WILD PIG CONFERENCE

SCIENCE, MANAGEMENT & SOLUTIONS

April 15-18, 2018
Oklahoma City,
Oklahoma

CO-HOSTED BY:

MISSISSIPPI STATE UNIVERSITY

NOBLE RESEARCH INSTITUTE

CONFERENCE NOTES

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THANK YOU

WELCOME

Welcome to Oklahoma City and the 2018 International Wild Pig Conference!

The mission of the Wild Pig Conference has been to provide a venue for learning, networking, and training. Once again, the 2018 WPC offers all of these opportunities. The WPC technical training will take place at the beautiful Wichita Mountains Wildlife Refuge and will offer a full-day of demonstrations and control techniques. The conference technical sessions will begin the following morning with a diverse agenda of topics related to wild pig management, biology, toxicants, human dimensions, and more. As with the 2016 WPC, the National Wild Pig Task Force will meet and conduct elections for the next group of Task Force leaders. The National Wild Pig Task Force provides a diverse, yet unified, voice for combating the issues surrounding wild pig control and management.

This year, we again received a wonderful array of abstracts for oral and poster presentations, providing a rich and diverse agenda. In order to accommodate as many speakers as possible, there will be concurrent sessions Tuesday and most of Wednesday. We also encourage you to view (at your leisure) the poster presentations that will be available between and after the oral presentations. Included with registration is supper at the National Cowboy and Western Heritage Museum on Tuesday evening, providing a great opportunity to network and interact with our presenters and colleagues.

Our plenary session will feature Jim Reese, Oklahoma Secretary and Commissioner of Agriculture; Bill Buckner, President and CEO of the Noble Research Institute; and noted Agricultural producer, Dave Wingo. We are grateful to these gentlemen for giving their time to our attendees, the conference, and Oklahoma.

I would be remiss if I didn't thank the Noble Research Institute, LLC for serving as co-host of the 2018 conference. A special thanks to Stephen Webb, Josh Gaskamp and the team at Noble for all their help with the conference. Collectively, we invite you to enjoy the fantastic educational and professional resources available at the 2018 WPC. Oklahoma City has many points of interest, including the Myriad Botanical Gardens, the Bricktown Water Taxi, and the Oklahoma City National Memorial and Museum. If at any time you have a need or special request, Laura Andrews (662-552-8371, laura.s.andrews@msstate.edu) will be glad to assist you.

Thank you for attending!

Bronson Strickland,
Conference Organizer

Oklahoma Soybean Board
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OKTWS

DAILY AGENDA

SUNDAY, APRIL 15

1 p.m. - 5 p.m.	Wild Pig Task Force Steering Committee Meeting	Balinese Room, 2nd Floor
5 p.m.	On - site Registration Opens	Pre-function Area, 2nd Floor
7 p.m.	Welcome Reception	Venetian Room, 14th Floor

MONDAY, APRIL 16

8 a.m.	Registration	Pre-function Area, 2nd Floor
8:30 a.m.	Buses Load for Wichita Mountains WR	Skirvin Motor Court
9 a.m.	Buses depart for Wichita Mountains WR	
11 a.m.	Animal - Activated Techniques, Training Demonstrations	Wichita Mountains WR
12:30 p.m.	Lunch - Provided	
1:30 p.m.	Human - Activated Techniques, Training Demonstrations	Wichita Mountains WR
2 p.m.	Training Non-attendee Buses leave for WR	
2:15 p.m.	Shooting Techniques Training Demonstrations	Wichita Mountains WR
3:15 p.m.	Toxicant Research Training Demonstrations	Wichita Mountains WR
4 p.m.	Refuge Tour	Wichita Mountains WR
6 p.m.	Welcome BBQ & Pig Roast	Wichita Mountains WR
8 p.m.	Buses load for hotels	

TUESDAY, APRIL 17

7 a.m.	Breakfast	Centennial Ballroom, 2nd Floor
7 a.m.	Registration	Pre-function Area, 2nd Floor
8 a.m.	Welcome/Introductions	Grand Ballroom, 2nd Floor
8:10 a.m.	Plenary Speakers/Welcome	
9 a.m.	State Agency Reports	
10 a.m.	Morning Break	Centennial Ballroom
10:20 a.m.	Biology/Ecology, Concurrent Technical Session	Grand Ballroom A-D
10:20 a.m.	Techniques, Concurrent Technical Session	Grand Ballroom E-F
12 p.m.	Lunch (on your own) Park Avenue Grill features buffet	
1:20 p.m.	Spatial Ecology, Concurrent Technical Session	Grand Ballroom A-D
1:20 p.m.	Management, Concurrent Technical Session	Grand Ballroom E-F
3 p.m.	Afternoon Break	Centennial Ballroom
3:20 p.m.	Population Trends, Concurrent Technical Session	Grand Ballroom A-D
3:20 p.m.	Toxicants, Concurrent Technical Session	Grand Ballroom E-F
5 p.m.	Adjourn	
5:30 p.m.	Buses load for National Cowboy & Western Heritage Museum Skirvin Motor Court	
6 p.m.	Dinner and Networking Evening	National Cowboy & Western Heritage Museum
9 p.m.	Buses load for Skirvin	

WEDNESDAY, APRIL 18

8 a.m.	Breakfast	Centennial Ballroom
9 a.m.	International Reports	Grand Ballroom, 2nd Floor
10 a.m.	Morning Break	Centennial Ballroom
10:20 a.m.	Human - Dimensions, Concurrent Technical Session	Grand Ballroom A-D
10:20 a.m.	Disease/Pathogens, Concurrent Technical Session	Grand Ballroom E-F
12 p.m.	Lunch (on your own) Park Avenue Grill, features buffet	
1:20 p.m.	Toxicant, Panel Discussion and Conference Wrap-up	Grand Ballroom, 2nd Floor
3 p.m.	Afternoon Break	
3:20 p.m.	National Wild Pig Task Force Update & Subcommittee Meetings	Grand Ballroom, 2nd Floor
3:20 p.m.	Research - Representative Jim Beasley	Grand Ballroom A-D
3:20 p.m.	Policy - Representative Alan Leary	Grand Ballroom E-F
3:20 p.m.	Applied Management - Representative Frank Boyd	Crystal Room, 2nd Floor
3:20 p.m.	Communications - Representative Open	Balinese Room, 2nd Floor
5 p.m.	Adjourn	

PLENARY SPEAKERS

JIM REESE,
OKLAHOMA SECRETARY OF AGRICULTURE

Jim Reese was appointed by Governor Mary Fallin as the Oklahoma Secretary of Agriculture and was sworn into office on January 10, 2011. He acts as Governor Fallin's chiefadvisor on policy development and implementation relative to agriculture, food, and forestry. Secretary Reese was welcomed into office with the hottest summer ever recorded, by any state, with average statewide temperature for three months of 86.6°, average maximum daily temperature of 100.4° for three months, and also ranked the third driest on record. Oklahoma not only managed, but thrived with average receipts with percapita income growing each year. Reese serves concurrently as the Oklahoma Commissioner of Agriculture and is a member of the Board of Regents for the Oklahoma Agricultural & Mechanical Colleges, the Commissioners of the Land Office, the Oklahoma State Board of Equalization, and Chairman of the Oklahoma Drought Commission.

Secretary Reese is a graduate of Northern Oklahoma College, where he earned an associate's degree in drafting and design. He later earned a Bachelor of Science degree in Engineering Technology from Oklahoma State University.

In 1986, he was elected to the Oklahoma House of Representatives, where he served from 1987 to 2001. Reese was appointed as the Oklahoma State Executive Director for the United States Department of Agriculture (USDA) - Farm Service Agency under the administration of U.S. President George W. Bush. In 2008, Reese was appointed as the Oklahoma's Policy Advisor to the Speaker of the House. Secretary Reese has been married to Margaret Lynn Lobmeyer Reese since 1985 and has four children — Joanna, Drew, Lainey, and Spencer.

BILL BUCKNER,
PRESIDENT AND CEO, NOBLE RESEARCH INSTITUTE

Bill Buckner is the President and CEO of the Noble Research Institute, LLC, and President of The Samuel Roberts Noble Foundation. The Noble Research Institute, an Agricultural Research Organization, conducts research, education and consultation activities, with its mission being "to deliver solutions to great agricultural challenges." Philanthropic activities, including grant making and scholarship programs, take place within The Samuel Roberts Noble Foundation. Buckner joined Noble in January 2012.

After obtaining his BS degree in Agricultural Economics from the Univ. of Missouri-Columbia in 1980, Buckner gained experience in the agricultural industry in areas of agriculture retail, agriculture lending, and animal health.

In 1993, Buckner joined Bayer AG as a Marketing Executive in their Animal Health business unit located in Shawnee Mission, KS. He moved to Monheim, Germany, in 1996 where he worked for the Animal Health Business Group as a Business Development Mgr. He became VP/General Mgr. of Bayer's Canadian Agricultural business in Toronto in 1998. Buckner was appointed President/CEO of Bayer CropScience, Inc., in Calgary, Alberta in 2002. He relocated to Research Triangle Park, NC, as Sr. VP of Commercial Operations for Bayer CropScience LP in 2004 and was appointed Country Head for the U.S. Crop Protection business in 2005. He was elected President/CEO of Bayer CropScience, LP in April 2006 and retired in December 2011.

Buckner currently serves on the boards of the Soil Health Institute (Board Chair), Wilbur-Ellis Company, Mercy Hospital Ardmore and the Farm Foundation. Buckner also serves as an industry advisor to the board of Trace Genomics, Inc., and has recently joined the Kirchner Food Fellowship Board of Advisors.

Buckner has previously served on the boards of the National Wild Turkey Federation, The Liberty Foundation, CropLife Canada and CropLife America.

DAVE WINGO
FIVE-DIAMOND PRODUCTIONS

Dave Wingo is a lifelong Oklahoman. He's a native of Hughes County, where he fell in love with agriculture while working on his grandparent's farm. Dave has been a school teacher and a conservation service employee, but his true passion has always been production agriculture. Working with his wife, Brenda, they started from scratch with a few stocker cattle on rented land and built up to an impressive and diverse operation. Over the years Dave and Brenda's operation has evolved to encompass many enterprises. They've grown peanuts, soybeans, grain sorghum, wheat and pecans. They have been cow-calf producers and participated the highly respected Integrity Beef Alliance. They've also been successful stocker operators, utilizing their own home-raised cattle, as well as calves purchased from across the southern plains and southeast. Their latest venture is Five-Diamond Productions, putting on team roping events, raising and developing quality roping cattle and occasionally providing roping cattle for other's events. For many years they have been active participants in the Noble consultation program, winning Noble's highest cooperator honor as the Leonard Wyatt Memorial Outstanding Cooperators. They've also received numerous other awards over the years for their contributions to Oklahoma agriculture and their community.

Over Dave's agricultural career, he's seen the feral hog problem grow from non-existent, to a minor nuisance to a major production issue. With his property being surrounded by river bottoms that provide excellent cover, he's been on the front-line of the exploding feral hog problem. There are few others who can provide better insight into facing the feral hog issue on a daily basis, so it is my pleasure to introduce Dave Wingo.

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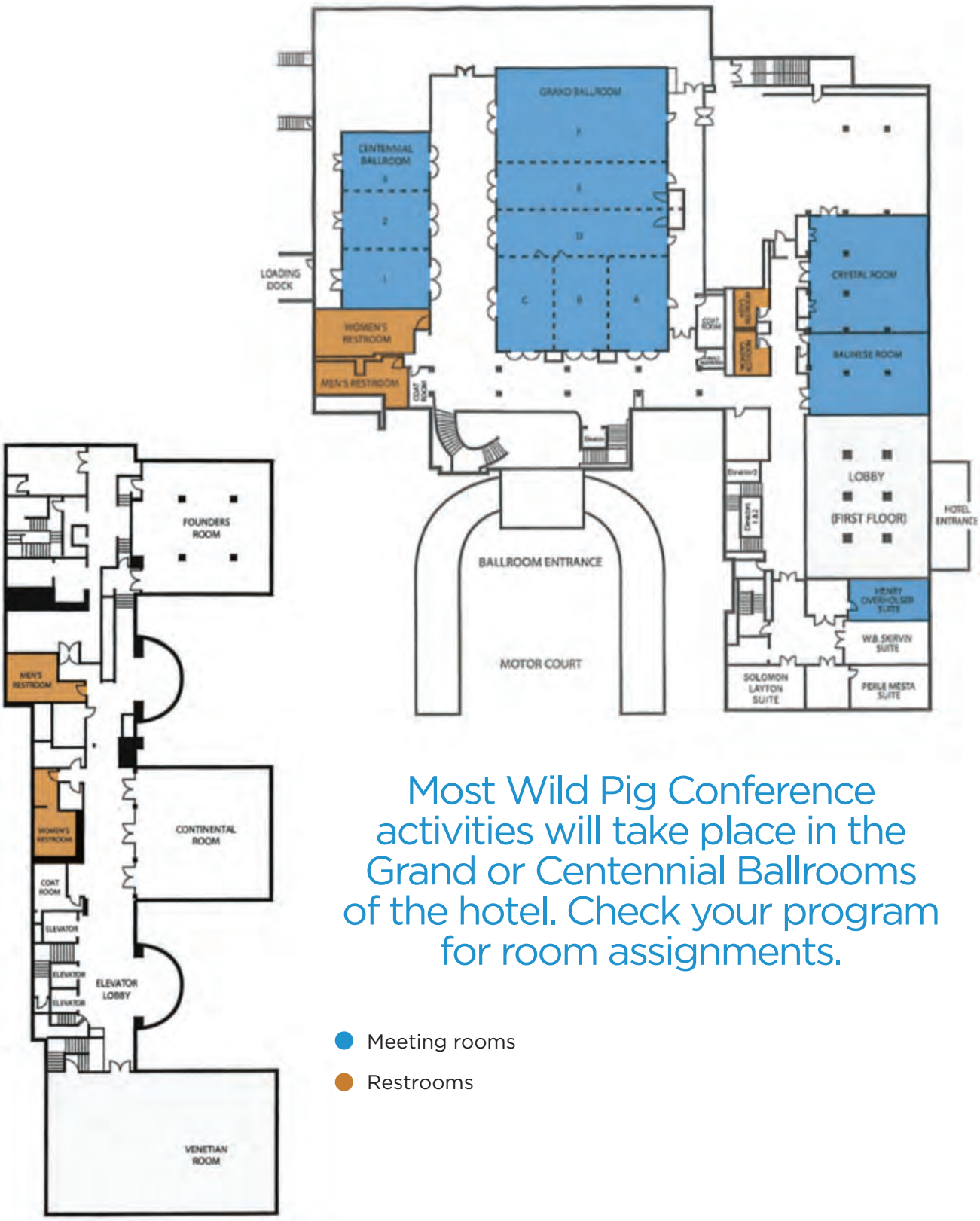
Deadline to enter: 3:30 p.m., Tuesday

SKIRVIN HILTON HOTEL



Most Wild Pig Conference activities will take place in the Grand or Centennial Ballrooms of the hotel. Check your program for room assignments.

- Meeting rooms
- Restrooms

MONDAY TECHNICAL SESSION

Join consultants from Noble Research Institute at the Witchita Mountains Wildlife Refuge for a day of technical training followed by a pig roast dinner.

11 a.m.
Animal-Activated Techniques, Training Demonstrations

Snaring Wild Pigs

Continuous Catch Design

Innovations for Box Traps

Corral Traps and Tactics

Silent Gate

Transitioning to Human - Activated Techniques

12:30 p.m.
Lunch provided

1:30 p.m.
Human-Activated Techniques Training Demonstrations

Portable Corral Traps

Suspended Corral Traps

Drop-nets

2:15 p.m.
Shooting Techniques, Training Demonstrations

Integrated Control and Private Contracts

Judas Pigs

Aerial Gunning

Helicopter Hog Hunts

Commercial Pig Hunting Facilities

3:15 p.m.
Toxicant Research, Training Demonstrations

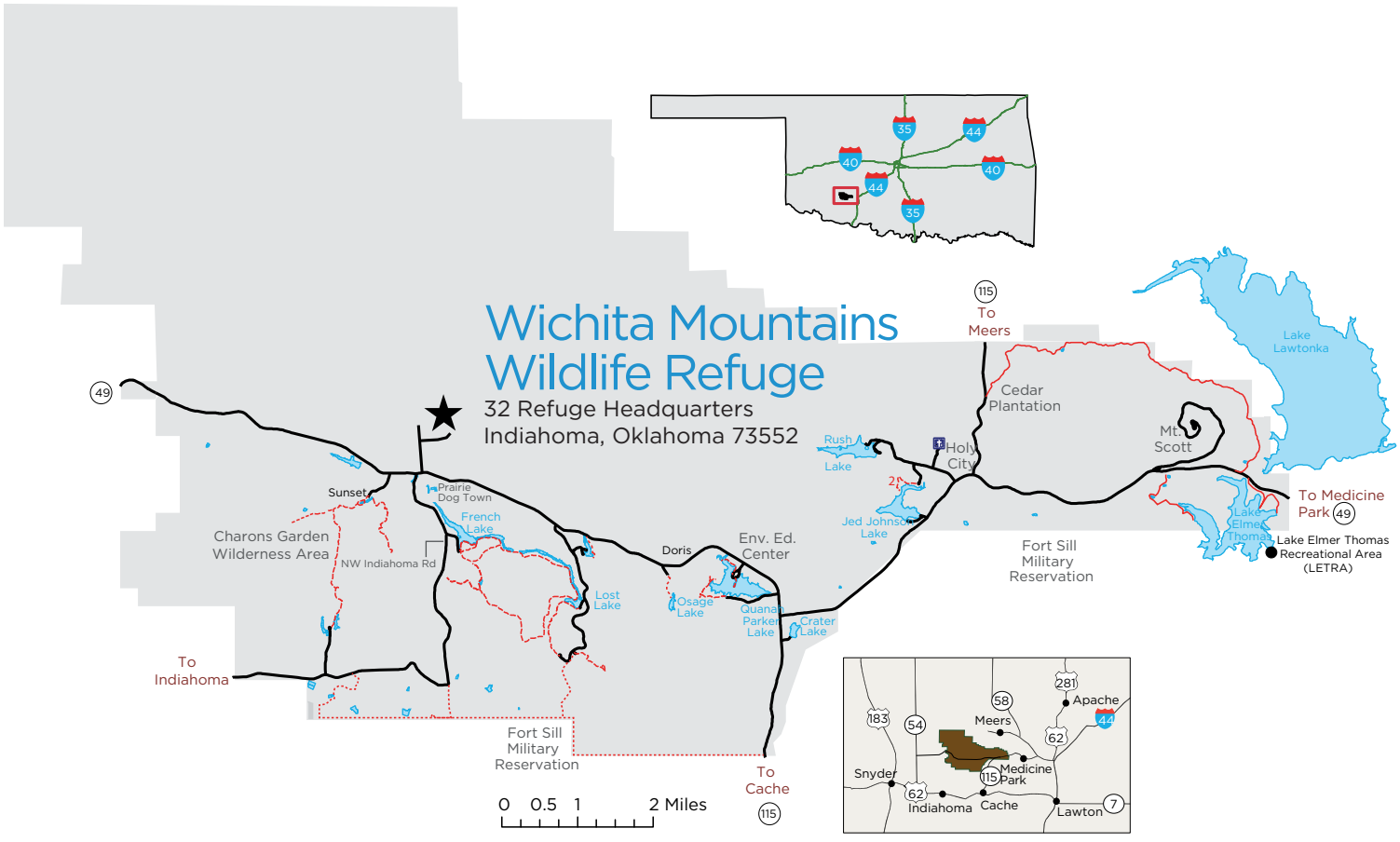
Kaput Feral Hog Bait

Sodium Nitrite/HOGGONE©

Species-Specific Bait Delivery Systems

4 p.m.
Refuge Tour

6 p.m.
Welcome BBQ & Pig Roast



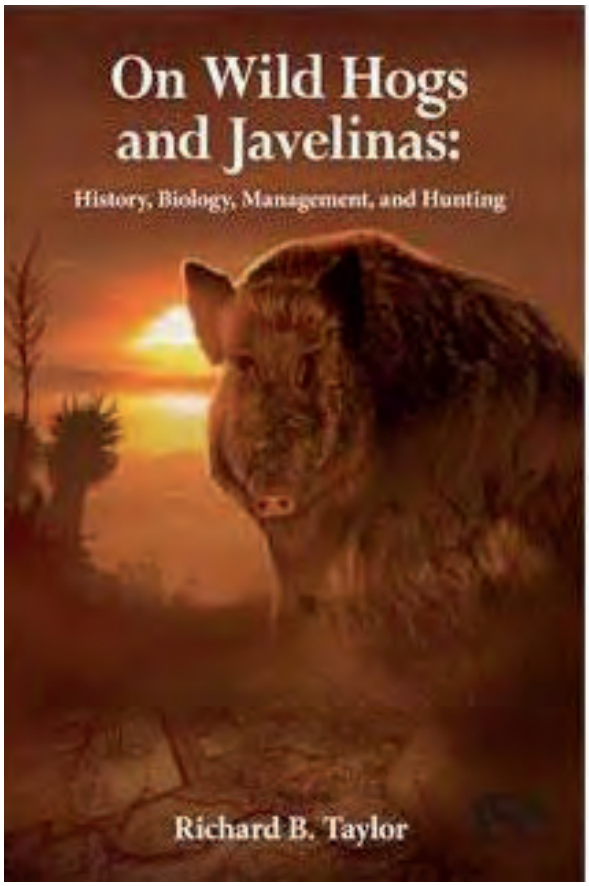
WEDNESDAY NIGHT NETWORKING

Network with conference attendees at the National Cowboy and Western Heritage Museum. Explore the old west through sculpture and paintings along with a catered dinner.

5:30 p.m.
Buses load for National Cowboy & Western Heritage Museum

6 p.m.
Dinner provided
Cash bar available throughout the evening

7 p.m.
Networking and giveaway announcements



ON WILD HOGS AND JAVELINAS:
History, Biology, Management, and Hunting
By Richard B. Taylor

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The Texas Invasion
Status and Distribution of Wild Hogs in North America
The Bad, the Good, and the Ugly
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SCHEDULE OF ORAL PRESENTATIONS

TUESDAY, APRIL 17, 2018

9 - 10 a.m.

State Agency Reports, Grand Ballroom
Moderator: John Kinsey, Texas Parks & Wildlife Department

Florida Fish and Wildlife Conservation Commission – Matthew D. Chopp;
Georgia Department of Natural Resources – Charlie Killmaster;
Tennessee Wildlife Resources Agency – Chuck Yoest;
Missouri Department of Natural Resources – Alan Leary;
Mississippi Department of Wildlife, Fisheries, & Parks – Anthony Ballard;
Louisiana Department of Wildlife & Fisheries – Jim LaCour;
Michigan Department of Natural Resources – Dwayne Etter;
USDA/APHIS Wildlife Services Oklahoma Program – Scott Alls;
Virginia Department of Game & Inland Fisheries – Aaron Proctor;
South Carolina Department of Natural Resources – Charles Ruth (Jack Mayer presenting); USDA/APHIS Wildlife Services Texas Program – Michael J. Bodenchuk

10:20 a.m. - 12 p.m.

CONCURRENT SESSIONS - Ballroom A–D
Technical Session 1: Biology/Ecology
Moderator: Mark Smith, Auburn University

10:20 a.m. Seasonal movements and habitat use of wild pigs at Fort Hood
Nathan R. Beane, University of Saskatchewan

10:40 a.m. Seasonal dietary variation in an invasive vertebrate across a subtropical agro-ecosystem
Raoul K. Boughton, University of Florida

11 a.m. Landscape calorie mapping to better understand wild pig resource selection and distribution: why is climate not limiting north of fifty-two degrees?
Ryan Brook, University of Saskatchewan

11:20 a.m. Determining survival of wild piglets
Sarah M. Chinn, University of Georgia/Savannah River Ecology Lab

11:40 a.m. Litter size variation in an introduced wild pig population over five decades
John C. Kilgo, USDA Forest Service Southern Research Station

10:20 a.m. - 12 p.m.

CONCURRENT SESSIONS - Ballroom E–F
Technical Session 2: Techniques
Moderator: Rod Pinkston, JAGER PRO™ Hog Control Systems

10:20 a.m. Immobilization of feral swine: comparison of three novel drug combinations
Christine Ellis, USDA/APHIS/WS/National Wildlife Research Center

10:40 a.m. Advancements in handling wild pigs: how trap shrouds and handling trailers can ease the process
Michael J. Lavelle, USDA/APHIS/WS/National Wildlife Research Center

11 a.m. Evaluating the use of stable isotopes to identify translocated wild hogs
Patrick Helm, University of Tennessee

11:20 a.m. Assessing agricultural damage by wild boar (Sus scrofa) using drones
Anneleen Rutten, University of Antwerp, Belgium

11:40 a.m. Predator fencing in cluster groups to manage pest animals in the Australian rangelands: is eradication achievable?
John Scriven, Queensland Murray Darling Committee Australia

1:20 - 3 p.m.

CONCURRENT SESSIONS - Ballroom A–D
Technical Session 3: Spatial Ecology
Moderator: Mike Porter, Noble Research Institute

1:20 p.m. A method for evaluating progress of the APHIS National Feral Swine Damage Management Program using management data to estimate prevention of spatial spread
Kim M. Pepin, USDA/APHIS/WS/National Wildlife Research Center

1:40 p.m. Short-term response by feral hogs to the presence of feeders during 2015-2017 warfarin bait evaluations in the Texas Panhandle, USA
Gregory A. Franckowiak, Genesis Laboratories, Inc.

2 p.m. A Landscape genetic approach to wild boar in Flanders: how is population structure influenced by a severe fragmented landscape?
Anneleen Rutten, Universtiy of Antwerp, Belgium

2:20 p.m. Predicting wild pig population establishment following introduction into a new location
Michael A Tabak, USDA/APHIS/VS/Center for Epidemiology and Animal Health

2:40 p.m. Potential for large-scale removal of invasive wild pigs using a toxic bait to protect resources
Kurt VerCauteren, USDA/APHIS/WS/National Wildlife Research Center

1:20 - 3 p.m.

CONCURRENT SESSIONS - Ballroom E–F
Technical Session 4: Management
Moderator: Bill Hamrick, Mississippi State University

1:20 p.m. The successes and challenges of working toward statewide elimination of feral swine in the U.S.
Wendy Anderson, USDA/APHIS/WS/ National Feral Swine Damage Management Program

1:40 p.m. Integrated wild pig control™ results from a Flint River project
Rod Pinkston, JAGER PRO™ Hog Control Systems

2 p.m. Feral swine management in Texas: the public and private sector approaches and their impacts
Michael J. Bodenchuk, USDA/APHIS/WS/Texas

2:20 p.m. Tools for estimating the return on investment of feral swine control
Amy J. Davis, USDA/APHIS/WS/ - National Wildlife Research Center

2:40 p.m. Shifting the focus to those left behind: using whole sounder removal to eradicate wild pigs
Alexandra A. Lewis, Auburn University

3:20 - 5 p.m.

CONCURRENT SESSIONS - Ballroom A–D
Technical Session 5: Population Trends
Moderator: Jack Mayer, Savannah River National Laboratory

3:20 p.m. Estimating population parameters of invasive wild pigs from baited camera sites
Peter E. Schlichting, Arizona State University

3:40 p.m. Developing monitoring protocols in Michigan watersheds for invasive feral swine using environmental DNA (eDNA)
Amberly Hauger, University of Michigan-Flint

4 p.m. A method for estimating the probability of local elimination of feral swine using camera trap and environmental DNA data
Amy J. Davis, USDA/APHIS/WS/National Wildlife Research Center

4:20 p.m. The importance of demographic connectivity in determining effective control budgets and spatial prioritization of resources
Kim M. Pepin, USDA/APHIS/WS/National Wildlife Research Center

4:40 p.m. Estimating feral swine abundance at the national, state, and county scales for the United States using agency removal data
Ryan S. Miller, USDA/APHIS/VS/Center for Epidemiology and Animal Health

3:20 - 5 p.m.

CONCURRENT SESSIONS - Ballroom E–F
Technical Session 6: Toxicants
Moderator: Bronson Strickland, Mississippi State University

3:20 p.m. Field assessments of HOGGONE® mesn feral pig bait for control of feral pigs in Australia
Jason Wishart, Animal Control Technologies Australia

3:40 p.m. Field evaluation of HOGGONE® sodium nitrite toxic bait for removing groups of invasive wild pigs
Nathan P. Snow, USDA/APHIS/WS/National Wildlife Research Center

4 p.m. Negligible risk of secondary mortality in turkey vultures (Cathartes aura) consuming wild pigs killed with HOGGONE®
Justin A. Foster, Texas Parks & Wildlife Department

4:20 p.m. Kaput feral hog bait containing 0.005% warfarin primary and secondary toxicity studies
Richard Poché, Genesis Laboratories, Inc.

4:40 p.m. PIGOUT® Econobait 1080: testing new technology for delivery of sodium fluoroacetate (1080) to feral pigs in Australia
Jason Wishart, Animal Control Technologies Australia

WEDNESDAY APRIL 18, 2018

9 - 10 a.m.

International Reports, Grand Ballroom
Moderator: Josh Gaskamp, Noble Research Institute

10:20 a.m. - 12 p.m.

CONCURRENT SESSIONS - Ballroom A–D
Technical Session 7: Human Dimensions
Moderator: Andrew Smith, Mississippi State University

10 a.m. Historical, current, and potential population size estimates of invasive wild pigs in the United States
Jesse S. Lewis, Arizona State University

10:20 a.m. Economic impacts of feral swine on livestock producers
Aaron Anderson, USDA/APHIS/WS/National Wildlife Research Center
10:40 a.m. Integrating ecological and human dimension research: improving feral pig management by fostering innovative community engagement
Darren Marshall, Queensland Murray-Darling Committee

11 a.m. Engaging a diverse public in feral swine damage management
Jeanine Neskey, USDA/APHIS/WS/National Feral Swine Damage Management Program

11:20 a.m. Perceptions of impacts and control of feral hogs on private lands in South Carolina
Shari Rodriguez, Clemson University

11:40 a.m. Genetic origins of feral swine reveal drivers of range expansion
Timothy J. Smyser, USDA/APHIS/WS/National Wildlife Research Center

10:20 a.m. - Noon

CONCURRENT SESSIONS - Ballroom E–F
Technical Session 8: Disease-Pathogens
Moderator: Scott Alls, USDA/APHIS/Wildlife Services

10 a.m. Seroprevalence of Neospora caninum in wild pigs (Sus scrofa)
Katelyn M. Haydett, Texas Tech University

10:20 a.m. APHIS National Feral Swine Damage Management Program: synthesis of feral swine surveillance
Michael Marlow, USDA/APHIS/WS

10:40 a.m. Enemy at the gate: how Germany prepares for arrival of African swine fever
Guntram G. Meier, InGrip-Consulting & Animal Control, Germany

11 a.m. Predicting watershed-level seroprevalence of pseudorabies virus and swine brucellosis in feral swine for the United States
Ryan S. Miller, USDA/APHIS/VS/Center for Epidemiology and Animal Health

11:20 a.m. A serological survey of wild pigs from south central Oklahoma
Steven T. Peper, Texas Tech University

11:40 a.m. Prevalence of five pathogens in wild pigs in the United States
Michael A. Tabak, USDA/APHIS/VS/Center for Epidemiology and Animal Health

1:20 - 3 p.m.

Grand Ballroom
Toxicant Panel Discussion
Moderator: Bill Hamrick, Mississippi State University

1:20 p.m. Public response to open survey about registration of Kaput® feral hog bait in Arkansas
Rebecca McPeake, University of Arkansas/Cooperative Extension Service

1:40 p.m. Stakeholder perspectives toward the use of a toxicant for managing wild pigs
Ellary TuckerWilliams, Auburn University

2 p.m. Discussion

3:20 - 5 p.m.

Grand Ballroom, Crystal Room, and Balinese Room
National Wild Pig Task Force Update and Subcommittee Meetings

This is your opportunity to meet the NWPTF Sub-committee representatives, learn about the mission for each of the sub-committees, and join any in which you wish to participate.

TECHNICAL SESSION 1: BIOLOGY-ECOLOGY

SEASONAL MOVEMENTS AND HABITAT USE OF WILD PIGS AT FORT HOOD

Nathan R. Beane[1], Darrell E. Evans[1] and Kevin Cagle[2], [1]U.S. Army, Engineer Research & Development Center/Environmental Laboratory, 3909 Halls Ferry Rd., Vicksburg, MS 39180 USA, [2]U.S. Army, Fort Hood, TX USA

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

SEASONAL DIETARY VARIATION IN AN INVASIVE VERTEBRATE ACROSS A SUBTROPICAL AGRO-ECOSYSTEM

Wesley M. Anderson, Department of Wildlife Ecology and Conservation, University of Florida, 110 Newins-Ziegler Hall, PO Box 110430, Gainesville, FL 32611-0430 USA
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The wild pig is well known for its generalist diet, a contributing factor to its successful invasion around the globe. We used DNA metabarcoding analyses of scat to examine spatial and temporal changes in wild pig diet on a cow-calf operation in south-central Florida. This 4,250-ha ranch is comprised of improved pastures planted with Bahiagrass and semi-native pastures that contain a mosaic of Bahiagrass and native vegetation. Fecal sampling was conducted from March 2016 to February 2017. At least five freshly deposited scats were collected every two months from each of five sampling areas. Regions of multiple genes that targeted either animal or plant DNA (CO1, trnL, and 12S) were selected for next generation sequencing. Sequences were identified from the GenBank reference database. One hundred ninety-eight pig fecal samples were analyzed. Consensus lineages were retained if they could be confidently identified to family and were likely intentionally consumed by a pig. One hundred thirteen plant, 110 animal, and 12 fungi taxa were retained for analysis. Plant species dominated the diet throughout the year with oak, torpedograss, joyweed, Bahiagrass, dayflower, and other grasses occurring in over half the samples analyzed. Plant diversity per sample was lowest in September and October, which coincides with the beginning of the oak mast. Animals were present across a wide taxonomic breadth, but encountered less frequently with the exception of an exotic earthworm. House mouse, cotton mouse, and mole cricket were recorded from over 10% of samples. Animal diversity per sample was lowest in improved pastures during November and December and highest in July and August whereas it was lowest in semi-native pastures in September and October and highest in November and December. This represents the first study to employ DNA metabarcoding to examine the dietary variation of this invasive vertebrate across an entire year.

LANDSCAPE CALORIE MAPPING TO BETTER UNDERSTAND WILD PIG RESOURCE SELECTION AND DISTRIBUTION: WHY IS CLIMATE NOT LIMITING NORTH OF FIFTY-TWO DEGREES?

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Wild pigs are generalist omnivores that have successfully spread over a wide range of habitats and span a broad climate envelope across five continents. Past modelling efforts in the continental US have suggested that cold climates and snow are limiting factors in the northern edge of wild pig distribution. Climate does limit the northern expansion of many large mammals due to the high energetic costs of surviving in the extreme cold, where January average temperatures above 52o north, can be < -25oC on the Canadian Prairies. Our research in Saskatchewan, Canada and other adjunct provinces has found that wild pigs are present in numerous areas north of 52o and indeed wild pigs have been detected north of 55 o where winters are long and cold. In Russia, native wild boar are present north of 67o, though average January temperature is -13oC. We present a framework for landscape mapping of accessible calories spatially and temporally to test the hypothesis that cold climates are not limiting to wild pigs in the presence of sufficient calories. We predict that the northern edge of wild pig distribution is limited in Canada by the northern edge of the presence of agriculture, which provides sufficient summer and fall calories that are stored by wild pigs to survive cold winters. This is further supplemented by storage and feeding practices by farmers that make agricultural crops available to wild pigs in winter as well. Thus far, sightings of wild pigs beyond the limit of agriculture are rare and are likely to remain so.

DETERMINING SURVIVAL OF WILD PIGLETS

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Wild pigs (Sus scrofa) are non-native in the U.S., where populations are rapidly increasing in part due to extremely high reproductive capacity. Survival of adults is relatively high and generally less variable compared to younger age classes. However, to date piglets <5 months old, and particularly neonates, have been largely excluded from survival monitoring due to difficulty in capturing and tracking individuals. Thus, ascertaining survival of piglets is important for determining drivers of population dynamics and developing realistic population models. Our objectives were to evaluate the utility of vaginal implant transmitters (VITs) for locating neonates, assess performance of several piglet transmitter attachment mechanisms, and quantify survival of piglets of various age classes. We deployed GPS/VHF radio-collars and VITs on pregnant sows to obtain parturition data and locate neonate piglets at the farrowing nest to affix a novel VHF ear tag transmitter. Additionally, we captured larger piglets (~3 kg) using live traps and evaluated average retention times of several transmitter attachment mechanisms for known-fate survival monitoring. VITs were found to be an effective method for ascertaining location and timing of wild pig farrowing and allowing for sampling and tagging of <3 day old neonates (~1kg). Stud ear-tags were the most effective and practical method for monitoring survival of piglets ≥3kg, but initial designs were not retained or suitable for neonates. This reinforced the need for smaller, lightweight ear-tag transmitters for neonates, which have been developed and we are currently deploying. Survival monitoring is ongoing and from these data we will elucidate the effects of environmental and demographic variables, as well as sow traits on neonate and piglet survival. Data generated from this study will inform population models for the devel-

opment of vigorous management strategies to ultimately reduce negative impacts of this destructive invasive species on native ecosystems, livestock, and human health.

LITTER SIZE VARIATION IN AN INTRODUCED WILD PIG POPULATION OVER FIVE DECADES

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Litter size is one of the most studied parameters of wild pig (Sus scrofa) reproductive biology, and it has been reported from a number of locations. However, most of these studies have had short time frames (1-2 years) and the collective findings have revealed inconsistencies. In addition, certain types of data (e.g., neonatal litter sizes) are almost completely lacking. The purpose of this study was to analyze a large dataset from the Savannah River Site, SC, compiled over almost five decades, focusing on variation in the different metrics for litter size observed in this wild pig population. From 1969 through 2017 data were collected from 875 fetal litters, 87 neonatal litters, the number of lactating teats from 430 sows, and 145 post-natal litters. The mean litter size decreased progressively from fetal (6.2) to neonatal (5.6) to number of lactating teats (5.4) and finally, to post-natal (4.2) samples. Fetal and neonatal litter sizes were not correlated with the sow's age class, but the number of lactating teats was positively correlated. Fetal, neonatal, and the lactating teat litter sizes were all positively correlated with the sow's total body mass. Despite an overall tendency toward even-numbered litters in all four types, only the fetal litters and lactating teat numbers were significantly biased toward even sizes. Sex ratio of fetal litters did not differ from parity, but neonatal litters were biased toward females. Litters were produced year-round, but the peak of conception was August-October, with a second minor peak in January. The peak of farrowing was December-February, with a minor peak in May. No measure of fetal litter size varied over the five decades. Information on litter size may be helpful in parameterizing wild pig population models and will enhance our understanding of the reproductive potential of this invasive species.

TECHNICAL SESSION 2: TECHNIQUES

IMMOBILIZATION OF FERAL SWINE: COMPARISON OF THREE NOVEL DRUG COMBINATIONS

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Immobilization and handling of feral swine (Sus scrofa) in the field presents a variety of challenges. Drugs used for field immobilization often include combinations of tiletamine-zolazepam with xylazine (TX), and/or ketamine (TX, TKX), and frequently produce inadequate, unpredictable sedation; undesirable physiological responses (hyperthermia); and long, sometimes violent recoveries which pose safety risks for animals and field operators. An additional disadvantage is the lack of reversal agents for each drug present in the drug combination. Therefore, there is need for improved feral swine immobilization agents deliverable via dart projector that provide highly successful immobilization rates with few adverse physiological effects; reasonable periods of safe handling; and are reversible with few adverse effects. We comparatively evaluated responses of captive-raised feral swine to administration of BAM (butorphanol-azaperone-meditomidine); NalMed-A (NAM; nalbuphine-azaperone-medetomidine); and MMB (medetomidine-midazolam-butorphanol) versus TX. Parameters measured included time to, duration and depth of, sedation; time to and quality of recovery; and physiological responses during sedation (temperature, pulse, respiration, SpO2, arterial blood gasses, response to venipuncture, ear tagging, noise, and other manipulations related to field work). Study results indicate that NalMed-A is not efficacious for sedation of feral swine. Many similar sedation parameter measurements were noted for TX, BAM, and MMB; however, quality of induction, some physiological responses; and quality of recovery were poorer for TX. BAM and MMB performed similarly; however, prolonged lethargy, anorexia, and vomiting were noted in some BAM pigs after reversal. We conclude that MMB is the optimal drug combination tested for feral swine immobilization. Following the pen study, a cohort of wild feral swine were sedated with MMB and monitored as described during field operations. The proposed presentation will discuss pharmacokinetics of the drug combinations, pen study observations, field use of MMB compared to TX, drug tissue residue testing results, and other details.

ADVANCEMENTS IN HANDLING WILD PIGS: HOW TRAP SHROUDS AND HANDLING TRAILERS CAN EASE THE PROCESS

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Research focused on behaviors and movements of wild pigs (Sus scrofa) often involves outfitting pigs with radio collars or other monitoring devices. Such extensive handling requires capture and immobilization which can be injurious and disruptive upon intact sounders, thus strategies to ease these processes are welcomed. In response to challenges experienced during 10 capture events in 2015, we devised a strategy of completely enshrouding occupied traps with customized shade cloth prior to initiating further handling. Then, during 27 capture events between 2016 and 2018 we trapped pigs in corral traps and implemented our enshrouding strategy. We collected data from direct observations and video recorded during handling and compared behavioral effects and injury rates from non-shrouded and enshrouded events. Overall, we achieved a 79% reduction in injury rates after implementing enshrouding. With quick enshrouding (≈ 73 sec) we documented a dramatic calming effect within 50 sec of initiating enshrouding, and a 65% reduction in time to dart each pig. In 2018 we combined the enshrouding strategy with a custom trailer designed, built, and refined to handle and release entire sounders in a relatively controlled manner. We incorporated the trailer into 9 capture events with 100 pigs and evaluated the functionality of the entire shroud/trailer system. Smaller pigs (≤ 100 lbs.) were physically immobilized for marking and sampling purposes and released into a holding pen. Larger pigs (100–300 lbs.) were weighed, anesthetized, and transferred to the vacant corral trap for sampling and collaring. Following reversal of anesthetized pigs, the sounder was reunited and gently released together. Consideration of incorporating such strategies into handling protocols is encouraged to facilitate handling procedures and accomplish the release of intact sounders.

EVALUATING THE USE OF STABLE ISOTOPES TO IDENTIFY TRANSLOCATED WILD HOGS

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Wild hogs (*Sus scrofa*) were reintroduced to Great Smoky Mountains National Park (GRSM or Park) in the 1930s. A nonnative and invasive species to North America, hogs compete with native fauna and destroy botanical resources by their feeding and rooting behavior. Despite extensive efforts to eradicate them, wild hogs are still present in GRSM. In recent years, GRSM has received credible reports that feral hogs are being illegally stocked in close proximity to Park boundaries. These reports have been supported by the continued presence of hogs that appear to be semi-domesticated and harbor physical characteristics that historically were not found in the Park. Human-facilitated augmentation

could obviously obstruct the costly and long-term control efforts by officials at GRSM. We performed stable isotope analysis on hog teeth collected in GRSM to evaluate the feasibility of using dietary history to identify animals that were not born in the Park. Development of tooth enamel in hogs begins at birth and permanently hardens within 4 to 6 months of age. Stable isotopes within food consumed prior to enamel hardening is trapped inside the glossy outer coating of the tooth. Hogs with higher concentrations of carbon (δ13C) within enamel may indicate that the individual was fed anthropogenic food (i.e., corn) at an early age and may have been released near park boundaries. Using domestic hogs as a baseline, we evaluate the use of stable isotopes to identify recently translocated animals in GRSM.

ASSESSING AGRICULTURAL DAMAGE BY WILD BOAR (SUS SCROFA) USING DRONES

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Growing populations of wild boar (Sus scrofa L.) increasingly cause damage to agricultural land in Europe over the last decades. In Flanders (Northern Belgium) the wild boar returned in 2006 after it had been extinct for almost 50 years and populations are expanding. Flanders' landscape structure changed during the absence of the wild boar. The current landscape is severely fragmented and is one of the most densely populated areas in the world (462 persons/km^2). A dense, mosaic-like pattern of agricultural, natural and urban areas emerged, which increasingly leads to human-wildlife conflicts. Especially, complaints about agricultural damage are increasing which often leads to conflicts because of associated economic losses. At present, the extent of crop damage by wild boar in Flanders is however unknown, there is no standardized method to monitor crop damage. Damage assessments are often performed by ground visits which is time consuming, subjective and damage spots can be overseen in high crops. Hence, there is a growing need for a fast, standardized, objective and highly accurate method for damage assessments. We present a UAV (Unmanned Aerial Vehicle) based method combined with Geographic Object-Based Image Analysis (GEOBIA) and Random Forests, to calculate the precise damaged area and associated yield losses in damaged fields. Using GEOBIA, pixels are merged into meaningful entities (objects), i.e. damaged and undamaged crops, hence the classification of the photographs is object-based as opposed to pixel-based. Damaged area and yield losses were calculated with a 83.45% (model performance, for fields not used for model construction) to 96.45% (model validation, for fields used for model construction) accuracy for maize fields and 89.41% (model performance) to 95.71% (model validation) accuracy for grasslands. By the use of this method, it is possible to get a first insight in the economic impact of crop damage by wild boar in Flanders.

PREDATOR FENCING IN CLUSTER GROUPS TO MANAGE PEST ANIMALS IN THE AUSTRALIAN RANGELANDS: IS ERADICATION ACHIEVABLE?

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The aim of this presentation is to showcase the new frontier in Pest Animal management in the Rangeland. In the last 2 - 3 years tens of thousands of miles of 6ft high fences with 2ft skirts have been built to stop the flow and recolonization of feral pigs and wild dogs. These fences have been used to make inland islands (clusters). Some cluster areas are as large as half a million acres while others are as small as ten thousand acres. More and more clusters are being built on from existing clusters or complete clusters. New clusters are being erected as more landholders are trying to limit the costs of pest animals. The Federal, State & Local Governments are also assisting with the costs of these fences. With Government funding landholders form a body corporate which oversees the building and maintenance of the cluster fences. Once the cluster is complete the body corporate plans how the land mangers work together to eradicate the pest animals. Monitoring is in place to measure the effectiveness of the program. I will be personally involved in doing the on ground work for a cluster fence around a property I manage along with some neighbors. The cluster size will be around fifty thousand acres. During the control phase the use of toxins, traps and shooting will be incorporated along with an intense before and after bench marking and monitoring program.

TECHNICAL SESSION 3:
SPATIAL ECOLOGY

A METHOD FOR EVALUATING PROGRESS OF THE APHIS NATIONAL FERAL SWINE DAMAGE MANAGEMENT PROGRAM USING MANAGEMENT DATA TO ESTIMATE PREVENTION OF SPATIAL SPREAD

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The APHIS National Feral Swine Damage Management Program (NFSDMP) seeks to eliminate feral swine where possible and reduce damage in areas where elimination is infeasible. Because the program is expensive and challenging to implement, continual evaluation of its return on investment and corresponding adjustment of implementation strategies is critical. To address these multiple objectives, two metrics of performance are important: 1) reduction of damage in areas where damage is occurring (not discussed here), and 2) prevention of future damage by decreasing the area occupied by feral swine (the focus of this presentation). We summarize NFSDMP control activities from Wildlife Services Management Information System (MIS) data to show spatial trends in management effort and take of feral swine before and during the program, and identify gaps in coverage. Generally, we found that feral swine take is increasing in states with large pig populations and decreasing in some states where feral swine are rare. We also developed a county-level occurrence model using feral swine distribution data from the Southeastern Cooperative Wildlife Disease Study (SCWDS) and the MIS data as a measure of management effort. In this latter analysis we determined locations where management has significantly decreased the rate of spatial spread of feral swine and identify areas where more effort is needed. We discuss how quantifying the rate of spread reduction can be linked to crop distribution data and crop damage assessments to determine the amount of crop damage prevented by NFSDMP activities, especially near areas where elimination may not be feasible. We also show how this tool can be used to determine effects of management on reducing the spatial distribution of feral swine populations, which is a good metric of performance in areas where elimination is the objective.

SHORT-TERM RESPONSE BY FERAL HOGS TO THE PRESENCE OF FEEDERS DURING 2015-2017 WARFARIN BAIT EVALUATIONS IN THE TEXAS PANHANDLE, USA

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Feral hogs are an invasive pest species that continue to increase their distribution throughout North America. Toxicants have proven to be a cost-effective tool in reducing feral hog numbers, and currently only one formulation is currently registered by the U.S. Environmental Protection Agency. During field testing, conditioning feed and Kaput® Feral Hog Baits were presented in feeders modified to allow feral hogs access to the feed, while minimizing non-target exposure. Locations of 12 feral hogs fitted with GPS collars were evaluated during warfarin bait field efficacy trials in 2015, 2016, and 2017 in the Texas Panhandle. The objective of our research was to determine potential changes in movements and space use over time in relation to feeder sites. We hypothesized that feral hog movements would shift closer to feeder sites for easier access to the supplemental food source. To test our hypothesis, we calculated areas of overlap in home range and feeder sites, observing hog locations over time to evaluate if movement shifted closer or more distant from these sites. Information on feral hog movement in relation to feeder sites during baiting campaigns can provide biologists and land managers a better understanding of hog behavior. Data analyses are in preliminary stages and will be presented on the day of the conference.

A LANDSCAPE GENETIC APPROACH TO WILD BOAR IN FLANDERS: HOW IS POPULATION STRUCTURE INFLUENCED BY A SEVERE FRAGMENTED LANDSCAPE?

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Wild boars returned to Flanders (Belgium) since 2006 after almost half a century of absence. During their absence, the landscape has changed dramatically due to transport infrastructure, urbanization and agricultural intensification. The current Flemish landscape is severely fragmented and is one of the most densely populated areas in the world (462 persons per square kilometer). This fragmented landscape with an intense interweaving between the urbanized, natural and agricultural landscape is causing frequent contacts between wild boar and human activities. Complaints about agricultural damage, traffic collisions, and rooting of gardens are increasing which often leads to conflicts because of the associated economic losses, human safety and human interests. Understanding the relationship between landscape structures and species biology is the basis of landscape ecology. Although the Flemish landscape is severely fragmented, wild boar can adjust to this situation: population numbers are increasing fast and their distribution range is expanding. Because of this fast increasing distribution range and increasing human-wildlife conflicts it is important to know how the Flemish landscape structure influences the wild boar distribution. Therefor a landscape genetic research has been conducted. 140 SNPs of 959 DNA-samples from Flemish hunting bag from 2007 until 2016 were genotyped. A landscape genetic analysis will show how population structure by wild boar is affected by the Flemish landscape. A STRUCTURE analysis will give a first idea of population structure. Next, a landscape genetic analysis in which relatedness is correlated with specific landscape elements (road network, forest coverage, urban areas, etc.) will reveal if there are landscape barriers and how they affect distribution. This analysis will allow us to assess landscape connectivity for wild boar and will provide a basis for the construction of a Species Distribution Model (SDM) which will assess the further distribution of the wild boar in Flanders.

PREDICTING WILD PIG POPULATION ESTABLISHMENT FOLLOWING INTRODUCTION INTO A NEW LOCATION

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Invasive wild pigs often arrive in new locations by either intentional introductions that provide recreational hunting access or from accidental escape from domestic pig farms. These novel arrivals of invasive wild pigs can either lead to population establishment or local extinction; newly established populations are problematic for national efforts to reduce wild pig populations. We used recently-developed short-term population dynamic models to predict the probability of population establishment under different forage conditions and with different numbers of pigs initially introduced. Simulated environments accounted for the presence of mast tree species (e.g., oaks) and agricultural subsidy, as crops can replace or supplement mast in the diets of invasive wild pigs. Simulated invasive wild pig populations had a higher probability of population growth in environments with more mast tree species and locations with agricultural subsidy. These models are being extended using data on the diversity of mast tree species and agriculture to predict the probability of invasive wild pig population establishment at all locations throughout the US. Our extended model provides greater understanding of the local risks of population establishment associated with intentional release or escape of pigs. These results may be used to support investigations of local illegal releases of pigs, state-level planning for invasive wild pig management, and monitoring for newly established populations.

POTENTIAL FOR LARGE-SCALE REMOVAL OF INVASIVE WILD PIGS USING A TOXIC BAIT TO PROTECT RESOURCES

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Invasive wild pigs (Sus scrofa; hereafter– wild pigs) are spreading throughout many regions of the world and causing extensive damage to ecological and agricultural resources. An international effort to development a safe, humane, and cost-effective toxic bait (HOGGONE®) for wild pigs is underway. We evaluated a simulated toxic bait deployment using a placebo bait containing a biomarker (rhodamine B), in lieu of the toxic ingredient, for potential population effects on a dense population of wild pigs in south-central Texas, USA. We conducted 18 days of pre-baiting to attract and accustom wild pigs, followed by 1 night of the biomarker bait deployment. We evaluated the movements of 28 GPS-collared wild pigs relative to the bait sites. Following bait deployment, we trapped or aerial shot 429 wild pigs to examine their vibrissae for evidence of biomarker exposure from consuming the bait. We found that ~91% of the population of wild pigs consumed the bait and would have been susceptible to lethal control within a 16.8 km2 area. Our results suggested that bait sites be spaced 0.75–1.5 km apart to achieve optimal control, but wild pigs ranging ≥3 km away were susceptible. Our use of wild pig-specific bait stations results in no nontarget species gaining access to the biomarker bait. Overall, these results indicate that a toxic bait for wild pigs may be an effective new tool for the large-scale removal of wild pigs, especially if used in conjunction with traditional methods of control as part of an integrated pest management strategy.

TECHNICAL SESSION 4: MANAGEMENT

THE SUCCESSES AND CHALLENGES OF WORKING TOWARD STATEWIDE ELIMINATION OF FERAL SWINE IN THE U.S.

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The United States Department of Agriculture's Animal Plant Health Inspection Service (APHIS) has developed a national strategy to reduce, and where possible eliminate, the damages inflicted by feral swine to agricultural and natural resources, property, and public health and safety. The APHIS strategy involves providing resources and expertise at a national level, while allowing flexibility to manage operational activities from a local perspective. Collaboration with other federal, state, tribal and municipal governments, universities and other research organizations, special interest groups, and local entities, along with landowners and others experiencing damage, is essential in preventing the expansion of feral swine, suppressing populations, and moving toward elimination. An integrated wildlife damage management approach, involving education, outreach, research, new legislation, monitoring, and an array of control methods is recommended and applied at the local level by the APHIS Wildlife Services' Program and partners. In the last three years, feral swine were eliminated from seven states. Three other states removed significant numbers of feral swine and indicate that elimination is attainable in the near future. This success is far ahead of original goals identified in the APHIS national strategy. Achieving these goals has required a non-standardized approach due to differences in partnerships, laws, environmental conditions, feral swine density and locations, land ownership, and public attitudes in each state. Additionally, as states move closer to complete elimination, the costs per pig increase drastically because home ranges tend to expand and individual animals move great distances frequently. Maintaining public and partner support during this time becomes crucial. In this presentation,

we highlight the approaches taken by four states (New Jersey, Illinois, New York, and New Mexico) in moving toward or obtaining statewide elimination of feral swine. We also discuss specific challenges, lessons learned, and beneficial tactics by states with lower densities of feral swine that have been successful at elimination.

INTEGRATED WILD PIG CONTROL™ RESULTS FROM A FLINT RIVER PROJECT

Rod Pinkston, JAGER PRO, 2900 Smith Rd, Fortson, GA 31808 USA

In January 2017, JAGER PRO™ was hired to remove the total wild pig population from a 4,800-acre property along the Flint River in Reynolds, Georgia using their Integrated Wild Pig Control™ (IWPC) model. IWPC™ is a strategic approach using a series of innovative control methods and technologies implemented in a specific sequence based on seasonal food sources. Emphasis is placed on efficient removal of entire sounders at one time to eliminate escapes and education. The control strategies continually change throughout the various seasons to effectively target adaptive survivors. This presentation will provide detailed control data (camera to harvest ratios, capture percentages, harvest methods, harvest numbers per method, harvest numbers per season, minutes of labor per pig per method, etc.) along with the biological data such as sex, age class and reproduction. The entire project was documented on video by a single Hog Control Operator™ to demonstrate the intel gathering strategies and control sequences used to eliminate the total wild pig population within the 4,800-acre target area in less than 15 months.

FERAL SWINE MANAGEMENT IN TEXAS: THE PUBLIC AND PRIVATE SECTOR APPROACHES AND THEIR IMPACTS

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Feral swine are widespread in Texas with a significant percentage of the national population residing in the Lone Star State. Multiple state and federal agencies share responsibility for feral swine management. The Cooperative Texas Wildlife Damage Management Program expends considerable efforts to manage feral swine and annually removes around 30,000 feral swine. Private users of feral swine include a regulated meat market with 2 processing stations, a meat processor which purchases dead pigs for pet food, private helicopter operators who sell hunts as a method of control and an unregulated hunting industry. Recreational hunters also kill feral swine. This presentation details the legal authorities for feral swine management, the scope of management conducted by various entities and the net effects on management. The need for quantifiable information is highlighted.

TOOLS FOR ESTIMATING THE RETURN ON INVESTMENT OF FERAL SWINE CONTROL

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Feral swine (Sus scrofa) have expanded their range across the United States in the last three decades, causing significant damage to agriculture, infrastructure, and native ecosystems, and spreading disease to livestock and wildlife. Consequently, feral swine management has ramped up accordingly and methods for assessing their return on investment ('performance metrics') are needed. Performance metrics based on body counts do not indicate impacts on population viability or damage reduction, and also fail to reveal important data for guiding future management decisions. To address these gaps, we developed a tool for calculating return on investment using management data from aerial gunning. We demonstrate both the ability of the tool to evaluate management effects as well as to provide information for planning future management activities. We used the tool to calculate the proportion of the population removed by flight, and difference in capture rate based on habitat and personnel. We used simple population modeling to show the time it would take for a population to recover if only one, two, or three flights were conducted. We also calculated the return on investment by incorporating the management and damage costs, and showed how this metric can be used to guide management as well as to assess performance. Our main conclusions were that > 1 flight over the same spatial area can (in some cases) provide better return on investment than a single flight, and that experimental data describing the density-damage relationship is a critical gap for providing science-based justifications for guiding management. Lastly, we show how our methodology can be extended to trapping data.

SHIFTING THE FOCUS TO THOSE LEFT BEHIND: USING WHOLE SOUNDER REMOVAL TO ERADICATE WILD PIGS

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Wild pig eradication in demographically open populations has seemingly been an impossible feat for most managers. This lack of success likely stems from management philosophies grounded in producing body counts versus those investing resources to initially identify individuals and sounders present and continuing removal efforts until all individuals are removed (i.e. whole sounder removal; hereafter WSR). WSR has been demonstrated to reduce populations with greater efficacy, and for greater duration, compared to individual-based removal methods. However, because WSR was first demonstrated as a viable approach in a predominately forested landscape where sounders exhibited high site fidelity, its effectiveness in other landscapes remains unknown. Our objective was to examine the relative effectiveness of WSR on a wild pig population embedded within an agriculturally-dominated landscape. We established a 27-km2 treatment area where sounders were removed using WSR and a 29-km2 control area at Lowndes Wildlife Management Area in Alabama. Using game cameras over bait at a density of 1 camera/km2 in November 2014, we estimated approximately 65 and 100 individuals on our treatment and control areas, respectively. WSR began July 2015 and by May 2016, we reduced the population by 90%. However, due to births and seasonal movements of pigs on and off the periphery of the study area, the population fluctuated between 10-20 individuals from May 2016 to December 2017. In December 2017, we removed the last remaining sounder and have since observed no sounders in the treatment area. Throughout our study, we removed 92 total individuals from 9 sounders on the treatment area. Monitoring continues as we target occasional transient single pigs (likely males) across the treatment area, however, our success indicates that identification and subsequent removal of entire sounders remains a viable, relatively efficient approach for management of wild pigs in agriculturally-dominant landscapes with abundant pulse resources.

TECHNICAL SESSION 5: POPULATION TRENDS

ESTIMATING POPULATION PARAMETERS OF INVASIVE WILD PIGS FROM BAITED CAMERA SITES

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Population parameters such as abundance, occupancy, and density can be used to evaluate or inform management actions. Accurate estimates of these parameters can be difficult to determine for wild pigs and the most rigorous methods are time and labor intensive. A method for the rapid assessment of relative abundance would benefit managers with limited resources. We evaluated how three metrics, occupancy, detection rates, and count data (measured via N-mixture models), compared at estimating relative abundance for baited cameras. Two 10 camera grids (cell size = 0.2 km^2) were created at two study sites (Buck Island Ranch (BIR), FL and Tejon Ranch (TR), CA), baited with 30 kg of corn, and operated 10 consecutive days over two seasons (4-6 months apart). Camera images were split into 24 hour events (1200 to 1200), and the total number of pigs that visited the camera site was recorded per event. At BIR the camera girds were set before and after removal efforts. Occupancy, detection rates, and count estimates varied by grid and seasonally at TR but remained seasonally constant at BIR with a final grid still to be analyzed. Contrary to predictions occupancy

estimates at TR declined between seasons with no detected birth pulse. Pigs were identified at all BIR camera locations and no decline was detected in occupancy, detection rates, or count based estimates. In areas of low density, occupancy models may be the preferred method due to successful trend identification, lower processing time, and high error in count based estimates. However, baited cameras may bias occupancy estimates in higher density sites where detection rates and count based models are more informative. Future analyses will include data from a long term non-baited camera grid to compare the utility and biases in using baited locations monitored with cameras for population estimates.

DEVELOPING MONITORING PROTOCOLS IN MICHIGAN WATERSHEDS FOR INVASIVE FERAL SWINE USING ENVIRONMENTAL DNA (EDNA)

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Invasive feral swine cause ecological destruction, impact crop production, and are reservoirs for disease. Traditional monitoring techniques for wildlife such as observation stations, tracking, and aerial surveys vary greatly in success for detecting feral swine. Environmental DNA (eDNA) has been used to successfully detect invasive aquatic species such as bighead (Hypophthalmichthys nobilis) and silver (H. molitrix) carp, but this technique has not been attempted for free-ranging feral swine. Feral swine are commonly associated with wetlands, so to assess the efficacy of detecting swine we manually introduced swine DNA (i.e., hide or leg) into two different stream systems (e.g., fast and slow moving) near Midland, MI. To assure that feral swine were absent from the selected watersheds, we used historical records of sightings and continually monitored for swine using trail cameras and track surveys. We sampled streams two times each, every six weeks to assess potential temporal differences in detection. We collected water samples two hours after DNA insertion, every 100m from introduction points to 400m downstream. Samples were processed in The Mahon Laboratory at Central Michigan University using the digital droplet polymerase chain reaction (ddPCR) technique. Preliminary results indicate that swine DNA was detected in the two streams to 400m from the source point. The highest concentration of detected DNA (23 copies/uL) was observed 400m from the introduction point. This study will provide wildlife managers with sampling protocols for detecting feral swine DNA in MI watersheds.

A METHOD FOR ESTIMATING THE PROBABILITY OF LOCAL ELIMINATION OF FERAL SWINE USING CAMERA TRAP AND ENVIRONMENTAL DNA DATA

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An important component to feral swine (Sus scrofa) management programs is surveillance of populations to assess the efficacy of management actions and identify target areas for continued management. At high densities it is useful to determine the proportional reduction of a population whereas at low densities the probability that individuals are present or absent becomes more important (i.e., elimination probability). Camera traps and environmental DNA collected from water bodies are two potential noninvasive methods of detecting wildlife species. When combined with dynamic occupancy analysis, both camera data and eDNA detections can be used to estimate the overall distribution of feral swine in an area, as well as changes in occupancy due to local extinction and colonization events, while accounting for imperfect detection. Additionally, we can estimate the probability of elimination and detection probabilities of different methods, which will help refine further surveillance efforts. We demonstrate how these methods can be used based on two field studies: a camera trap study in San Diego County, California from July 2014 to August 2015, and an eDNA study in central Texas in 2016. We found feral swine distribution declined in San Diego County during our study and demonstrate how increased removal efforts related to overall detection reductions. Our study in Texas showed that eDNA can be used to detect feral swine in natural settings. We identified an optimal sampling strategy to maximize the probability of detecting feral swine in natural water bodies while optimizing lab efficiencies. This method includes collecting several (10+) water samples per water body in the field and iteratively examining these samples in the laboratory and stopping once a detection is reached.

THE IMPORTANCE OF DEMOGRAPHIC CONNECTIVITY IN DETERMINING EFFECTIVE CONTROL BUDGETS AND SPATIAL PRIORITIZATION OF RESOURCES

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Management of feral swine is challenged both logistically by limited funding and ecologically by population structure. Studies have shown that populations typically consist of multiple subpopulations that cluster in space but show some level of genetic mixing across long-distances, presumably due to human-mediated movement. We use a dynamic population model to identify conditions where the frequency and magnitude of movement between subpopulations (demographic connectivity) would influence the outcome of spatial management strategies. We complement this approach with an economic model that determines the likelihood of elimination success based on the resource budget and movement patterns. Our main objective is to develop tools for identifying optimal spatial control strategies and the financial budget needed for elimination of feral swine in a target area. With the ecological model we found that elimination can be achieved faster and require removing fewer individuals when control efforts are preferentially allocated to source subpopulations (those that provide migrants or translocated individuals) before shifting allocations to recipient subpopulations (those that receive migrants or translocated individuals), but these benefits are only achieved when source to recipient movements are frequent (≥ 3 events totaling ≥ 5% of the population) and unidirectional. Our results suggested that allocating all resources equally among subpopulations initially is optimal if it results in large initial decreases for all populations. The economic model predicted that larger budgets are necessary when populations have higher connectivity and when translocation of individuals from other populations occurs. We discuss how these tools can be applied to management data to support planning of large scale feral swine removal activities.

ESTIMATING FERAL SWINE ABUNDANCE AT THE NATIONAL, STATE, AND COUNTY SCALES FOR THE UNITED STATES USING AGENCY REMOVAL DATA

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Estimating abundance of invasive species such as feral swine is critical in understanding effectiveness of management activities and estimating potential damage caused by invasive species. We developed a spatial-temporal Bayesian hierarchical model to predict county, state and national feral swine abundance using agency removal data. We included environmental factors previously found to be associated with invasive wild pig survival, litter size, and population density and factors that contribute to the detection of wild pigs. For each county with invasive wild pigs we estimated annually the population size from 2004 through 2018. For the majority of counties the abundance of feral swine has remained constant or increased during the 14 years we investigated. The exceptions are counties along the northern margin of feral swine range in the United States. The estimated effects of environmental factors varied regionally. However, the amount of cultivated land was consistently associated with counties that had high feral swine abundance. The amount of forest cover and temperatures during the coldest quarter of the year were also important in predicting feral swine abundance. Our model and results are useful for predicting wild pig abundance and changes in abundance and can be useful for predicting the damage caused by wild pigs. This approach is also useful in detecting changes in wild pig populations that can be useful in evaluating control programs and communication of the risks posed by invasive wild pigs.

TECHNICAL SESSION 6:
TOXICANTS

FIELD ASSESSMENTS OF HOGGONE® MESN FERAL PIG BAIT FOR CONTROL OF FERAL PIGS IN AUSTRALIA

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Feral pigs cause enormous damage to agriculture and biodiversity in many parts of the world. They are particularly problematic in Australia and the United States, as these countries contain some of the world's largest populations of feral pigs outside their native range. Alarmingly, these populations continue to expand today. While traditional techniques like shooting and trapping can, and will continue to help to curb population growth, new tools are needed to enhance control program effectiveness. Because feral pigs are vulnerable to methemoglobinemia, a condition that can be fatal when methemoglobin levels reach ~ 80%, they are susceptible to poisoning with sodium nitrite. Sodium nitrite is a powerful methemoglobin inducer, capable of causing death in feral pigs within 1 – 3 hours after ingestion. Accordingly, Australia, New Zealand and United States have collaborated to optimize a shelf-stable and humane feral pig bait, HOGGONE® meSN Feral Pig Bait, that contains sodium nitrite in a stable form. The resulting optimized, and patented, product HOGGONE® meSN Feral Pig Bait is a peanut flavoured semi-solid paste that contains microencapsulated sodium nitrite. HOGGONE® meSN Feral Pig Bait has been extensively tested in Australia and in the United States, where it has achieved impressive results with regard to palatability and efficacy. Here we focus on the results obtained in Australia during a series of pen studies (three pens ~ 4 acres each), and a large field trial on free ranging feral pigs over 25,000 acres to replicate broad-scale use.

FIELD EVALUATION OF HOGGONE® SODIUM NITRITE TOXIC BAIT FOR REMOVING GROUPS OF INVASIVE WILD PIGS

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Invasive wild pigs (Sus scrofa; hereafter– wild pigs) are spreading throughout many regions of the world and causing extensive damage to ecological and agricultural resources. An international effort to develop a safe, humane, and cost-effective toxic bait (HOGGONE®) for wild pigs is underway. We evaluated a deployment of HOGGONE® under an Experimental Use Permit for efficacy on a population of wild pigs in northern Texas, USA during March 2018. Prior to toxic bait deployment we uniquely marked 100 wild pigs from 6–10 family groups using GPS collars on adults, VHF ear tags on juveniles, and ear tag buttons on piglets. We also marked 12 raccoons (Procyon lotor) with VHF collars in areas surrounding the bait sites to monitor non-target effects. We accessed efficacy and non-target effects using 3 methods, including mortalities of marked animals, mortalities of animals found during walking transects, and reduction of visitation to bait sites. Preliminary results from this study will be discussed.

NEGLIGIBLE RISK OF SECONDARY MORTALITY IN TURKEY VULTURES (CATHARTES AURA) CONSUMING WILD PIGS KILLED WITH HOGGONE®

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Invasive wild pigs are increasing in range and abundance in temperate zones worldwide. They are well-documented to harm natural resources and human interests. Moreover, wild pigs pose threats to humans as vectors of zoonotic disease and causes of injury. Contemporary control measures are costly, with regional and seasonal limitations, and have been ineffective in halting large-scale population increases. Toxicants are relatively cost-effective and may present low environmental risk. Our collaboration developed a stable and palatable sodium nitrite formulation (HOGGONE®). The product is: approved in New Zealand; under final review in Australia; and is being evaluated under USEPA Experimental Use Permit. Avian scavengers are likely to be exposed to wild pigs killed by the toxicant. Turkey vultures are sympatric to wild pigs in North America and may be surrogates for avian scavengers worldwide. We estimated LD50 of microencapsulated sodium nitrite from gavaged vultures and evaluated secondary risk in 2 no-choice controlled studies, each with 3 groups of 5 captive subjects, which scavenged exclusively on either carcasses or stomachs of pigs killed with HOGGONE®. An LD50 of 663 mg/kg with short half-life, no death or intoxication in feeding trials, and feeding behavior indicate negligible risk to turkey vultures feeding on wild pigs killed with HOGGONE®.

KAPUT FERAL HOG BAIT CONTAINING 0.005% WARFARIN PRIMARY AND SECONDARY TOXICITY STUDIES

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Kaput Feral Hog Bait was approved by the US Environmental Protection Agency in 2017 for use against wild pigs because of proven efficacy using low-dose warfarin. The benefits were assessed as being far greater than the risks. Laboratory and pen studies were conducted on a number of wildlife species to examine the potential for primary and secondary toxicity to non-target wildlife. Over a period of 10 years, studies were completed on magpies Pica pica, American alligators Alligator mississippiensis , mallard ducks Anas platyrhynchos, European ferrets Mustela purtorius furo, and bobwhite quail Colinus virginianus to assess dietary exposure to 0.050, 0.025, or 0.005% warfarin baits. Twelve ferrets were exposed to prairie dogs fed 0.05% warfarin bait for 5 days. The prairie dogs were then fed to ferrets for 5 consecutive days and observed for 21 days and showed no effects of warfarin intoxication. A replicate study utilized 10 ferrets exposed to prairie dogs for 7 days, then observations for 21 days, resulting in no effects of warfarin poisoning. A similar study was conducted using five alligators fed 0.025% warfarin-killed rats. The reptiles were fed one rat per week for 5 weeks then monitored for 4 weeks with no signs of anticoagulant poisoning. A similar study was conducted with magpies fed Norway rats killed with 0.025% warfarin bait. Exposure was five consecutive days with 22-post treatment observations with no signs of intoxication, mortality, nor morbidity. Bait containing 0.025% warfarin was given to mallard ducks in a choice test with avian diet and resulted in no effects on the birds. Bobwhite quail were presented 0.005% warfarin baits for 30 days and exhibited no signs of warfarin intoxication. Field studies conducted in northern Texas from 2015-2017 using 0.005% warfarin (Kaput Feral Hog Bait), resulted in efficacy against wild pigs averaging >95% with no issues related to primary or secondary toxicity to domestic animals or wildlife.

PIGOUT® ECONOBAIT 1080: TESTING NEW TECHNOLOGY FOR DELIVERY OF SODIUM FLUOROACETATE (1080) TO FERAL PIGS IN AUSTRALIA

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Sodium fluoroacetate (1080) is registered and commonly used to poison feral pigs in Australia. Typically, 1080 is added to meat or grain and this fresh bait is offered to feral pigs where they occur. There are concerns that some non-target species, that also eat grain or meat, may be accidentally poisoned and the risk is exacerbated by the high 1080 dose required to kill feral pigs. In 2004, the former Pest Animal Control Cooperative Research Centre (PAC CRC) and Animal Control Technologies Australia (ACTA) commenced a collaborative project to develop and register a feral pig targeted bait to reduce the risks to non-target species. The resulting product, PIGOUT® Feral Pig Bait, launched in 2008, was found to be highly attractive to feral pigs in cool temperate areas and significantly more target specific than meat or grain bait. More recently, ACTA and its partners have developed a new generation and smaller bait, "PIGOUT® Econobait 1080" that remains attractive and stable in all environments including hot and/or dry climates. This recent innovation has the potential to broaden the

application of feral pig targeted baits in Australia. Early field testing has shown that PIGOUT® Econobait without 1080 is highly palatable to feral pigs and unappealing to non-target species. This presentation will discuss the results from a series of smaller pen trials (three pens ~ 4 acres each) that also confirmed PIGOUT® Econobait containing 1080 is lethal to feral pigs. In addition, the presentation provides information relating to humaneness and target specificity.

TECHNICAL SESSION 7: HUMAN DIMENSIONS

HISTORICAL, CURRENT, AND POTENTIAL POPULATION SIZE ESTIMATES OF INVASIVE WILD PIGS IN THE UNITED STATES

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To control invasive species and prioritize limited resources, managers need information about population size to evaluate the current state of the problem, the trend in population growth through time, and to understand the potential magnitude of the problem in the absence of management actions. We used two national-scale data sets to estimate historical, current, and future potential population size of invasive wild pigs (Sus scrofa; hereafter wild pigs) in the United States. Between 1982 to present, the Southeastern Cooperative Wildlife Disease Study (SCWDS) mapped the distribution of wild pigs in the United States. In addition, recent research has predicted potential population density of wild pigs across the United States by evaluating broad-scale landscape characteristics. We intersected these two data sets to estimate potential population size of wild pigs in 1982, 1988, 2004, 2010, 2013, and 2016. In addition, we estimated potential population size if wild pigs were present at equilibrium conditions in all available habitat in each state. We demonstrate which states have experienced recent population growth of wild pigs and are predicted to experience the greatest population increase in the future without sufficient management actions and policy implementation. Regions in the western, northern, and eastern United States contain no or few wild pig populations, but could potentially support large numbers of these animals if their populations become established. This information is useful in supporting assessments of potential agricultural damage and can identify regions at greatest risk if wild pigs become established, which can assist in prioritizing management actions aimed at controlling or eliminating this invasive species.

ECONOMIC IMPACTS OF FERAL SWINE ON LIVESTOCK PRODUCERS

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While it is accepted that feral swine impose significant impacts on domestic livestock production in the form of depredation, disease, and control costs, large-scale aggregate estimates do not exist. To obtain representative estimates of livestock impacts and costs of feral swine at the state level, the National Agricultural Statistical Service (NASS) conducted a survey of domestic producers in 13 US states. Targeted operations included producers of cattle (beef, calving, and dairy operations), swine, sheep, and goats, although producers of other commodities were expected (e.g. poultry and equine). A total of 12,000 surveys were administered by NASS, with a response rate of 53%, for a total of 6,394 responses. In addition to operation-wide questions regarding potential disease spread from feral swine and related concerns, producers were asked about livestock loss from feral swine depredation, disease, and other causes. Based on survey results, we estimate that the total annual cost of deaths and medical expenditures approaches $40 million for the group of targeted producers in the 13 states.

INTEGRATING ECOLOGICAL AND HUMAN DIMENSION RESEARCH: IMPROVING FERAL PIG MANAGEMENT BY FOSTERING INNOVATIVE COMMUNITY ENGAGEMENT

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Significant advances have been made using the biophysical sciences to improve our knowledge of feral pig (Sus scrofa) ecology in Australia. Similarly, new management tools, such as HOGGONE®, are being developed to help manage feral pig populations and their damaging impacts. Despite this, the landscape-scale management of feral pigs and their impacts is hampered by the limited participation in applying control strategies by land managers. In partnership with individual land managers, Animal Control Technologies Australia, Arrow Energy, Santos GLNG, Northern Tablelands and North West Local Land Services, NSW National Parks and Wildlife and the Queensland Murray Darling Committee, this study integrates ecological research on feral pigs, whilst field testing HOGGONE®, with human dimensions research applied in an experimental framework. We fitted iridium-enabled telemetry collars to 52 feral pigs, across four sites, to develop a better understanding of their spatial ecology. Simultaneously, the human communities associated with these sites were assigned different community engagement treatments, to assess the relative benefits of these treatments or approaches for feral pig management programs. The approaches were assessed using a most significant change evaluation strategy. We present findings from the study to date, including spatial data from feral pigs and key lessons regarding community engagement for feral pig management purposes.

ENGAGING A DIVERSE PUBLIC IN FERAL SWINE DAMAGE MANAGEMENT

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As we learn more about feral swine impacts to urban and suburban habitats, the role people play in their movement, and their damage to native wildlife and ecosystems, finding ways to reach and engage diverse publics becomes more critical to the success of our damage management programs. Feral swine damage and disease risks impact an exceedingly wide range of stakeholder groups. Everyone from farmers, ranchers and gardeners, to outdoor recreationists, hunters, hikers, bird watchers, and golfers are negatively impacted by invasive feral swine. Reaching and engaging such a wide array of stakeholders requires a variety of communication techniques and outreach methods. Communications surrounding feral swine damage management must go beyond the simple assumption that people lack knowledge and that by merely "informing the public" we can change attitudes and behaviors. To realize our objectives, it becomes necessary to not only inform, but to empower and elicit change. In this presentation the importance of audience demographics, trust, mutual learning, and relationship building is explored as a basis for public engagement. Applied theories, methods, and tools for engaging diverse stakeholders are discussed utilizing case studies and real world examples.

PERCEPTIONS OF IMPACTS AND CONTROL OF FERAL HOGS ON PRIVATE LANDS IN SOUTH CAROLINA

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Feral hogs are responsible for an estimated $120 billion annually in economic damage to U.S. agriculture industries and private lands. Information on hog damage, hog control methods used, and landowner expenditures on such methods exists for some states, yet little information exists for South Carolina. We sent a mail survey to a random selection of 2500 rural landowner and farmer members of the South Carolina Farm Bureau to better understand the extent of perceived damage by

hogs and hog management efforts on South Carolina private lands, for which we received a 30.3% response rate. One third of respondents indicated they'd experienced economic loss from hog damage, with the most severe damage reported to wheat/hay/pasture and corn. Of those with hogs on their property, ~70% indicated they spent nothing on hog control, while another 30% spent $1 or more. Most respondents experiencing damage felt hog populations on their property were increasing (48.4%) or not changing (38.7%). We used the data on the perceived economic damage to agriculture, livestock and timber to extrapolate to the statewide level; we estimate that hogs cause $115 million in perceived damage to these industries annually. As populations of hogs increase, we expect perceptions of economic loss to increase.

GENETIC ORIGINS OF FERAL SWINE REVEAL DRIVERS OF RANGE EXPANSION

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Feral swine (Sus scrofa) are a long-established invasive species in the United States with populations established in the 1200s in Hawaii and mid-1500s on the mainland. Despite their long history, feral swine remained geographically restricted to the southeast, California, and Hawaii until the 1980s but have since expanded dramatically with populations in >40 states. We used high resolution SNP genotyping to gain a greater understanding of the origins of both historic and newly emerging populations and elucidate the processes driving range expansion. Specifically, we compared the genetic association of feral swine, sampled throughout the entirety of the US invaded range (n = 7622), with a comprehensive reference set that included commercial breeds of swine, historic breeds, and Eurasian wild boar (n = 2516). A combination of multivariate statistics and genetic clustering algorithms revealed that the vast majority of feral swine in the continental US represent a genetic mix between European wild boar and historic breeds of European or US origins. A very limited number of continental populations have descended directly from domestic swine without wild boar introgression or wild boar without domestic swine introgression. The genetic ancestry of Hawaiian and Guam populations differ from continental populations with a strong association to Asian lineages, likely the result of historical introductions with Polynesian colonization. These oceanic populations also demonstrate some associations with historic European/American breeds, revealing the effects of introgression that has occurred over the past 225 years. Although our analyses detected recent influences from domestic swine, potbellied pigs, and wild boar, contributions from these novel genetic sources amounted to <1.5% of sampled feral swine. Conversely, genetic similarities between historic populations and newly emerging populations suggest that the expansion of feral swine has been driven by range expansion out of historic populations, which has likely been facilitated by anthropogenic translocation.

TECHNICAL SESSION 8: DISEASE-PATHOGENS

SEROPREVALENCE OF NEOSPORA CANINUM IN WILD PIGS (SUS SCROFA)

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Neospora caninum is a protozoan parasite reported as a leading cause of cattle abortions and reproductive failure worldwide. After ingestion of infected tissues, definitive hosts such as coyotes and dogs excrete oocysts into the environment and can contaminate food and water sources available to livestock. Ingestion of N. caninum oocysts results in infection of cattle and other intermediate hosts. The parasite can then be vertically transmitted, resulting in spontaneous abortions, fetal reabsorption, and decreased milk production; costing the cattle industry approximately $1.3 billion dollars annually. With wild pig populations nearing 6 million in the United States, contact between wild pigs and livestock is inevitable. This is a result of an already widespread geographic distribution combined with continuous, rapid range expansion. As a known reservoir for numerous bacterial, viral, and parasitic diseases, wild pigs are of particular importance for public and veterinary health relative to the prevention of infectious diseases. Exposure to N. caninum in wild pig populations was first documented during 2013, raising the question as to whether they serve as an intermediate host or reservoir. In collaboration with the Noble Research Institute, 388 wild pigs were captured in southern Oklahoma over approximately 11,000 acres during a three-year study. From this collection, 59 pigs were screened for N. caninum antibody presence using a qualitative sandwich porcine Neospora caninum antibody ELISA Kit. Of those tested, 39 (66.1%) were positive, suggesting a drastic increase in exposure since the first documentation of seroprevalence in wild pigs (15.8%). This data signifies the importance of disease surveillance in wild pigs to better understand the threat of environmental exposure and the role wild pigs play in disease transmission to livestock.

APHIS NATIONAL FERAL SWINE DAMAGE MANAGEMENT PROGRAM: SYNTHESIS OF FERAL SWINE SURVEILLANCE

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Wildlife Services (WS) responded to the recognized threat of feral swine as a pathogen reservoir as early as 2004 through opportunistic sampling of animals harvested by its operational component to curtail swine damage to agriculture and property. Initially, pseudorabies and swine brucellosis were of most concern, as they both serve as a potential threat to the domestic swine industry and the latter also possessing zoonotic implications. In 2006, classical swine fever, a foreign animal disease (FAD), became the main driver for feral swine pathogen surveillance. Subsequent years of surveillance identified a host of other disease risks inherent within populations of feral swine throughout the U.S. Presently, feral swine surveillance falls under the purview of the APHIS National Feral Swine Damage Management Program which began in 2014. In January of this year, a panel of animal disease experts, representing industry, government, and academia were invited to Fort Collins, Colorado to discuss successes of this surveillance, identify any shortcomings or needs, and to propose future feral swine surveillance design. This presentation serves to synthesize WS' surveillance and the future direction of these efforts.

ENEMY AT THE GATE: HOW GERMANY PREPARES FOR ARRIVAL OF AFRICAN SWINE FEVER

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African swine fever (ASF) is a virus disease causing high mortality rates among domestic pigs. After arrival in Eurasia in 2007 (Caucasus) it made its way by unknown pathways to eastern European countries of Belarus and Ukraine (2013), Baltic states and Poland (2014) and Czech republic (2017). Germany shares over 900 km of border with the latter two countries and infection patterns are indicating an advance toward this border. Due to the "Schengen treaty" mostly no border control among inner-European borders exists anymore within the EU and restriction and monitoring of disease spread is much more difficult. Emergency plans need to buffer this situation. Examples from the 20.000 square miles containing federal state of the Brandenburg and it's polish bordered administrative territory of 2.000 sq. miles containing Landkreis Oder-Spree describing how the German authorities preparing for the possible arrival of ASF in 2018. The region has major routes from Poland to inner Germany, thin human population, large natural areas, wide agriculture land with often corn production and a record number of wild boar. Ways of interaction between government

and non-government sector are shown and practical examples given for how volunteers, hunters, foresters, veterinarians and agricultural stakeholders are cooperating. Arrival of ASF in Germany is considered not a question of "if" but a question of "when". Thus reflection is given, if the preparations are sufficient to detect and fight back any outbreak of ASF by time. ASF is threatening the German pig meat export economy of 1 Mio. t with US $ 2,5 Billion of value since export bans and mass culling will become unavoidable. But a spread of ASF to Germany will also mean a progress of the disease into the heart of Europe and its strongest economies - affecting much more than the border region the disease is threatening now.

PREDICTING WATERSHED-LEVEL SEROPREVALENCE OF PSEUDORABIES VIRUS AND SWINE BRUCELLOSIS IN FERAL SWINE FOR THE UNITED STATES

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The risk invasive wild pigs pose for disease transmission to humans and livestock is increasingly a concern, and reducing these risks is central to the goals of the National Feral Swine Damage Management Program (NFSDMP). Due to logistical and fiscal constraints, sampling of invasive pig populations needs to be targeted; necessitating the need for methods to predict disease status across populations. These methods can be used to inform surveillance and monitoring activities; and may be used in risk assessments of disease transmission to humans and livestock. We developed a hierarchical Bayesian approach to predict seroprevalence of Pseudorabies virus (PRV) and swine brucellosis (SB) in watersheds for the United States. We evaluate hypotheses about the influence of environmental conditions associated with wild pig survival, diversity of alternate hosts for the pathogens, and demographic factors on the probability of infection for PRV and SB. Comparison of out-of-sample data with model predictions found our model accurately predicted apparent seroprevalence in most watersheds (96.3% of watershed for PRV and 93.0% of watersheds for SB). Predicted PRV seroprevalence had the greatest variation among all watersheds and was highest in Florida and Texas. SB had less variation in seroprevalence with highest predicted seroprevalence occurring in southeastern watersheds. PRV and SB seroprevalence estimates had different responses to environmental gradients associated with host survival. PRV seroprevalence declined with increasing precipitation during the coldest quarter of the year. SB seroprevalence was most sensitive to changes in precipitation and temperature in the driest quarter. Older and female pigs had an increased probability of infection for both PRV and SB. This approach can be used to improve targeted surveillance, provides a repeatable method to detect seroprevalence changes, improves risk assessments by providing consistent data, and can be used to evaluate invasive wild pig control efforts.

A SEROLOGICAL SURVEY OF WILD PIGS FROM SOUTH CENTRAL OKLAHOMA

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Wild pig (Sus scrofa) is one of the most distributed mammals in the world and is found on every continent except Antarctica. The wild pig population in the United States is of growing concern as their distribution and abundance continue to expand. A wild pig's ability to carry and harbor disease is one of the greatest animal and public health concerns in the United States. Wild pigs have been found to harbor as many as 45 parasites and infectious diseases, many of which can be transmitted to humans and livestock. As part of a multi-year surveillance project, we evaluated wild pigs from south central Oklahoma for antibody presence against: Brucella spp., Francisella tularensis, pseudorabies virus (PSRV), Porcine Reproductive and Respiratory Syndrome virus (PRRSV), and Trypanosoma cruzi (Chagas Disease). We harvested 388 wild pigs from 2015-2017. Rose Bengal card test was used to detect the presence of antibodies for Brucella spp. and slide agglutinations were performed for F. tularensis and confirmed by tube agglutination. Enzyme-linked immunosorbent assays (ELISA) were used to detect antibodies for PSRV, PRRSV, and T. cruzi. We detected Brucella spp. antibodies in 15.5% (60/388), F. tularensis in 19.9% (30/388), PSRV in 34.0% (132/388), PRRSV in 0.26% (1/388), and T. cruzi in 0.0% of our samples. It is important that we are aware of the infectious pathogens that wild pig populations harbor, especially those that can spread to humans and livestock populations around the country. Screening for infectious pathogens, such as that done in this study, is an important tool to gaining a greater understanding of the potential threat posed by these wild animals. This information can aid in the management of wild pig populations to help prevent the spread of disease and reduce contact between human and livestock populations.

PREVALENCE OF FIVE PATHOGENS IN WILD PIGS IN THE UNITED STATES

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Understanding the prevalence and distribution of pathogens in invasive wild pigs is important for efforts to prevent the spread of these pathogens to livestock. We investigated the national-level prevalence of five pathogens in wild pigs in each year in which wild pigs were sampled for these pathogens using serological data from the APHIS Wildlife Services National Wildlife Disease Program: Porcine Respiratory and Reproductive Syndrome (PRRS), Pseudorabies Virus (PRV), Swine Influenza (SI), Hepatitis E (HEV), and Swine Brucellosis (SB). We used models that incorporated false negative and false positive detection error (i.e., 'sensitivity' and 'specificity'). We also evaluated the effects of demographic parameters (sex and age class) on prevalence. To compare our model results with those of other researchers, we conducted a literature review on all studies examining the prevalence of these pathogens in wild pigs in the US. We found that our modeled estimates of sensitivity and specificity differed from those values expected for the serological tests. Additionally, estimated prevalence for each pathogen was different from the median of values found in the literature. Demographics had mixed effects on estimated prevalence, but were often similar to the effects found in the literature. Specifically, adults (≥ 2 years old) were more likely to be seropositive for SI, HEV, and SB and females were more likely to be seropositive for SB than males, while males were more likely to be seropositive for SI. We also found that estimated prevalence, sensitivity, specificity, and demographic effects had differing results when models included the watershed where pigs were sampled. This indicates that differences in prevalence and risk factors among populations may vary considerably.

TOXICANT PANEL

PUBLIC RESPONSE TO OPEN SURVEY ABOUT REGISTRATION OF KAPUT® FERAL HOG BAIT IN ARKANSAS

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In September 2017, the manufacturer of the warfarin-based toxicant Kaput® Feral Hog Bait requested pesticide registration in Arkansas. The Arkansas State Plant Board has never declined registration of a product. In October 2017, the Arkansas Agriculture Department issued a news release asking for public response through a web-based survey. Results were understood a priori not to be representative, but were intended to provide a forum for collecting diverse public opinion for decision makers to consider. The Arkansas Agriculture Department issued a news release and members of the Arkansas Feral Hog Eradication Task Force distributed the announcement to stakeholders. Respondents were expected to be (1) highly engaged in agriculture, natural resources, wildlife, and/or human health issues, (2) connected to mass and/or social media channels where the announcement was published, and (3) concerned enough to respond to a survey. Given these biases, the survey generated 5,034 responses, indicating much interest. Many responded feral hogs were "very im-

portant" (29%) to them personally; however, one-fifth indicated feral hogs were "not at all important" (20%), implying their interest rested on pesticide registration rather than feral hogs. A slight majority (58%) were able to correctly identify the active ingredient from a list. Almost three-fourths (72%) opposed the product being registered for feral hog control in Arkansas. Of the 455 (9%) respondents who supported state restrictions, most popular were a pilot project allowing use for a limited timeframe and re-evaluation (50%), or registration as a Restricted-Use-Pesticide used only by agriculture and pest business operators who attend safety courses and receive state certification (40%). A content analysis using AntPConc for Windows (Anthony 2017) will be conducted to categorize key concepts and relationships of comments recorded in the survey. An open-ended question asking for additional comments or feedback for the task force to consider received 1,902 responses.

STAKEHOLDER PERSPECTIVES TOWARD THE USE OF A TOXICANT FOR MANAGING WILD PIGS

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The wild pig (Sus scrofa) is one of the most detrimental invasive mammals in the Southeastern US. Lack of adequate population control has allowed pigs to become well established across the landscape, wreaking economic and ecological havoc. Given the need for additional wild pig management options, one recent approach being considered is the use of toxicants. Within Alabama, sodium nitrite has recently started field trials as a toxicant after receiving EPA approval. However, no research has been conducted looking into stakeholders' perspectives and acceptance towards pig toxicants. Given the lack of knowledge our goal was to determine stakeholders' attitudes, beliefs, and acceptability towards the legal use of toxicants for managing wild pig populations. To address our goal, we surveyed Alabama farmers, hunters, and forestland owners during February 2018 following the Tailored Design Method, which uses multiple reminders and incentives to encourage responses. Preliminary results indicate that ~ 75% of farmers view sodium nitrite as a completely acceptable to somewhat acceptable toxicant for wild pigs, while ~ 59% of hunters and ~ 80% of forestland owners agreed. Comparatively, ~ 45% of farmers and ~ 50% of forestland owners viewed warfarin as a completely acceptable to somewhat acceptable toxicant for wild pigs, while ~ 56% of hunters viewed warfarin as completely unacceptable to somewhat unacceptable. Farmers and hunters were most concerned about the human health impacts, water contamination, and incorrect usage of a toxicant for wild pigs. Contrastingly, forestland owners were most concerned with the effectiveness of a toxicant, non-target impact, human health impact and legal liability for accidental death of non-target animals. The findings of this on-going research project will have direct implications for shaping the potential future policy and use of toxicants as a wild pig management strategy.

POSTER SESSIONS

WILD PIG IMPACTS IN PECAN OPERATIONS

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Pecans (Carya illinoinensis) are an economically important specialty crop that are managed and harvested where sympatric populations of wild pigs (Sus scrofa) occur. Through foraging behaviors such as rooting, digging, direct consumption, and trampling, wild pigs may reduce harvestable yields. As part of a larger study, we quantified pecan harvest inefficiency resulting from wild pig damage. To assess harvest inefficiency of pecans, rooting damage was identified, marked and measured in pecan groves and orchards. Pecans within a 0.33-m^2 sampling frame were counted, sized, and weighed in damaged plots before and after pecan harvest in orchards (n = 60 plots) and groves (n = 51 plots) over the 2-year study period to quantify the residual. We conducted identical sampling on control areas without any damage (n = 30 plots). We found that treatment (whether a plot was damaged or not) was the only significant predictor ($F_{1, 133} = 5.21$, $P = 0.024$) of harvest inefficiency; depth and whether the damage was in a native or improved plot were not significant predictors ($P \geq 0.827$). Inefficiency of pecan harvest (i.e., loss) was greater in damaged areas (loss = 43.7%) compared to non-damaged (control) areas (loss = 10.0%), which results in a net loss of 33.7% as the result of rooting damage. Thus, loss of harvested pecans to pig damage alone is considerable, and when combined with direct depredation and consumption will compound total annual losses. Further research on resource selection and temporal use of pecan operations is forthcoming and will help to mitigate and prioritize areas for management intervention (e.g., control) to reduce loss of pecans from wild pigs.

EVALUATING USE OF JUDAS PIGS AND HELICOPTER CAPTURE USING NET-GUN FOR FERAL SWINE DISEASE TESTING AND POPULATION CONTROL

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Multiple approaches are currently used to detect and euthanize wild pigs for disease testing and population control efforts. Shooting firearms from a helicopter has been used extensively in some jurisdictions. However, an important challenge with using firearms discharged from a helicopter is social license; there are groups and individuals that disapprove of this method due to perceptions regarding safety and ethics, and some government agencies will not allow this approach. Furthermore, shooting firearms may not be feasible in areas where humans are present, or near roads and highways. In order to evaluate efficacy, we captured and GPS collared n =31 wild pigs in Saskatchewan, Canada (2015-2016) and in February 2017 we relocated all living collared wild pigs (i.e. Judas Pigs) with active collars using Iridium data capture and VHF beacons on the collars. Using a small spotter plane and a Hughes 500 helicopter with an infrared camera in the winter months, we counted the number of individuals in each sounder (1-12 animals/sounder). The helicopter team then captured animals individually (>40 kg) or in groups of up to six at one time (<40 kg) using 12x12ft nets. The plane flew overhead and monitored the remaining animals and helped coordinate efforts to capture all members of each sounder, which were restrained and euthanized with a penetrating bolt gun to the head. We evaluated capture success and cost/animal. Cost per animal is high but only one sounder had <100% success for capture. Advantages of net gunning are that captures were <500m from roads, approval was easily obtained from Canadian Council on Animal Care, and no complaints were received. During this time, uncaptured members of the sounder may disperse, though losses were greatly minimized by using an infrared camera and having top cover from the fixed wing overhead that monitored the uncaptured animals.

NEW MEXICO FERAL SWINE LITTER SIZE AND BODY WEIGHT: 2010-2016

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The goal of APHIS Wildlife Services' National Feral Swine Damage Management Program is to prevent the spread of feral swine, as well as reduce their population, damage, and associated disease risks. Progress on these goals depends, in part, on greater understanding of feral swine fecundity. Fecundity and body mass data is needed to estimate population dynamics and predict disease transmission, both useful to informing management decisions. In order to assess fecundity of feral swine in New Mexico, body metric, litter size, and pregnancy data were collected from 2010-2016 as part of control operations led by the USDA-Wildlife Services throughout New Mexico. Data were analyzed and summarized, with particular emphasis on litter size and pregnancy status. Findings included a positive correlation between the latitude at which a sow was captured and the size of her litter. Litter size also increased with sow body mass, with the exclusion of five animals above 200 pounds that had smaller than average litters. The proportion of adult females that were pregnant varied

between months of the year, with a large increase in the proportion of pregnant females observed in September. Despite this monthly variation in the proportion of females pregnant, the mean litter size remained relatively consistent throughout the year. No significant difference was found in body mass by year of capture, physical condition, or mean annual precipitation at the location of capture. While these analyses may inform management approaches in New Mexico and in similarly arid environments, it is essential to evaluate fecundity in other climatic regions. Future analyses will assess the effects of an individual pigs' genotypic origin (e.g., proportion of domestic heritage) and additional bioclimatic variables on feral swine fecundity in New Mexico and other regions of North America.

COMMUNITY-BASED FERAL SWINE MANAGEMENT

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Congaree National Park (CNP) encompasses the largest intact expanse of old growth bottomland hardwood forest remaining in the southeastern United States and also has one of the largest concentrations of feral swine in the state. CNP is comprised of ~30,000 acres and is bordered by agricultural lands both east and west of the park's boundaries in Richland and Calhoun Counties. In November 2015, USDA APHIS – Wildlife Services (WS) entered into a Cooperative Service Agreement with CNP to address feral swine problems within park boundaries. Once the word spread about the feral swine program at CNP, WS received a number of requests for assistance from private landowners in the area where there are significant losses to property and agricultural fields. A series of stakeholder meetings and workshops were held in both Richland and Calhoun Counties in an effort to educate residents on feral swine management. As a result of these meetings and through a joint effort with the National Feral Swine Program, CNP, County Soil/Water Conservation Districts, and several other agencies and NGOs, funding was secured to hire an additional technician. This allows for one technician to focus on CNP and another to focus on private land around the park. Since hiring the second technician in January 2017, over 14,000 ac have been added to the program with participating landowners reporting an average of $37,000.00 in damages annually. The results of this project can help in the development of future projects by outlining the importance of community involvement when addressing the ever growing feral swine problem.

FERAL SWINE IN THE MOUNTAIN BIOME

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Feral pig sightings and reports in Southeastern New Mexico began to surface in the early 1990's. USDA Wildlife Services began a full eradication project on the Lincoln National Forest (LNF) in Otero and Lincoln Counties, as well as on the Mescalero Apache Reservation in 2013. Feral hogs on the LNF and Mescalero Reservation are being extirpated at elevations just below 3,300 feet all the way up to elevations above 9,200 feet. Based on telemetry data, home ranges of feral swine in this area are anywhere from two square miles all the way up to two hundred forty square miles. USDA Wildlife Service specialists are faced with many challenges while conducting eradication efforts in the forested, mountainous habitat. Remoteness, restrictions associated with threatened and endangered species and wilderness areas, extreme weather conditions, and habitat type all limit accessibility and visibility for both wildlife specialists on the ground and for aerial hunting. Aerial shooting, GPS collared "Judas" pigs, and monitoring cameras have proven to be most effective techniques for locating and removing feral swine. Swine in this area have become both bait and trap shy. Varying bait mixtures, moving traps, and altering trap style have all been incorporated in an attempt to increase trap success. Feral pig eradication in the Sacramento Ranger District (Otero County, LNF) began in 2013. The US Fish and Wildlife Service gave USDA Wildlife service approval to begin using an integrated approach to remove feral hogs in the White Mountain Wilderness Area (WMWA), and work there began in October 2015. Wildlife Services in New Mexico has two full time employees working to remove feral hogs in mountainous habitat located in southcentral and southeastern New Mexico. As a result, 19 million acres have been cleared statewide. Thus far, 213 feral pigs have been taken on the Mescalero Reservation. In the Sacramento Ranger District 173 feral hogs were removed. And finally in the White Mountain Wilderness Area, 23 individuals have been extirpated (the numbers of feral swine exterminated does not include those pigs taken by hunters or other resource management personal).

AN ILLUSTRATIVE GUIDE FOR AGING FERAL SWINE IN THE FIELD

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In research, control, and disease surveillance of feral swine there is much utility in understanding the age or age structure of individuals and local populations. However, wildlife professionals lack a user-friendly standardized method for accurately aging feral swine in the field. The most comprehensive and frequently cited tooth eruption and replacement data collected on known age feral swine in the United States was collected by George Matschke in 1967 who evaluated known age captive progeny of wild boar captured in Tennessee. Using these data, we generated 9 age intervals and collected representative photographs of teeth at various stages of eruption and replacement for each interval. We then created an easy-to-use 11x17 inch photo guide to portray all 9 intervals spanning from 0 - 48 months of age. This guide is complete with photographs, captions, defining characteristics, special notes, and tips to easily facilitate the aging of feral swine in the field.

STATEWIDE DELIVERY OF LONE STAR HEALTHY STREAMS FERAL HOG MANAGEMENT PROGRAMMING IN PRIORITY WATERSHEDS IN TEXAS

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Wild pigs (Sus scrofa) are found in nearly all Texas counties, and there are currently more wild pigs estimated in Texas than in any other U.S. state. Because the vast majority (>95%) of Texas lands are privately owned, the responsibility of wild pig control falls primarily on private landowners. Outreach efforts to relay science-based information related to wild pig biology and management remains an important component of fostering private lands stewardship. The Texas A&M AgriLife Extension Service has offered educational materials by conventional and non-traditional methods to maximize our reach to audiences in Texas and beyond. From 10/1/2008 to present, we accomplished this task through funding by the Texas State Soil and Water Conservation Board (TSSWCB) and the San Antonio River Authority (SARA). Through TSSWCB consecutive projects, direct outreach efforts included: 379 face-to-face community presentations (26,159 attendees). Post program evaluations showed 98.7% participant reported knowledge gained concerning feral hog biology, legal control options, efficient trap/bait techniques and types/extent of feral hog damage. We also conducted 116 in-person technical guidance site visits. Additional outreach included: 26 extension publications (8 translated to Spanish), 91 "Wild Wonderings" blog articles (224,167 views); 50 news releases; 43 media interviews (TV, radio, newspaper); 11 magazine articles; 94 external articles about project activities; 48 educational videos (409,297 views); 6 editions of the "Wild Pig Newsletter" (343 subscribers and an online reach of 6,514 readers); the development of web-based statewide feral hog reporting tool; 2 wild pig distance education courses; 4 wild pig distance education lessons; a "Coping with Feral Hogs" website (562,191 page-views and 278,709 unique visitors); a Feral Hogs Community of Practice website (320,145 unique page-views); a feral hog smartphone application; and dedicated social media campaigns (Twitter and Facebook) that have reached over 500,000 people and received 50,000 clicks on shared resources since 2015.

ANALYSIS OF STOMACH CONTENTS FROM FERAL

SWINE COLLECTED IN AGRICULTURE DOMINATED LANDSCAPES IN MISSISSIPPI AND MISSOURI

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A comprehensive review of journal articles, theses, and dissertations on the analysis of feral swine diet was conducted to develop a rigorous 2-part protocol for both the acquisition of feral swine stomach samples in the field and the preparation and analysis of those samples in the laboratory. We ensured stomach samples were collected with the consistency and attention to detail necessary for an accurate representation of agricultural crop consumption by feral swine in Mississippi and Missouri. Feral swine were dispatched in both aerial gunning and trapping operations. The stomachs were extracted, placed into plastic bags, and frozen. Once the samples arrived at the laboratory, they were processed through a series of stations until they were dried to a loose, clean mixture. After the samples were examined, each category of contents found in the sample was weighed and recorded. Photos of new specimens were taken to aid in identification and create a visual record of the findings. The dried stomach contents were broadly categorized with a focus on the identification of agricultural plants. Statistical analysis is ongoing, but most major agricultural crops grown in the study areas were present. In addition to agricultural plants, several varieties of non-agricultural vegetation, hard and soft mast, vertebrate, and invertebrate specimens were identified. These findings reinforce both the need to prioritize the protection of farmers' crops as well as the need for ongoing research into the best methods for mitigation of this invasive species.

WILD PIG BEHAVIORAL RESPONSES TO NATURAL REPELLENTS ON COWDEN PLANTATION, JACKSON, SOUTH CAROLINA

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Current management of wild pigs (Sus scrofa) in Georgia and South Carolina primarily consists of lethal removal or trapping efforts. These procedures may not be applicable in all situations. Our efforts have focused on determining a readily available natural substance that is capable of successfully excluding wild pigs from a targeted area. Scents tested in our studies have included the following oils or substances: black pepper, tea tree, camphor, dog hair, cinnamon, habanero extract, and Carolina Reaper peppers. Various application colors have also been examined to gauge effects on wild pigs. Centralized and perimeter based scent dispersion arrays were also tested. Pig behavior was documented using camera trapping on a private plantation in the Savannah River swamp area of Jackson, SC. Sample sites have historically experienced consistently large acreages of pig damage. Wild pig behavior appeared unaffected by most scent and color applications as long as food (dried corn) was present in the test array. Measurements of presence versus absence of wild pigs in these tested areas indicated a decrease in activities when dog hair was applied.

FERAL HOG HUNTING AND TRAPPING IN OKLAHOMA

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The Oklahoma Department of Wildlife Conservation (ODWC) conducts an annual survey of Oklahoma (OK) hunters to estimate hunter participation and harvest for game species. In the 2016 season survey, for the first time, hunters were asked about feral hogs. ODWC desired baseline knowledge about participation in feral hog hunting and trapping, hog harvest, and hunter motivations for pursuing feral hogs. The survey found that 25% of active OK hunters hunted or trapped feral hogs in 2016. The majority pursued hogs with traditional hunting methods (78%), while 5% trapped, and 17% both hunted and trapped. Forty-two percent of hog hunter/trappers pursued feral hogs independent of other game; 33% hunted swine while hunting other species; and 25% hunted hogs both exclusively, and while hunting other species. Hunters' primary motivations for pursuing feral hogs were for damage or nuisance control (84%), recreation or sport (45%), food (41%), and other reasons (5%). The survey estimated hunters harvested 307,069 feral hogs (95% CI: 210,433 - 403,705); and trappers harvested 148,108 hogs (95% CI: 100,434 - 195,782). These survey results have provided ODWC with its first look at feral hog pursuit in Oklahoma, and will allow the agency to monitor hunter/trapper participation, harvest and motivation trends over time.

MANAGEMENT CHANGES OF THE WILD BOAR POPULATION IN POLAND DUE TO THE AFRICAN SWINE FEVER VIRUS EPIDEMIC

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The Polish Hunting Association, which is affiliated with over 123,000 hunters, conducts the management of the wild boar population in Poland. Poland's hunting season runs each year from April 1st to March 31st. Determination of the culling of each species in each hunting season is based on national regulations, (ie: hunting law, and the regulations of the Minister of the Environment). The number of wild boars in Poland is inventoried by a scientific method such as "Trial Drives." Each estimation of the population takes place on a yearly basis around March 10th. In Poland, under normal conditions, the birthrate of the wild boar in spring increases the population close to 250%. Hence, the annual hunting plan is established on the basis of the birthrate and number of animals from the spring of year. In the 2000-2001 hunting season, the number of wild boar in Poland was approximately 118,300 animals (culling in this season was equivalent to 93,000). Five years later, in the 2005-2006 hunting season, the number of wild boar increased to 173,500 animals (culling increased to 138,000). In the 2010-2011 hunting season there were 249,900 wild boars in Poland (233,000 animals were harvested). Four years later, the number of wild boar increased to 248,600 (culling 240,000 animals). From the hunting season 2014-2015 through 2016-2017 the number of animals started to decrease gradually. During these three hunting seasons (2014-2015, 2015-2016 and 2016-2017), the population size was 264,000 (harvesting 242,000), 249,000 (harvesting 291,000) and 214,800 (harvesting 310,000) respectively. The reason for this decrease in the wild boar population was the discovery of the African Swine Fever virus, which forced hunters to sharply reduce the species through reduction hunting using sanitary methods. African Swine Fever is a disease caused by viruses affecting all breeds of pigs and wild boars. In Poland, the first case of Swine Fever in wild boar was recorded on February 17, 2014. Since then, this disease has been constantly spreading both in the population of wild boars and domestic pigs, constituting a huge epidemiological and economic threat to the economy. Since January 5, 2018, there have been 103 known outbreaks of ASFV on domestic pig farms and 904 cases of ASFV in the wild boar population of Poland. There are two main areas where the disease has occurred in Poland. The first area is the eastern part of the country near the border with Lithuania, Belarus and Ukraine. The second is near the capital of Poland - Warsaw (where there have been about 1000 incidences) and the adjacent areas. The virus was transferred by a man who illegally imported food across the border. There is a risk of the disease spreading further in the wild boar population of Poland. This forces a change in the species management plan (a radical reduction of numbers without protective season/species limits).

RURAL OR URBAN LANDSCAPE: THE INFLUENCE OF THE LIVING ENVIRONMENT ON THE CONDITION OF THE EUROPEAN WILD BOAR POPULATION

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Wild boar, Sus scrofa L. is a generalist species with a diet that consists of a large variety of food sources. It has one of the largest geographical ranges among all the ungulate mammals. Because of this wide geographical range it can live in different natural habitats or environments, where they can find a diverse variety of food sources. As a result in the wild boars diet from the different types of habitats, differences can be shown which may result in different body conditions for each individual

animal. It is necessary to point out that the diet is one of the factors which has a huge impact on the body condition of wild boars. The individual body condition of wild animals is measured by the amount of body fat stored around internal organs. One of the most common parameters used is the measurement of fat around the kidneys and calculation kidney fat index (KFI). The purpose of this study was to assess the individual body condition of wild boars from two differing habitats using the kidney fat index (KFI). In order to assess the influence of habitat/environment on the animal body condition in two different wild boar populations, the kidneys with kidney fat were removed from 18 harvested wild boar females of approximately 2 years of age. The two wild boar populations which inhabited two different areas were compared: Area 1- large scale monocultural crops (maize, rapeseed etc.) with a mosaic of forest; Area 2 – strong urbanized areas located next to Warsaw. Two kidney mass measurements were made in order to calculate KFI: 1) kidney mass with perirenal fat, 2) kidney mass without kidney fat. KFI was calculated using the formula: KFI= Kidney mass with fat / kidney mass without fat. The mean value of KFI for two year old females in the agricultural area totaled 1,82. The mean value of KFI for two year old females from the urban areas located next to Warsaw was 0,35 lower than in the agricultural area. Differences between the mean value of KFI in the two distinct territories was significant (P≤0,05). Difference between the mean value of the females body weight (without entrails, with fur) was not significant. Results suggest that better natural living/habitat conditions for wild boars are the agricultural areas rather than in urban areas, where there are a substantial number of factories, houses, warehouses and other facilities.

UNDERSTANDING THE DISTRIBUTION AND RISKS OF WILD PIGS (SUS SCROFA) ACROSS CANADA USING LOCAL KNOWLEDGE AND EXPERT ELICITATION

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Wild pigs are an invasive species that have established populations across Canada's Prairie Provinces. Wild pigs pose many direct and indirect environmental and socio-economic issues and present new and unique management challenges to wildlife and land managers. Wild pig distribution was systematically documented using provincial wildlife enforcement and management jurisdictions, as well as snowball and random stratified sampling techniques. This research is in progress, however preliminary results have identified the range and distribution of wild pigs across Canada since the first introduction events occurred from wild boar farms. Wild pigs are well established across the Prairie Provinces, and occur sporadically in BC, ON, and QB. Resource selection function models will supplement the distribution maps by illustrating suitable wild pig habitat across the country, highlighting areas at risk of future range expansion. Risk analysis models will develop relative scales of risk to highlight protected areas and domestic pig farms at risk of spatial overlap, and therefore, the negative impacts associated with wild pigs. Central to the design and effectiveness of long-term wildlife management, control, and monitoring programs, as well as disease monitoring and risk management strategies, is the knowledge of species distribution and population size. The results of this research will provide government agencies and wildlife and livestock managers with resources for establishing effective wild pig management and control strategies.

CONTRASTING RESULTS FROM CHARACTERIZING 'RESOURCE USE' AND 'RESOURCE SELECTION' FOR WILD PIGS IN AGRICULTURAL CROPS

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Wild pigs make extensive and intensive use of agricultural crops across large parts of the United States and Canada, resulting in significant economic losses due to crop damage. For most of Canada, agricultural crops are highly seasonal, with high levels of intensive production in summer (April – October) followed by long cold winters with often heavy snow cover. Resource selection, a function of both the use and availability of resources such as crops, has been the primary focus of ecological research in recent years, primarily using resource selection function (and similar) models. While useful and important, this approach can be limiting in understanding the role and impact of crop damage since it is reliant on estimates of availability. As such, crops used frequently but that are also widely available may be determined to be weakly selected for or even 'avoided'. For managers dealing with actual levels of crop damage, only looking at selection may be less helpful. Here we compare estimates of 'use' and 'selection' for n=14 different agricultural crops by n=31 (19 female and 12 male) GPS collared wild pigs in Saskatchewan, Canada using the Agriculture and Agri-Food Canada annual crop inventory maps during the snow-free period. We will present findings from this research in progress to compare 'use' and 'selection' in the context of effectively managing crop damage by wild pigs in North America.

ADVANCES IN THE MEXICO – US BINATIONAL COLLABORATION FOR FERAL SWINE DAMAGE MANAGEMENT

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The Wildlife Program in Mexico is established to serve as a liaison with the Mexican Counterparts to develop binational collaboration activities for surveillance, monitoring and management of wildlife diseases according with the directives and guidelines established for the USDA/APHIS/WS National Programs of Rabies, Wildlife Diseases and Feral Swine Damage Control. The main goal of the developed activities is in strategic planning, coordinating and implementing cooperative programs with the Govt. of Mexico (GOM) agencies of Health (SALUD), Agriculture (SAGARPA), and Natural Resources (SEMARNAT), as well as several institutions like Universities (UNAM and IPN), the State Committees of Animal Health (SCAH), Research Centers, Veterinary Associations, Hunting Associations, other NGO's and other organizations involved in the Wildlife Services Management Programs, to implement training programs, track progress and resolve technical, personnel, research and planning issues, and assists with several goals including feral swine diseases in collaboration with the Mexican Agencies. The report will present the collaborative activities developed on the period 2015 – 2017 including the national negotiation to develop joint national plans for feral swine damage management, the field activities developed during the period, the feral swine workshops conducted in the states of Coahuila (2015); Mexico City, Nuevo Leon and Chihuahua (2016); Laredo, Texas, Mexico City and Sonora (2017); the participation in several meetings, workshops and conferences organized by the Mexican Ministries of Health, Agriculture and Natural Resources, the Mexican Association of Veterinarians Specialized in Swine, the Hunting Associations, and the Mexican Universities. During those events, the US-Mexico plans for collaboration in Feral Swine issues with veterinarians, swine and wildlife producers, students, animal health professionals and ranch owners were reviewed.

EFFECTS OF WILD PIG REMOVAL ON LOCAL DEER AND TURKEY POPULATIONS

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Wild pigs may negatively impact local white-tailed deer and eastern wild turkey populations through both competition for food resources and direct predation. Given the economic and recreational importance of these game species, reductions in recruitment or displacement of individuals are of great concern. Whereas several studies have reported anecdotal observations of increased deer and turkey sightings after removal of large portions of resident wild pig populations, very little research exists that empirically measure the impacts of wild pigs on local deer and turkey populations. Therefore, our objectives were to determine the effects of wild pigs on deer and turkey visitation to baited camera sites and then to estimate changes in deer and turkey population characteristics after removal of wild pigs. We conducted camera surveys from 2015–2018 on 27-km^2 treatment (pig removal) and 29-km^2 control (no pig removal) areas of Lowndes Wildlife Management Area (LWMA) in Alabama. We used camera sites baited with whole corn to conduct 1-week surveys on each area during late winter (February-March; 1 camera/4-km^2) and summer (July-August; 1 camera/1-km^2) prior to and after removal of wild pig sounders

from the treatment area. We collected 459,502 images from the 2015-2017 surveys and will use information from this year's (2018) late winter camera survey to determine if these variables impact overall deer, pig, and turkey detection and occupancy probabilities. However, this research is in progress and we will report preliminary results of our occupancy analysis. After preliminary analysis, we will determine if deer and turkey occupancy differs with variables such as age class, sex, or group size. This information will enable us to explore not only if wild pig management affects deer and turkey, but how.

THE NEED FOR CONTINUED MONITORING AFTER FERAL SWINE ELIMINATION

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The monitoring and removal of feral swine (Sus scrofa) are demanding and challenging wildlife damage management actions. Quantifying the number of swine killed is one step in management, but certainty of complete elimination poses a problem for continued monitoring: if or when to cease the monitoring efforts. Populations have been known to be extirpated from one area only to appear in another after a period of time (Flessa and Jablonski 1983). Three years after Wildlife Services eliminated swine from all known locations in New York, one boar was detected in an area with no known prior populations. This single Eurasian boar was living undetected in a 1,994 ha swamp in a northern New York county for an unknown amount of time. Wildlife Services received a report of a feral swine sighting from the public and was able to immediately begin monitoring and surveillance of the swamp. New York receives over 30 feral swine sighting reports on an annual basis with reports originating in 22 counties that span the state. The majority of swine sightings and reports do not indicate feral swine activity but, without a thorough investigation of each report, the potential exists for swine to go undetected. New York Wildlife Services, in collaboration with other organizations, is monitoring feral swine by methods of investigating reports, contacting landowners, and continuing public education on issues surrounding feral swine and their damage. With these methods in place, Wildlife Services assesses and manages reported feral swine occurrences and continues to keep New York free of feral swine.

USING UAS TO MEASURE FERAL SWINE DAMAGE IN CORN

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Feral swine (Sus scrofa) are an invasive pest species that cause billions of dollars in damage to agriculture, private lands, endangered species, and native ecosystems. Because feral swine have escaped from game farms and commercial operations, and have been illegally transported and released throughout this U. S., their population has grown and spread at an alarming rate. In 1982, only 17 states reported having feral swine, however 30 years later, feral swine have been documented in at least 40 states. As populations of feral swine continue to grow, so has concomitant damage. One underlying problem is the lack of reporting of feral swine damage. Damage to agricultural crops can occur throughout the lifecycle of the crop, but many times damage has occurred inside the field perimeter where the producer will not notice it until the crop is harvested. New tools to measure feral swine damage are emerging and one is small unmanned aircraft systems (sUAS) or drones. With the use of sUAS, producers and wildlife management officials can quickly discover and quantify the amount of damage in an area. Wildlife Services used sUAS, natural color, and multispectral cameras to document and assess damage to corn fields in Missouri. With this new tool, we will be able to successfully show that as feral swine populations are eliminated, damage to crops will also be reduced. Wildlife Services will expand these methods in 2018 and apply them to other agricultural crops receiving feral swine damage.

ENVIRONMENTAL DNA (EDNA) AS AN OPERATIONAL TOOL FOR DETECTING FERAL SWINE

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At the edges of feral swine (Sus scrofa) distributions, managers are faced with tough questions. Are feral swine invading previously uninhabited areas? Were previous removal efforts successful? Answers to these questions are necessary to manage feral swine in a timely manner and are dependent upon our ability to detect individuals on the landscape. Although detecting pigs when abundance is low can be a challenge, environmental DNA (eDNA) detection methods have proven to be an effective tool under such circumstances. Our lab previously demonstrated the efficacy of this molecular detection tool for feral swine from water samples in controlled experiments. In 2017, we implemented this tool in an operational setting. From February to November, 827 water samples were collected from sites across New Mexico with suspected and unknown feral swine presence. DNA was extracted from the water samples in two technical replicates using DNeasy® mericon® Food kits and quantitative PCR (qPCR) reactions were run in triplicate before and after an inhibitor removal treatment. We identified 79 positive samples and several additional putative positives (those outside our thresholds of detection that still warranted further investigation). Importantly, many positives came from sites where the status of feral swine occupancy was unknown. Return visits to positive sites confirmed the presence of feral pigs. As feral swine continue to pose a challenge for managers tasked with reducing economic and ecological damage, eDNA is emerging as another viable tool for the detection of feral swine and description of their distribution. We have shown that eDNA assays are a viable operational tool that can provide managers with the information needed to prioritize removal efforts and resources. Additional field sampling is now underway in California and Indiana as we continue to apply this tool to help inform management action.

HUMAN FATALITIES RESULTING FROM WILD PIG ATTACKS ON A WORLDWIDE SCALE – 2007-2017

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Although reported to be rare in occurrence, wild pig (Sus scrofa) attacks on people can result in serious outcomes including fatalities among the human victims. Worldwide data on fatal wild pig attacks on humans were compiled between 2007 and 2017. Similar to studies of large predator attacks on humans, data came from a variety of sources. Information was collected from a total of eighty-four humans who died in seventy-seven separate incidents. The mean annual number of persons killed in these attacks was 7.6 individuals per year during this decade. These attacks took place mostly within the wild pig's native species global range, in either the Indomalaya or Palearctic biogeographic realms; a small number happened in the species introduced global range in the Australasian realm. These attacks variously took place in twenty-two countries, with over half occurring in India. The habitats associated with these incidents were all in rural areas, decreasing in frequency from agricultural lands (i.e., croplands and groves/orchards), to woodland/forest, to remote villages/settlements and to open habitats (i.e., meadow, pasture, shrub/scrub fields). Most of these fatal attacks occurred under non-hunting circumstances and appeared to be unprovoked. Animals being threatened (e.g. cornered, chased or struck) were the chief cause in hunting circumstances. Most victims were senior (i.e., 60+ yrs. of age) males walking alone. All of the victims, ranging in age from 3 to 81 years old, were traveling on foot. Most incidents resulted in a single human fatality; however, in 2008 four men in rural India were all killed during a single attack by a group of wild pigs. In contrast, most of these fatal attacks were caused by a solitary wild pig. The identified causes of death included exsanguination/hemorrhagic shock, severe lacerations/punctures/bites, traumatic limb dismemberment, septicemic shock with peritonitis, and penetrating craniocerebral injury.

COMPARATIVE TAXONOMIC ANALYSIS OF ADULT

MALE WILD PIG CRANIA

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Skull characteristics have been reported to be some of the most reliable means for identifying the three primary types of introduced wild pigs (Sus scrofa) found in North America [i.e., Eurasian wild boar, feral pigs (i.e., wild pigs solely of domestic ancestry), or hybrids between these two types]. Previous research employed multivariate statistical methods to analyze skulls to discriminate among the three types wild pigs, as well as known domestic swine for comparison with the wild types. Canonical variate analyses were then used to classify unknown specimens into one of the four target groups. In addition to giving good separation among the four target groups, that previous research determined that crania provided better target group resolution than mandibles, and group separation decreased with decreasing age class and in going from males to females within the same age class. The purpose of the present study was to focus on only analyzing adult male crania to further assess the discrimination ability of this method with a larger sample of known specimens compared to the previous research. The cranial specimens were obtained from both institutional and private collections. Seven cranial dimensions were measured to the nearest millimeter with either anthropometers or dial calipers. The known specimens were then analyzed with a canonical variate analysis (JMP). Resolution among the target groups did increase with larger sample sizes, with little unexpected overlap observed (i.e., Eurasian wild boar – 5% w/ hybrids; hybrids – 30% w/ wild boar and feral pigs; feral pigs – 11% w/ hybrids; and domestic swine - 0%). The absolute ability to discriminate between the domestic specimens and all of the wild specimens was significant. Such analyses would be useful in determining the taxonomic identity of a wild pig population or an individual animal for legal, classification and monitoring purposes within a management context.

FERAL HOG CONTROL IN BURNET COUNTY, TEXAS

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Burnet County is located in central Texas encompassing 636,160 acres of land. The County's agriculture is dominated by cattle and goat production. Feral hogs were first discovered by Texas Wildlife Services Technicians in the west and east ends of the county in the mid 1980's. These populations of feral hogs were most likely due to the escaping of free range domestic swine production. Transporting and releasing of feral hogs began on a few ranches in the early 1990's. Now feral hogs are abundant across most parts of the county. More serious efforts to start reducing feral hog damage began in 2013. MIS was used to analyze the feral hog take during a 5 year period. During this time period it was estimated that feral hogs caused a total of over 1.8 million dollars in damages. From February 1, 2013 to December 31, 2017 2,132 feral hogs were removed by various methods from 81,180 acres. Corral trapping was found to be the most successful method removing 1,168 feral hogs.

A NATIONAL APPROACH FOR RISK-BASED TARGETED SURVEILLANCE FOR FERAL SWINE DISEASES OF CONCERN TO DOMESTIC ANIMAL AND HUMAN HEALTH

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Surveillance and monitoring of invasive wild pigs for diseases of concern to human and livestock health is central to the goals of the National Feral Swine Damage Management Program (NFSDMP). Disease data collected through surveillance and monitoring is important for conducting risk assessments, identifying areas of importance for implementing risk mitigations, can be used operationally to target populations for control, and is used for reporting to stakeholders and trading partners. However, it is not logistically nor fiscally feasible to routinely sample all invasive wild pig populations. To maximize the benefits of conducting surveillance, we developed an adaptive risk-based targeted surveillance approach that has two primary objectives. The first objective is to target surveillance in areas of greatest risk for foreign animal disease introduction and wild pig-livestock disease transmission. The second objective is to improve local and national estimates of pathogen prevalence by adaptively allocating sampling effort spatially. We developed an approach that uses a Bayesian model to predict pathogen prevalence in each U.S. County. A risk score is then developed for each county based on their proximity to ports of entry, landfills, and presence of livestock commodities. Counties having high risk scores and greater uncertainty in pathogen prevalence are prioritized for surveillance. Counties are reprioritized annually based on the previous year's surveillance data. We expect that over time estimates of pathogen prevalence will improve as sampling is allocated adaptively improving surveillance, reducing cost, and increasing the usefulness of the data for risk assessments.

PSEUDORABIES IN HUNTING DOGS IN ALABAMA AND ARKANSAS AFTER CLOSE CONTACT WITH FERAL SWINE (SUS SCROFA)

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Pigs are the only natural hosts of pseudorabies virus (PRV), also known as Aujeszky's disease, which is an important disease of mammals that is often characterized by extreme itching, facial swelling, and excessive salivation followed by death in non-suid species. The risk to susceptible mammals was assumed to decrease with elimination of the virus from commercial swine in the U.S. in 2004; however, PRV remains endemic in feral swine. Due to their widespread geographic range, and relatively high PRV antibody prevalence (approximately 18%), feral swine are important maintenance hosts. In addition, PRV causes latent infections in swine which recrudesce when stressors such as farrowing or transport occur. Feral swine pose a threat not only to the disease-free status of the commercial swine industry, but also to other animals that have direct or indirect contact with feral swine. Dogs are commonly used for hunting feral swine and are at high risk of being exposed. We report infection in a dog in Alabama after exposure to feral swine at a wild hog rodeo, and infection in multiple dogs in Arkansas after exposure through hunting or consumption of the offal or raw meat. Our objective is to highlight the persistence of this disease in U.S. feral swine, and to increase the awareness of hunters, dog owners, veterinarians, wildlife biologists, and others that are involved in activities involving feral swine.

A POPULATION GENOMIC APPROACH TO ESTIMATING MIGRATION WHEN SAMPLE SIZE IS SMALL AND POPULATIONS ARE CLOSELY RELATED

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Population genetics methods are commonly used to evaluate movement of individuals among subpopulations. However, it can be difficult to infer migration when subpopulations are closely related or sample sizes are small (< 30 individuals). We developed a population genomic method for estimating migration among subpopulations under these conditions. Specifically, we conducted a supervised analysis with ADMIXTURE using a leave-one-out (LOO) approach in which we iteratively queried the genetic origin of a single individual while all other individuals in the dataset served as reference samples for the population in which they were collected. Using the observed allele frequencies within each population, we then simulated parental populations, descendants of migrants, and grand descendants of migrants. In a permutation framework, we repeated the LOO analysis with the simulated dataset. By comparing the assignment of observed individuals among respective populations to parallel assignment distributions generated from the simulated dataset, we were able to classify observed individuals as residents, migrants, descendants of migrants, and grand descendants of migrants. We applied this method to evaluate mi-

gration rates of invasive wild pigs (Sus scrofa) among counties in Missouri, USA. We documented high rates of translocation among populations as well as translocation into Missouri from exogenous sources. Using Bayesian models to evaluate the environmental and anthropogenic covariates associated with the movement of invasive wild pigs, we found introduction of wild pigs into counties in Missouri was positively associated with domestic pig farms and the recreational hunting industry. These results allowed us to predict the risk of additional introduction of wild pigs into each county in Missouri.

ASSESSMENT OF INVASIVE WILD PIG DISEASE RISKS AND MANAGEMENT PRIORITIES

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Wild pigs (free-ranging 'feral' swine; wild boar; Sus scrofa) are highly successful invasive mammals occupying at least 41 U.S. states and 4 Canadian provinces. The U.S. wild pig population is estimated at more than 6 million animals, annually causing millions of dollars in damage to agriculture, native species, and historic resources through their rooting and other feeding activities. Wild pigs carry viral and bacterial pathogens and macro parasites that are potentially transmissible to livestock, wildlife and people. Understanding risks of disease transmission from invasive wild pigs is a key objective of the USDA APHIS National Feral Swine Damage Management Program (NFSDMP). As OIE Collaborating Centers, APHIS Veterinary Services Center for Epidemiology and Animal Health and the USGS National Wildlife Health Center co-sponsored an International Workshop on Feral Swine Disease and Risk Management in November 2014. This workshop was attended by 17 international (including Canada) experts on wild pigs and 20-30 U.S. experts and audience members. The workshop's strategic goals were to establish relationships among U.S. and international experts on wild pig ecology and epidemiology, to identify successes and failures from other global efforts to manage disease risks from wild pigs, and to begin integrating lessons learned into the research and operational execution of the NFSDMP. Speakers presented topics on regional wild pig issues that addressed themes and questions in a risk assessment framework. Moderated panel discussions summarized key findings, including socioeconomic and ecological consequences of diseases in wild pigs (e.g., trade/livelihood losses, impacts on endangered species), classification of diseases by hazard level (e.g. ASF, CSF – high economic impact with confirmed suid maintenance host), objectives and tools for surveillance and risk mitigation (e.g., local knowledge surveys, oral vaccine delivery), and guidance on transfer of research into effective policy for invasive wild pig management (e.g., expanded community engagement and social science research).

EXAMINATION OF FERAL HOG (SUS SCROFA) DIET IN SOUTHERN ARKANSAS

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Hard mast is a very important source of forage through the winter for many wildlife species, including feral hogs (Sus scrofa), which compete with native species. In some studies, feral hog diet was shown to consist of over 80% acorns and hickory nuts. Feral hogs feeding on acorns and seeds, as well as trampling and uprooting seedlings, have also been shown to reduce abundance of woody seedlings. With the importance of commercial forestry to the economy of Southern Arkansas, feral hogs may be having a severe negative effect on forest regeneration. In our research, we are studying the diets of feral pigs and their impacts on bottomland oak regeneration in Southern Arkansas. We will present the current results from our study of feral hog diets, for which stomachs are being collected from animals harvested in collaboration with recreational hunters and state and federal trappers. At the time of harvest, the animals sex and weight range are being collected. Utilizing the point frame count method, stomach contents are categorized into 100 points for each stomach, so that potential correlations between diet and season, sex and weight can be examined. The data collection is ongoing, and current results from early 2017 through early 2018 will be presented at the conference.

MORPHOMETRIC MEASUREMENTS AND BODY WEIGHTS OF WILD PIGS IN NORTH AMERICA

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Knowledge of animal body weights is important to understanding their biology, ecology, and population responses to environmental changes, reproductive rates, or management interventions. For large-bodied mammals, where it can be impractical to weigh individuals, researchers have developed models for estimating body weights incorporating morphometric measurements such as length, girth, and height. Here we report these measurements and weights collected from 1,539 wild pigs in California, New Mexico, Texas, Florida, and Saskatchewan. We generated a model for estimating body weights of invasive wild pigs based on the relationship between scale measured weight, body length, girth, height, and sex as predictor variables. We developed generalized linear models using 80% of the data, and used the remaining 20% of the data to validate the best-fit model. We provide recommendations on which morphometric measurements are best to collect during field operations to allow for estimation of body weight. Given the variation in genotype and resource availability in occupied habitats of wild pigs, there may be regional differences in the physical characteristics of pigs leading to some variation in body-weight estimation models. As such, it is important to collect data for model refinement and validation throughout the species' range.

TRAPPING BOARS AND "TRAP SHY" FERAL SWINE USING A "BAIT SOW"

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This project was conducted in order to determine the efficacy of using a wild caught feral swine sow as "bait" to catch boars. A young sow weighing approximately sixty pounds was captured in a cage trap in Brazos County, TX as part of an urban swine management program. The "bait" sow was given a 2ml injection of Lutalyse and was placed inside a secure 4x4 cage which was placed inside a corral trap. Eight days after the sow had received the Lutalyse injection two mature boars were trapped. A period of time was given without injection in order to determine if the sow would cycle naturally. It was determined she was not, and a second injection of Lutalyse was given on November 20th. On November 27th three pigs were trapped; one mature sow and two young, but sexually mature boars. Again, six to seven days after the injection was given. Prior to beginning this operation, seventy-five feral swine had been removed due to trapping efforts in this area. The remaining pigs in the area were the smarter, warier and more educated pigs and trapping success had rapidly declined. It was determined during this successful, albeit short, program that feral swine can be caught with a sow in heat as bait.

THE USE OF LOW-COST GPS LOGGERS FOR WILDLIFE STUDIES: DEVELOPMENT AND DEPLOYMENT ON FERAL SWINE IN CENTRAL FLORIDA

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Global positioning system (GPS) loggers allow researchers to collect location and movement data to examine ecological and biological questions such as home range size, habitat selection, and dispersal. Recent developments of low-cost GPS loggers used for vehicle and pet tracking have high potential to be used on wildlife. Several studies have tested the performance and accuracy of low-cost GPS loggers and deemed them suitable for use in wildlife studies. We tested two low-cost GPS data loggers and deployed these units on feral swine in central Florida. The low-cost GPS loggers, iGOTu and Catlog, were compared to pre-built GPS Lotek collars in open and closed canopy habitats to examine fix rate success, reported error, and true location error. All units had high fix success rates regardless of habitat (>99%). As expected all units had higher location error in closed canopy. In open canopy the iGOTu loggers had the highest average location error at 13.4 m (SD=44, n=964). Average location error for Catlog loggers in open canopy was 7.6 m (SD=9, n=958), similar to Lotek loggers at 6.4 m (SD=7, n=960). To date we have collected over 126,000 location points from 23 unique animal deployments of low-cost GPS loggers on feral swine. Wildlife tracking companies still offer some advantages in pre-built collars, enclosures, and software, as they have gone through decades of trial and error. However, low-cost GPS loggers have comparable location errors to pre-built loggers at a fraction of the cost. Our future challenges in the development of low-cost loggers will be refining robust water tight enclosures to protect electronics and batteries. We plan to continue the development, assessment and deployment of low-cost GPS units, especially GSM or satellite, to reduce costs for wildlife studies in order to answer more biological and ecological questions.

THE INFLUENCE OF ENVIRONMENTAL CONDITIONS ON THE LITTER SIZE AND SURVIVAL OF NATIVE AND NON-NATIVE WILD PIGS

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Understanding the within- and among- population variation resulting from differences in survival and fecundity that influence population growth is a critical element to the Feral Swine Damage Management Plan. Variation in vital rates are common between different populations and can fundamentally influence the ability of a species to colonize new areas and persist once present. A key driver of the success of invasive wild pigs is thought to be their reproductive and behavioral plasticity, yet testing of these hypotheses has relied largely on phenomenological observational studies. Using a meta-analysis approach, we compiled a global dataset (23 countries, 5 continents) of wild pig litter size and survival from 89 studies conducted between 1959 and 2016. We investigated the relationship between survival, fecundity, and environmental covariates which have been shown to be influential on population growth in previous pig research. We chose, a priori, a set of models to test several main hypotheses including the effects of temperature, precipitation, vegetative abundance, and nearby agriculture on native and non-native wild pig populations. The model which best predicted survival included the following covariates: precipitation in the coldest, warmest, and driest quarters, temperature in the coldest and driest quarters, an index of seasonality, the proportion of cultivated land within 40km, and the normalized difference vegetation index (NDVI). The model that best predicted litter size only contained the variable precipitation during the warmest quarter. We did not find significant differences between native and non-native pig populations, indicating that environmental conditions influence both types of populations similarly. Improving our understanding of how environmental factors contribute to invasive wild pig survival and litter size will aid in the development of accurate predictions of population growth and range expansion, thus adding to the efficiency and effectiveness of wild pig management.

SOLUTIONS FOR BIG DATA: HARNESSING THE POWER OF MACHINE LEARNING TO AUTOMATE THE IDENTIFICATION OF CAMERA TRAP IMAGES

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Remotely triggered cameras (camera traps) have become a vital tool for detecting wildlife to address a plethora of needs associated with wildlife and invasive species research and management. When analyzed collectively, occurrence data from images can help inform parameters such as species presence and efficacy of management strategies. To this end, we have amassed across our labs alone over 5 million images from trail cameras while conducting research on wild pigs. A great cost to using this technology, however, is visual interpretation to derive the data from each image. One common solution to the manual identification of camera trap data is crowd-sourcing, using volunteers to manually identify animals in camera trap images. However this can pose other issues, such as logistical difficulties coordinating volunteers, variable observer skill, and the reliance on technical expertise to administer databases and web applications to manage tens or hundreds of volunteers. To address these limitations, an automated camera trap image classification algorithm has been developed by the Evolving Artificial Intelligence Lab at the University of Wyoming. The approach uses a deep convolutional neural network which was used to identify 3.2 million images from Snapshot Serengeti, one of the world's largest camera trap datasets, with 94.9% overall accuracy (equivalent to saving over 17,000 hours). The model was able to automate identification of 99.3% of the data while still performing at the same accuracy level as crowd-sourced volunteers. This algorithm is being adapted to automatically classify wild pigs in camera trap images across our collective studies. Once completed, the algorithm will be developed into a tool that can be used by researchers and managers to quickly identify wild pigs as well as other species in camera trap images. This advancement will enable cameras to be used more efficiently for pre-, during and post-elimination monitoring of control operations.

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