National Laboratory	Technical Session 10: Human Dimensions and Wild Pig Distribution Union Station Meeting Room Moderator: Bill Hamrick, Extension Service, Mississippi State University
3:15pm	<i>Too many pigs? Population trends and control methods for wild boar and feral pigs</i> Giovanna Massei, Food and Environment Research Agency, United Kingdom	<i>Characterizing, quantifying, and addressing wild pig damage: building your case for a call to arms using landowner surveys.</i> Billy Higginbotham, Texas
3:35pm	<i>Preliminary results of a localized management or "whole-souder" approach to pig control</i> Robert Holtfreter, School of Forestry and Wildlife Sciences, Auburn University	<i>Techniques indexing feral swine populations near high density commercial swine operations on the coastal plain of North Carolina</i> Carl Betsill, USDA/APHIS/Wildlife Services
3:55pm	<i>Techniques used to manage feral hogs on Cumberland Island National Seashore</i> Doug Hoffman, National Park Service, Cumberland Island National Seashore	<i>National Feral Swine Mapping System</i> Joseph Corn, Public Service Associate, Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine, University of Georgia
4:15pm	<i>Methods and results in managing feral hog damage to a project area in the Upper Gulf Coast of Texas</i> T.J. Muir, USDA/APHIS/Wildlife Services	<i>The distribution of wild pigs on Department of Defense lands in North America</i> Thomas Smith, US Army Corps of Engineers, Champaign, Illinois
4:35pm	<i>Pigs under pressure: evaluation of fences for containing motivated feral swine during depopulations</i> Michael Lavelle, USDA/APHIS/WS National Wildlife Research Center	<i>Wild swine policy and management on Eglin AFB</i> Jeremy Preston, Eglin AFB, Florida

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Oral Presentations

Technical Session 3: Disease

Foot-and-mouth disease in feral swine: susceptibility and transmission

Brandon Schmit¹, Fawzi Mohamed², Seth Swafford¹, Samia Metwally²

¹ USDA/APHIS/Wildlife Services, National Wildlife Disease Program, Fort Collins, CO, USA

² USDA/APHIS/VS/NVSL/FADDL, Plum Island Animal Disease Center, Greenport, NY, USA

Foot-and-mouth disease (FMD), a highly contagious acute vesicular disease of cloven-hoofed animals, represents a significant threat to American agriculture. This threat would be intensified if an introduction of FMD into feral swine populations were to occur within the United States. Management of a potential outbreak of FMD in feral swine requires early detection of the outbreak through adequate surveillance. Hence, an understanding of disease dynamics and virus shedding in feral swine populations and the potential of disease spread from feral swine to domestic swine is critical in developing countermeasures for disease control and eradication. Unfortunately, studies of FMD in feral swine are limited and data for disease transmissibility and clinical manifestations do not exist. While the abundant documented data derived from FMD infection in domestic swine (*Sus scrofa domestica*) can be utilized to establish epidemiological models for feral swine that escaped from domestic populations, inferences for feral swine populations with predominantly Eurasian wild boar heritage may not be adequately supported. In an effort to begin filling the knowledge gaps associated with feral swine disease surveillance and modeling requirements, a study of FMD in feral swine was conducted at the USDA, APHIS, Foreign Animal Disease Diagnostic Laboratory at Plum Island Animal Disease Center, Greenport, NY. The main objectives of the study were to compare the susceptibility of feral swine to FMD with that of domestic swine, characterize and document clinical signs of FMD in feral swine, create reference materials for FMD test validation in feral swine, and to gain knowledge on FMD virus transmission between feral and domestic swine. Data comparing susceptibility, transmission, clinical signs, viral shedding and persistence of FMD in feral versus domestic swine will be shared.

Select bacterial zoonoses from feral swine and public health concerns

Kendra Stauffer¹, Danielle Stanek, Seth Swafford, Marta Guerra, Sean Shadomy, Rita Traxler

¹Bacterial Zoonoses Branch, Division of Foodborne, Bacterial and Mycotic Diseases, National Center for Zoonotic, Vectorborne and Enteric Diseases, Centers for Disease Control and Prevention, Atlanta, GA, USA

Feral swine hunting and management have increased throughout the U.S. due to translocation of feral swine and natural range/population expansion. These factors have resulted in significant populations being reported in at least 30 states. More than 24 zoonotic diseases have been reported in feral swine, raising public health concerns for wildlife managers and hunters. These diseases can be transmitted directly and indirectly when people come in contact with tissue or fluids during wildlife management, disease surveillance, field dressing or butchering, eating undercooked meat, or consuming contaminated produce. Select bacterial zoonoses will be discussed and recommendations made for monitoring of and mitigating risk of exposure from zoonotic diseases commonly found in feral swine. We reviewed recent pertinent studies and case investigations for tuberculosis, brucellosis, leptospirosis, and *E. coli* 0157:H7 from the U.S. Bacterial zoonoses have been assessed in feral swine through wildlife serologic studies for tuberculosis, brucellosis, and leptospirosis. These studies show that feral swine can serve as reservoirs for disease for domestic swine and livestock and that occupational or recreational activities associated with feral swine pose a risk for disease transmission to humans. Human case reports conclude that brucellosis has been transmitted through field dressing, leptospirosis through contact during animal production or slaughtering animals, and *E. coli* 0157:H7 through consumption of spinach grown in fields contaminated with feral swine urine and feces. The expansion of feral swine populations increases the risk of zoonotic disease exposure from infected feral swine. Wildlife biologists and hunters should use Personal Protective Equipment properly when handling or processing feral swine to prevent infection as well as cooking meat as recommended. Federal and state agencies involved in feral swine management are encouraged to utilize federal or state employee occupational health screening/monitoring tools for early identification and treatment of zoonotic diseases from feral swine.

***Trichinella spiralis* and *Toxoplasma gondii* surveillance in feral swine**

John Baroch¹, Seth Swafford¹, and Dolores E. Hill²

¹ USDA/APHIS/Wildlife Services, National Wildlife Disease Program, Fort Collins, CO, USA

² USDA, ARS, ANRI, Animal Parasitic Diseases Laboratory, BARC-EAST, Beltsville, MD, USA

The U.S. feral swine population is estimated at 5 million animals and is growing rapidly. Feral swine are now found in at least 36 states due to natural range expansion as well as transplanting of animals for hunting opportunities. Localized populations of feral swine are posing an increased risk to non-biosecure domestic swine facilities by serving as reservoirs for pathogens which might be transmitted to domestic swine. Additionally, feral swine are attracted to these facilities due to breeding sows, ease of food resources, and commingling. *Trichinella spiralis* and *Toxoplasma gondii* are two important zoonotic parasites with worldwide distribution, and feral swine may be infected with either of these organisms without showing clinical signs of disease. Since October 2008 USDA/APHIS Wildlife Services (WS) National Wildlife Disease Program has been working with the USDA's Agricultural Research Service (ARS) to collect and test feral swine serum for antibodies to *Trichinella spiralis* and *Toxoplasma gondii*. The collaborative surveillance project has tested serum from more than 2000 feral swine in 20 states for antibodies to *Trichinella spiralis* and *Toxoplasma gondii*. Surveillance data and preliminary results indicate that 2% of the samples are sero-positive for *Trichinella spiralis* and 18% are sero-positive for *Toxoplasma gondii*. These data improve the knowledge of infection rates for these parasites in feral swine and will help in the development of effective strategies for preventing introduction into domestic swine herds and humans.

Avian disease surveillance as a model for improved feral swine disease surveillance in Florida

Michael Milleson¹, Mark Cunningham², Danielle Stanek³, and Anthony Duffiney⁴

¹USDA WS 2820 E University Ave, Gainesville, FL, USA

²DVM Florida Fish and Wildlife Conservation Commission

³DVM FL DOH

⁴USDA Wildlife Services

USDA Wildlife Services has been conducting feral swine disease surveillance in Florida for the past four years, and USDA Veterinary Services did limited surveillance in feral swine prior to WS involvement. Florida is second only to Texas in the number of feral swine serum samples collected. An overview of how WS Florida conducts feral swine surveillance is presented, demonstrating how samples are collected statewide with limited resources, as well as highlighting limitations of the current approach. This is contrasted with avian disease surveillance in Florida which utilizes a more integrated interagency approach and greater public involvement, in large part due to the success of an online morbidity/mortality reporting system managed by the Florida Fish and Wildlife Conservation Commission. Suggestions are proposed on how feral swine disease surveillance can incorporate some of the strengths of the avian approach. A case study of an FWC investigation into a pseudorabies outbreak in Palm Beach County, FL and Wildlife Service's role in conducting follow-up surveillance will be used to highlight the successes of existing interagency cooperation and the benefits of increasing this cooperation.

Technical Session 4: Damage Assessment

Quantifying feral pig rooting in ecologically-sensitive plant communities at Avon Park Air Force Range in Florida

Eric A. Tillman¹, Michael L. Avery, William E. Bruce, John S. Humphrey, Steve L. Orzell, Rick M. Engeman, and Gary Killian

¹National Wildlife Research Center, USDA-APHIS-WS, 2820 East University Avenue, Gainesville, FL, USA

Rooting damage by feral pigs (*Sus scrofa*) in the southeastern United States is widely recognized by ecologists as a significant threat to botanical biodiversity. In 2008 we began documenting feral pig rooting at 35 ecologically-sensitive plant sites (730 acres) at Avon Park Air Force Range (APA FR) in south-central Florida. Our study, part of an ongoing integrated approach to managing the pig population at APA FR, attempts to evaluate both the spatial and temporal changes in feral pig rooting in conjunction with selective removal of

feral pigs by professional trappers and recreational hunters. Using systematic site surveys to locate all pig rooting in each study site, we delineate each incidence of rooting using highly accurate GPS receivers. For each rooted area, we estimate the percentage of rooted substrate, categorize the severity, and estimate the relative age of the rooting activity. In our first year, we conducted surveys in both the winter dry and summer wet seasons documenting over 1400 areas of rooting activity. During the dry season survey (December-January), more pig rooting was documented in seepage slopes and wet flatwood sites, but in the spring survey (May-June), rooting in wet prairie sites increased. While preliminary, our findings lead us to suspect feral pig rooting maybe dictated by soil moisture differences as reflected by seasonal variation across the landscape in the sensitive plant communities. As we continue to document site-specific rooting behavior, we will be better able to anticipate such changes in pig behavior. This information in turn should contribute to targeted trapping and removal efforts aimed at protection of biodiversity hotspots.

Preliminary results from a rapid assessment monitoring technique for wild pigs on public lands

Buddy L. Goatcher¹, Tony Vidrine, Adam M. Goatcher

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Monitoring is a critical component of any professional wild pig eradication or population reduction campaign. Without monitoring the outcomes are in doubt and future support is threatened by speculative claims or discounted as insignificant. We report preliminary results of an on-going rapid-assessment monitoring technique for wild pig removals on public lands managed for wildlife. Our goal is to develop a monitoring method with low initial set-up costs, implemented by existing agency staff with a diversity of technical skill levels and that keeps demands on labor inputs reasonable. The lack of dedicated monitoring funding and logistical considerations such as extremes of heat and humidity, poisonous snakes, closed forest canopy, thick mid-story and ground cover vegetation, and frequent flooding of poorly drained management units precluded the use of standard random stratified sampling of ground or aerial strip transects. Using common handheld Global Positioning System units to mark and map the locations of wild pig habitat injuries from all terrain vehicles, we are developing a rapid-assessment technique. Based on limited preliminary data, this monitoring method, in spite of its biased nature, may reliably indicate the presence or absence of wild hog habitat injury in response to wild pig removals by a public sport hunting program with dogs. Our report also compares data collected from our rapid-assessment monitoring to another monitoring method used state-wide at all Wildlife Management Areas, the self-clearing permit for sport hunters. We are also contacting sport hunters by telephone that held special use permits for hog-dog hunting for follow-up interviews on hunter success and observations of wild pig sign. The information from the interviews will be compared to data from the self-clearing permits and our rapid-assessments. This multiple lines of evidence approach will be used to evaluate sport hunting for wild pig control on 27,948 ha of wildlife management areas.

Texas feral swine control: project results and the development of a statewide strategy

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The Texas Wildlife Services Program (TWSP) conducts feral swine control statewide through its' established wildlife damage management program and in special project areas. In FY's 09-10, TWSP conducted over 20 special projects statewide to protect a variety of resources, including property, endangered species, crops, pasture, watersheds and native wildlife. During the 2-year period, TWSP removed 43,581 feral swine. The overall benefit:cost ratio for the special projects was 7.5:1. However, some projects did not perform as well as expected due to environmental conditions. Notably, due to drought conditions, wheat protection was diminished in one of the years in one project area and quail protection did not result in any observed benefits. Additionally, benefit:cost ratios are calculated based on a single year benefit while intensive feral hog control has multiple year benefits. Benefits, based on density dependent damage, may be expected for 2 years following control, although they diminish over time. Individual project results and a discussion regarding the development of a statewide strategy are presented.

Evaluation of feral hog removal to reduce damage to sensitive plant sites at Avon Park Air Force Range in Florida; preliminary results and challenges

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Feral swine (*Sus scrofa*) are an exotic species that is overabundant, widespread and increasing largely unabated throughout much of the southeastern United States. While recreational hunting is popular in some areas the harvest is often not sufficient to reduce ecological damage, decrease the threat of disease transmission to native wildlife and domestic livestock and lower the economic costs of agricultural damage. Current strategies for management of feral hogs recognize that reduction of population density can mitigate damage and may rely on one or more approaches including hunting and trapping by professionals. The Avon Park Air Force Range (APAFR) is a 106,034 acre Department of Defense training installation located in central Florida in Highlands and Polk Counties. Federally-mandated responsibilities of the Air Force include natural resource management of APAFR. The impacts of feral hog rooting at APAFR on ecologically sensitive-plant sites, listed species, forestry and grazing programs, and archeological sites raise significant concerns. In response, an ongoing cooperative effort was initiated in late 2008 between the Air Force, and the USDA-APHIS-WS to reduce damage from feral hog rooting through the use of a scientifically based management strategy that is humane, cost-effective, and that integrates with ecologically sustainable land management. We will present an overview of the project's goals and methods to 1. quantify damage to sensitive plant communities caused by feral hogs; 2. implement a reduction/removal program to prevent further degradation of sites and; 3. evaluate and support the effectiveness of control methods using passive tracking index methodology to monitor hog populations. The dataset being collected should address a variety of questions, including changes in plant site damage and analyses of population trends over time as they relate to both temporal and spatial hog removal.

Florida's natural lands and feral hogs: a domestic disturbance

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Feral hogs are a significant threat to Florida's natural lands; understanding their role as disturbance agents and seed dispersers has important implications for both the conservation of these lands and management of these animals. Feral hogs destroy patches of vegetation when they forage (i.e. "root") and potentially facilitate native and non-native plant colonization by exposing soil and depositing seeds in their feces. Intermediate disturbance by hogs may enhance plant diversity, but repeated or intense disturbance may reduce it by preventing germination or causing irreparable damage to individual plants. To understand the effects of feral hogs on Florida's natural lands, we monitored seven wetlands and four recreational trails at the Little Big Econ State Forest bi-monthly over the course of a year. To assess hog disturbance we documented the location and size of rooted patches using a global positioning system (GPS), which over time indicated rooting frequency. Intensity of rooted patches was also recorded using the chain-and-tape method for surface roughness. Lastly, fecal samples were collected from the surrounding areas for seed germination trials. Most rooting occurred from July-November with a surprisingly large number of small (<2 m²) patches. The majority of patches were re-rooted at least once, but some patches were re-rooted as many as five times. Though germination trials are still in progress, 32 plant species (4 non-native) have germinated from fecal samples to date. Approximately 60% of the species are obligate or facultative wetland species from the Cyperaceae (sedges) and Poaceae (grasses) families. Feral hogs disperse more native wetland species than non-natives in central Florida, but their re-rooting chronically disturbs extensive patches of vegetation and prevents the successful colonization of any plant species. Feral pigs hinder conservation efforts of Florida's natural lands and need to be managed more effectively.

Technical Session 5: Biology, Genetics, and Behavior

Genetic relatedness of feral pigs in the United States: national and regional perspectives with implications for management

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In North America, both domestic pig breeds and Eurasian wild boar have been introduced and feral pig populations have become largely mixed by human trade and release of animals. The implications of these introductions are too many to list here, but include ecological damage, economic losses, and spread of disease. As such, there is a need for a better understanding of the relatedness of feral pig populations throughout the country, which will facilitate more effective management. We acquired tissue samples from 28 U.S. states and obtained molecular data for a ~400 base pair region of the mitochondrial D-loop and a panel of 96 nuclear single nucleotide polymorphisms. We accessed published mitochondrial sequence at the National Center for Biotechnology Information representing domestic breeds and wild populations worldwide to increase our sampling scheme. We then performed a series of phylogenetic analyses on the individual and combined datasets utilizing the programs STRUCTURE and MrBayes 3.1. Results indicated 5.6% variation in the mitochondrial sequence, useful for determining origins and tracking dispersal of U.S. feral pig populations. Single nucleotide polymorphisms increased resolution of relationships and identified translocated and hybrid domestic/wild pigs. Our results show that hybrids occur in at least 10 states, including an isolated population in Great Smoky Mountains National Park (TN and NC) with a distinct genetic profile. We also found corroboration of written histories of pig introductions to California, and insights into the origins for recently established feral populations in the Midwest and Northern Plains. We conclude that U.S. feral pig populations possess genetic patterns useful for improved management of this species.

Phage Display: opportunities for development of species specific contraceptive vaccines for feral swine

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Feral swine cause public health, environmental, and agricultural problems. Contraceptive products would be practical adjuncts to current trapping/eradication methods. Our goal is to develop effective, low-cost contraceptive vaccines based on peptides mimicking sperm that bind to zona pellucida (ZP) proteins at fertilization. Our novel approach is designed to produce species-specific contraceptives which will control feral swine, but not harm other wildlife or adversely affect soil, water, or plant life. Peptides with contraceptive properties are selected from phage display libraries on intact oocytes surrounded by ZP. Such ZP-binding peptides have the potential to act as antigens which stimulate production of anti-sperm antibodies, leading to contraceptive effects in pigs. Our selection scheme includes steps to remove peptides that bind to ZP from other species, allowing identification of peptides specific for porcine ZP. Six peptides selected from a pIII 12-mer phage display library and one control peptide were synthesized and conjugated to a carrier protein. These constructs were injected into domestic pigs and blood samples collected for four months to evaluate antibody responses. Two of the candidate peptides elicited high titers ($\geq 1:25,600$) of anti-peptide antibodies detected at five weeks post-primary injection. These peptides will be studied further to assess effects on fertility. Finally, antigenic sequences will be incorporated in virally vectored delivery systems to create oral vaccines practical for use in feral pigs. We have identified five additional porcine ZP-binding phage clones using a landscape phage display library. These peptides will be tested in pigs in a phage-vectored format where phage body plays the role of carrier protein/adjuvant and 4000 copies/phage of a ZP-binding peptide stimulate production of anti-peptide/anti-sperm antibodies. Based on these and additional canine data obtained in our laboratory, we conclude that phage display is a powerful tool to select peptide antigens for the development of species-specific contraceptives for wildlife.

Habitat selection of feral pigs on Fort Benning, Georgia

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We examined how territoriality, resources, and human activity affected third order selection of habitat by sounders (female groups) of feral pigs using Global Positioning System (GPS) telemetry on the Fort Benning military installation in Eastern Alabama and Western Georgia. Land managers on Fort Benning were concerned with the impacts of an increasing pig population on sensitive, threatened, and endangered species. Pig sign was abundant in hardwood bottomland forest, but infrequently found in pine and pine-hardwood forest and this was thought to reflect habitat use of feral pigs on Fort Benning. We hypothesized that the territorial behavior of feral pigs on Fort Benning resulted in use of forest cover types proportional to their availability overall, and that differences in foraging strategies and not habitat preferences was responsible for the lack of pig sign in pine and pine-hardwood forest. We also hypothesized variation in hard mast availability and avoidance of human activity would cause seasonal and daily variation in habitat selection. We categorized the forested landscape into three forest cover types (pine forest, pine-hardwood forest, and hardwood bottomland forest) based on differences in the food and cover resources they provided feral pigs. We measured pig sign (tracks, rooting, wallowing) in pine and hardwood bottomland forest to compare estimates of pig activity to habitat selection indices. Estimates of pig activity from pig sign indicated higher pig activity in hardwood bottomland forest. However, habitat selection analysis based on GPS locations of collared pigs showed that pigs used pine forest, pine-hardwood forest, and hardwood bottomland forest in proportion to availability. Habitat use of forested cover types did not vary with the availability of hard mast, which was surprising given the importance of hard mast in the breeding biology of this species. Since feral pigs use forest cover types in proportion to availability, feral pig management actions need to address potential impacts across Fort Benning instead of limiting management actions to hardwood bottoms where pig activity may be more apparent.

Ground cover and understory vegetation in relation to habitat type and wild pig rooting at Congaree National Park, South Carolina

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Ground cover and understory vegetation were examined in relation to habitat type and wild pig rooting at Congaree National Park. Quadrats (0.25 m²) were randomly placed in areas with and without recent rooting across four habitats: three floodplain forest types (bottomland hardwoods, cypress-tupelo, seepage forest) and pine flatwoods. In the absence of recent rooting, floodplain habitats had higher vegetation cover, lower leaf litter cover, and greater species richness compared to pine flatwoods. In recently rooted areas, vegetation and leaf litter cover were lower than in areas without recent rooting, and were similar among habitats, with high bare soil cover. Species richness was still greater for the floodplain versus flatwoods with recent rooting. Low herbaceous cover values in pine flatwoods were attributed to former pine plantation management and lack of fire, likely influencing the minimal hog disturbance levels observed there. Herbaceous cover values in bottomland hardwoods and cypress-tupelo were higher than expected, especially for cypress-tupelo, which typically has little understory. Herbaceous cover on the floodplain may have been related to a combination of drought, extended dry down, forest tent caterpillar canopy defoliation, long-term pig rooting, and hurricane influences. Recently rooted areas had greater association with coarse woody debris than areas without recent rooting. Pig rooting in and around downed logs and snags likely relates to microhabitat selection and potential food/prey resources. Bottomland hardwoods, unexpectedly, did not have overall greater plant species richness or diversity than cypress-tupelo. Also unexpectedly, recently rooted areas were not generally less diverse than areas without recent rooting. Within habitat, recently rooted bottomland hardwoods had lower species richness and diversity than areas without recent rooting; however, recently rooted cypress-tupelo had greater species richness and similar diversity, and seepage forest had greater diversity, than areas without recent rooting. Seepage forest with recent rooting had the most diverse understory among all combinations of habitat and rooting. Pig rooting may act as a periodic disturbance, contributing to species richness and diversity in some habitats. Within seepage forest, these results might also relate to microhabitat selection by pigs for small wet depressions with more abundant and diverse herbaceous cover. If pig rooting creates, enhances, or maintains depressions in seepage forest, pigs may both influence the understory

vegetation and respond to it as well. Habitat had a stronger influence on understory species composition than recent rooting. This may be due to differences in hydrology, landforms, and soils; as well as long-term pig rooting, which likely influences the entire floodplain over time. Within habitat, differences in species composition for areas with and without recent rooting were limited to seepage forest (with possible microhabitat selection by pigs). Recent rooting may also have a homogenizing effect on the understory, lessening cross-habitat differences.

Reproductive biology of an introduced wild pig population over four decades

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Wild pigs (*Sus scrofa*) have a high reproductive potential. This aspect of their biology has been studied at a number of locations. However, most of these studies have had short time frames (1-2 years) and the collective data have revealed inconsistent results. In addition, certain types of data (e.g., neonatal litter sizes and sex ratios) are almost completely lacking. The purpose of this study was to analyze a large data set from the Savannah River Site, SC, compiled over four decades. The data analysis focused on female reproductive variables (e.g., pregnancy and lactation), litter size and composition, breeding season, and chronological variation. Data were collected from a total of 2,483 sows from 1969 to 2009. Of these, 29 and 14 percent were either pregnant or lactating, respectively. One sow was determined to have conceived when it was three months of age. The frequency of both pregnancy and lactation increased with age class. However, fetal litter size was not significantly correlated to either the sow's age class or total body mass. The same was also true for the number of lactating teats. Implantation was not significantly biased between the uterine horns. The mean fetal litter size was six. There was a significant tendency toward even-numbered fetal litters. Observed litter sizes decreased progressively from fetal to neonatal (13%), and then from neonatal to post-natal (20%). The fetal sex ratio (N=1,110 sexed fetuses) was equal, while the neonatal sex ratio (N=446 sexed neonates) was female-biased. Breeding occurred year-round, with the peaks of conception and farrowing taking place in September and January, respectively. Based on monthly and seasonal comparisons, the fetal litters did not vary significantly in size as to when the litters were either conceived or farrowed. Lastly, fetal litter size did not vary significantly among the four decades.



Technical Session 6: Bait Delivery

The development of HOGGONE®, a new lethal control option for the management of feral pigs in Australia

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The first feral pig-tailored manufactured bait (PIGOUT® containing 1080) was registered for use in Australia in 2008. Since commencing the PIGOUT® project there was a desire to identify an improved toxicant that increases target species efficacy and reduces welfare concerns related to 1080 use for feral pig control. An “Achilles Heel” approach was taken to discover potential alternative toxic substances that exploited particular pharmacological weaknesses of pigs. This has led to the identification of sodium nitrite as a rapid and humane feral pig toxicant. The incorporation of sodium nitrite into a shelf-stable and target-specific omnivore bait commenced in January 2009 and has been challenging due to the properties of the chemical. Notwithstanding, successful field trials have so far demonstrated that the new HOGGONE® bait is palatable, efficacious and possibly an even more target-specific product for feral pig control. Final refinements to enhance product stability and in turn palatability are now occurring. HOGGONE® field trials will continue throughout 2010 in a variety of habitats to obtain sufficient data for the national registration of the product as an additional tool for feral pig control. The lower chemical scheduling of this product will mean that it will be more readily available than PIGOUT®. Nitrite antidote trials will also shortly commence to assess whether methylene blue can reverse HOG-GONE®-induced nitrite toxicosis. Concurrent independent assessments of humaneness, residues and non-target species risk have or are being conducted. This presentation will discuss the HOGGONE® development process to date.

Development of the Boar Buffet®: A feral pig specific bait delivery device

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Feral pigs are a declared pest in all Australian states and must be controlled by law. The most economic form of control used to suppress feral pig populations over vast rural areas in Australia is toxic baiting. Sodium fluoroacetate (1080) is the primary toxin used and it is added to bait substrates found palatable to feral pigs, including grain, meat, pellets and manufactured baits. However, pigs are a large animal with low sensitivity to 1080, thus they require a large 1080 dose which compromises non-target species safety.

Commencing in 2006 the Invasive Animals Cooperative Research Centre began to develop a bait delivery device (Boar Buffet™) that aimed to exploit the unique characteristics possessed by the feral pig such as reach, size, strength and feeding behaviour to prevent non-target species exposure during baiting campaigns. The Boar Buffet™ has now been subjected to multiple pen and field trials and its original design has evolved considerably to become smaller and more target specific, yet easier to transport and assemble and cheaper. The Boar Buffet™ is now at a point where it can be positioned at feral pig hotspots to provide long term target specific control of feral pigs with minimal operator input. This presentation will discuss the past three years of research that have ultimately taken the Boar Buffet™ from the drawing board to the final article-of-commerce. Also discussed will be the potential utility of the device in the USA for contraceptive or even toxic baits.

The development of PIGOUT® - a case study in commercialisation of scientific research

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The requirement for new control options for feral pigs in Australia was proposed at a national workshop of stakeholders in June 2003. Financial and logistical support was required to offset the risk that the R&D cost might outweigh the commercial returns, as the developmental challenge was considerable and the market uncertain. The collaboration between Animal Control Technologies (commercial partner) and the Invasive Animals CRC on the PIGOUT® 1080 pig bait project provided a greater range of testing and development

opportunities than could be assembled in-house by a small production company for such a complex product. The development and testing program was financially supported by a rural industry research organisation (Meat and Livestock Australia Ltd) and the Federal Government.

Research aimed to identify a delivery system for 72mg of sodium fluoro-acetate ("1080") that improved target specificity of toxin delivery to feral pigs while reducing risks to non-target species. After several iterations a palatable bait matrix was identified, which was then enhanced by a hydrophobic toxin delivery system that confined the 1080 within a central core. Field trials with the prototype PIGOUT® bait commenced in September 2004, and the product was registered nationally in December 2007.

Unfortunately PIGOUT® was launched into the agricultural sector at the height of decade-long drought in the predicted market heartland (western NSW and Queensland). Compounding this problem, traditionally used grain or meat baits remains popular amongst field operators despite the obvious safety and convenience of a packaged shelf-stable and pre-dosed product. Furthermore, PIGOUT® could not initially be deployed in NSW as state based "Control-of-Use" approvals came many months after official registration.

Despite these initial setbacks, uptake of the new technology has increased and Australia has an improved approach to feral pig management that is of both immediate and strategic value. The project has also facilitated a phase two bait development (HOGGONE®), an innovative concept based on the use of a methaemoglobin-forming compound that overcomes many of the concerns on the current use of 1080 for pig control.

The development of the ultimate feral pig bait hopper - are we heading in the right direction?

Steve Lapidge and Jason Wishart

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Due to the diverse mammalian vertebrate assemblage in the USA, it is unlikely that target-specific delivery of feral pig-tailored pharmaceutical or toxic baits will occur without the aid of a mechanical exclusion and delivery device. As a consequence, the last five years has seen a plethora of bait hoppers developed for target-specific delivery of baits to feral pigs. These include the Boar Operated System (BOS™) from the United Kingdom, at least two simplified hoppers from the USDA National Wildlife Research Centre, a further design from New Zealand, and three Boar Buffet™ prototypes from Australia. No single design is ideal for all situations. Each design has its own advantages and disadvantages depending on what is being delivered (grain versus solid baits; contraceptives versus toxicants), the feral pig population density, the non-target species present, the initial cost and the field longevity required. This presentation will discuss the pros and cons of each device, before asking for audience participation regarding future design features, particularly in relation to avoiding black bear depredation.

Utility of simple baits for camera surveys of wild pigs

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Attracting animals to and enticing them to remain at camera stations is often an important element in population surveys relying on the ability to identify individual animals observed in images captured by motion-triggered or time-lapse game cameras. The ability to capture a sufficient number of images containing the desired animals while minimizing the amount of time a camera must be deployed to complete a survey is invaluable. We conducted surveys of a portion of the wild pig (*Sus scrofa*) population on Fort Benning, Georgia, utilizing game cameras set at sites baited with three different combinations of dry and soured corn to determine whether the use of soured corn, ostensibly due to its distinct odoriferousness, decreased the time necessary for pigs to locate a new camera site and/or increased the time pigs lingered at a site. Our results suggest that soured corn neither attracts pigs to a site any quicker than plain, dry, whole-kernel corn nor holds them at a site longer. No difference was observed in the time to first detection among dry corn ($\bar{x} = 74.6$ h; SE = 17.0), soured corn ($\bar{x} = 82.2$ h; SE = 25.6), and mixed ($\bar{x} = 65.8$ h; SE = 16.7) bait types. No difference was observed between the average feeding bout length at sites baited with soured corn ($\bar{x} = 23.3$ min; SE = 2.24) or a mixture of soured and dry corn ($\bar{x} = 23.6$ min; SE = 2.09); however, pigs feeding at sites baited with whole corn ($\bar{x} = 33.5$ min; SE = 2.06) tended to remain longer than pigs at sites baited with either of the other two bait types. The increased effort required to produce soured corn does not

result in any substantial improvement in the attractiveness of a bait site for wild pigs, nor, therefore, any substantial improvement in the efficiency with which a site is surveyed for wild pigs.

Adapting hog control methods and technology to agricultural crop cycles

Rod Pinkston

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Feral hogs (*sus scrofa*) are causing millions of dollars in crop damage and soil erosion in the United States. Aggressive feral hog management is essential to protect future agricultural interests. We have developed three high volume removal methods using first to civilian market technology. These methods and products allowed one hog control operator in the state of Georgia to remove 812 feral hogs from a three county service area during only 134 days of operation. 219 hogs were removed using a remote control trap door release on large corral traps (7.30 hogs per trap, 1.83 hogs per hour) during the winter months when no crops were planted. 446 hogs were removed using 640x480 resolution thermal imaging equipment in 74 nights of operation (6.03 hogs per night, 0.75 hogs per hour) during the corn/peanut planting and peanut harvest seasons. 147 hogs were removed using ear tag transmitters and radio telemetry (4.90 hogs per day, 0.61 hogs per hour) with dogs while hogs were feeding in mature wheat and corn fields during spring and summer months. These aggressive management methods allowed high volume removal throughout the entire year. Each specific hog control method and technology was implemented at the appropriate agricultural crop cycle to be most effective. This presentation includes video documentation of each method and technology.

Technical Session 7: Disease

Evaluation of a National classical swine fever disease surveillance program in feral swine

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Feral swine have rapidly become a species of great concern due to their potentially negative impacts to domestic animal health and their occurrence in at least 1272 counties in the U.S. USDA Wildlife Services has been conducting surveillance in feral swine to detect Classical swine fever (CSF) virus as well as other endemic pathogens which pose a risk to livestock and humans. To evaluate the effectiveness of the CSF surveillance project in feral swine from 2007-2009, data were evaluated for overall distribution and proximity to high risk areas. High risk areas were identified in a CSF Risk Assessment conducted by USDA and include locations such as international airports, domestic swine facilities, and public landfills. Over 3 years the CSF surveillance project has collected and analyzed 5811 feral swine samples from 377 counties in the U.S. Approximately 0.5% (30) of all samples taken were within 1 mile of landfills, while 9.0% (522) of all samples were within 1-5 miles of landfills and 34.8% (2030) within 5-10 miles. Similarly, 0.1% (7) samples were within 1 mile of airports, 3.4% within 1-5 miles, and 4.8% within 5-10 miles of airports. Within year sampling shows a similar distribution across years for both landfills and airports. Given average home ranges of feral swine and evaluation of these data indicate that the project is moderately effective at sampling in high risk areas and effectively surveying approximately 30% the overall U.S. feral swine population. While the CSF surveillance project in feral swine is geographically effective, adjusting sample locations near high risk areas to accommodate monitoring for endemic pathogens is an important consideration if established feral swine populations are present in these locations. Balancing foreign animal disease surveillance with monitoring endemic viruses, bacteria, and parasites must be considered to implement an effective comprehensive feral swine disease project.

Feral swine disease surveillance and human health in Florida

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Feral swine may potentially harbor at least 30 bacteria and viruses of human health or agricultural significance, as well as numerous parasites including *Trichinella*, *Toxoplasma* and cysticercosis. Feral swine

may also act as feeding stations for ticks carrying bacteria causing illness in people and domestic animals, and could act as reservoirs for foreign animal diseases such as foot and mouth disease. Feral swine *Brucella suis* and pseudorabies virus surveillance data collected by USDA Wildlife Services and USDA Veterinary Services is shared with Florida Department of Health (FDOH) and Florida Department of Agriculture and Consumer Services (FDACS) Animal Industry to facilitate epidemiologic surveillance for people and domestic animals, and more importantly, utilize for disease prevention outreach. In addition, FDACS Animal Industry shares domestic animal disease reports of human health significance with FDOH as they receive them. As *Brucella* and most other potential bioterrorist (BT) agents are transmissible from animals to people, these partnerships are important for both day-to-day health concerns as well as for expediting detection during a potential BT or foreign animal disease introduction event. Information and communication flow for *Brucella suis* surveillance are briefly described. Examples of how feral swine may pose potential threats to human health in Florida are also provided.

Economic benefit of feral swine disease surveillance: foot and mouth disease

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Feral swine are a known reservoir and vector for economically threatening diseases. In the late 1980's, the distribution of feral swine was found mostly in southern states. Due to their high fecundity, mobility and adaptability, feral swine populations are rapidly expanding throughout the U.S. Combined with their frequent interactions with livestock and people, feral swine are quickly increasing the risk of endemic disease transmission, as well as the potential spread of foreign animal diseases such as foot-and-mouth disease (FMD). The economic impact of FMD introductions into livestock operations was shown by the dramatic losses suffered in Taiwan (\$1.6 billion in 1997) and the U.K. (\$11 billion in 2001). Early detection and monitoring of FMD through surveillance can be an effective way to minimize the spread, therefore minimizing the resulting impacts to the livestock industry and the economy. Disease surveillance in feral swine is currently being conducted across the U.S. by Wildlife Services National Wildlife Disease Program (NWDP) to monitor for several important diseases (e.g., pseudorabies and swine brucellosis). For this study, the economic benefit of surveillance was estimated as the decrease in the potential negative economic impacts caused by feral swine transmitting FMD in California, Kansas, Iowa, Missouri, North Carolina, and Wisconsin. To estimate this benefit, we simulated a hypothetical FMD outbreak with different levels of feral swine disease surveillance using a bio economic model. Initial results of this simulation indicate that surveillance significantly reduced the potential negative economic impacts of FMD. This presentation will discuss the bio economic model used and our initial results, using North Carolina as a case study.

Age and gender analyses of pseudorabies virus in feral swine

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Pseudorabies (PRV) is one of the most prevalent diseases in feral swine, and it would cause a significant economic impact if introduced into the commercial swine industry. Since 2006, the U.S. Department of Agriculture's Wildlife Services' National Wildlife Disease Program has implemented a comprehensive feral swine disease surveillance project which targets endemic diseases (including PRV) in feral swine. Data have been collected to establish baseline information on occurrence and distribution; however, additional analyses are warranted. Therefore, 2169 serum samples collected in 31 states from October 1, 2008 to September 30, 2009 were tested for antibodies to PRV and analyzed for differences in gender and age. Preliminary results during this sampling period indicate that 15 states in the U.S. have localized populations of feral swine that are seropositive for PRV. Analyses were performed to compare apparent prevalence for PRV by gender and age groups. Results from these analyses are reported and can be used to inform feral swine disease monitoring and research.

Classical swine fever surveillance in feral swine in the United States

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Feral swine populations are rapidly expanding across the United States and are now estimated at approximately 5 million individuals. These populations are known to transmit and harbor numerous pathogens which pose a risk to the \$18 billion commercial swine industry. Foreign animal diseases such as Classical Swine Fever (CSF), while eradicated in the U.S. in 1976, could have a devastating economic impact to the swine industry and economy if reintroduced into the U.S. To proactively address foreign animal disease risks, the U.S. Department of Agriculture Animal and Plant Health Inspection Service conducts surveillance for CSF in domestic and feral swine. To date, within this surveillance program, more than 6,300 serological and tissue samples have been collected from feral swine and tested for CSF. None of the 6,376 samples have tested positive. Because of this surveillance and the response infrastructure already in place, if CSF was detected in feral swine, swift response and recovery would reduce the impact of an outbreak on the U.S. swine industry and U.S. economy.

Technical Session 8: Control Measures

Aerial hunting feral hogs in non-traditional areas

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Feral hog populations continue to invade new states each year. In most cases, these hogs are intentionally released for sport hunting but in some cases they appear to be accidental releases from game farms or hog farms. The immediate reaction by most states is to create an “open season” on hogs and encourage hunting to eliminate the population. This action in our opinion is a mistake and will likely make control efforts more difficult. In Kansas, we have legislation that prohibits sport hunting of feral hogs primarily to remove the incentive of “sport hunting releases”. Coupled with legislation, we have an aggressive state and federal control program that primarily utilizes trapping, shooting and aerial hunting with a helicopter. After four years of statewide control, our populations have nearly been eliminated in some areas and we have very good control on others. We believe the success of our control program could not have been achieved without the use of aerial hunting.

Aerial hunting is costly, time consuming to organize, controversial to the general public and a media nightmare, but it works! There seems to be a consensus among states that have never aerial hunted that it won't work in their state for a variety of excuses such as the trees are too tall, or that the land ownership is too broken up, or the public will oppose it. Kansas has overcome all those issues and more while developing a successful program. States that are conducting feral hog control and do not have a history of aerial hunting need to step back and reconsider this tool as a necessary part of their control program. This presentation will provide advice to states that may be interested in developing an aerial hunting program.

Techniques used to manage feral hogs on Cumberland Island National Seashore

Doug M. Hoffman

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Cumberland Island National Seashore is the largest barrier island in the state of Georgia, encompassing 36,400 acres. The presence of feral hogs on this island dates back to arrival of Spanish settlers in the 1500's. National Park Service (NPS) hog control efforts have varied since establishment of the Seashore in 1972. Wilderness use restrictions affecting 10,000 acres, dense vegetation, and large home range sizes of hogs make management challenging. Prior to 2001, feral hog impacts to federally threatened loggerhead sea turtle (*Caretta caretta*) nests approached 25%. Intensive control efforts over the last 10 years have been successful in preventing depredations to turtle nests and minimizing damage to the island's natural resources. Current methods include trapping along open roads, hunting on foot, and the use of night vision equipment. Hunting by experienced NPS personnel has proven the most efficient at removing the maximum number of animals per unit of time expended, accounting for 88% of hogs removed. Trapping requires a significant amount of

time investment per animal captured; is only successful during spring and summer months when no mast is available; and has accounted for 12% of hogs removed. Night vision equipment (Gen. 3 goggles and riflescopes) has been essential for removing specific animals threatening sea turtle nests and other important resources. The use of dogs is unfeasible due to large expanses of impenetrable vegetation, private property inholdings, and public perception. There is evidence of younger age class females breeding, likely due to increased harvest pressure on the population. Analysis of pregnant females (N=73) reveals fetal sex ratio of 0.86f:1m; mean fetal count of 5; mean corpora lutea count of 6; and fertilization success of 73%. While the island's feral hog population is relatively low (≤ 500 hogs) compared to other sites, continuous control is necessary to combat their reproductive potential.

State regulations pertaining to feral swine in the United States and implications for management

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We examined the game and agricultural laws regarding feral pigs in 32 states. We categorized these states into those with widespread and established pig populations, emerging pig populations, and states trying to preclude the establishment of feral pigs. We examined the difference in the legal classifications of feral pigs between these states, and how this relates to management goals. In states with widespread pig populations, pigs were most frequently categorized as game animals, whereas in states without pigs or with emerging pig populations they were more likely to be classified as nuisance species. The increasing popularity of feral pig hunting seems to be increasing along with populations of feral pigs, and game and agricultural laws are the best tools we have to manage this expanding problem. We would like to discuss the efficacy these laws may or may not have on expanding pig populations and the illegal transport and release of feral pigs into new areas of the US. We will take a look at the different legal strategies employed by different agencies to achieve the desired management or eradication goals. States that do not yet have feral swine problems could gain from the experiences of those that have been dealing with this issue for some time.

Trained dogs and nuisance wild pig management

Buddy L Goatcher¹ and Adam M. Goatcher²

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The role of trained dogs in nuisance wild pig management has a controversial and sometimes conflicting history. The sequence for integrating trained dogs into a wild pig removal program with other techniques like trapping, stalk-and-shoot, snares, shooting from aircraft and other modes of removal depends on multiple factors. Not all literature accounts agree on the timing and sequence of trained dog deployments in concert with other common removal methods. Trained dogs handled by professionals are commonly erroneously equated to sport hunting dogs used by the general public. The differences lie in the efficiency, non-target losses/harassment and ethical/humane character of wild pig removals with trained dogs. We report our experiences using trained dogs to remove over 6,000 nuisance wild pigs in a variety of habitats from California to Florida since 1985. Our work with radio telemetry collared wild pigs (e.g., the "Judas-pig") has provided us insight into wild pig responses to trained dogs and the development of eradication resistant populations of wild hogs. We reviewed the suite of wild pig hunting dogs worldwide, tested a few unique breeds, and conclude effective wild pig location and removal with trained dogs is more about individual exceptional trained canines, rather than specific breeds of dogs. A recent innovation in technology, the Global Positioning System (GPS) canine tracking collar, allows the professional dog handler more control of the trained dog, increases wild pig removal efficiency and reduces political and legal issues associated with trespass and lost dogs typically associated with hunting dogs and wild pig removals. The GPS collar allows users to upload hunt data to personal computers for analysis in Geographical Information Systems and on-line mapping programs such as Google Earth. We make recommendations on the strategic use of professional handlers and trained dogs for wild pig population control and eradication.

Effectiveness of the pilot bounty program on wild pigs at Fort Benning, GA

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The cost of hiring permanent employees or contactors for the purpose of removing wild pigs (*Sus scrofa*) is often a limiting factor in control efforts. To forgo the expense of hiring permanent staff, the Fort Benning military installation in west-central Georgia, USA, began offering a \$15-\$40 bounty on pigs, as funding allowed, in June of 2007. Participants were required to present the tails of harvested wild pigs as proof of harvest on the installation. To gauge the effectiveness of the program, we conducted camera surveys of the pig population within a 37km² section of the installation at 1, 6, and 18 months, respectively, after the start of the program. We also recorded the percentage of tagged pigs harvested throughout the first 18 months of the program to compare to the proportion of tagged pigs harvested by hunters in 2004 and 2005. In the first 18 months of the program, 285 participants reported harvesting 2,671 pigs at a cost of \$87,505 or \$32 per pig. Minimum density estimates from July of 2007 (1.07 pigs/ km²) and December of 2007 (1.15 pigs/ km²) showed little change in the number of pigs in the population; however, by December of 2008 pig density had increased 71% to 1.97 pigs/km². Participants reported harvesting 8% (10/120) of tagged pigs in the first 18 months of the program, which was a 23% decrease from previous years. Heavy persecution of pig populations has resulted in temporary reductions in population density in several studies. Failure to do so in this case may have been partially due to extensive bait use early in the program as well as a general increase in productivity following a severe drought in 2007. The number of pigs harvested may also have been exaggerated, as participants could have received funds for pigs harvested off the installation or for multiple sections of individual pig tails. We suggest offering a bounty on pigs may be a cost effective method of removing animals where hunter interest is minimal; however, where pigs are heavily persecuted, offering a bounty is likely unnecessary. Where bounty programs are implemented, we suggest prohibiting shooting over bait piles, and requiring whole carcasses be presented for proof of harvest.

Technical Session 9: Control Measures

Too many pigs? Population trends and control methods for wild boar and feral pigs

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Wild boar and feral pigs (*Sus scrofa*, hereafter collectively referred to as wild pigs), are among the most widely distributed mammals in the world and have the highest reproductive output compared with other ungulates. Data derived from hunting statistics in several European countries indicate that in the past four decades the species increased in numbers and distribution throughout Europe. Similar trends were also recorded in the US and Australia. Wild pigs occupy an extremely wide spectrum of habitat types ranging from semi-arid environments to tropical forests, mountains and marshes. Recently, wild boar have been observed in suburban areas: cities such as Berlin, Barcelona, Genoa and several towns in Italy, France, Switzerland and Spain reported increasing numbers of wild boar sightings. This study will examine some of the factors commonly quoted to explain the increase in numbers and range of wild pigs. These factors include human depopulation and reforestation of rural areas, changes in agricultural practice, deliberate introductions for hunting purposes, lack of predators, limited hunting, supplementary feeding and climatic changes. The study will also illustrate lethal and non-lethal control methods used to control wild boar populations in Europe and wild pigs worldwide. Each method will be discussed in terms of effectiveness, feasibility, cost, humaneness, sustainability and public support.

Preliminary results of a localized management or "whole-sounder" approach to wild pig control

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Recent evidence indicates wild pig (*Sus scrofa*) matriarchal groups, i.e., "sounders", maintain exclusive core-use areas and show little or no home range overlap between adjacent sounders. Based on this territorial behavior, we focused control efforts on the removal of individual sounders on an 11,000 ha portion of Fort Benning, GA. In May, 2009 we trapped and removed 100% (34/34) of pigs from 2 selected sounders within a 1,489 ha preliminary removal area. These sounders were among 8 that had been identified through camera surveying in January of 2009 and captured and tagged during a trapping session in February and March of 2009. Within each captured sounder, we deployed 1-2 GPS collars on adult sows in effort to determine the location of individual sounder home ranges. To detect the presence of re-colonizing pigs in the removal area, we maintained camera monitoring sites within the home ranges of removed sounders. In July, 2009 a sounder adjacent to the removal area was detected at a camera site within the removal area; however, GPS data revealed this sounder had spent time within a 245 ha portion of the area prior to sounder removal. No other sounders have re-colonized this original removal area. During November, 2009 we removed 95% (39/41) of pigs in 3 additional sounders, expanding our original removal area to 2,409 ha. Of the remaining two pigs, 1 adult sow was killed by a hunter and 1 piglet avoided capture. To date, we have documented 5 temporary sallies into the removal area by adjacent sounders; however, re-colonization has not occurred. Results suggest trapping efforts can be greatly economized by utilizing a whole-sounder approach, and, furthermore, the successful removal of whole sounders will likely yield reduced re-colonization times in relation to current control efforts.

A recipe for successful pig control: lessons learned from the third largest island pig eradication

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Santa Cruz Island, California is the third largest island (62,000 acres) in the world where feral pigs (*Sus scrofa*) have been eradicated. Island co-owners, the National Park Service and The Nature Conservancy, solicited competitive bids and awarded the US \$3.9M contract to a New Zealand company (Prohunt, Inc.) that specialized in ungulate control. Prohunt developed an eradication plan which centered on reducing the population to zero detectable density as quickly as possible, while ensuring that the pigs remained naïve to eradication methods throughout this process. This was achieved by the extensive use of a helicopter (Schweizer 269C) flown by experienced hunter pilots, a team of six professional hunters and 26 dogs, and the systematic application of a range of conventional hunting techniques that put all pigs at risk and minimized the chance of them escaping at all population densities. A comprehensive range of hunting data was collected and analyzed daily in a geographic information system. The island was fenced into five zones before hunting commenced, and within each zone the same general sequence of control methods were used. The following totals represent the percentage of pigs dispatched per method and in the order they were implemented: trapping = 16% (1,660 trap-nights); aerial shooting = 77% (8,589 miles of flight path); ground-based hunting with trained dogs = 5% (1,111 hunter-days), and Judas pigs = 2%. Island managers initially modeled this eradication on the nearby Santa Catalina pig project, and estimated it to take seven years to complete. Prohunt removed 5,036 pigs from the island within fourteen months, making this the most efficient feral pig eradication to date. A further eight months of an intensive monitoring confirmed eradication was successful. The lessons learned through this project can serve as a model for future pig removal projects elsewhere.

Methods and results in managing feral hog damage to a project area in the Upper Gulf Coast of Texas

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Texas Wildlife Services personnel have conducted feral hog management in a project area in the upper gulf coast region of Texas for the past two years to protect a variety of resources. The hogs are primarily damaging rice and corn crops, pasture, livestock feed, and posing a threat to the endangered Attwater's

prairie-chicken. Numerous methods have been implemented to reduce hog numbers and minimize damage suffered by local farmers and landowners. Wildlife Services personnel have employed snaring, shooting, aerial hunting, spotlighting, and the use of night vision and infrared equipment in the attempts at reducing the feral hog population. The success and results of these methods have been varied and are influenced by a number of limiting factors. Aerial gunning was the most cost effective method but was heavily limited by ground and canopy cover. Night shooting proved effective but was also limited greatly by crop height.

Pigs under pressure: evaluation of fences for containing motivated feral swine during depopulations

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Means for quickly and effectively containing feral swine (*Sus scrofa*) during disease outbreaks are needed. We conducted preliminary evaluations of 5 fence types and, based on efficacy, selected traditional 0.86-m-high hog panels to test rigorously for containing feral swine in 50-m × 75-m pens under progressively increasing levels of motivation over the course of 4 to 14 days in southern Texas, USA. During 35 trials with 6 pigs each a total of 7 out of 214 individuals breached. Motivation ranged from minimal human disturbance, pursuit by humans with paintball projectors, and pursuit by gunners in a helicopter. We conducted 2 additional trials of longer duration, 14 days, during which a single pig escaped during 1 trial. In addition to being quite effective in containing motivated feral swine, enclosures constructed of hog panels were relatively inexpensive (\$5.73/m) and easier to erect than other fencing options.

Technical Session 10: Human Dimensions and Wild Pig Distribution

Characterizing, quantifying, and addressing wild pig damage: building your case for a call to arms using landowner surveys

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Since the St. Louis conference, chances are good that wild pigs in your state have increased: 1) in both number and distribution, 2) their negative economic impacts, 3) expenditures of fiscal and physical resources towards their control and 4) your frustration as to whether your management efforts are making any difference! The Texas AgriLife Extension Service recognized the need to measure the success of management efforts by going beyond a “body count” of wild pigs removed. Therefore, survey data were collected from: 1) cooperators who characterized and quantified damage before and after professional (i.e., Wildlife Services) control efforts and 2) landowners who characterized pig damage/control efforts and the associated impacts of educational outreach program efforts. Cooperator surveys revealed that agricultural economic impacts of wild pigs were reduced by 66% over a two year period (2006-07) following direct control efforts on 48 cooperator properties (223,017 acres). Program impacts were measured by administering surveys to landowners attending 109 wild pig management educational outreach programs from 2006-2009. Survey respondents (n=4,369) attending programs characterized wild pig damage, landowner-initiated control efforts and economic impacts. Approximately 98% increased their knowledge of wild pigs and their management, assigned a value of \$5.1 million to the information received and planned to adopt an average of 3.0 new management practices each. Respondents also assigned a Net Promoter Score of 54.2% to the Texas AgriLife Extension Service as a recommended source of information for wild pig management. These cooperator/landowner-generated data are particularly valuable for briefing agency policymakers and officials on identified needs in order to direct resources toward appropriate and efficient control and educational outreach efforts. Characterizing, quantifying and addressing damage via measured impacts of control/education efforts are the first steps in building your case for a call to arms in the on-going war against wild pigs.

Indexing feral swine populations near high density commercial swine operations on the coastal plain of North Carolina.

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Feral swine populations in eastern North Carolina have increased dramatically in eastern North Carolina over the past decade. Of the top ten swine producing counties in the US with feral swine populations, this area of North Carolina contains has eight in the list (Corn, et al. 2005:296). While the counties have known breeding populations of feral swine, nothing was known about the distribution within the counties or their proximity to commercial swine operations. Wildlife Services in North Carolina and the NC Department of Agriculture and Consumer Services teamed up in an effort to survey 120 randomly selected commercial swine operations in four counties in North Carolina using personal interviews with farm operators and a passive track index using trail cameras.

Results from interviews with farm operators indicated that only 3 of 112 were not aware of feral pigs in the county of their operation. Twenty out of 109 respondents (18.3%) indicated that they had observed feral pigs or sign on their facility at some time in the past. Fourteen operations of the 120 surveyed had observed feral swine or sign within the last year. (Interestingly, however, feral swine activity was observed by NCDA personnel on 19% of the properties where the operator had indicated never having observed feral swine.) Observations were also made concerning biosecurity on the selected farms. Trail cameras did not detect any feral swine activity during the 12 days of camera activity but results from other, more abundant, species indicate the camera technique has promise as feral swine populations increase. We concluded that feral swine are present near commercial farm operations in the four study counties. Sign and observations indicated that present biosecurity methods may not be adequate to protect from potential airborne disease transmission and in some cases may even allow feral swine direct contact with commercial swine. The use of trail cameras have potential in enabling better monitoring of feral swine in proximity to commercial swine operations.

National Feral Swine Mapping System

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The Southeastern Cooperative Wildlife Disease Study (SCWDS) began producing maps of the distribution of feral swine in the United States in 1982. Maps were produced in 1982, 1988 and 2004 using data provided by the state and territorial natural resources agencies of the United States. In 1982, 17 states reported feral swine in a total of 475 counties. In 2004, 28 states reported feral swine in 1014 counties. In 2008 we implemented the National Feral Swine Mapping System (NFSMS) in cooperation with USDA-APHIS-Veterinary Services. The NFSMS is an interactive data collection system being used to collect and display area data for the distribution of feral swine in the United States. Data are provided by state and territorial natural resources agencies and USDA-APHIS-Wildlife Services. Distribution data submitted by agency personnel are evaluated on a continual basis, and the distribution map is updated with verified additions on a monthly basis. Feral swine populations and/sightings are designated on the map either as established and breeding populations, or as sightings. The NFSMS is accessed via the internet at <http://feralswinemap.org/>. Over 400 changes to the national feral swine map have been made through the NFSMS since its initiation in 2008 and as of early 2010 a total of 36 states were reporting a presence of established feral swine populations.

The distribution of wild pigs on Department of Defense Lands in North America

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³ Kansas State University, Manhattan, KS, USA

Either through natural or man induced movement, wild pigs appear to be expanding their range throughout North America. There is concern within the Department of Defense about negative effects of wild pigs on

natural habitats and on military and other infrastructure. We conducted a survey of Natural Resources Managers on US military and civilian Department of Defense lands throughout North America to determine the occurrence of feral pigs, types of damage they are causing, and levels of management effort devoted to feral pigs. We present an analysis of responses we received from over 175 different Department of Defense land locations. The results of this survey indicate that wild pigs are widely distributed on Department of Defense lands, that their presence and origin has been strongly influenced by deliberate human (but not necessarily Department of Defense authorized) introduction, that there appears to be significant appearance of Eurasian ancestry, and that management efforts are largely directed at control. We hope that the results of this survey will lead to better coordinated management programs.



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Poster Sessions

Invasive.org and the center for invasive species and ecosystem health: tools to support invasive species outreach and education

Charles T. Bargeron, David J. Moorhead, G. Keith Douce, Joseph H. LaForest, Karan A. Rawlins, and J. Erin Griffin

The University of Georgia – Center for Invasive Species and Ecosystem Health, 4601 Research Way, P.O. Box 748, Tifton GA, USA

The Center for Invasive Species & Ecosystem Health at the University of Georgia (www.bugwood.org) mission is to serve a lead role in development, consolidation and dissemination of information and programs focused on invasive species, forest health, natural resource and agricultural management through technology development, program implementation, training, applied research and public awareness at the state, regional, national and international levels. The Center was formalized in 2008 as an expansion of The Bugwood Network, which is now the information technology component of The Center. Bugwood web sites received 165 million hits and were accessed by 9.1 million worldwide users during 2009. 110,000 images are available for educational uses through the Bugwood Image Database System. EDDMapS is being implemented and used for invasive plant, animal and biological control projects across the U.S. ranging from Florida, the SE, into the Mid-Atlantic and upper Missouri River areas, and in Alaska. EDDMapS contains 610,000 county reports, 236,000 point reports on 1,728 species and is being used by more than 1,100 Users.

Comparing the use of twelve parameters for estimating total body mass in wild pigs

John J. Mayer

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The collection of total body mass (TBM) data from wild pigs (*Sus scrofa*) is essential for various management applications. Unfortunately, the harvest of these animals does not always provide the aforementioned TBM data needed. The purpose of this study was to develop predictive methods of TBM estimation for wild pigs using a large data set from the Savannah River Site (SRS), located in western South Carolina. The parameters compared would include both the previously used variables (i.e., gutted weight and heart girth) as well as ten others that have heretofore not been evaluated. A collective total of 2,174 animals were included in this study. The variables were analyzed using either a Bivariate Linear or Polynomial Fit program. The most accurate estimates (i.e., r^2 values of 0.97 to 0.99) were derived using gutted weight, body volume (i.e., heart girth x head-body length) and heart girth. However, all twelve of the parameters evaluated gave good results with r^2 values of ≥ 0.80 . The best predictors of TBM to use were those that either were reversible or had a reversible component. However, even those parameters that did not have that characteristic were still found to be useful in making TBM estimations in this species. In general, these techniques yielded mean TBM estimates of sufficient accuracy to meet the aforementioned application needs. Although developed for use on the wild pigs found at the SRS, these techniques should be applicable to other populations of this species found in the United States.

Feral pigs and volcanoes: a hot topic

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Evacuations of small holdings due to volcanic activity in the late 1990's have led to the establishment of feral pig populations on Montserrat, West Indies. Montserrat is a global biodiversity hotspot with high levels of endemism, including the critically endangered Montserrat Oriole (*Icterus oberi*). Feral pigs have a direct environmental impact through predation, feeding on plants, seed dispersion, and soil disturbance. We established a pig population monitoring program based on a network of 23 camera traps. These cameras were run for a total of 1998 camera days over an area of 21Km², from July 2009 to February 2010. During this

period, 56 independent pig visits to the cameras were recorded, with an average of 4.63 visits/camera/100 days. These data show that the distribution of pigs is concentrated in the South of Montserrat where there is no public access due to ongoing volcanic activity. This population may act as a source for feral pig incursion into the Centre Hills, the most ecologically important region of Montserrat. In February 2010 a workshop was held with stakeholders including NGO's, Government agencies, hunters and landowners to explore management options for this population.

Economic estimate of wild pig damage to farm land owners in Alabama

Wen Shi, Bin Zheng, Yaoqi Zhang, Steve Ditchkoff

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It has been well documented that many farmers suffer significant damage by wild pigs in Alabama and across the Southeast. However, the extent of this damage is largely unknown. This study used a survey to investigate the extent and types of damage that occur, the crops that are most susceptible to damage, and the actions that have been taken to mitigate damage. The survey was conducted at a conference organized by the Alabama Farmers Federation. We received more than 200 respondents from the 500 participants and another 50 respondents from 300 participants at a Peanut Producer Conference in 2010. This paper provides a summary of the results of the survey, and provides suggestions to assist in mitigation of damages.

Optimization of time-lapse intervals for camera surveys of wild pigs

Brian Williams

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A number of techniques for conducting population surveys rely on the ability to identify individual animals observed in images captured by motion-triggered or time-lapse game cameras. In species for which this is a feasible concept, and especially for abundant, relatively easy to observe species, the ability to capture a sufficient number of images containing the desired animals while minimizing efforts necessary to complete a survey is invaluable. We conducted surveys of a portion of the wild pig (*Sus scrofa*) population on Fort Benning, Georgia, utilizing game cameras set at varying time-lapse intervals to determine if longer time-lapse intervals than had been previously used in surveys of wild pigs would still generate acceptable detection results for use in subsequent population estimations. Our results suggest that a 9-minute time-lapse interval, which is three times that previously reported as suitable for camera surveys of wild pigs, still generates dependable (97% similarity with a 3-minute interval) detection results for pigs. It is possible that longer intervals may continue to yield similarly dependable results.

Avoiding pitfalls when purchasing night vision and thermal equipment

Rod Pinkston

JAGER PRO™ Hog Control Systems 10 Sweetwater Drive, Cataula, GA, USA

Many Federal agencies are researching various night vision and thermal imaging products from multiple manufacturers to perform future wildlife control work. These product spec sheets are difficult to understand and confusing. Be an informed consumer and stop wasting your budget on sales hype. This presentation will allow agents and biologists to better understand the technology and purchase the right equipment for their specific needs.

Night Vision Performance-- The image intensifier tube is the heart and soul of any night vision device and represents 75% of the overall system cost. Each substantial change in technology establishes a new generation. Night vision devices can be either a 1st, 2nd or 3rd generation unit depending on the type of intensifier tube used.

There are three important factors for measuring image tube performance. They are signal-to-noise, photocathode sensitivity and resolution. All three items are listed on the tube's manufacturer data sheet. You need to understand these three characteristics to determine the performance level of a night vision system.

Thermal Imaging Performance-- The digital size of the pixels used in the thermal core represents the overall performance of a thermal imaging device. Each substantial change in technology establishes a new detector type. Thermal imaging detectors can be either 160x120, 320x240 or 640x480 resolution. There are currently no thermal scopes on the civilian market which perform well enough to recommend for wildlife control

purposes. Civilian 320x240 thermal scopes are manufactured with a digital pixel size of 53 microns and cannot handle recoil on rifles larger than a .223 caliber. It takes a military-grade pixel size of 38 microns or smaller to use for wildlife control. Federal agencies can purchase 640x480 "military and law enforcement only" products with a 28 or 25 micron pitch to allow users to see 800+ yards at night.

Immunocontraception of male feral swine with a recombinant GnRH vaccine

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New tools and techniques are needed to effectively manage feral swine (*Sus scrofa*). Our objective was to determine if a recombinant GnRH vaccine is a potential immunocontraceptive agent for young male feral swine. We randomly assigned animals to 1 of 4 treatment groups, each with 6 replicates or animals. We treated animals in Treatment 1 with a single injection of a sham vaccine containing 1 ml of a buffer AdjuVac™ emulsion. Treatment 2 received 1,000 µg GonaCon™, developed at the National Wildlife Research Center. Treatment 3 received 1,000 µg of a recombinant GnRH (rGnRH) vaccine, called IMX294, provided by Imaxio from Lyons, France. Animals in Treatment 4 received a 500 µg rGnRH vaccine. On Day 90 of the trial, Treatment 4 received an additional 500 µg boost treatment rGnRH vaccine. All vaccines were made into an emulsion with AdjuVac and injected intramuscularly into the rump. At the end of the study we performed necropsies on swine and compared mass of testes, percent normal tubules, number of spermatogonia, number of spermatocytes, and number of spermatids, serum testosterone levels, and anti-GnRH antibody titers among treatments. As expected, a single dose of GonaCon vaccine reduced testes mass, serum testosterone, percent normal tubules, and restricted sperm development at each stage. These reductions in reproductive development were associated with elevated GnRH antibodies. The single injection of rGnRH was not as effective in reducing these reproductive parameters; however, the two dose injection of rGnRH was as effective as the single injection of GonaCon. In addition to our positive control GonaCon, the two dose rGnRH vaccine was successful at altering reproductive parameters in young male feral swine. Consequently, we conclude that the product could be used as a potential immunocastration agent for male feral swine.

Evaluation of feral swine specific feeder systems

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Invasive feral swine (*Sus scrofa*) have been introduced across many portions of the globe, including rangeland ecosystems of the United States. Rangelands are impacted by feral swine primarily through soil disturbance caused by rooting activities. New damage control methods are needed and will require an oral delivery system for effective administration to feral swine populations. Our objective was to evaluate candidate non-target exclusion feeder systems for feral swine as a means to deliver baits containing pharmaceuticals in a rangeland ecosystem of southern Texas. We used three non-target exclusion feeder system prototypes during this study baited with whole kernel and fishmeal baits. We monitored each feeder system for 4 wks (during November–December 2008) using motion sensing digital photography. The percent decrease in bait removal following the activation of the boar operated systems (BOS) was 48% for feral swine and 100% for all other species. The percent decrease in bait removal following the activation of the non-target exclusion device (NED) was 19, 28, 100, and 100% for raccoons, feral swine, white-tailed deer, and collared peccaries, respectively. The importance of the BOS feeder at delivering baits to only feral swine in a rangeland setting cannot be overstated. We recommend further evaluation of the BOS feeders within rangeland and other ecosystems of the United States, particularly those containing sympatric feral swine and black bears (*Ursus americanus*).

Wildlife contact rates at artificial feeding sites in Texas

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In Texas, white-tailed deer (*Odocoileus virginianus*) are often supplemented with artificially prepared grain or pellets, which are also used by non-target animals. The intraspecific and interspecific contact rate among wildlife is a fundamental factor in disease transmission, yet few estimates of contact rates exist. Our objectives were to determine the rate of intraspecific and interspecific contacts by sex for species visiting artificial feeding sites, and to estimate the number of raccoons (*Procyon lotor*), feral swine (*Sus scrofa*), and collared peccaries (*Pecari tajacu*) that visited feeders. We built gravity fed free-choice corn feeders using 6" PVC and monitored units with infrared digital camera systems and a passive integrated transponder (PIT) reader programmed to store all tag numbers, date, and time. We marked individuals with ear and PIT tags to quantify population size and feeder use. We trapped, anesthetized, and marked 39 raccoons, 42 collared peccaries, 70 feral swine, 3 opossums (*Didelphis virginiana*), and 1 fox squirrel (*Sciurus niger*) on 3 properties in southern Texas in the spring and fall of 2009. We accumulated 407,000 digital images and 102,000 PIT tag scans during spring. From these we observe 9 mammalian and 14 avian species visiting feeders. Our data suggest artificial feeding sites facilitate contact among and within species and increase the possibility of disease transmission.

Feral swine exclusion fencing at deer feeders

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Feral swine (*Sus scrofa*) cause damage to property and resources throughout Texas. Surveys indicate that Texas landowners feed 136 million kg of corn intended for wildlife, particularly white-tailed deer (*Odocoileus virginianus*). However, on properties with feral swine much of this feed is consumed by swine. Our objective was to evaluate 3 heights of exclusions fencing for effectiveness at reducing feral swine access to deer feeders. From 29 June–28 July 2009 we monitored 6 deer feeders with motion sensing photography. During the first 14 days, wildlife had free access to feeders. On day 15 we constructed exclusion fencing around feeders at heights of 51, 61, and 86 cm and a diameter of 9 m. Each fence type had 2 replicates. We downloaded data from cameras 3 times per week and recorded the maximum number of animals per hour by species. We calculated the percent change in number of animals per hour from the 14 days before fencing to the 14 days after fencing. We found feral swine access to be reduced 100% for the 86 and 61 cm fence and 58% for the 51 cm fence. We found deer access to be reduced 11% for the 86 cm fence and that deer use increased 9 and 13% for the 61 and 51 cm fences, respectively. Our data indicate that feral swine damage to deer feeders can be reduced with the addition of exclusion fencing ≥ 61 cm in height.

Feral swine behavior relative to aerial gunning in southern Texas

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Feral swine (*Sus scrofa*) impact resources through their destructive feeding behavior, competition with native wildlife, and impacts to domestic animal agriculture. We studied aerial gunning on feral swine to determine if aerial gunning altered home range and core area sizes, distances between home range centroids, and distances moved by surviving individuals. We collected data pre, during, and post aerial gunning in southern Texas. Using Global Positioning System collars deployed on 25 adult feral swine at 2 study sites, we found home range and core area sizes did not differ between pre and post aerial gunning. However, feral swine moved at a greater rate during the aerial gunning phase than during the pre and post periods. We concluded

that aerial gunning had only minor effects on the behavior of surviving swine and that this removal method should be considered a viable tool in contingency planning for a foreign animal disease outbreak.

Activity patterns of feral swine in southern Texas

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Feral swine (*Sus scrofa*) are increasing in abundance and distribution throughout North America. Limited evidence suggests that feral swine activity patterns may be influenced by temperature in portions of eastern and southern Texas. However, this relationship has not been clearly demonstrated. Our objectives were to determine feral swine daily and weekly activity patterns and to evaluate the hypothesis that temperature influences feral swine activity in southern Texas. We placed global positioning system collars on 25 feral swine from two properties in southern Texas and programmed collars to store locations at 15 minute intervals on two consecutive days during each week. Feral swine on both properties displayed highly nocturnal activity patterns. Our data related to temperature influences suggests that during the dormant and early growing season (January–March) feral swine increase activity during warmer periods. However, our activity data from summer (May–July) suggests no influence of temperature. We believe that reductions in trapping success were observed during the summer because of the availability of alternative forage associated with the growing season and therefore not directly related to temperature. In fact, during summer drought periods we believe that trapping success can be increased above other times of the year by targeting trapping effort near sources of water.

Visitation to cottonseed storage sites by feral swine and evidence of gossypol exposure

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The increasing popularity of feeding whole cottonseed as a supplement to livestock and wildlife provides avenues for feral swine (*Sus scrofa*) to consume cottonseed, thereby causing damage and possibly toxicosis. Our objectives were to describe our visual and telemetry observations of feral swine visitation to whole cottonseed storage sites, to estimate the proportion of feral swine consuming whole cottonseed, and to infer toxicosis using erythrocyte osmotic fragility of feral swine. We trapped and ear-tagged 76 feral swine on 11 and 14 January 2008. We placed GPS collars with VHF mortality sensors on 12 adults (8 boars and 4 sows). We collected blood from feral swine located ≤ 1.5 km from cottonseed storage sites on 29 February 2008. We determined erythrocyte osmotic fragility using standard procedures. We found 7 (58%) GPS monitored feral swine to have visited a cottonseed storage sites frequently (from 11-41% of locations). We found erythrocyte osmotic fragility for swine in close proximity to cottonseed storage sites to be greater than that found in control animals. Our data suggest that feral swine regularly travel long distances to consume whole cottonseed during periods of resource scarcity in southern Texas, which may pose challenges for wildlife managers.

Present distribution, abundance, and problems of wild pig (*Sus scrofa*) in Iran

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I collected information on presence, distribution, abundance, and problems associated with wild pigs based on questionnaires sent to Provincial Offices of Iran Department of Environment (DOE). I also interviewed wildlife experts of DOE who could travel to Tehran to collect further information. Published literature, thesis and dissertations were also reviewed on the subject. Synopsis of gathered information indicates that wild pig live in a range of habitats throughout Iran with growing populations. This is due to expansion of agricultural

fields and orchards, reduction of hunting and suppression of top predators as wolves and leopards following the extinction of lions in 1940's. Permits issued by DOE to religious minorities and foreign hunters are not adequate to curtail the growth of populations. We observe higher number of collision with pigs on roads, more complaints by farmers, especially around protected areas, and reports of the spread of diseases as Balantidiasis in rural communities. Wild pigs are also implicated in dissemination of diseases as foot and mouth (FMD), Ectyima and Brucellosis among Iranian wildlife including wild sheep, wild goats and gazelles besides domestic animals. Various control techniques are used by farmers to safeguard their farms. These include baiting, using electrically charged fences, mixing flour with gypsum and even guarding the farms overnight. (Please note: this research is in progress)

Comprehensive surveillance for various diseases in feral swine in the United States

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As feral swine populations increase in size and spread throughout the U.S., the likelihood for disease transmission to domestic swine and humans increases. To proactively address this possibility, the U.S. Department of Agriculture's Wildlife Services' National Wildlife Disease Program has implemented a comprehensive feral swine disease surveillance project which targets endemic and foreign animal diseases that have been documented in feral swine. Serum samples are collected from feral swine and tested for classical swine fever, pseudorabies, swine brucellosis, toxoplasmosis, and trichinosis. Several other pathogens such as porcine reproductive and respiratory syndrome virus and swine influenza virus have been investigated locally. Preliminary results from the nationwide surveillance project indicate that several diseases are widely distributed in feral swine populations while others are rare or apparently nonexistent, and others require more robust sampling.



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