Proceedings
of the
First National

FERAL SWINE CONFERENCE

June 2 – 3, 1999 Ft. Worth Texas

Introduction

Max E. Coats, Jr., DVM
Deputy Executive Director
Texas Animal Health Commission

> Wild/feral swine have been a feature of the landscape of the "New World" since the time of Columbus. Over the years they have been a bane to some and a blessing to others. A famous person once said, "The more things change, the more they stay the same!" In the case of feral swine, this is certainly true. I welcome you all here to this symposium and thank you for your interest in this important event.

The theme for this Feral Swine Symposium is "Cooperative Solutions for Managing Feral Swine." In the process of planning this symposium, four objectives were identified. We hope to share information related to each of the following:

1. Field studies and research on diseases of feral swine as they relate to public health as well as the risk of disease transmission to domestic swine.
2. Economic aspects of harvesting and marketing feral swine and feral swine products.
3. Potential adverse affects of feral swine such as crop damage, vehicle accidents and decreased marketability of domestic swine.
4. Potential impact on soil erosion and water quality as well as impacts on native plants and wildlife populations.

During this seminar it is my hope that together we can develop some strategic management plans and goals for use by state and federal governmental agencies, the research and development community as well as members of the various industry groups. In order to accomplish this purpose, it seems to me that we will need to identify needs and issues important to government, industry and research entities. Additionally, prioritizing issues that can be most effectively addressed is an essential goal for this seminar. You will note that the structure of the agenda for our deliberations reflects these items. The group discussions toward the end of this seminar will be forums where synthesis will produce some useful prioritized statements of issues to be addressed along with a plan of action essential to those who would successfully manage this very challenging renewable natural resource.

Wild hogs in the Central United States: A New Management Challenge

Philip S. Gipson, PhD
Leader of the Kansas Cooperative Fish and Wildlife Research Unit
U.S. Geological Survey
Kansas State University, Manhattan, KS

Charles D. Lee
Department of Animal Sciences and Industry
127 Call Hall
Kansas State University
Manhattan, Kansas 66506

Wild hogs have expanded their range into the central tier of states from Colorado and Kansas to Indiana and Ohio during the last 10 years. Major causes for the range expansion include translocation to establish populations for hunting, escape of hogs from shooting preserves, and dispersal from established wild populations. Research is critical in order to develop meaningful programs to manage wild hogs in recently invaded states. Studies of the distribution, population dynamics, and health status of newly established populations should be initiated as soon as possible. Other priority needs include: studies of competitive relationships with deer and other wildlife, objective assessments of the views of hunters, farmers, and other citizens about wild hogs, and gaining insight into the goals of wild hog enthusiasts that are responsible for releasing wild hogs into new areas. The effectiveness of hunting and other population control tools should be evaluated. A national coordinating group is needed for the study and management of wild hogs.

INTRODUCTION

Wild hogs (Sus scrofa) have existed for 2 hundred years or more in most southern states and California (Mayer and Brisbin 1991). Present populations of wild hogs include free-living, formerly domestic swine, Eurasian wild boar, and hybrids between these forms. All are members of the species S. scrofa and interbreed readily.

Large scale expansions of range and concurrent population increases by wild hogs have occurred during the past 40 years in two regions of the United States:

1) southern plains and forests of Texas (Taylor 1993) and Oklahoma (Stevens 1996), and 2) northern and central coastal areas of California (Waithman et al. 1999). Numbers of wild hogs in Texas may exceed 1,000,000 (Taylor 1993) and approximately 133,000 probably occur in California (Waithman 1999).

In the last 10 years wild hogs have expanded their range from the Southeast Region of the United States into the central tier of states extending from Colorado and Kansas to Indiana and Ohio (Gipson et al. 1998) (Figures 1 and 2). Natural resources managers and animal health officials in Texas, California, and southeastern states have a long history of dealing with wild hogs. Officials in the recently invaded central states have little experience with wild hogs and some of these states are only beginning to pass laws to control introductions of wild hogs and to protect domestic animals and wildlife from diseases potentially carried by wild hogs. Some natural resources managers are attempting to develop local management strategies (Richardson et al. 1995) to deal with expanding populations of wild hogs, but few resources have been committed to the effort and professionals are generally operating alone with little coordination between states or even among agencies within states. In this paper we discuss 3 issues that are key to managing wild hogs in recently invaded areas of the central United States: 1) reasons for range expansion into the central states, 2) additional information needed to develop sound management strategies, and 3) actions that should be taken now to document expanding populations and minimize negative impacts.

REASONS FOR RANGE EXPANSION

The reason most often cited for range expansions of wild hogs in the United States is deliberate releases by wild hog enthusiasts to establish new populations or to enhance existing stocks for hunting (Waithman et al. 1999, Gipson et al. 1998, Mayer and Brisbin 1991). Gipson et al. (1998) summarized 4 reports from law enforcement officials and wildlife mangers in Kansas indicating that wild hogs had been transported into the state and released. Most hog introductions are undocumented which makes assessment of their role in establishing or invigorating populations difficult.

Gipson et al. (1997) suggested 7 additional factors that may have contributed to establishment of wild hog populations: escape of wild hogs from shooting preserves, dispersal from established wild populations, avoiding capture in free range commercial operations, abandonment of wild hogs by agents unable to sell them to shooting clubs, release of domestic hogs to establish populations for hunting, escape of domestic hogs from confinement operations, and abandonment of pet hogs. An additional factor was suggested by Waithman et al. (1999) that may have been particularly important since 1997 - release of domestic hogs by individuals no longer interested in producing hogs for the market. This may have been exacerbated during 1998 when prices for domestic hogs were severely depressed and many producers found that it was not economically profitable to continue feeding hogs.

INFORMATION NEEDED FOR SOUND MANAGEMENT

To manage wild hogs effectively, natural resource management agencies and animal health officials need factual information about the biology and distribution of wild hogs, practical management and public education goals, and regional coordination. The fact that wild hogs are already established to the point that it may not be practical to eradicate them from central states is not generally known or accepted by government officials. High priority should be given to the distribution and dynamics of newly established populations, including DNA studies to determine likely genetic associations with other wild populations or domestic herds. In order to estimate increases in wild hog populations, survival rates of cohorts of wild hogs are needed, especially piglets and breeding females. Radio telemetry investigations or tag and release studies could provide these data. An effort should be made to evaluate the effectiveness of hunting along with other population control tools to regulate local populations.

Other priority needs include studies of competitive relationships with deer and other wildlife, and determination of health status. Taylor et al. (1998) found that wild hogs in southern Texas had a reproductive output approximately 4 times greater than native collared peccaries (Tayassu tajacu) or white-tailed deer (Odocoileus virginianus). They hypothesized that the higher reproductive output of wild hogs could affect ungulate community structure in the region. The health status of 2 newly established populations of wild hogs have been evaluated; 1 in Kansas where the population appeared healthy (Gipson et al. 1999) and 1 in Missouri where pseudorabies was discovered (Farrell 1992). The impacts of wild hogs on soil processes and the distribution of native plants is poorly understood, particularly in grassland dominated ecosystems, and should be investigated .

No published accounts present the views of the public in the central United States regarding wild hogs. An objective assessment of the wishes of farmers, hunters, non-consumptive wildlife observers, natural resources managers, and animal health specialists is needed as laws are considered to control wild hogs. In addition, the position of wild hog enthusiasts that are responsible for transporting and releasing wild hogs into new areas has not been articulated in the literature. A better understanding of their goals and methods used to achieve them would be useful to wildlife managers and animal health officials. An open forum is needed where wild hog enthusiasts and natural resource mangers and agriculture specialists can exchange ideas in a candid manner. An objective 2 way educational effort is needed to provide factual information about wild hogs to the public and special interest groups, and at the same time, to gather information about how our society wants wild hogs to be managed.

ACTIONS NEEDED NOW

Government agencies and organizations concerned with natural resource management and livestock production need to be aware that wild hogs are rapidly expanding in the central United States and that populations may already be so firmly established in most states that eradication is no longer practical. Wild hogs are likely to become major components of many local wildlife communities in the region.

A national coordinating group for the study and management of wild hogs is needed. A working group within The Wildlife Society could assure that national and international issues related to wild hogs are addressed. Alternatively, study groups within the respective regional sections of the International Association of Fish and Wildlife Agencies may be adequate to coordinate research and educational programs regionally. A Wild Hogs Study Group is needed within the MidWest Association of Fish and Wildlife Agencies, similar to the White-tailed Deer Study Group or the Pheasant Study Group.

Support for research and educational programs outlined above is critically needed. Sound ecological and human dimension studies, and educational efforts should be initiated as soon as possible.

Literature Cited

Farrell, J. 1992. Feral pigs in the Irish Wilderness Area of the Mark Twain National Forest. Feral hog project executive summary. U. S. Forest Service, Mark Twain National Forest, Rolla, Missouri.

Gipson, P. S., B. Hlavachick, and T. Berger. 1998. Range expansion by wild hogs across the central United States. Wildlife Society Bulletin. 26: 279-286.

Gipson, P. S., B. Hlavachick, T. Berger, and C. D. Lee. 1997. Explanations for recent range expansions by wild hogs into midwestern states. Proceedings of the Great Plains Wildlife Damage Control Workshop. 13: 148-150.

Gipson, P. S., J. K. Veatch, R.S. Matlack, and D. P. Jones. 1999. Health status of a recently discovered population of feral hogs in the tallgrass prairie region of Kansas. Journal of Wildlife Diseases. In Press.

Mayer, J. J., and I. L. Brisbin. 1991. Wild pigs in the United States: their history, comparative morphology, and current status. University of Georgia Press, Athens.

Richardson, C. D., P. S. Gipson, D. P. Jones, and J. Luchsinger. 1995. A long term management plan for feral pigs on Fort Riley Army Base, Kansas. Proceedings of the Eastern Wildlife Damage Control Conference. 7: 100-104.

Stevens, R. L. 1996. The feral hog in Oklahoma. Samuel Robert Noble Foundation, Ardmore, Oklahoma.

Taylor, R. B., E. C. Hellgren, T. M. Gabor, and L. M. Ilse. 1998. Reproduction of feral pigs in southern Texas. Journal of Mammalogy. 79: 1325-1331.

Waithman, J. D., R. A. Sweitzer, D. V. Vuren, J. D. Drew, A. J. Brinkhaus, I. A. Gardner, and W. M. Boyce. 1999. Range expansion, population sizes, and management of wild pigs in California. Journal of Wildlife Management. 63: 298-308.

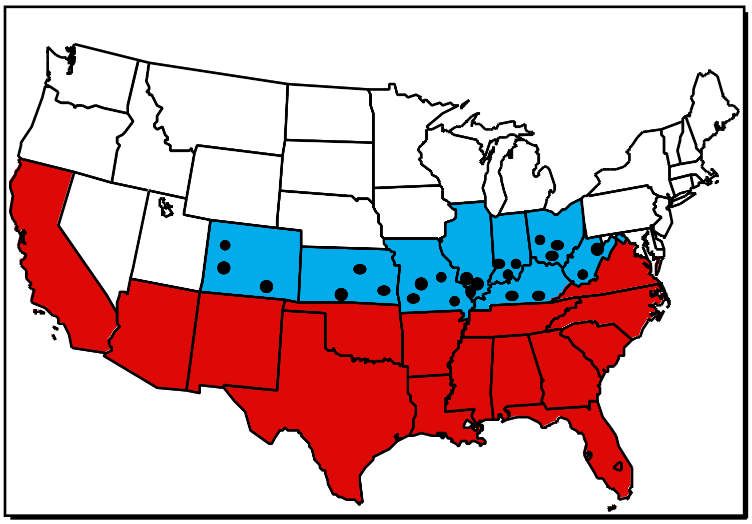


Figure 1. Distribution of wild hogs in the United States. Wild hog populations were present prior to 1981 in states with dark shading. In states with light shading, wild hog populations have been verified since 1988; black circles are locations of current populations.

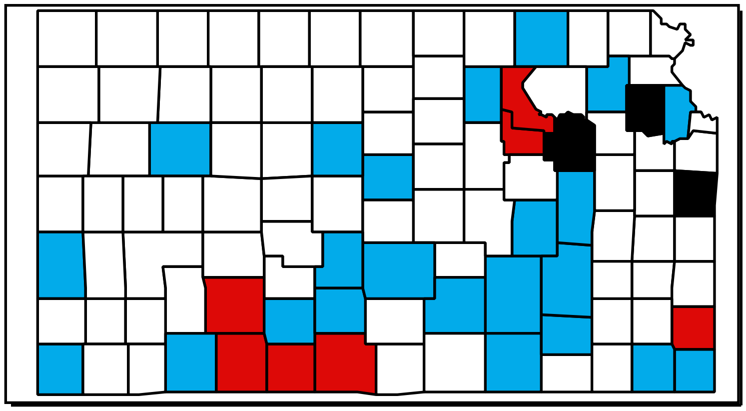


Figure 2. Distribution of wild hogs in Kansas from 1950 to 1999. Dark gray indicates counties where reproducing populations were documented in 1998 and 1999. Light gray indicates counties where wild hogs were known to exist between 1993 and 1999 but reproduction was not confirmed. The counties with cross-hatching had populations from the 1950's through the 1980's that may have been extirpated.

State Reports

Kansas State Report

Dr. Phil Gipson

In the 1700-1800s, Indians raised hogs, and archaeologists also have detected hog remains with bison and elk. During the ensuing years, there is a definite shift northward by feral swine, and some have been spotted at elevations of 10,000 feet and higher. The Ohio River Valley is a "hot spot" for these animals.

Feral swine prefer the strip-mining lands that have been reclaimed, as the pits make a great area for hogs to wallow. They also like the mid-grass and short-grass regions from Wichita, Kansas, westward. Can feral hogs be eradicated? No. The criteria for eradication would mean that the rate of removal exceeds the rate of increase, and this is not happening. Furthermore, emmigration of these animals has not been prevented from state to state. People and natural movement of these animals have helped the wily animals stay alive-and thriving. Politics are changing the tide of hog hunting. We must educate consumers and citizens about the detrimental effects of these animals. But first, we must learn about these swine:

- Where are they? What is their health status?
- What DO people think of them?
- What do our citizens really want us to do with them?
- There are ranks of people who are restoring hogs into areas previously clear of the pests. Movement of the animals also comes from:

1. Deliberate transport by people.
2. Escape from hunting preserves.
3. Natural dispersal. But what are these techniques of natural movement?

California State Report

Doug Updike

> These animals have been researched for "a number of years." In the late 1960s, wild pigs existed in California in a dozen counties. Today, a conservative estimate put their population numbers at 300,000 and hunters have killed wild hogs in 53 of the state's 58 counties.

Expansion of these animals is an ongoing issue. Populations are emigrating to new areas, and some are spread by the deliberate release of animals. State regulations prohibit the deliberate release of domestic hogs.

Since 1957, the wild pig has been legally classified as a "game animal" in California. Pigs in captivity are livestock. Current regulations allow hunting with no bag limit. A 1992 law requires a "wild pig tag", which allows authorities to monitor where the animals were killed. Where there is wild pig hunting, the pigs are managed at low densities and damage seems to be fairly minimal.

Pseudorabies in these animals has been found in the Channel and Catalina Islands. Rooting damage to native vegetation is being researched.

What's the solution: Increase hunting pressure on private lands. Many land owners in the state suffer damage from the animals but they are unwilling to allow hunting on their land.

Alabama State Report

Dr. Cheatham/Mr. Keith Guyce

> In 1998, Alabama was declared pseudorabies and swine brucellosis free. Since the last cases in domestic swine in 1996, eighteen premises where feral swine were trapped have been found infected with both pseudorabies and brucellosis. Two cases also had domestic swine on the premises but fortunately there had been no exposure or spread of infection.

Nine counties were involved with 11 of the 18 premises located in just two counties in the southern part of the state. The infected swine were detected through routine surveillance at custom slaughter plants, livestock markets, and on-farm testing. Most all were depopulated without indemnity.

Alabama does not have a defined feral swine program nor has much public information been disseminated. The state has authority to quarantine and handle animal disease problems. State and federal officials consider feral swine as an on-going risk factor and view this symposium as an opportunity to learn what other states are doing and what can be done to meet this challenge.

On the wildlife side? The largest populations of feral swine have been in the floodplains along the Mobile and Alabama Rivers in southwest Alabama. Populations were sparse outside that area until about five years ago. Populations are now springing up in new areas primarily in south Alabama but also some spots in northern counties. Feral swine are listed as "game animals" with no closed season and no bag limit. Survey estimates indicate there are approximately 13, 000 feral swine hunters in Alabama and they take approximately 28,000 animals each year. Nuisance complaints are frequent and most are related to damage on areas being managed for deer and turkey.

As for research, we need to know more about the range and density of feral swine in Alabama and we have a cooperative project underway with Auburn University to address that. We also hope to collect additional information on reproduction and food habits of feral swine.

Indiana State Report

Dr. B. Marsh

> Two areas in Southern Indiana have feral swine, and these appeared about six years ago. Where did they come from? None had pseudorabies or swine brucellosis. We encourage hunters to hunt them and allow us to collect serum from the animals.

In Southern Indiana, we suspect there are 500 to 1,000 head on former strip-mining country. We prohibit the importation of feral swine and would like to prevent the establishment of these animals. As the 5th leading producer of domestic swine, we cannot afford to introduce the risk of disease.

Most folks are not aware that we even have feral swine in Indiana.

Kansas State Report

> There is a lot of interest from hunters, and there are also "livestock" conflicts, as producers don't want to be told what to do. In North Central Kansas, around Fort Riley, there are 40,000-50,000 acres with wild swine, but we won't be doing a lot of work there.

There is no statewide management plan, but we do foresee holding educational meetings to find common ground.

Missouri State Report

Tom Hutton

We became involved with feral hogs in helping a cattleman whose newly seeded pasture and hay fields were destroyed by these animals. We subsequently surveyed our conservation agents to better define the distribution and density of feral hogs in Missouri.

We have significant populations in nine or ten counties and at least some hogs are present in another six or seven counties. We have instances where people have released hogs on public land and other instances where hogs are released / escaping without adequate confinement.

Legally in Missouri, feral swine are in "no man's land" with no one claiming ownership or responsibility and without penalties attached to our "livestock running at large" statutes. We are in the process of developing a consensus on legislation to correct these deficiencies.

At the same time, we are raising awareness to the damage they cause and encouraging private landowners to work with their neighbors to eliminate feral hogs on their properties. We are concentrating hunting pressure on public lands to limit their increase and spread to larger areas. Both the Missouri Farm Bureau and Missouri Conservation Federation have passed resolutions supporting efforts to eradicate feral hogs.

Although we detected pseudorabies in one population 5-6 years ago, that population was substantially reduced and we haven't found other hogs that tested positive for pseudorabies or swine brucellosis. We are concerned about the more frequent occurrence of these diseases with the merging of our population and those of adjacent states. When feral hogs appear in new locations, we try to eradicate them quickly to prevent further spread.

Oklahoma State Report

Dr Burke Healey

Our animal damage control folks are providing education, especially since we have feral swine in 55 of our 77 counties.

Are they game, strayed or wild? Legislature says not "wild." We have found pseudorabies and swine brucellosis in them in Southeastern Oklahoma. We see them merging with wastefood feeding operations, and that's where disease could really be transmitted.

Dr. Hellgren, Oklahoma State University: Fall is the main breeding season, with a second "pulse" in March. Surveys indicate that sows younger than 12 months have a 12 percent pregnancy rate, while those animals from 12 to 21 months of age achieve a 21 percent pregancy rate. Most prolific are those sows older than 21 months of age. They have a 38 percent pregancy rate.

Most sows have 1.22 litters per year, with 56 percent of the piglets being male, and 44 percent female. Feral swine have higher reproductive rates than native ungulates.

In the Oklahoma study, hogs ranged in an area of about three square miles. Adult females will disperse from their "sounder," or herd, and encroach on a new area. This rapid colonization has promoted the spread of feral swine.

Arkansas State Report

Dr. Bob Harbison

> Like Oklahoma, Arkansas also has a significant number of counties affected by these animals. They are in 50 to 55 of the state's 75 counties.

During the l999 legislative session, feral swine were defined as domestic livestock, meaning the animals could be hunted on private land at any time. On public land, weapons used must correspond to the proper season (i.e. bow-hunting season, etc.). Arkanasas officials will also establish regulations to require testing of released hogs. An educational pamphlet has been developed.

Greg Mathis: We get a lot of complaints about the animals. One family has been affected by swine brucellosis. The animals also cause critical habitat destruction and have negative impacts on flora and fauna.

We have a feral hog task force, comprised of representatives from natural resources, state, federal and industry agencies and businesses.

The goal? Get informed. Develop a network. "Feral hogs are like cancer. Once you know you've got it, it's too late."

Florida State Report

Jay Levenstein

Florida is in Stage 3 for pseudorabies eradication and Stage 2 for swine brucellosis. Infection from feral swine to domestic swine accounts for about a third of the pseudorabies infection in domestic swine.

There are two marketing channels for these animals:

If the animals are tested, they move as "known status" animals and may move without restriction.

Untested animals are of "unknown status" and must move to quarantined feedlots and on to slaughter only.

Florida has five buying stations for feral swine.

The US Animal Health Association has a resolution requesting research grants and more study into the use of RB-51 brucellosis vaccine for feral swine.

Dr. Patrick Walsh: At the Avon Park Bombing Range, research has been conducted on the 106,000-acre range near Orlando to determine the impact of hunting feral swine. This property has 17 percent marshes and 5 percent scrub, and for the past 40 years, the Air Force has permitted hunting. More than 7,000 feral hogs have been harvested; a number accounting for only 20 to 30 percent of the hogs.

Population counts are conducted in August at 64 bait stations throughout the area. For the past seven years, 200 feral hogs have been sampled. As the hogs get older, there is a greater chance of their having pseudorabies or swine brucellosis. In the Avon Park Bombing Range surveys, 50 percent of the adult hogs were positive for pseudorabies, and 50 percent were positive for swine brucellosis.

Dr. Carlos Romero--Dept of Pathobiology, University of Florida: The priorities for research include:

- studying the transmission of pseudorabies
- finding the relationship of serology, PCR testing and virology in feral swine
- developing immunological approaches to controlling pseudorabies in feral swine
- identifying the immunogenic sequences

How is pseudorabies transmitted from feral swine to domestic swine and hunting dogs? When infected boars are commingled with "clean" sows, only three weeks passed before the sows developed antibodies. Transmission from feral boars to domestic boars was not seen in research.

On the other hand, feral sows will transmit the disease to feral boars during mating. In feral swine, pseudorabies virus has been recovered only from the genital tract, not the nasal cavity.

We did not see much transmission of disease from feral sows to domestic boars, as the domestic boars will not get very close to the feral females.

The transmission of pseudorabies from feral swine to domestic hogs:

- is it viral dose and virulent dependent?
- is it route-of-infection dependent?
- is it age dependent (age of the swine)?

Georgia State Report

Dr. Carter Black

> These feral swine are growing, moving and spreading. Considered in Georgia to be non-game animals, they are the property of the landowner. Our major concern is preventing disease spread.

Dr. Stallknecht: There are about 2,000 feral swine on Ossabaw Island, Georgia, a 24,000 acre, pine and oak forest area. (In the l980s, population estimates were at 5,000 feral swine.) The origin of these pigs is a bit "fuzzy," but we know that domestic introductions have been made into the population. The success of the acorn crop will determine the success of the hog population.

We have determined that pseudorabies is essentially a venereal disease in feral swine. From l994-97, we had virus isolations from the male, mostly from the sex organs. We did not have luck in isolating the virus from the nasal swabs. When feral swine and domestic pigs intermingle, there is a 1 in 25 chance that the feral swine (male) will be shedding the virus.

To reduce the potential for pseudorabies transmission to domestic herds, we must decrease the population, the number of infected animals, and stop the connection between domestic and feral swine.

To reduce the population, we must use aggressive hunting, capture and habitat manipulation techniques. As well, we must find some oral contraception to slow the population explosion of these animals.

On Ossabaw Island, 800 to 1,200 feral swine are removed yearly, and this has only stablized the population. On the other hand, promoting sport hunting may spread the feral swine population range, as hunters will transfer the animals to new sites.

To eradicate pseudorabies, the development of an oral vaccine would be extremely beneficial. Other methods including culling and removal of older swine and testing. Vaccination by routine methods on Ossabaw Island did nothing to significantly reduce pseudorabies. To prevent spread of infection to domestic swine, the construction of barriers and the separation of markets must be maintained.

An “all-out” war is necessary, should we wish to reduce the population down to 10 percent of the current count. We would also need an oral contraception, and all of this would be very costly.

National Pork Producers' Council

Dr. Paul Sundberg

> The National Pork Producers' Council has 85,000 members in 44 states. We had the highest production in l998 and the lowest prices in history.

The implications of feral swine and their potential spread of pseudorabies could wreck the confidence of our trading partners in Japan and Canada. This would have huge budget implications, as well as affect our statuses by state and our surveillance programs.

Gary Simpson: We must finish the eradication of pseudorabies and swine brucellosis. More than $100 million has been spent by the government, and our biggest threat comes from feral swine that could transmit the disease to domestic herds.

Wildlife Services

Gary Nunley

> Feral swine damage field crops, and prey on livestock and wildlife. They compete for limited resources, and are reservoirs for pests and diseases. Furthermore, they root and wallow, damage fences and deer feeders and can be instrumental in vehicular collisions.

In fiscal year l998, the Wildlife Services staff took 4,690 feral hogs. We have additional funding provided for training and education.

Extension Service

Dr. Higginbotham

> A decade ago, hunting of feral swine wasn't too popular. Today, they are seen as a supplemental species for hunting, and they make good money for trappers. Often feral swine are worth twice the price of domestic swine. On the other hand, landowners and producers often hate them.

We estimate a population of 1 to 2 million feral swine in Texas. To help in education, we offer:

1. Field Days
2. Meetings
3. Result and method demonstrations
4. Phone calls and e-mails
5. On-site visits
6. Provide publications.

Legal ways to control feral swine? Hunting, trapping and using catch dogs.

Texas Agricultural Extension Service

Dr. Dale Rollins
Professor and Wildlife Specialist,

> Wild hogs pose a threat to big game and threaten upland game species. In Jack County, a "Feral Hog Appreciation Day" is used to heighten awareness of the animals. So, what qualifies these animals as a threat?:

1. They are prolific, having as many as 3 or 4 piglets per litter
2. They are omnivorous, meaning they'll eat ANYTHING
3. As adaptable animals, they are smart and can cope with a variety of situations and in many habitats.
4. They are difficult to control.

In winter or drought situations, the feral swine compete with deer for acorns. Although this is diet overlap, it is not competition.

Javelina and pigs also have a diet overlap in spring and summer. As predators, feral swine will eat fawns and ground birds, but there is a question as to whether they are predators or if they eat carrion.

There are signs of nest predation by feral swine. These animals, in one study, took between 8 and 28 percent of the quail eggs placed in "dummy nests."

In Florida, this has not been shown to occur in turkey areas.

Although some ranchers detest feral swine because they stir up the ground, there is some positive impact to their wallowing, as it aereates the soil.

Some suggestions for research:

- biological recruitment
- census-taking techniques
- interspecific competition
- predatory importance
- quantify nuisance aspects

Texas Wildlife Services, Uvalde

Mark Mapston

> In l998, 4,690 feral swine were taken by the Wildlife Services. Of these, 35 percent were shot from aircraft; 38 percent were caught in snares; 11 percent were caught in cage traps; 8 percent were shot; 4.5 percent were chased with dogs; and in 1.5 percent of the cases, steel traps were used.

The method of capturing or killing the feral hogs will depend on the season, terrain, level of population density, and the desires of the landowner.

The snare consists of a loop of aircraft cable wire with a sliding device that locks, but won't unlock. The loop is connected to an anchor, to prevent the ensnared prey from leaving. Among the considerations for using the snare: it is inexpensive, but it catches only one hog at a time. Big hogs can break the snares.

The cage traps are a box-shaped cage with a gated door also, stock panels can be welded to posts that are placed into the ground.

Outfitter

Bob Richardson

> As an outfitter and a free-lance trapper, I see both sides of the feral swine issue. I say that the litter size is about four, but eight usually survive. I work on 80,000 acres leased by our outfitting operation, where we estimate that 15 hogs per square mile reside. We charge $450 per person per weekend for hog hunts. Many out-of-state hunters flock to Texas for the excitement of shooting a "Texas hog." The hogs also make an excellent supplemental hunting species, as

> we charge $980 for a turkey hunt. This could involve two turkeys, one hog and one turkey, or two hogs.

As a trapper, I control populations for farmers and ranchers. In some fields, it "looks like someone pulling doughnuts with a bulldozer." Many of the trappers catch pigs that weigh less than 100 pounds, and the meat processors don't want these small animals. So, these feral swine are moved illegally onto hunting leases, without the required pseudorabies and swine brucellosis tests.

Texas Parks and Wildlife

Rick Taylor

> From l989-91, a study of the food habits of feral hogs was conducted in the several counties, including Uvalde, La Salle, Web, Zavala, Maverick, Dimmitt and Kinney.

Nearly 200 hogs were collected during the research period, and their stomach contents were analyzed. For the the most part, grasses made up the bulk of the contents, followed by forbes, corn, roots, and mast. There were also small animals, prickly pear and browse found in the animals. In one hog, deer parts were found, but was it a predatory act or scavenged?

Feral swine shift their diet, depending on weather and availability of food. Although they aren't popular, the feral swine's foraging activity and rooting on a well-managed area could benefit soil and help to regenerate plants.

David Whitehouse

I am responsible for 180,000 acres of timber land in East Texas. In preparing for this meeting, I conducted a survey of 18 biologists in the Southeast who work for timber companies.

Among the questions and answers:

Are feral hogs present? In all cases "YES."

Does your company have problems with these animals? Ten respondents answered "YES," and another five said "NO."

Do you allow hunting with dogs? "YES"

Do you allow trapping of the hogs? "YES"

The majority of the respondents said their states call feral swine non-game animals, making them "huntable" all year.

Some recommendations by my colleagues:

- make it illegal to release hogs
- allow hunting at night and baiting
- educate the public about the need to control numbers of hogs and the competition for food
- don't limit the number of hogs allowed to be taken by hunters or trappers

After all, we must kill 70 percent of the hogs yearly on a site, just to maintainthe population.

On our timberlands, hunters won't shoot a hog early in the season, as they are afraid they might miss a deer that could be hiding around the corner. These feral swine root up areas around young pine trees on plantations and tear up food plots for deer.

Eden —Texas

Regan Beck, Rancher

> As a rancher of cattle, sheep and goats, I am intimately familiar with my ranch land, and until two years ago, there were no feral swine in my area. Since then, we have trapped and hunted the animals, and 350 pigs have been killed.

Deer hunters introduced the animals as a supplemental hunting animal. I have seen a 15 to 20 percent reduction in the goat kid crop on the portion of my ranch where the feral swine reside. I have heard that in Australia, up to 30 percent of the kid crop is lost, due to boars killing the young animals.

I have also experienced damage to mesh fences, and Spanish goats escape. The feral swine muddy water troughs and break valves on the spigots, damage which is expensive and frustrating.

Where these animals root up the grass, they roughen pastures and chase deer from feeders.

University of Illinois

Dr. Ned Hahn

> Our goals in molecular epidemiology is to establish the ability to "type" the pseudorabies virus and show where it comes from. We do know that pseudorabies is mutating.

Can feral swine virus recombine with domestic vaccines? What would be the consequences? Increased virulence?

Many wild swine are infected with pseudorabies, but these animals go undetected.

Feral Swine- National Concerns

Arnold C. Taft, DVM
Senior Staff Veterinarian
National Animal Health Programs
Veterinary Services, Riverdale, MD

Wild/feral swine may be an asset to some in that they can be harvested as a meat producing animal and provide substantial revenue. In other instances, revenue can be generated by providing game for the sportsman. On the other hand, wild/feral swine are destructive creatures that invade environments where they are not wanted. From a federal perspective the goal is to optimize both scenarios. This is why we are having this meeting. Certain participants need to have the opportunity to capitalize on the commodity that may exist on land that they own or manage. For others we must develop strategies to prevent damage to your properties by the invasion of unwanted species.

The domestic swine industry has progressed to the point of nearly eradicating swine brucellosis and pseudorabies. Threats of wild/feral swine transmitting these disease back to our domestic swine must be avoided. Further research and field studies are needed to develop strategies for reducing the levels of disease in the wild/feral pigs and to remove this threat to our domestic swine industry.

To avoid misunderstandings between different citizens concerning the control and movements of wild/feral swine, it is a challenge to the participants of this seminar to make recommendations for rules or regulations that can serve the interests of all parties. I will conclude by listing certain goals that need to be considered:

1. Harvesting of wild/feral swine for slaughter should be encouraged. This provides an economic incentive and population control.
2. Certain habitats should be maintained for use by sportsmen.
3. Populations of wild/feral swine should not be allowed to create or cause long term damage to properties into which they migrate or are moved.

4. Populations of wild / feral swine should not pose a disease threat to our domestic swine industry.
5. Further research or field studies are needed to develop disease control strategies and population control strategies.
6. Reasonable, uniform, and enforceable regulations should be developed that serve all citizens in all states.

The Cooperative Texas Wildlife Damage Management Programand Feral Swine Damage Management

Gary L. Nunley
State Director
Texas Wildlife Damage Management Service
USDA-APHIS Wildlife Services
San Antonio, TX

My primary charge today is to explain the structure and short history of the Texas Wildlife Damage Management Program as it relates to our model of bringing private individuals and local, state, and federal governments together to conduct organized wildlife damage management activities with special reference to feral swine. The Texas Wildlife Damage Management Program is a cooperative effort among the Wildlife Services program of USDA Animal and Plant Health Inspection Service; the Texas Wildlife Damage Management Service, an agency of the Texas A&M University System which is administered through the Texas Agricultural Extension Service; and the private Texas Wildlife Damage Management Association which is custodian of local funds provided by individuals, counties, and local associations. These three cooperative entities operate as one under the supervision of Wildlife Services under the terms of a Memorandum of Understanding (MOU). This MOU delineates the individual roles of the cooperating entities that conduct Wildlife Damage Management Program activities in Texas. The MOU serves to coordinate efforts to limit duplication among the cooperating entities and allows for sharing of such resources as funds, facilities, equipment, and personnel. Wildlife Services provides direction and supervision for the cooperative program.

The statutory basis upon which the cooperative program functions under federal supervision is contained in the following legislation: (1) The Animal Damage Control Act of March 2, 1931, (46 stat. 1486,7 U.S.C. 426-426b), gave the United States Department of Agriculture (USDA) the authority to control animals (including birds) deemed injurious to agriculture, horticulture, forestry, animal husbandry, wild game animals, fur-bearing animals, and birds. (2) The 1939 Reorganization Plan No. II (Stat. 1433) transferred this authority from USDA to the United States Department of Interior. (3) Public Law 99-190; H J Res 465, 99th Cong. 1st Sess., 1985. transferred the authority and the Animal

Damage Control Program, now Wildlife Services, back to USDA. (4) The Rural Development, Agriculture, and Related Agencies Appropriations Act, 1988, (P.L. 100-202) which authorizes the agency to enter into agreements with States, local jurisdictions, individuals, and public and private agencies, organizations, and institutions in the control of nuisance mammals and birds and those mammal and bird species that are reservoirs for zoonotic diseases.

The statutory basis upon which the cooperative program functions as a state agency is contained in Subchapter A of Chapter 825 of the Texas Health and Safety Code which allows for the cooperation of state and federal agencies in controlling predatory animals and rodents. It directs the state to cooperate through The Texas A&M University System with the appropriate federal officers and agencies in controlling coyotes, mountain lions, bobcats, Russian boars, and other predatory animals and in controlling prairie dogs, pocket gophers, jackrabbits, ground squirrels, rats and other rodent pests to protect livestock, food and feed supplies, crops, and ranges. This authorizes the Texas Agricultural Extension Service to enter into a master program agreement with the Federal government represented by USDA for the control of predatory animals and rural rodent pests. Prior versions of this enabling legislation have shaped the cooperative program of today. In 1929 Texas was first authorized to cooperate with USDA's Bureau of Biological Survey through the Livestock Sanitary Commission of Texas, now the Texas Animal Health Commission, for predatory animal control and the Texas Agricultural and Mechanical (A&M) College for rodent control. In 1951 the Legislature created the then Texas Rodent and Predatory Animal Control Service by moving the predatory animal functions from the Livestock Sanitary Commission and combining them with the rodent control functions of the Rodent Control Service of the A&M College System of Texas. The federal cooperating entity at that time had changed to the U.S. Fish and Wildlife Service of the Department of Interior. In 1961 the Legislature amended the enabling legislation by adding Russian boars to the list of animals of major concern to be controlled. In 1981 the enabling legislation was again changed to allow the state to cooperate with the appropriate federal agency instead of solely the U.S. Fish and Wildlife Service of the Department of Interior. This was done in the anticipation of the transfer of the federal responsibility of the program back to USDA which did occur in 1986. In 1987 the Texas A&M University System Board of Regents changed the state agency name to the Texas Animal Damage Control Service and later in 1998 to its current name of Texas Wildlife Damage Management Service.

In 1929 the now Texas Wildlife Damage Management Association was formed to promote a concerted action by the state and federal government in the control of nuisance predatory animals. In 1939, the association became the custodian of all cooperative private and county funds provided to the cooperative Texas Wildlife Damage Management Program. This arrangement through the Association's Wildlife Damage Management Fund continues today. These funds are generated by an $1800 per month assessment to counties and local associations to cover their part of the cost of each Wildlife Damage Management Technician providing service.

In Fiscal Year 1999 the cooperative Texas Wildlife Damage Management Program budget was over 8 million dollars comprised of 28% Federal appropriations, 39% State appropriations, 28% private and county funding through the Texas Wildlife Damage Management Association and 5% from various other contracts. A major portion of the other contract funding is provided by the Texas Sheep and Goat Predator Management Board to support our aerial hunting operations which includes the taking of feral swine for the protection of sheep and goats. Of the program's 192 personnel, 46% were funded by state appropriations, 18% by federal appropriations, and 36% by the Texas Wildlife Damage Management Association. With the State Headquarters in San Antonio, the cooperative program is administered through nine districts.

The overall mission of the cooperative program is to provide statewide leadership in the science, education, and practice of wildlife damage management to protect the state's agricultural, industrial, and natural resources as well as the public's health, safety and property. The cooperative program accomplishes its mission through the protection of:

- Human Health and Safety from wildlife-related diseases such as rabies and plague and wildlife-related hazards such as bird-aircraft strikes.
- Facilities, Structures, and Other Property from damage caused by rats, mice, raccoons, skunks, opossums, squirrels, beaver, birds, and other wildlife.
- Crops, Timber, and Rangeland from damage caused by gophers, prairie dogs, feral hogs, raccoons, rabbits, coyotes, grackles, beaver and other wildlife.
- Livestock from depredation caused by coyotes, bobcats, feral hogs, mountain lions, raccoons, birds and other wildlife.
- Wildlife and Other Natural Resources such as endangered species and game animals as well as soil, water and flora from damage and predation by wildlife.

Most wildlife has both positive and negative aspects. Currently, feral swine are perceived to be an agricultural pest, a disease hazard, an environmental liability, a valued meat commodity, a recreational asset for hunters and a source of income for landowners providing this recreational opportunity. Our cooperative program and the Wildlife Services programs in other states become involved in managing the negative economic, environmental, and disease aspects of these animals to the degree that their resources and legal parameters allow.

Feral swine cause damage to field crops such as corn, milo, rice, watermelon, peanuts, hay, turf, wheat and other grains by their feeding, trampling, and rooting activities. Feral swine prey on lambs, kids, fawns, and ground nesting birds. They also compete with deer and turkey populations for limited resources such as mast and forage. Feral swine populations can be a potential reservoir for numerous diseases and parasites that threaten livestock and deer, i.e. pseudorabies, swine brucellosis, and leptospirosis. Feral hog rooting and wallowing activities damage pastures, spoil watering holes and generally deteriorate riparian habitat. They are destructive to livestock fences and may also damage livestock and game feeders as well as consume and waste feed, mineral and protein blocks. Farm equipment can be also be damaged by hitting the holes created by feral swine. Feral swine can also be a highway safety hazard when automobiles strike the animals or have an accident trying to avoid them. There are even reports of feral swine and aircraft conflicts due to their presence on runways.

The participation of Wildlife Services in feral swine damage management in those states where feral swine are present varies due to the legal status of feral swine in each state and the availability of federal, state, and private resources to manage this resource problem. Most states will at least provide some technical assistance while others also provide varying degrees of direct control assistance. The Kansas Wildlife Services program removed 207 hogs from Fort Riley in FY 1998 because they wallow in and deteriorate streams inhabited by the federally endangered Topeka shiner, destroy grain crops, and attempt to breed with domestic swine being raised on farms surrounding the Fort. In Georgia in FY 1998, Wildlife Services removed 2 hogs from Robins AFB to reduce hog/aircraft conflicts and 12 were removed due to property damage to turf in residential areas. Wildlife Services in Hawaii removed 83 hogs in FY 1998 due to their destruction of native species of plants and tree snails. Oklahoma Wildlife Services removed 110 feral swine and California Wildlife Services removed 69 animals in FY 1998 due to various types of property damage.

In FY 1998, the Texas cooperative program removed 4,690 feral swine from 448 different properties due to damage to multiple resources. This was up from the 66 animals taken by the program in 1982. A discussion of the methods of control are the topic of another paper later in these proceedings.

In conclusion, we anticipate that feral swine problems will continue to grow as they continue to expand their range and their populations increase. During the current biennium, the Texas Legislature provided our program with an additional $100,000 above what the agency already spends on feral swine damage management. The same amount has been approved during this legislative session for the next biennium. We expect that the trend will continue of our agency receiving more requests for assistance each year with feral swine damage management.

Getting The Word Out About Feral Hogs: An Extension Perspective

Billy J. Higginbotham, PhD
Professor and Extension Wildlife and Fisheries Specialist
Texas Agricultural Extension Service
Department of Wildlife and Fisheries Sciences
Texas A&M University, Overton, TX

The Texas A&M University System serves as the Land Grant Institution for the state of Texas. Simply stated, this means that the university is made up of three major entities: formal teaching, research and extension. Extension is the informal teaching arm of the university system and is charged with providing factual, research-based information to clientele. Traditionally, Extension's clientele base was made up of rural landowners and agricultural producers.

However, as Texas continues to strengthen its dubious claim as the most "urban rural state in the Union", program expansion to urban and consumer audiences has increased in order to address and meet the needs of all stakeholders. Today, with 80% of our population living in just six metropolitan areas, programmatic efforts must encompass all audiences and stakeholders in order to maintain and enhance the quality of life for all Texans.

The uniqueness of program delivery by Extension lies in its partnership between federal, state and county entities. This relationship between USDA, the state of Texas and each county commissioner's court results in a grass roots approach to education that is unparalleled. County Extension agents in each of the 254 counties rely on program building committees that are made up of representative clientele to continually identify and address educational needs and emerging issues.

The county Extension agent then develops educational programs and related responses to meet these clientele needs. To accomplish these goals, county Extension agents rely on subject matter specialists and other authorities from both the private and public sector to support these programming efforts.

In 1990, such a county program was planned and conducted in the tiny Anderson County town of Cayuga. Feral hogs had been expanding throughout much of the state since the mid-1980's and agricultural producers intent on growing hay crops were suffering tremendous damage. At the same time, a "new" fan club of feral hogs was singing their praises as an additional species available for sport hunting as well as for hunting with dogs. Entitled “Feral Hogs: The Good, The Bad, or The Ugly?” the program addressed both the negative and positive attributes of feral swine. This balanced approach to the program topic produced some interesting if not surprising results as the evening progressed.

On one side of the aisle were the landowners, faces red and veins popping out in their temples as they spoke of damage to crops, winter pastures and bermuda grass meadows. On the other side of the aisle were the sport and dog hunters, speaking warmly of this supplemental game species that extended the hunting season to a full 12 months or gave them an opportunity to hunt with dogs. Suddenly both groups, still standing and now facing each other, realized that one man’s problem was another man’s blessing. The two groups quickly got together and strategies were developed to help each other.

This broad spectrum of attitudes relative to feral swine has continued to prevail and perhaps strengthen over the ensuing decade. Feral swine have continued to expand their range and as a result, damage and hunting opportunities via gun, trap and dog have increased as well. Whether you love or hate them seems to be irrelevant at this point in time--they seem to be here to stay!

The basic program presented in Cayuga has been replayed a number of times across the state of Texas since that 1990 beginning. In fact, interest increased to the point that a statewide feral swine program was conducted in Kerrville. The symposium consisted of presentations by authorities from across the nation on both the vices and virtues of feral swine. The proceedings from that 1993 Extension sponsored symposium is widely viewed as the best and most complete information available on feral swine.

During a typical week in hog country, a County Extension Agent or Extension Wildlife Specialist will get a number of calls regarding feral swine. In sheep, goat, crop and/or pasture country, many of these calls may be from landowners seeking information on how to control or at least curb feral hog damage. However, there is a good chance that some of these calls will be from urbanites seeking information on where hogs can be hunted. Other calls will be from landowners recognizing that there is money to be made by leasing hog hunting ($169/hunt according to a 1993 survey).

Last but not least will be the calls from dog hunters and trappers, offering their control services for a small or perhaps no fee at all. Feral hogs that are trapped and caught may be destined for the white table cloth restaurants on the west and east coasts and have brought $0.50 per pound or more from the many buyers that can be found across the state. Damage control, recreational opportunities and income–all viable objectives among the varoius clientele groups that are sure to be found wherever feral swine roam!

As a result of this wide spectrum of clientele, the county Extension agent and Extension wildlife specialist must be prepared to provide information clientele need to meet very different objectives. This can be accomplished, if need is sufficient, by conducting a program that addresses all issues and perspectives of the clientele in that particular county or region.

Other methods of addressing clientele needs to include the development and dissemination of fact sheets on life history and control methods of feral hogs. Informational videos are also an effective means of meeting clientele needs relative to questions regarding feral swine. Slide presentations on all aspects of feral swine, from life history to disease implications to damage control to income potential have proven particularly effective. One favorite presentation is a slide program entitled "What's Your Feral Swine I.Q.?" This presentation is made up of 20 true- false and multiple choice questions that invokes audience participation. Participants are given a hard copy of the "test" to complete prior to the program. Throughout the presentation, scribbling and erasures are common as participants "compete" to score the highest grade!

Extension often conducts method and result demonstrations, where landowners gather at a demonstration site for a field day to see and learn first hand how to accomplish a particular task, such as how to design, construct and use an effective hog trap. Landowners who adopt and then demonstrate a particular technology or technique are powerful spokesmen among their friends and neighbors.

In addition to the group methods employed for educational purposes , one-on-one contact through site visits are sometimes necessary to assist clientele obtain the best solution for their individual problem. While on-site visits may be limited due to time constraints, they remain one of the most effective methods for extending information to clientele.

In addition to these various direct methods of providing clientele with information on feral swine, a number of indirect methods are also employed. These methods are typically grouped under the heading of mass media and include local and statewide news releases, TV and radio interviews, newspaper columns, newsletters and magazine articles. Mass media efforts serve to provide additional information on feral swine as well as effectively advertise the direct methods of extending information to the public.

In conclusion, the Texas Agricultural Extension Service relies on a variety of methods to extend unbiased, factual and research-based educational information to all clientele. With the variety of attitudes toward feral hogs in Texas, Extension strives to provide the right information to answer the question asked or conduct the demonstration necessary to provide the solution needed. This must be done without compromising the credibility of the agent or specialist among any or all clientele group. After all, one's attitude toward feral hogs, like beauty, is in the eye of the beholder!

The Noble Foundation's Wildlife and Fisheries Program

Michael D. Porter, Kenneth L. Gee, J. Grant Huggins and Russell L. Stevens
Wildlife and Fisheries Specialists
Noble Foundation

A large variety of life exists on this earth. Humans influence the destiny of all species so we have an awesome responsibility to be good stewards of all species. Most people have long recognized their responsibility to properly manage the domesticated life forms such as pets, livestock, poultry, crops, and horticultural plants. However, we have mostly neglected the wild life forms even though most life forms are still wild. The Noble Foundation recognizes that it is important to properly manage all natural resources, including wild animals.

The Noble Foundation has a wildlife and fisheries management program in addition to the many other services it provides for the local area. The Noble Foundation initiated it's wildlife and fisheries program on August 1, 1980 when the first Wildlife and Fisheries Specialist was employed. Since 1980, the program has grown to include four Wildlife and Fisheries Specialists, two Wildlife and Fisheries Aides, two temporary college student Interns, and a wildlife research and demonstration area called the Noble Foundation Wildlife Unit.

Actually, the Noble Foundation was involved with certain aspects of fisheries research, demonstration, and consultation before it formally established it's wildlife and fisheries program. Between 1969 and 1980, Jerry Rogers, Soil and Fertility Specialist, worked with catfish farming. Between 1949 and 1965, Jim Gaylor, Horticulturist, worked with aquatic vegetation control and other aspects of pond management.

The primary thrust of the Noble Foundation wildlife and fisheries program is to help people better understand scientific wildlife and fisheries management. The Noble Foundation attempts to accomplish this goal through consultation, demonstration, extension and research.

The Wildlife and Fisheries Specialists, Ken Gee, Grant Huggins, Mike Porter, and Russell Stevens, provide consultative technical assistance to people who request it. The Wildlife and Fisheries Specialists do this over the telephone, when people visit their offices, through letter correspondence, and sometimes by one of the Specialists visiting the property of a person. If someone needs immediate assistance, they can obtain it quickest by visiting' one of the specialists at his office or over the telephone.

Each of the Wildlife and Fisheries Specialists is involved in the management of one or more of the five of the Noble Foundation demonstration and research farms. The Noble Foundation Headquarters Farm is located in Carter County adjacent to the Noble Foundation offices on the east side of Ardmore. The Noble Foundation Pasture Demonstration Farm is located in Carter County just northwest of the Ardmore city limits. The Noble Foundation Red River demonstration and Research Farm is located at Burneyville in Love County along the Red River. The Noble Foundation D. Joyce Coffey Resource Management and Demonstration Ranch is located between Marietta and Burneyville in Love County along the Red River. The Noble Foundation Wildlife Unit is located south of Allen in Pontotoc, Hughes, and Coal Counties along the Muddy Boggy Creek. The Noble Foundation wildlife and fisheries personnel are responsible for managing the fish and wildlife resources on the five farms.

The Wildlife Unit emphasizes wildlife and fisheries projects more than the other farms. The Noble Foundation Wildlife unit is unique in that it is the largest of the very few privately funded wildlife research and demonstration areas in Oklahoma. The primary purpose of the Noble Foundation Wildlife Unit is for studying, demonstrating, and teaching wildlife management and wildlife science. Most game and nongame species that occur in east-central Oklahoma are present on the Wildlife Unit. One of the Wildlife and Fisheries Specialist, Ken Gee, lives at the Wildlife Unit and is the manager of the area. He is assisted by Wildlife and Fisheries Aide, John Holman, who also lives at the Wildlife Unit.

An important purpose for the Noble Foundation farms is to demonstrate good management techniques. Tours and field days are conducted at all the farms. The Headquarters Farm demonstrates various aspects of pond management. Examples of pond management, bobwhite management, waterfowl management, bIuebird management, and beaver damage control are demonstrated at the Pasture Demonstration Farm. The Red River Farm demonstrates bobwhite management, mourning dove management, and wildlife damage management. Recreational leasing, pond management, turkey management, and deer management are demonstrated at the Coffey Ranch. The Wildlife Unit demonstrates pond management, waterfowl management, bluebird management, and white-tailed deer management. Other aspects of wildlife and fisheries management are also demonstrated on these farms. Much of the wildlife and fisheries work on the farms is performed by the Wildlife and Fisheries Aides, John Holman and Brady DeVille. Any group can make an appointment to tour a Noble Foundation farm to observe and discuss wildlife and fisheries management.

The Noble Foundation Wildlife and Fisheries Specialists perform several extension functions. They give programs to clubs, school classes, scouts, and other groups. They present scientific information at seminars, scientific technical meetings, and field days. They write bulletins, fact sheets, and articles for newspapers, newsletters, magazines, and journals. The Wildlife and Fisheries Aides also assist with some of these extension functions. Anyone interested in obtaining some of the Noble Foundation literature can contact the Agricultural Division of the Noble Foundation and request a list of available publications.

Most of the Noble Foundation's wildlife and fisheries research projects investigate techniques of management. Wildlife and fisheries research projects have involved subjects such as largemouth bass harvest regulations, seine sampling ponds, pond fertilization, rainbow trout cage culture, channel catfish cage culture, wildlife damage control in pecans, woody seedling plantings, quail food plant management, bobwhite habitat improvement, bluebird nest predation control, wood duck nesting ecology, deer population estimation procedures, deer food habits, nutritional qualities of deer foods, capture and marking deer, refinement of deer aging technique, and efficiency of deer harvest management. Most of the research is conducted on the five farms of the Noble Foundation.

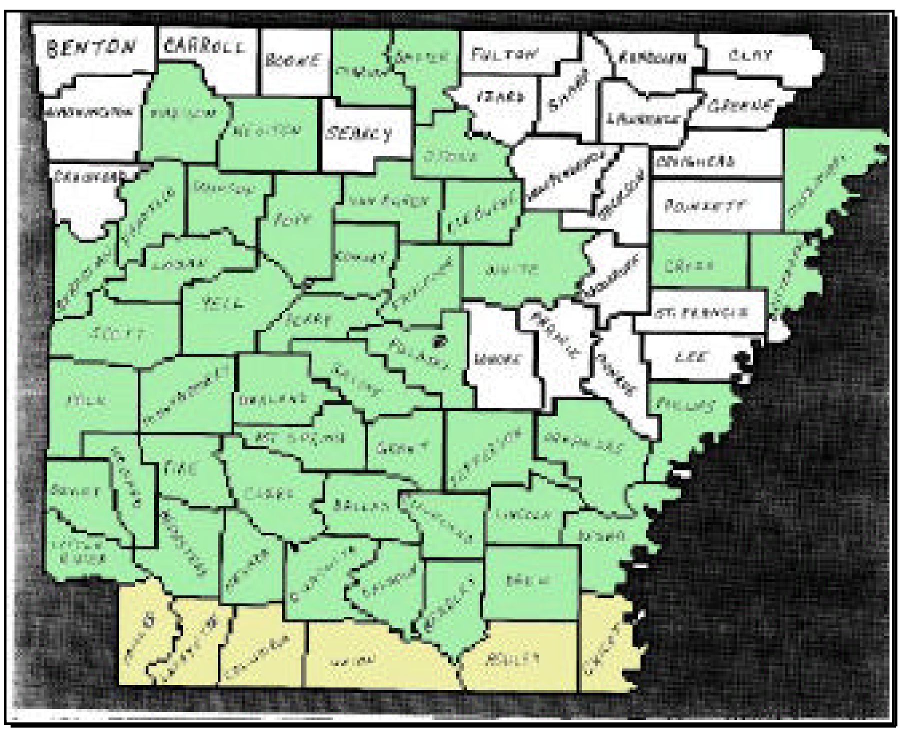
All the wildlife and fisheries services provided by the Noble Foundation are free to the public.

Existing Arkansas Laws Regulating Feral Pigs 1800 - 1840 Origin

Greg Mathis
Wildlife Biologist
Arkansas Game and Fish Commission

- Protected free ranging bogs and their owner, hog claims legal, registered ear markings the norm, allowed release
- Had a damage clause to protect a landowner but guidelines about liability, how they had to be held and disposed, real time consuming and difficult
- Regulations enforced by the local Sheriff in a loose fashion unless you killed someone's hog
- No disease control measures or testing required.

"Technically, feral hogs could not legally be taken by anyone who did not own or claim the hog."



Hog Populations 1900 - 1970's (Six lower counties)
Hog Populations As of 1997 (Includes lower counties and other shaded)

"ATTENTION GETTERS "

- Dramatic increase in landowner complaints, Farmers - crops, pastures, Timber Companies - new plantations, old plantations, wildlife habitat, Deer / Turkey clubs and leases............
- Tyson swine producer herd and producers family infected with swine brucellosis - Tyson, Ark. Pork Producers, Farm Bureau, Health Dept., Ark. Livestock and Poultry, Game and Fish.........
- Natural resource managers increasing concern and wide spread problems with hogs on public land, critical habitat destruction........
- Increasing documentation in the literature and on the Internet impacts on flora and fauna, advertised guided "hog hunts"...........
- A Commission very concerned with the problem.....and looking for answers and solutions, develop a plan and act..........

FERAL HOG TASK FORCE

• ARKANSAS FARM BUREAU • ARKANSAS GAME AND FISH COMMISSION • ARKANSAS PORK PRODUCERS ARKANSAS STATE PARKS • ARKANSAS WILDLIFE FEDERATION • AUDUBON SOCIETY • POTLATCH • WEYERHAUSER • INTERNATIONAL PAPER • DELTIC TIMBER • NATIONAL PARK SERVICE • U.S. D.A. FOREST SERVICE • U.S. FISH AND WILDLIFE SERVICE • OZARK NATIONAL FOREST • OUACHITA NATIONAL FOREST • STATE HEALTH DEPARTMENT • U.S. DEPARTMENT OF AGRICULTURE • ARKANSAS POULTRY AND LIVESTOCK COMMISSION • UNIVERSITY OF ARKANSAS COOPERATIVE EXTENSION SERVICE • ARKANSAS CHAPTER OF THE NATIONAL WILD TURKEY FEDERATION • THE OZARK SOCIETY • QUAIL UNLIMITED • AUDUBON SOCIETY • NATIVE PLANT SOCIETY • GEORGIA PACIFIC

FERAL HOG TASK FORCE PURPOSE:

Combine Industry, Private Organizations, Public and Animal Health Agencies, and Natural Resource Managers into a strong working team charged with identifying problems and solutions, developing and implementing legislative lobbying strategies, and educating the public regarding the current and potential problems associated with feral hogs in Arkansas.

GOAL:

Inform and educate the public and pass new and stronger laws related to feral hogs.

ACCOMPLISHMENTS:

1. Developed a working network between all participates. 2. Developed and distributed a feral hog brochure. 3. News releases in major newspapers, on the radio, and magazines. 4. Passed ACT 457 of 1999.

ACT 457 OF 1999

- Defines "Feral Hogs". Any hog roaming freely upon public lands or private land not enclosed by a fence and without the landowner permission. A stray domestic hog becomes feral 5 calendar days after escaping domestic confinement. If notice is provided within those 5 days, the hog will not be considered feral for an additional 10 calendar days.

For purposes of this section, feral hogs are deemed domestic livestock.

- Authorizes "taking and killing's". Any person may take or kill feral hogs.
- Feral hogs taken on public property during established hunting seasons must be taken with weapons and methods allowed for that hunting season. Feral hogs may be taken on any land where the hunter has legal access unless prohibited by the landowner. No person may take or kill feral hogs whose hunting license is revoked.
- Eliminates liability for injuring feral hogs.
- Prohibits releasing into the wild.
- Any person who willfully releases any hog in a wild or feral state upon public land or upon private land, unless the landowner has consented is in violation ($500 fine).
- Establishes animal health requirements. Feral hogs shall be subject to animal health requirements established by the Arkansas Livestock and Poultry Commission (To Be Determined).

One Commissioners Quote
"Feral Hogs are like cancer, once you know
you've got them, it's too late."

Feral Swine as a Source of Infection
Source of Newly Affected PRV Herds 1997-1999

Jay S. Levenstein
Chief, Bureau of Animal Disease Control
Florida Department of Agriculture and Consumer Services

RULE 5C-21.015, FLORIDA ADMINISTRATIVE CODE, FERAL SWINE, MOVEMENT AND TEST REQUIREMENTS.

(1) Feral swine of unknown status may be moved only for immediate slaughter. Movement to hunting preserves or game farms is not considered as movement to slaughter.

(2) Feral swine moved to hunting reserves or game farms, or for exhibition, breeding, or feeding, must be from qualified pseudorabies negative herds, or be found negative to a pseudorabies serologic test conducted within 30 days prior to movement.

(3) Feral swine moved for breeding purposes, in addition to meeting the requirements in (2) above, must be segregated from all domestic swine and be found negative to two pseudorabies serologic tests with the first conducted at 30 to 60 days following segregation and the second at 60 to 90 days after the first test.

(4) The person who removes the feral swine from their natural habitat is responsible for satisfying the test and permit requirements for movement in this section.

SWINE MOVEMENT CHANNELS

RESTRICTED SWINE PROCESSORS

- 160 under agreement
- Restricted to premise until death
- Maintained in a confined area with adequate fencing to prevent escape
- No breeding
- Records kept of sources from which swine are purchased or received
- Regular inspections

FLORIDA SWINE MARKETS

FERAL SWINE BUYING STATIONS

- 5 Florida sites
- Number of wild hogs permitted to slaughter
  – 1997……..10,150
  – 1998……….8,586
  – 1999………....685 (to date)
- Surveillance program being developed

PROPOSED FIELD STUDIES AND RESEARCH

- Vaccine Oral Delivery System for immunization of high risk penned swine
  – Brucella abortus strain RB-51
  – Optivac pseudorabies vaccine
  – RB-51 and Optivac combined
- Determine effectiveness of Brucella abortus strain RB-51 administered in oral bait to a naturally infected feral/wild swine herd
  – Determine effectiveness of leaves from the cabbage palm as a biodegradable feeder
- Evaluation of Forward Looking Aerial Infrared (FLAIR) to locate feral/wild swine in vegetative cover
- Methods of estimating population density at Avon Park Air Force Range
  – Bait station survey
  – Mark-recapture
  – Harvest

The Wild Boar Population Model Workbook For Excel97 V.5-30-99

Reginald H. Barrett, PhD
Professor, Wildlife Management
University of California, Berkeley, CA

WELCOME TO POPMODWB (WILD BOAR) V.5-30-99

POPMODWB is a version of POPMODxx designed to model the dynamics of a wild boar population, particularly one subjected to seasonal harvest.

The model's primary use is for judging the effects of proposed cropping schemes on the population. Seasonal carrying capacity and harvest are the driving variables. CC can be stochastic if desired. The coefficients used are "best guesses" by R.H. Barrett based on published literature and expert opinion. The model has not been validated and hence must be used with caution until tested against empirical data. Assumptions inherent in the model are as follows. Physiological longevity is 9 years. Females first reproduce at 1 year of age and every 6-mo season thereafter. Young are recruited at 3 months of age. All hunting related losses occur after recruitment. All natural losses occur after hunting losses. Thus the population may be tracked at 3 points in the seasonal cycle: 1) pre-recruitment (PrRcN), 2) pre-harvest (PrHvN), and 3) post-harvest (PsHvN). Recruitment (i.e. births minus juvenile mortality), is zero for 6-mo-old females. It is otherwise age specific and density dependent.

F1	=	2.26 - (2.26/(1 + (8*@exp(-6.5*(N/K))))),
F1	=	2.26 - (2.26/(1 + (8*@exp(-6.5*(N/K))))),
F1.5	=	4.25 - (4.25/(1 + (16*@exp(-4.8*(N/K))))),
F2,F9	=	4.64 - (4.64/(1 + (32*@exp(-3.4*(N/K))))),
F2.5,F8.5	=	5.08 - (5.08/(1 + (96*@exp(-3.7*(N/K))))),
F3,F8	=	5.54 - (5.54/(1 + (128*@exp(-3.9*(N/K))))),
F3.5,F7.5	=	6.07 - (6.07/(1 + (128*@exp(-3.8*(N/K))))),
F4-7	=	6.55 - (6.55/(1 + (128*@exp(-3.6*(N/K))))).
Natural mortality is also age specific and density dependent		
M0.5,M9,F0.5,F9	=	0.85 - (0.85/(1 + (16*@exp(-3.577*(N/K))))),
M1,M8.5	=	0.83 - (0.83/(1 + (32*@exp(-2.6*(N/K))))),
F1,F8.5	=	0.83 - (0.83/(1 + (32*@exp(-2.3*(N/K))))),
M1.5,M7.5-8	=	0.86 - (0.86/(1 + (64*@exp(-2.4*(N/K))))),
F1.5,F7.5-8	=	0.88 - (0.88/(1 + (64*@exp(-2.3*(N/K))))),
M2,M6.5-7	=	0.91 - (0.91/(1 + (64*@exp(-2.2*(N/K))))),
F2,F6.5-7	=	0.93 - (0.93/(1 + (64*@exp(-2.2*(N/K))))),
M2.5,M5.5-6	=	0.96 - (0.96/(1 + (64*@exp(-2.2*(N/K))))),
F2.5,F5.5-6,M3-5	=	0.98 - (0.98/(1 + (64*@exp(-2.1*(N/K))))),
F3-5	=	1.00 - (1.00/(1 + (64*@exp(-1.8*(N/K))))).

Recruitment is assumed to be affected primarily by the nutritional status of females, which in turn is a function of the ratio of the pre-recruitment population and the seasonal carrying capacity set by forage quantity and quality. Natural mortality is similarly related to seasonal carrying capacity. Mast crop is assumed to be a primary determinant of seasonal carrying capacity. Dispersal and non-human predation are assumed to be included within "natural mortality".

Young under 6 mo are not harvested, and adults are taken in proportion to their percentage in the adult (0.5+) population. Harvest related losses are compensatory with natural mortality; i.e. up to a point hunting mortality subtracts from rather than adds to natural mortality. The model assumes an even recruit sex ratio. The default starting population structure is a stationary age distribution at summer carrying capacity. The model allows one to produce a one-way data table that lists the sustained yield and other parameters after a population has been subjected to a range of seasonal harvest rates. Age-specific recruitment and survival rates cannot be changed without a major modification and reverification of the model. Initial structure of the population and hunter selectivity for age can be modified. The model is most applicable to statewide or regional analyses where carrying capacity is set at 500 or above.

TO RUN THE MODEL you set a number of parameters via menu choices and view the results on any of several graphs.

The full matrix of results and the graphs may be printed or saved. After establishing the number of seasons to simulate (normally 40), set up a carrying capacity scheme. Seasonal carrying capacity can mimic mast crops and rainfall.

Run the model with zero harvest to provide a "baseline" with which to compare various harvest patterns.

Run "worst case" and "best case" harvests for each of a range of carrying capacity schemes, including deterministic and stochastic ones, even empirical ones if appropriate data exist.

1) Set number of seasons you wish to include in your simulation; you can always add seasons, but you must reload the model to run fewer.
2) Set the desired seasonal carrying capacities using deterministic or stochastic modes, or set the value for each season individually.
3) Set the desired harvest schedule as a percentage or absolute number for each sex and season. If actual harvests are known they can be entered by sex for each season.
4) Run and view the results on one of several graphs; rerun stochastic models to observe the effect of a random (uniform distribution) influence.
5) Produce a data table of sustained yields and other values.
6) Print the entire matrix of results if desired.
7) Save the worksheet for later printing if desired.
8) Exit the menu system if you wish to explore or modify the worksheet, e.g. starting population structure and hunter selection coefficients.

GLOSSARY

WCC = Winter carrying capacity (related to mast crop)

WCCV = Variation in WCC (plus or minus this absolute amount)

SCC = Summer carrying capacity (related to rainfall)

SCCV = Variation in SCC (plus or minus this absolute amount)

SPMHV = Percent harvest of males in summer
SPFHV = Percent harvest of females in summer
WPMHV = Percent harvest of males in winter
WPFHV = Percent harvest of females in winter
SMHV = Absolute harvest of males in summer
SFHV = Absolute harvest of females in summer
WMHV = Absolute harvest of males in winter
WFHV = Absolute harvest of females in winter
PrRcN = Pre-recruitment population size
PrHvN = Pre-harvest population size
PsHvN = Post-harvest population size

Impacts of Feral Swine on Wildlife

Dale Rollins, PhD
Professor & Extension Wildlife Specialist
Texas Agricultural Extension Service
Texas A&M University, San Angelo, TX

Feral swine are perceived to be a threat to various species of endemic wildlife, including big game (e.g., white-tailed deer [*Odocoileus virginianus*] (Wood and Lynn 1977, Yarrow and Kroll 1989), collared peccary [*Tayasu tajacu*]) (Ellisor and Harwell 1979, Taylor et al. 1997), upland gamebirds (e.g., northern bobwhite [*Colinus virginianus*]) (Tolleson et al. 1993), and endangered species (e.g., sea turtles [*Chedonia mydas*]) (Baron 1980). In this paper I review these perceived liabilities, empirical evidence to support or refute these perceptions, and the various processes (e.g., competition) that may exist between feral swine and various game species.

Most of the research conducted on feral swine impacts has been conducted in states where feral swine are well established (e.g, Texas, Florida and California). In Texas, research to date has focused on three ecoregions: post-oak savannah (Kroll 1986, Yarrow and Kroll 1989), gulf coastal prairie (Springer 1977, Ilse 1993), and south Texas Plains (Ellisor 1973, Taylor 1992, Everitt and Gonzalez 1980, Mansouri and DeYoung 1987, Taylor et al. 1997).

The 3 most important manifestations of feral swine relative to wildlife management include (a) competition with native wildlife, (b) predation on native wildlife, and (c) nuisance aspects relative to wildlife management (e.g., damage to food plantings). Although feral hogs have been credited with an array of maladies injurious to native wildlife, for the most part such liabilities have not been quantified (Ilse 1994, Ilse and Hellgren 1995). The most commonly cited concern deals with the *potential* for interspecific competition.

COMPETITION WITH NATIVE WILDLIFE

Competitive interactions and niche overlap between feral swine and other vertebrate herbivores have not been adequately researched (Hellgren 1993). Sweeney and Sweeney (1982) emphasized the need to document the impact of feral swine on native flora and fauna. Previous work has focused on dietary overlap between feral swine and white-tailed deer (Springer 1977, Wood and Barrett 1979, Yarrow and Kroll 1989, Taylor and Hellgren 1997). In Texas, Yarrow and Kroll (1989) suggested that during years of low mast availability, deer populations may be seriously impacted by competition with hogs for scarce food.

There is a tendency when dealing with feral hogs to imply that diet overlap between 2 species indicates competition is occurring. However, niche overlap does not constitute competition for a particular resource unless that resource is limited. Therefore diet overlap (e.g., acorns) may evolve into competition during periods of low mast availability, or during drought periods.

Food habit studies conducted on feral hogs confirm the potential for competition with other species. Feral hogs exhibit a broad feeding niche and thus may have advantages over other species with more specialized diets (e.g., collared peccaries). Springer (1977) noted potential competition for food in South Texas (Aransas National Wildlife Refuge) with white-tailed deer, turkey (*Meleagris gallopavo*), and collared peccaries but concluded that competition was minimal at the present population level of feral hogs. Kroll (1986) noted potential for competition between feral hogs and white-tailed deer in northeast Texas to be highest in fall and winter. R. Taylor (this volume) and other studies (Taylor 1992, Taylor and Hellgren 1997) failed to detect significant dietary overlap between feral hogs and collared peccaries, or between feral hogs and white-tailed deer.

Feral hogs and peccaries have been the focus of several studies because of their ecological similarities (Ellisor and Harwell 1979, Hellgren 1993, Ilse 1994, Ilse and Hellgren 1995, Gabor 1997). Ellisor and Harwell (1979) reported that feral hogs and collared peccary competed for space based on observations of interspecific aggression. However, they provided no data on the degree of range overlap or separation between the two species. Ilse (1993) documented niche overlap between feral hogs and collared peccaries relative to diet, habitat use, and activity patterns on a sympatric site in southeast Texas. While there was considerable overlap in activity patterns, overall the overlap between the two species was lower than expected *a priori*. Taylor (1992) found that prickly pear (*Opuntia* spp.) comprised about 15% of the annual diet of feral hogs. Prickly pear is a staple in collared peccary diets, but at least in most areas of south Texas, prickly pear is far from being a limited resource.

PREDATION ON WILDLIFE

Because of their acute sense of smell, feral hogs are viewed as serious threats to ground nesting gamebirds (e.g., bobwhites) (Tolleson et al. 1993). However, field studies are inconclusive about the absolute importance of feral hogs as an agent of nest depredation. Wood and Lynn (1977) indicated hogs were important predators of wild turkey nests while Henry (1969) concluded hogs to be haphazard nests predators and that hogs were not additive to nest depredation. Tolleson et al. (1993) reported that feral hogs were implicated (based on physical evidence of rooting) in 8 and 28% of simulated bobwhite nests in Shackelford and Foard counties, Texas (respectively). During this study, one feral hog was observed indirectly (fresh tracks following a rain) to have successfully located and depredated 6 of 8 nests in one transect.

Additional studies on feral hogs in those regions using TrailMaster cameras (D. Rollins, unpublished data) suggest that hogs are capable of depredating simulated nests without any visible rooting evidence, thus their role as a nest predator may be underestimated. W. B. Frankenberger (Florida Fish and Game Dept., personal communication) indicated that feral hogs were not a significant nest predator on wild turkeys in Florida, even at feral hog densities approaching 40 per square kilometer.

Henry (1969) suggested that hogs served as a competing risk with depredation that would have occurred by other predators either driven off or preyed upon by feral hogs, e.g., snakes. I often encounter landowners who are convinced that feral hogs are an active predator on various snakes, including rattlesnakes (*Crotalus* spp.)

Thompson (1977) found hogs represented minor problems in predation of ground nesting birds, rabbits and freshwater turtles. Wood et. al. (1992) found that in Georgia 80 percent of sea turtle nests were lost on Ossabow Island due to hog predation. Kroll (1986) documented the presence of lizards, mice, birds, juvenile pigs and deer remains in hogs on the Engling WMA and Tisdell (1982) documented cannibalism in hogs. Springer (1977) indicated snakes were taken every season of the year in South Texas. Springer found remains of white-tailed deer fawns in 4 of 107 hogs (4%) sampled. Taylor and Hellgren (1997) reported one hog stomach contained a deer fawn’s leg, and others contained remains of mourning doves (*Zenaida macroura*), but both instances were thought to involve scavenging rather than predation.

Feral hogs are omnivorous and opportunistic, and are frequently attracted to livestock birthing grounds where they feed on afterbirths and fetal tissue (Beach 1993). Feral hogs are considered a significant predator on healthy newborn lambs or kid goats in the southern Edwards Plateau of Texas (e.g., Real and Uvalde counties) (Beach 1993).

NUISANCE ASPECTS

Perhaps the most universally accepted liability of the presence of feral hogs is nuisance damage caused to fences, game feeders and wildlife food plots. The Texas Wildlife Damage Management Service annually receives reports from deer hunting operations that feral hogs consume corn placed out to bait deer and that the hogs' presence causes deer to avoid the feeders (Beach 1993). Hogs have proved to be a nuisance when trapping bobwhites for research purposes. The walk-in traps for quail are baited with grain (e.g., sorghum) and once feral hogs find the trap site, modifications using livestock exclusion panels are necessary to deter hogs from destroying trap sites (Tolleson et al. 1994).

SOIL DISTURBANCE

The soil disturbance associated with rooting activities by feral hogs, while viewed negatively among farmers (e.g., hayfields), can have positive impacts on game birds. The disturbed soil promotes pioneer forbs (e.g., *Croton* spp.) the seeds of which are staples in the diets of game birds like quail and doves.

CONCLUSIONS

I sometimes cite "Wilson's Law" as "if I hadn't seen it, I never would have believed it with my own two eyes." This admission of our perceived biases on certain topics seems appropriate for feral hogs relative to wildlife. While dogma has it that feral hogs are a an ominous threat to game species like bobwhites and white-tailed deer, the literature (for the most part) fails to substantiate the threats, at least at present populations of feral swine. While concern is warranted, and additional monitoring recommended, it appears that the risk to wildlife from feral hogs is somewhat exaggerated, or at least has not been substantiated to date.

Additional research on feral swine biology (e.g., fecundity, recruitment, survival) ecological interactions (e.g., seasonal diet overlap, spatial relationships) (Taylor et al. 1998), and economic consequences (e.g., nuisance damage, population impacts on game species versus feral hogs) is needed to accurately define and assess the relative and absolute value of feral swine on Texas rangelands.

LITERATURE CITED

Baron, J. 1980. Vegetation impact by feral hogs: Gulf Island National Seashore, Mississippi. Proceedings Second Conference Science Research Nat'l. Parks 8:309-318.

Beach, R. 1993. Depredation problems involving feral hogs. Pages 67-75 *in* C.W. Hanselka and J.F. Cadenhead (eds.) Feral swine: a compendium for resource managers. Texas Agricultural Extension Service, San Angelo.

Ellisor, J. E. 1973. Feral hog studies. Federal Aid. Proj. No. W-101-R-4 Final Report. Texas Parks and Wildlife Department. Austin.

Elisor, J.E. and F. Harwell. 1979. Ecology and management of javelina in South Texas. Federal Aid Report Series No. 16. Texas Parks and Wildlife Department. Austin.

Everitt, J. H., and M. A. Alaniz. 1980. Fall and winter diets of feral pigs in south Texas. Journal of Range Management 33:126-129.

Gabor, T.M. 1997. Ecology and interactions of sympatric collared peccaries and feral pigs.

Dissertation. Texas A&M University-Kingsville, and Texas A&M University, College Station (joint program).

Hellgren, E.C. 1993. Biology of feral hogs (*Sus scrofa*) in Texas. Pages 50-58 *in* C.W. Hanselka and J.F. Cadenhead (eds.) Feral swine: a compendium for resource managers. Texas Agricultural Extension Service, San Angelo.

Henry, V.G. 1969. Predation on dummy nests of ground-nesting gamebirds in the southern Appalachians. Journal of Wildlife Management 33:169-172.

Ilse, L. M. 1993. Resource partitioning by sympatric populations of feral hogs and collared peccaries in south Texas. Thesis. Texas A&M University-Kingsville.

Ilse, L.M., and E. C. Hellgren. 1995. Spatial use and group dynamics of sympatric collared peccaries and feral hogs in southern Texas. Journal of Mammalogy 76:993-1002.

Kroll, J. C. 1986. Interspecific competition between feral hogs and white-tailed deer in the post oak savannah region of Texas. Federal Aid Proj. W-109-R-8 Job. No. 44, Final Report.

Mansouri, A., and C.A. DeYoung. 1987. Feral hog fidelity to home range after exposure to supplemental feed. Texas Journal of Agriculture and Natural Resources. 1:46-49.

Springer, M. D. 1977. Ecologic and economic aspects of wild hogs in Texas. Pages 37-46 *in* G.W. Wood, ed. Research and management of wild hog populations. The Belle W. Baruch Forest Science Institute, Clemson University, Georgetown, S.C.

Sweeney, J. M., and J. R. Sweeney. 1982. Feral hog (Sus scrofa). Pages 1099-1113 in J. A.Chapman and G. A. Feldhamer, eds. Wild mammals of North America: Biology, management, and economics. Johns Hopkins Univ. Press, Baltimore, MD.

Taylor, R. B. 1992. Feral hog food habits and reproduction in the Rio Grande Plains. Federal Aid Project No. W-125-R-3 Job No. 82 Perf. Rep.

Taylor, R.B., and E.C. Hellgren. 1997. Diet of feral hogs in the western South Texas Plains. Southwestern Naturalist 42:33-39.

Taylor, R.B., E.C. Hellgren, T.M. Gabor, and L.M. Ilse. 1998. Reproduction of feral pigs in southern Texas. Journal of Mammalogy 79:1325-1331.

Tisdell, C.A. 1982. Wild pigs: environmental pest or economic resource? Pergamon Press. Sydney, Australia.

Tolleson, D., D.Rollins, W.E. Pinchak, M. Ivy, and A. Heirman. 1993. Impact of feral hogs on ground-nesting gamebirds. Pages 76-83 *in* C.W. Hanselka and J.F. Cadenhead (eds.) Feral swine: a compendium for resource managers. Texas Agricultural Extension Service, San Angelo.

Tolleson, D., D. Rollins, W.E. Pinchak, and L.J. Hunt. 1994. Feral hogs in the Rolling Plains of Texas: perspectives, problems, and potential. Pages 124-128 *in* R.E. Masters and J.G. Huggins, eds. Twelfth Great Plains Wildlife Damage Control Workshop Proceedings, Ardmore, Oklahoma.

Wood, G.W., and R.H. Barrett. 1979. Status of wild pigs in the United States. Wildlife Society Bulletin 7:237-246.

Yarrow, G. K., and J. C. Kroll. 1989. Coexistence of white-tailed deer and feral hogs:management implications. Southeast Deer Study Group 12:13-14 (abstract only).

Demographic and Epidemiological Investigations of Feral Hogs at Avon Park Air Force Range Florida

Dr. Patrick Walsh
Wildlife Biologist
Department of Defense
Avon Park Force Range, Florida

Forty-two years of harvest history on the wild hog (*Sus scrofa*) at Avon Park Air Force Range (APAFR) indicates a cyclic harvest that has ranged from as few as 29 to as many as 405 hogs. Although influenced by non-population factors, harvest numbers have value as a population trend indicator. For the past ten years, the harvest has been higher than the long-term average. Harvest density is not uniform throughout APAFR.

Two measures of population abundance were used at APAFR--a bait-station survey which has occurred annually since 1992, and a mark-recapture census which occurred 1995-1997. The bait-station survey indicated that wild hog abundance increased until 1997, then declined. Abundance was strongly influenced by productivity. Hogs occurred throughout APAFR, but distribution changed within APAFR over time.

Population density was higher in unhunted areas than in hunted areas, indicating that the population was annually diminished by hunting, but it was replenished to some degree by natality of survivors, plus immigrants dispersing from the refuge areas or from adjacent properties. Hunting effort did not cause sufficient mortality to exceed the hog's capacity to increase, indicating that hog population size was more a function of habitat factors than hunting pressure.

The mark-recapture surveys indicated that the 1995 population was composed of 775 +/- 236 hogs. This increased to 1,768 +/- 441 in 1996, and did not change significantly in 1997, at which time the population estimate was 1,685 +/- 454. Harvests during these years accounted for 18-31% of the estimated population.

The distances hogs traveled from mark to recapture locations ranged from approximately 137 m to more than 20 km. The average distance traveled was 3,061 m, which indicates a home range of 29.4 km^2, assuming the average distance is the radius of a circular home range.

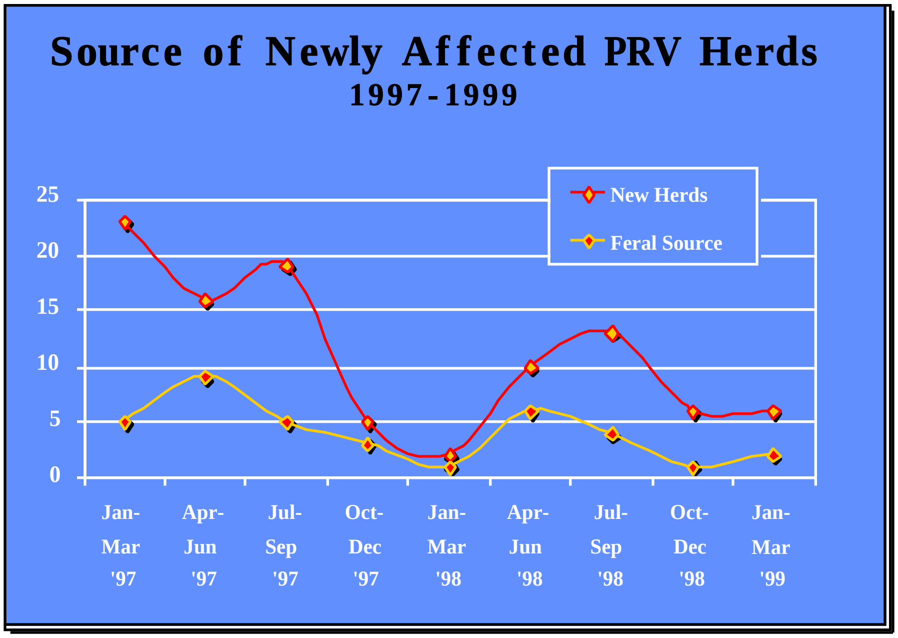
Physical condition was monitored by measuring height and weight of hogs annually since 1987. Both average height and weight increased as hogs aged. Both parameters also increased linearly over time, and may be due to improvement in nutritional state. Farrowing occurred throughout the year but peaked primarily in September—October and secondarily in May. Breeding peaked primarily in June and secondarily in January.

Seroprevalence of swine brucellosis and pseudorabies virus was monitored annually since 1992. Brucellosis increased linearly from an average seroprevalence rate of 11.5% in 1992 to 47.1% in 1998. Pseudorabies virus remained stable from 1992-1997 (ranging from 39.1-49.4%), then increased significantly in 1998 to 64.6%. Prevalence of both diseases was directly related to age.

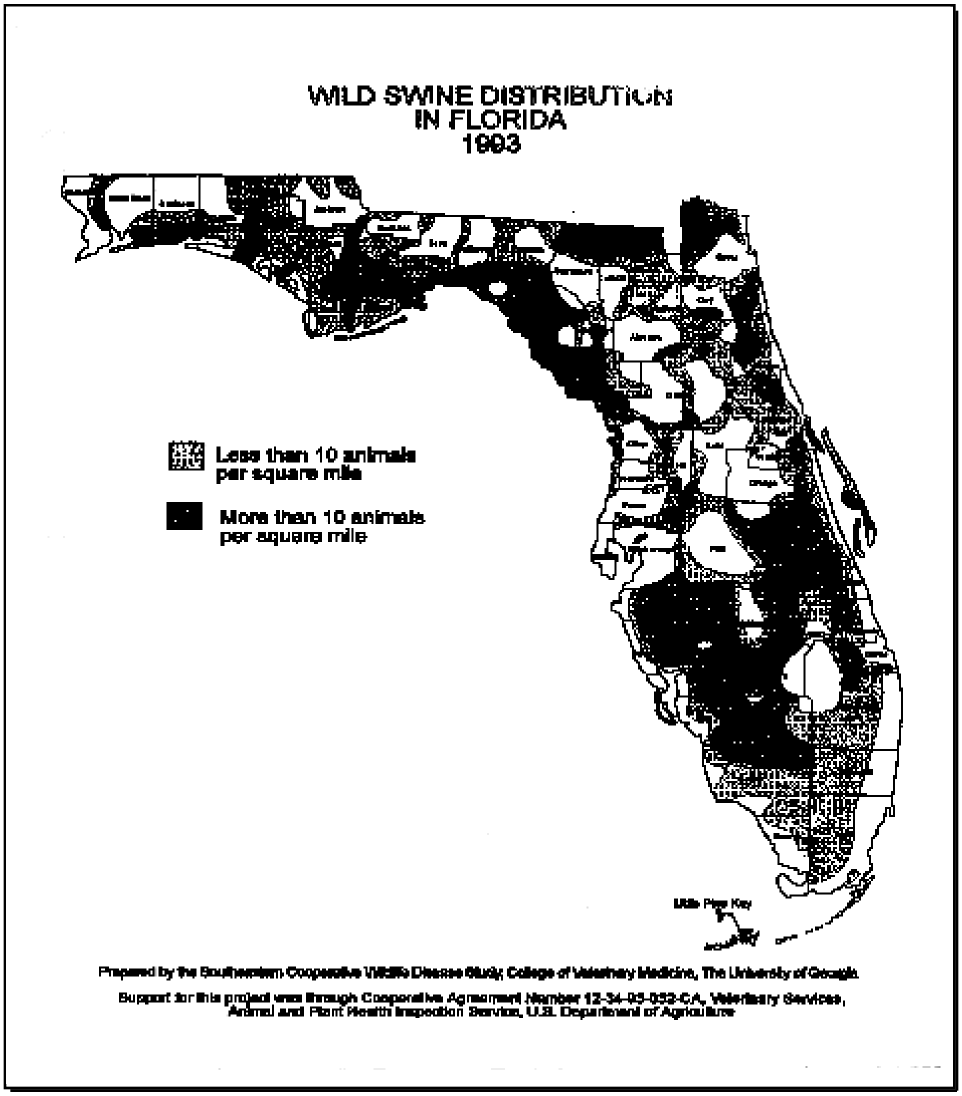
Feral Swine as a Source of Infection

	1997	1998	1999
New PRV Herds	63	31	6
Feral Source	22	15	2
% Feral Related	35%	48%	33%
New SB Herds	23	14	3
Feral Source	8	5	2
% Feral Related	35%	36%	67%

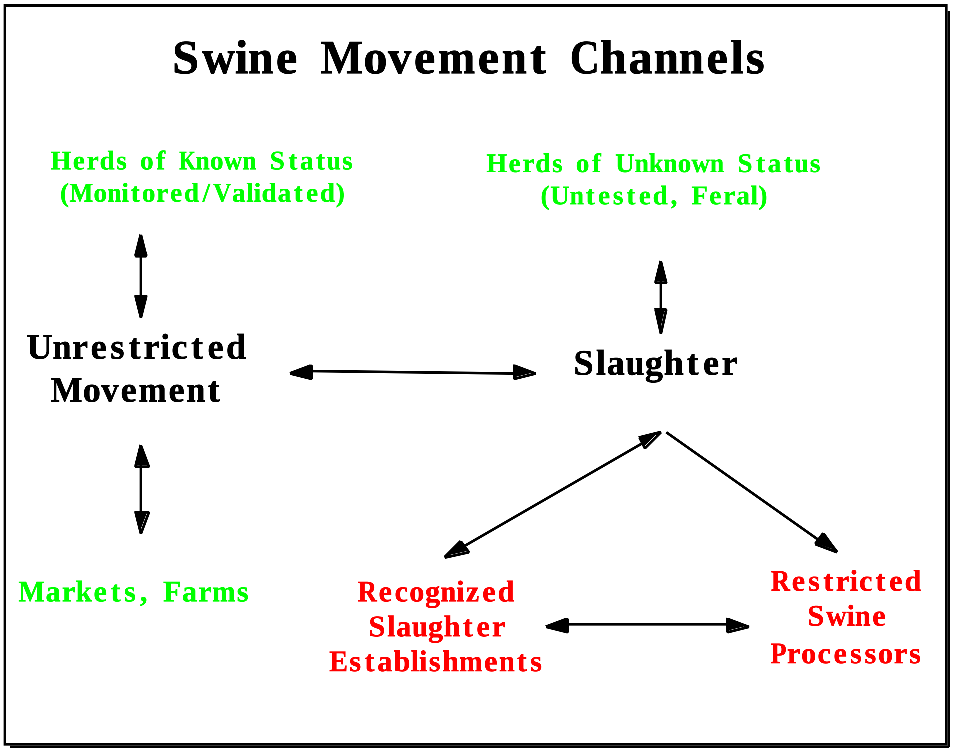
Slide 1


Source of Newly Affected PRV Herds
1997-1999
New Herds
Feral Source
25
20
15
10
5
0
Jan-Mar '97
Apr-Jun '97
Jul-Sep '97
Oct-Dec '97
Jan-Mar '98
Apr-Jun '98
Jul-Sep '98
Oct-Dec '98
Jan-Mar '99

Slide 2


WILD SWINE DISTRIBUTION
IN FLORIDA
1993
Less than 10 animals per square mile
More than 10 animals per square mile
Prepared by the Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine, The University of Georgia.
Support for this project was through Cooperative Agreement Number 12-34-93-032-CA, Veterinary Services, Animal and Plant Health Inspection Service, U.S. Department of Agriculture

Slide 3


Swine Movement Channels
Herds of Known Status
(Monitored/Validated)
Herds of Unknown Status
(Untested, Feral)
Unrestricted
Movement
Slaughter
Markets, Farms
Recognized
Slaughter
Establishments
Restricted
Swine
Processors

Slide 4

Feral Swine Buying Stations

- 5 Florida sites
- Number of wild hogs permitted to slaughter
  - 1997........10,150
  - 1998..........8,586
  - 1999.............685 (to date)
- Surveillance program being developed

Slide 5

Seasonal Diets and Food Habits of Feral Swine

Richard B. Taylor
Wildlife Biologist
Texas Parks and Wildlife Department
Uvalde, TX

Abstract: The diets and food habits of feral hogs (Sus scrofa) were determined in the semi-arid Rio Grande Plains of South Texas. A total of 197 feral hogs were collected during nine seasons beginning in the fall of 1989 and terminating in the fall of 1991. Diets were determined by analysis of stomach contents. Vegetation comprised approximately 93% of the annual diet by volume, and animal matter comprised approximately 6.6%. Relative food composition and frequency of occurrence within the diet varied considerably between years and seasons. The diets of feral hogs in south Texas compared similarly to diets found in other regions of the United States. Feral hogs are opportunistic feeders and compete directly with native wildlife for mast and seasonal foods. The extent and effect of this competition is unknown. Feral hogs are not active predators on native wildlife and current research suggests a minimal negative impact.

INTRODUCTION

Spanish explorers brought the first hogs into the United States in the mid-1500's and into Texas by 1600. As colonization increased, domestic hog populations subsequently increased. Hogs provided an important source of meat and lard for settlers. Free-ranging domestic hogs introduced by settlers throughout the 1800's consequently established feral populations. In the late 1930's and 40's European hogs were introduced into Texas by ranchers to increase hunting opportunities. The continuing intentional releases of domestic swine by sportsmen and ranchers for hunting have augmented the population throughout the last several decades (Taylor, 1993). Improved agricultural practices such as habitat and water improvement, better animal husbandry, disease irradication and vaccinations, and increased predator control have further benefited wild hog populations.

Historically, swine populations were controlled by natural mortality, diseases, parasites, predators, and subsistence hunting. Feral hog density and distribution have increased substantially throughout the southern United States and can now be found in approximately 24 states, including Hawaii. Gipson et al. (1998) found a dramatic northward expansion in the range of wild hog since 1988. Texas has the distinction of harboring the greatest number of hogs estimated in excess of 1.5 million. With the exception of the western panhandle and the northern and western Trans-Pecos region, they are found throughout Texas with heaviest densities occurring in the eastern, central, and southern regions of Texas (Taylor, 1993).

Climatic factors and land use may affect the nutritional levels and availability of food, and therefore have been considered a probable limiting factor in the range expansion and density of feral hogs (Hanson and Karstad, 1959; Barrett, 1978). In south Texas, droughts are frequent and habitat recovery is slow. While much of the foraging activities of feral hogs are visible, the long term effects on native flora and fauna are relatively unknown and possibly the most detrimental. The objectives of our investigation was to determine the food habits and seasonal food components in the diets of feral hogs in a semi-arid environment. We also examined the relationship of food habits to habitat and climate, as well as the possible impact of feral hog foraging on game and nongame species. We compared our results with other food habit studies conducted throughout the United States to determine potential differences.

STUDY AREA AND METHODS

The Rio Grande Plains are located on the western side of the south Texas ecological region of Texas (Gould, 1975). The study area included seven counties: Uvalde, Kinney, Maverick, Webb, Zavala, Dimmit, and LaSalle. Climate is characterized by short winters and moderate temperatures. Days with freezing temperatures are infrequent and growing seasons often exceed 325 days. Precipitation averages 61 cm. on the east side and declining to 51 cm. on the west side of the study area, with the majority of rainfall occurring in the spring and fall. Frequent droughts and extreme fluctuations are relatively common. The topography of the area is flat to gently rolling, interspersed with many creeks and drainages. Numerous stock tanks are found randomly throughout the study area. Vegetation is predominantly low level diverse chaparral brush dominated by mesquite (Prosopis glandulosa), prickly pear (Opuntia spp.), and acacias (Acacia spp).

A minimum of 25 feral hogs were randomly collected by shooting and aerial gunning during each season (Fall: Sept.-Nov.; Winter: Dec.-Feb.; Spring: March-May; Summer: June-Aug.) from September 1989 through November 1991. A total of 197 feral hogs were collected during nine seasons of this study beginning with the fall of 1989 and terminating with the fall of 1991. The stomach contents were analyzed by the point frame method (Chamrad and Box, 1964) after sieving through either a 3.2 or 6.3 mm sieve. Contents were separated into the following classes: grasses, forbs, roots and tubers, woody browse, cactus pads, cactus fruit, corn (shelled), hard mast, soft mast, vertebrates, invertebrates, and debris or unknown plant or animal matter. One hundred hits were recorded for each stomach for each sieve size. Since hogs are monogastric, differential passage rates of foods from the stomach into the small intestine was not considered a potential bias. Corn was the only food category affected ($p<0.05$) by grid size (more corn was found in samples sieved through the smaller sieve), hence data in all other food categories were pooled across grid sizes, with season as the main effect. Data were tabulated on a frequency basis and converted to volume percent and presented as volume percentage and percent frequency of occurrence.

The results were analyzed to determine the potential impact feral hog foraging may have on game and nongame animals. Additionally, we used climatic data to test for a correlation between feral hog diets, and monthly and seasonal precipitation and temperature.

FOOD HABITS

Overall, vegetation comprised approximately 93% of the annual diet by volume while 6.6% was animal matter. The average volumetric percentages for the various food classes were 22.4% grasses, 17.3% roots and tubers, 14.4% corn, 14.0% forbs, 10.4% cactus fruits, 9.0% hard mast, 4.9% cactus pads, 4.2% vertebrates, 2.4% invertebrates, 0.6% soft mast, and <0.1% woody browse. Approximately 0.3% was debris or unknown plant or animal matter (Table 1)(Taylor and Hellgren, 1997). Hard mast was represented by woody plant seeds and nuts, whereas soft mast consisted of the fruits and berries of plants. Annual percent frequency of occurrence was highest for grass, forbs, and roots/tubers. Corn, cactus fruit, and hard mast showed seasonal variation due primarily to availability.

Spring and summer diets were dominated by vegetative matter with 80-95%, respectively composed of grasses, forbs, roots/tubers or cactus pads. Grass was greater in the drier spring (below average) of 1991, whereas forbs were proportionally higher in the diet during the wetter spring (above average) of 1990. The highest occurrence of invertebrates in diet was during the wet spring of 1990. Summer diets shifted from predominantly spring herbage (grass and forbs) to available prickly pear fruit and hard mast. Hard mast was predominantly mesquite and quajillo and comprised approximately 23% of the summer diet (Taylor and Hellgren, 1997).

Approximately 50% of the fall diets were dominated by underground plant parts and corn with herbaceous vegetation and cactus parts constituting approximately 32%. In winter, grasses and corn comprised approximately 60% of the average diet (Taylor and Hellgren, 1997). Heavy consumption of corn in the fall and winter diets can be attributed to heavy baiting and supplemental feeding of wildlife by landowners and sportsmen. Corn is readily available whereas natural winter mast such as acorns are limited and may serve as a replacement. A mild climate, and long growing season in south Texas often enables a considerable amount of winter vegetational growth.

Animal matter was seasonably variable comprising only 6.6% of the annual diet by volume. The major invertebrate food identified and observed was lepidopteran larva (Taylor and Hellgren, 1997). Certain mammals, birds, and reptiles were identified but it is unknown whether they were scavenged or preyed upon.

DISCUSSION

The diet of feral hogs in the Rio Grande Plains of south Texas was composed chiefly of plant materials. These results were similar to those conducted in the coastal plains of south Texas, California, Florida, and Tennessee where vegetation also comprised a major part of hog diets (Scott and Pelton, 1975; Springer, 1977; Barrett, 1978; Everitt and Alaniz, 1980; Wood and Roark, 1980; Baber and Coblentz, 1987; Beldon and Frankenberger, 1990). In general, herbage is extremely important in the spring and summer, while mast, roots and tubers, and grasses dominate the fall and winter seasons. Among herbaceous forages, feral hogs selected forbs when available. Hogs had a higher percentage of grasses in their diet under periods of average or below average rainfall. Oaks are not abundant in western south Texas so acorns are replaced by various acacia beans (e.g. guajillo, blackbrush), mesquite, and corn.

Seasonally, the diet in south Texas is similar to diets in other areas of Texas and the United States, with only minor variations in frequency and volume (Scott and Pelton, 1975; Springer, 1977; Barrett, 1978; Everitt and Alaniz, 1980; Wood and Roark, 1980; Baber and Coblentz, 1987; Beldon and Frankenberger, 1990). In the central Rolling Plains of Texas, preliminary results of a similar study currently being conducted indicates seasonal use of available resources. In the spring feral hogs consumed 25% grass and 35% roots and tubers by volume and 49% soft mass in the summer. Grain crops were consumed, by volume, 43% in the fall and 55% roots and tubers in the winter (Lucia, et al., 1999). Frequency of roots and tubers was higher than any other item in the spring and winter, whereas roots/tubers and soft mass was more frequent in the summer. In the fall, grain crops and invertebrates were found more often than any other food item (Lucia, et al., 1999).

Animal matter constituted only a small percent of the feral hog's diet in south Texas. This compares with the majority of other studies conducted throughout the United States on the limited consumption of animal matter (Scott and Pelton, 1975; Barrett, 1978; Everitt and Alaniz, 1980; Wood and Roark, 1980; Baber and Coblentz, 1987; Beldon and Frankenberger, 1990). Significant amounts of animal matter in the seasonal diets of feral hogs have been reported, however further investigations suggest possible biases based on questionable techniques, limited samples sizes, and considerations of seasonal variability (Springer, 1977; Kroll, 1986; Hellgren, 1993). Lucia et al.(1999), claims preliminary results indicate invertebrates and grain crops were found more frequently in the fall than any other food item in the Rolling Plains of Texas.

The actual volumetric composition and percent frequency of occurrence varied seasonally, on a year by season basis, and with food availability. Diet variability can be attributed to annual precipitation, length of growing season, diversified plant communities, and the large study area. The long growing season, high nutritional value of the vegetation, and quantity of various mast producing plants contribute to this success. Habitat diversity in the Rio Grande Plains allows feral hogs to utilize all habitats found within this region, shifting their diets seasonally based on food availability.

While annual precipitation is important in forage production, there was no apparent correlation found between temperature variations and feral hog diets in this study although climate may effect availability of certain plants at certain times of year. According to Heitman and Hughes (1949), as air temperature increases, food consumption by hogs decreases. In the Rio Grande Plains, food consumption probably decreases; however, high ambient summer temperatures did not affect forage availability although temperature extremes may cause plant defoliation and can affect the nutritive values of available forage (Davis and Winkler 1968). Plant diversity and adaptability to climatic extremes in South Texas generally produces some foliage or fruit in every month of the year except during extreme freezes. Even after a freeze, warm daytime temperatures often allow winter vegetation growth between freezes.

Feral hogs may compete with several species of wildlife for specific seasonal food. (Springer, 1977; Everitt and Alaniz, 1980; Kroll, 1986). Since hogs are efficient foragers, they may reduce food availability for other wildlife. A review of food preferences of various game and nongame wildlife was used to determine potential effects feral hogs may have on them.

White-tailed deer (Odocoileus virginianus) and javelina or collared peccary (Tayassu tajacu) are the most numerous and economically important game species found in south Texas. Competition between native wildlife and hogs for food and space is a concern among landmanagers and sportsmen. Kroll (1986) stated that competition between hogs and deer differed on a seasonal and yearly basis and was based on abundance and diversity of foods. White-tailed deer are primarily browsers, but forbs, mast and cactus are extremely important food items in south Texas (McMahan and Inglis, 1977; Arnold and Drawe, 1979). Javelina feed on prickly pear pads and fruit, forbs, hard and soft mast and some browse (Everett et al., 1981; Ilse and Hellgren, 1995). The high consumption of herbaceous plants and mast by deer and hogs indicates seasonal competition. Hogs, deer, and javelina have dietary overlap and compete for preferred foods such as acorns, mesquite beans, pricklypear fruit, and acacia beans. Competition for food is most critical in the late winter when vegetation availability and diet quality is low and diet overlap is high (Kroll 1986). Late winter defoliation of browse plants and droughty conditions increase competition between deer and hogs for other available foods in south Texas. The degree of competition is unknown and assumed to be directly related to range conditions, vegetation diversity, forage availability, and animal density. Woody browse constitutes only a small amount of the hogs diet; therefore, there is very little competition with deer and javelina for browse. Grass was only a minor component of deer and javelina diets. When food becomes limited, feral hogs are capable of shifting their diets to a wide selection of other available foods, with no apparent consequences. In south Texas, corn is an important feed for deer and javelina in late winter. Competition for supplemental feed, especially corn, at wildlife feeders may be intense at times.

Seed eating birds such as turkey, quail, and mourning doves generally pick seeds from the ground, and hogs will consume seed producing plants and seed heads. While some competition may exist for seed heads, it is unlikely that feral hogs by themselves would cause a depletion of the food source and might knock seeds off producing plants and increase availability. On well-managed range, foraging and rooting activities by feral hogs may even benefit game and nongame birds. These activities stimulate vegetation regrowth and set back plant succession, thus increasing grass and forb seed sources and availability (Everitt & Alaniz, 1980; Springer, 1977). Their foraging activities may also thin ground vegetation allowing more accessibility for seed eating birds. In addition to eating seeds, turkey eat green vegetation throughout the year supplemented by insects when available (Dickson, 1992). Feral hogs compete directly with turkey for seasonal foods such as fruit, nuts, and seeds. However, the extent and effects of hog competition with game birds is unknown.

As a predator, feral hogs do not appear to pose a significant threat to wildlife in the Rio Grande Plains. Animal matter constitutes a minor part of the diet, however it is unknown whether the animal matter was scavenged or preyed upon. This study reinforces similar conclusions concerning the insignificance of predation on deer by feral hogs (Cook et al., 1971; Springer,1977; Everitt and Alaniz, 1980). Although Tolleson (1993) and Matschke (1965) documented destruction of simulated ground nests by feral hogs, this study agrees with Baker (1978), finding no evidence of predation on ground nesting birds in south Texas. Reptiles appear to be the most susceptible species to feral hog predation in the Rio Grande Plains. In east Texas, Kroll (1986), also found lizards in the diet of feral hogs. In the coastal prairies of south Texas, reptiles and amphibians were commonly found in feral hog diets. Snakes were the only vertebrate found in all seasons (Springer, 1977). Cold temperatures may conceivably increase vulnerability of reptiles and amphibians due to decreased activity while hog activity increases.

Feral hogs are opportunistic and rely heavily on vegetation. Geographic location and climatic conditions do not appear to be a hindrance in the range expansion of feral hogs. While conditions may limit food availability, they have an uncanny ability to respond and adapt to changes. They compete with native wildlife for preferred foods, however the extent of competition is unknown. Feral hogs present a challenge to resource managers and further investigations should be conducted to determine the long term effects of feral hogs on native wildlife.

Acknowledgments

I would like to thank Texas Parks & Wildlife Department, Wildlife Division, District 8 staff who spent many long hours in the field. Many thanks go to Dr. Eric Hellgren of Oklahoma State University for all his assistance in this research project and publishing the results. Also, I would like to thank Dr. Tim Ginnet, Texas A&M University Research and Experiment Station in Uvalde for reviewing and editing this manuscript. I would like to especially thank my wife Lisa, for reviewing this manuscript and above all, putting up with my incessant babbling about wild hogs.

Literature Cited

Arnold, L. A., and D. L. Drawe. 1979. Seasonal food habits of white-tailed deer in the south Texas Plains. J. Range Manage. 32:175-178.

Baber, D. W., and B. E. Coblentz. 1987. Diet, nutrition, and conception in feral pigs on Santa Catalina Island. J. Wildl. Manage. 51:306-317.

Baker, B.W. 1978. Ecological factors affecting wild turkey nest predation on south Texas rangelands. Proc. Ann. Conf. S.E. Assoc. Fish and Wildl. Agencies 32:126-136.

Barrett, R. H. 1978. The feral hog on the Dye Creek Ranch, California. Hilgardia Journal. California Agricultural Experiment Station. Vol. 46:283-355.

Beldon, R. C. and W. B. Frankenberger. 1990. Biology of a feral hog population in south central Florida. Proc. Ann. Conf. S. E. Assoc. Fish and Wildl. Agencies 44:231-242.

Chamrad, A. D., and T.W. Box. 1964. A point frame for sampling rumen contents. J. Wildl. Manage. 28:473-477.

Cook, R. S., M. White, D. O. Trainer, and W. C. Glazener. 1971. Mortality of young white- tailed deer fawns in south Texas. J. Wildl. Manage. 35:47-56.

Davis, R.B. and C.K. Winkler. 1968. Brush vs. cleared range as deer habitat in southern Texas. J. Wildl. Manage. 32:321-329.

Dickson, J. G. Ed. 1992. The wild turkey: biology and management. Stackpole Books. Harrisburg, Penn. 463 pp.

Everitt, J. H. and M. A. Alaniz. 1980. Fall and winter diets of feral pigs in south Texas. J. Range. Manage. 33:126-129.

--------, C. L. Gonzales, M. A. Alaniz, and G. V. Latigo. 1981. Food habits of the collared peccary on south Texas rangelands. J. Range. Manage. 34:141-144.

Gipson, Philip S., Bill Hlavachick, and Tommie Berger. 1998. Range expansion by wildhogs across the central United States. Wildlife Society Bulletin 26(2):279-286.

Gould, F. W. 1975. Texas Plants--A checklist and ecological summary. MP-585, Texas Agricultural Experiment Station, Texas A&M Univ. College Station, Tx. 121 pp.

Hanson, R. P. and Lars Karstad. 1959. Feral Swine in the Southeastern United States. J. Wildl. Manage. 23:64-74.

Heitman, H. Jr., and E. H. Hughes. 1949. The effects of air temperature and humidity on the physiological well being of swine. J. Anim. Sci. 8:171-181.

Hellgren, E.C. 1993. Biology of feral hogs (Sus scrofa) in Texas. Pp. 50-58, in C. W. Hanselka and J. F. Cadenhead, eds., Proceedings--Feral Swine: A compendium for resource managers. Texas Agricultural Extension Service, Texas A&M Univ., College Station, Tx. 169 pp.

Ilse, L.M. and E.C. Hellgren. 1995. Resource partitioning by sympatric populations of collared peccaries and feral hogs in southern Texas. Journal of Mammalogy 76:993-1002

Kroll, J. C. 1986. Interspecific competition between feral hogs and white-tailed deer in the Post Oak Savannah Region of Texas. Final Rep., Fed. Aid Proj. W-109-R-8: Job No. 44. Texas Parks and Wildl. Dep., Austin, Tx.

Lucia, D., B. Simpson, and C. Richardson. 1999. Food habits, reproduction, disease and condition of feral hogs in the central Rolling Plains. In print: Wildlife Research Highlights: vol. 4. Texas Parks and Wildlife Department. Austin, TX.

Matschke, G.H. 1965. Predation by European wild hogs on dummy nests of ground dwelling birds. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 19:154-156.

McMahan, C. A., and J. M. Inglis. 1977. Deer show their preference. Texas Parks and Wildl. 35(7):26-29.

Scott, C. D., and M. R. Pelton. 1975. Seasonal food habits of the European wild hog in the Great Smoky Mountains National Park. Proc. Ann. Conf. S. E. Assoc. Fish and Wildl. Agencies 29:585-593

Springer, M. D. 1977. Ecological and economic aspects of wild hogs in Texas. Pages 37-46 in G. W. Wood, ed. Research and management of wild hog population. The Belle W. Baruch For. Sci. Inst., Clemson Univ., Georgetown, S.C.

Taylor, R. 1993. History and distribution of feral hogs in Texas. in C. W. Hanselka and J. F. Cadenhead, eds., Proceedings--Feral Swine: A compendium for resource managers. Texas Agricultural Extension Service, Texas A&M Univ., College Station, Tx. 169 pp.

--------- and Hellgren, E. 1997. Diet of Feral Hogs in the Western South Texas Plains. The Southwestern Naturalist 42(1): 33-39

Tolleson, D., D. Rollins, W. Pinchak, M. Ivy, and A. Hierman. 1993. Impact of feral hogs on ground-nesting gamebirds. Pp. 76-83 in Proceedings—Feral Swine: a compendium for resource managers. C.W. Hanselka and J. F. Cadenhead, eds. Texas Agricultural Extension Service, Texas A&M University, College Station, TX.

Wood, G. W., and D. N. Roark. 1980. Food habits of feral hogs in coastal South Carolina. J. Wildl. Manage. 44:506-511.

Reproduction of Feral Swine

Eric Hellgren, PhD
Assistant Professor
Department of Zoology
Oklahoma State University, Stillwater, OK

As a group, the Suidae (or pigs) have the highest reproductive rate of any ungulate family. Its potential reproductive rate is the highest of any ungulate, but data on reproductive rates of feral pigs are limited. Allometrically, suids have large litter sizes, short gestation periods, and early sexual maturity for their body mass. These characteristics have been magnified by animal scientists into breeds of domestic pigs (Sus scrofa domesticus) that produce litters of >12 young. Feral pigs are free-ranging swine of varied domestic origin that retain these r-selected traits. For example, average litter sizes of feral pigs in several states and countries range from 4.8 to 7.4 for adults. These values compare with litter sizes of 4.5--6.3 for Eurasian wild boar, which represent the original genetic stock for domestic swine.

Reproduction of feral swine was studied in two regions of southern Texas: the Gulf Coast Prairies and the western South Texas Plains. Pregnancy rates of adults (>21 months) ranged from 78% during winter (December--February) in the Gulf Coast Prairie to 6% in summer (June--August) in the western study area. Fetal litter sizes in adults tended to be greater ($P = 0.11$) than those of yearlings. Litter frequency was estimated to be 1.22 for all swine >1 year in age and 1.57 for adult swine (>21 months of age). Fecundity ranged from 1.1 female young / year for juvenile females to 4.5 female young / year in adult females. Sex ratio of fetuses ($n = 298$) was male-biased ($P < 0.05$) when data from both study areas were combined. Two seasonal peaks of births were observed (January--March and June--July). Fecundity of pigs in southern Texas was more than four times higher than native ungulates, raising serious questions about dynamics of the ungulate community in this region.

Determination of litter frequency may be the most difficult parameter to estimate in feral swine because of their capability to breed year-round. Although animals were collected in all seasons in the western South Texas Plains, sample sizes were adequate for inclusion in the calculation of litter frequency during only 7 months. If pregnancy rates were dramatically different during the other 5 months, the above estimates would be biased. Although capable of two litters per year, feral pigs generally produce only one litter per year. Double litters may increase when nutritious forage is available year round or if entire litters are lost soon after birth .

High productivity of pigs relative to other ungulates in the region is of ecological, conservation, and management interest. Feral pigs in southern Texas may compete with native ungulates, fill an empty niche, or use a new niche created by changes in land-use patterns. Data on demography and resource use are needed to address these concerns. Annual gross fecundity in collared peccaries (Tayassu tajacu), an ecologically-similar species, was estimated to be 1.0 female young/female in the same habitat. White-tailed deer (Odocoileus virginianus) in the region only produce one litter per year, litter size averages 1.8, and fecundity is <1.0 . Relative to native ungulates, the four-fold higher reproductive output of feral pigs could affect ungulate community structure in southern Texas. However, reproductive data alone provide an incomplete view. More information is needed on survival rates of cohorts of feral pigs, especially juveniles and adult females. Without simultaneous estimates of survival and reproductive rates or repeated population estimates, population growth rates for feral pigs cannot be calculated.

Taylor, R. B., E. C. Hellgren, T. M. Gabor, and L. M. Ilse. 1998. Reproduction of feral pigs in southern Texas. Journal of Mammalogy 79:1325-1331.

PRV in Feral Swine on Ossabaw Island Georgia: Options for Control or Eradication.

David E. Stallknecht, PhD
Associate Research Scientist
Southeastern Cooperative Wildlife Disease Study
College of Veterinary Medicine
University of Georgia, Athens, GA

Ossabaw Island is a 12,000 ha barrier island located off of the Georgia coast and is currently managed by the Georgia Department of Natural Resources (DNR). About half of the Island consists of salt marsh habitats while the remainder includes pine, mixed hardwood, and maritime forest habitats. The Island has and continues to support a dense feral swine population. Prior to the mid 1980's, the population was estimated at 6,000. During the early 1990's, this was reduced to approximately 2,000 animals. As with many other feral swine populations in the Southeast, annual reproduction is mast (acorn) dependent, and reproductive success during a given year can be extremely variable. Up until the mid 1980's the population was controlled by trapping and removal. At present it is controlled by sport-hunting and year round shooting by DNR personnel. The origin of these animals is uncertain and it has been suggested that they were either introduced by the colonial Spanish or that they were established following the collapse of Barrier Island agriculture during the later 19th century. Regardless of source, this population has not been entirely closed and in recent history additions of a limited number of domestic swine have taken place.

PRV was initially detected by serologic testing of this herd in 1978 during a comprehensive survey of feral swine conducted by the Southeastern Cooperative Wildlife Disease Study (SCWDS) throughout the United States. This herd is Brucella free. In the early 1990's, we initiated a large-scale mark-recapture study of this population to determine the epidemiology of PRV as part of a simulated vaccine trial. Results indicated that the prevalence of seropositive animals was associated with the older age-classes especially the reproductively-mature age classes (greater than 1yr-old). This suggested that transmission was reproductive-dependent and this was subsequently confirmed by researchers at the University of Florida when PRV was routinely isolated from reproductive swabs. We have subsequently field tested this hypothesis on

Ossabaw by incorporating virus isolation into our mark-recapture studies. To date, 6 isolations have been made (5 boars, and 1 sow) from reproductive swabs collected from approximately 600 adult (unstressed) animals. No virus isolations were made from nasal swabs collected from these same animals. All of the boars were seropositive as tested by latex agglutination. The virus-isolation positive sow tested negative by latex agglutination. Currently, both field and experimental (UFL) data suggests that this virus is transmitted through sexual contact and essentially PRV represents a venereal disease of wild swine. In addition, there are no reports and no evidence from any field studies to date that PRV causes any disease in naturally affected feral/wild swine suggesting that this is a near perfect host/virus relationship. Although there is some PCR-based evidence that pigs may be infected early in life, our serologic data suggests that transmission (as detected by seroconversion) does not occur prior to reproductive age. More information, however, is needed to determine the significance of these PCR positive pigs.

There are three components in the epidemiology of PRV in feral swine that are important in evaluating potential control and eradication strategies. The first involves the establishment of latent infections. The second is venereal transmission, and the third relates to the populations dynamics of these herds, specifically their high reproductive potential.

What are the control and eradication options?

This discussion will be limited to established PRV-infected feral swine populations such as exists on Ossabaw Island. For this discussion, the objective of control options are to reduce or eliminate the potential for PRV transmission from wild to domestic populations. For eradication, the objective is to eliminate feral swine or PRV from these populations.

CONTROL OPTIONS ARE AS FOLLOWS:

1. Decrease the population or manipulate population structure
2. Decrease number of infected animals
3. Eliminate all contact with domestic swine

ERADICATION OPTIONS ARE AS FOLLOWS:

1. Elimination the host population
2. Eliminate PRV from the host population

What would these strategies need for success and what information and technology are required?

It is logical to assume that a population reduction will reduce the potential for these animals to come into contact with domestic swine. However, it currently is unknown if the transmission of PRV in a feral swine population is density dependent. With latent infections , a high prevalence of infection, and venereal transmission, even extreme population reductions may fail to eliminate or reduce the prevalence of infection in the herd. Currently, most feral swine removals are related to sport-hunting, professional trapping and hunting, and more recently to the marketing of “wild boar” meat. Effective and safe oral contraception technology currently is not available and should not be considered as an option at this time. Ecological manipulations have a potential to reduce the carrying capacity of an area or to reduce cover and provide greater harvest potential. However, due to cost and potential negative impacts to other species, such large-scale habitat manipulations are difficult to justify. The pertinent question for a population reduction strategy is: Is the management effort removing more animals than the population is capable of replacing in a given year through reproduction? This cannot be ascertained by a simple body count and due to annual variation in reproduction this also cannot be determine in a short-term field study. The second major consideration, especially related to sport-hunting and development of markets is: Do these management tools actually promote an increased demand (create a value) for these animals? If so, there may be little incentive to reduce a population and in fact the problem may become worse. On Ossabaw Island the DNR recently has allowed the harvest of swine during managed deer hunts and has established several hunts specifically for feral swine. It will be interesting to see if these “recreational” opportunities become something the hunting public expects and demands to be maintained.

Reducing the prevalence of PRV in a population of feral swine might be achieved by vaccination (reducing susceptibility or viral shedding) or culling of infected animals or older age classes (removal of known seropositive animals or a disproportionate removal of those age classes with the highest prevalence of infection). Vaccination has been suggested as both a control and eradication tool. Our work on Ossabaw Island, however, suggests that vaccination is an ineffective method for reducing PRV transmission. To be effective, a vaccine must have the ability to be administered by the oral route and have a high efficacy as defined by its ability to prevent infection not disease. Although oral baiting trials conducted on Ossabaw suggests that a vaccine could be orally delivered to a large proportion of a feral swine population, it must be understood that other non-target species will be exposed during such a delivery and the susceptibility of these non-target species to the vaccine also must be considered. As with contraception, such a vaccine currently is not available and when available will require extensive long-term field tests. Another consideration to vaccination is cost. If elected as a control option it must be understood that annual reproduction and the resulting influx of susceptible animals will require continued (and perhaps never ending) vaccination requirements. Culling, that is the removal of infected animals also would require continued efforts to counteract the effects of population recruitment, and such intensive management would be impractical on a large scale. A population removal directed at the older age classes would be practical through sport hunting and in fact probably takes place naturally with hunters selecting the larger “trophy” animals. However, with pigs reaching sexual maturity within a year any effects would be short-term. On Ossabaw, increased removals of feral swine have changed the age-class structure of this herd and appear to have reduced the prevalence of PRV in this herd.

The only method of PRV control which is currently proven and available is the absolute separation of feral and domestic swine at both the farm and market level. The successes achieved in PRV eradication throughout the Southeast, where PRV infected feral swine populations are common, attests to the effectiveness of this approach. However, if such a control strategy is accepted, continued surveillance of domestic herds must continue to assure that these barriers are maintained. This may require some additional work to understand: how these viruses would be transmitted and spread if introduced into a domestic herd, how easily they would be to detect in domestic animals, and finally the technology and resources to truly identify feral swine as a source of such an outbreak.

Eradication of feral swine or of PRV within these populations is the obvious choice to prevent all risks of subsequent infection of domestic swine. These are also the most difficult and at the national level are probably not achievable. Progress might be possible at a very local level or as with the case of a closed population such as Ossabaw Island. There are no reliable estimates of what the eradication of an established feral swine population would cost and there are few if any success stories to tell. As for eradication of PRV in these herds, vaccination has been the only proposed option to date and such a vaccine currently is not available. Even if available, the cost might be prohibitive on a large-scale. An important consideration in any population or PRV eradication should be the potential for reintroduction. It is obvious from the recent spread of these populations that many uncontrolled and in many cases illegal translocations are taking place. Such an introduction in the wake of successful eradication attempts (either directed at the host or the virus) could negate all of the investment in these efforts overnight. During the last 5-10 years, such swine translocations have resulted in the establishment of populations on several of the Georgia barrier islands. It is unknown if these translocations also resulted in the introduction of PRV and brucellosis. Such a possibility would and should be considered before investing the large sums of money that would be needed in an eradication attempt on a population as exists on Ossabaw.

In conclusion, none of the options currently available for the control or eradication of PRV in feral swine populations are without costs or risks. In addition, with the exception of feral swine/domestic swine separation, most of these strategies are untried on a large scale or the needed technology currently does not exist. All of these options will be expensive to develop, test, implement, and perhaps an attempt to estimate the cost/benefit associated with a given control or eradication strategy might provide us with some badly needed direction.

Pseudorabies Virus in Feral Swine: A Research Update

Carlos H. Romero, PhD and Paul N. Meade
Department of Pathobiology, College of Veterinary Medicine
University of Florida, Gainesville, FL

Research on feral swine, in an effort to define their role as a potential source of bacterial and viral infections for domestic swine herds in this country, has been intensified over the past ten years. The National Pseudorabies Eradication Program, that aims to eliminate pseudorabies virus (PRV) from all domestic swine herds by the end of the year 2000, has given further impetus to the study of the biology and transmission of PRV in feral and domestic swine.

Initial studies concentrated on determining whether free-ranging populations of feral swine possessed PRV antibodies, as evidence of natural infection with this virus. The results of sero-epidemiological studies performed in several states indicated that the "National Feral Swine Herd" was indeed infected with PRV and that the rates of infection varied with the locality, the season during which the samples were collected, and the age of the population at sampling.

Early virus isolation attempts by various groups were fruitless, most probably prejudiced by the fact that in domestic swine PRV infection is mainly spread through the respiratory route. The serendipitous isolation of the first PRV isolate from the vaginal swab of an antibody-negative feral sow, provided the first clue that indigenous feral swine PRV might employ a mode of transmission different from that seen in domestic pigs. A series of commingling experiments, in which naturally PRV-infected feral boars and sows transmitted PRV to both feral and domestic pigs of the opposite sex but not to those of the same sex, showed this to be the case. Thus venereal, and not respiratory transmission, appears to be the principal mode of natural transmission of feral swine PRV. Since PRV arrived in this country almost half a millenium ago in pigs brought by Spanish explorers, the free-ranging populations of feral swine have not been subjected to the same stresses and pressures (genetic, nutritional, immunological, and etc.) as their domestic cousins. As a result, the venereal transmission and tissue tropism of the virus have most probably remained unaltered in this species. However, infection of domestic swine with the PRV indigenous to feral swine can be established experimentally by the intranasal instillation of as little as 100 TCID50. Under the conditions in these experiments, domestic swine were infected with feral swine PRV by a mode of transmission other than venereal.

Recent experiments have shown that the pathogenicity and invasiveness of feral swine PRV in domestic pigs is limited or markedly reduced, even in piglets as young as ten weeks of age. Experimentally infected domestic pigs older than 10-weeks-of-age gain weight as rapidly as uninfected controls and show no clinical signs related to PRV infection. Additional studies in this area are still needed, in order to define the parameters for pregnant sows and very young piglets.

Molecular studies, aimed at isolating and cloning immunogenic glycoprotein genes of feral swine PRV, have been initiated. To this end, the glycoproteins B (gB), C (gC) and D (gD) have been engineered, cloned, and shown to be functional by the electroporation of Cos-7 cells. Utilizing bacterial or viral vectors, these genes could serve as the basis for the development of recombinant vaccines to raise the levels of feral swine herd immunity and reduce the transmission of PRV among feral swine.

The existence of free-ranging PRV antibody-positive feral swine can certainly be seen as a threat to the National Pseudorabies Eradication Program. However, because these viruses are spread mainly by a manner different from those of domestic pigs, being largely transmitted in nature through mating, a few precautions can be taken. The employment of a double fence policy, along with a ban on the introduction of feral swine into domestic swine herds, may be sufficient to prevent the infection of pseudorabies-free domestic swine herds with feral swine PRV.

Research on PRV in Feral Swine: Past, Present and Future Directions

Ned Hahn, PhD, Chris Hsu, Brian Paszkiet
College of Veterinary Medicine
University of Illinois at Urbana-Champaign

In this presentation, I want to update you on some of our recent studies with pseudorabies virus (PRV) and feral swine. Work over a number of years, in collaboration with researchers at the University of Florida and the University of Georgia, has studied the modes of transmission of the virus in feral swine and characterized virus isolates from wild pigs. We have shown that the virus in the latent state is difficult to reactivate, but that transmission by acute infection can be achieved when virus is shed from oral/nasal infection or after venereal infection. Cannibalism of acutely infected tissues will transmit infection, but not ingestion of tissues from latently infected pigs. We have been biologically characterizing isolates, showing the attenuated nature of these viruses by comparing isolates from wild swine with the more virulent domestic strains. In this report, I will describe our recent studies of virus from feral swine in terms of their genetic and molecular characteristics, using newer techniques to define viral markers at the molecular level in situations where infectious virus cannot be isolated.

Our recent objectives have been to characterize molecular markers for several virus isolates from wild (or feral) swine so that these can be used for molecular epidemiology. This will provide proof that suspected transmission from feral to domestic swine has actually occurred. Up until now, no one has really shown that virus from a feral population has been transmitted to a domestic herd by actually typing that virus. Transmission from feral swine has often just been assumed when no better explanation is forthcoming. By improving the ability to detect wild type as well as vaccine strains at the end of the eradication program, we are trying also to establish the molecular methods to differentiate what is vaccine virus and what is feral pig derived or wild-type domestic virus. The challenge is to detect the virus without having to isolate the virus in an infectious form. We do this by sequencing the gene for gC, the major immunodominant glycoprotein of the virus, using viral DNA that is amplified by polymerase chain reaction (PCR). We have derived methods to differentiate wild type virus infection from vaccination by PCR detection of the gene for gC (or gIII as it used to be called). The gene for gE (gI) is used as a marker for recombinant vaccines, being absent in pigs that are only infected with vaccine. We are also looking at the consequences of potential recombination between feral swine virus and vaccine virus. These investigations were prompted by other studies supported by the USDA, where we have been able to show a fairly remarkable presence of pseudorabies in a number of different wildlife species that live outside of heavily vaccinated farms in Illinois.

The first study is some collaborative results that we have been doing with David Stalkneckt at the University of Georgia using some of their material from Ossabaw Island. In a number of different published studies (Pirtle et al., 1989; van der Leek et al., 1993), including some from Ossabaw Island, prevalence of anti-PRV antibody has been shown to increase with age. In addition to looking for changes in serology, we also took tonsils and used our very sensitive PCR technology to look for viral DNA in tonsils from these very same pigs. Figure 1 shows the sensitivity of the PCR system compared to various serological assays.

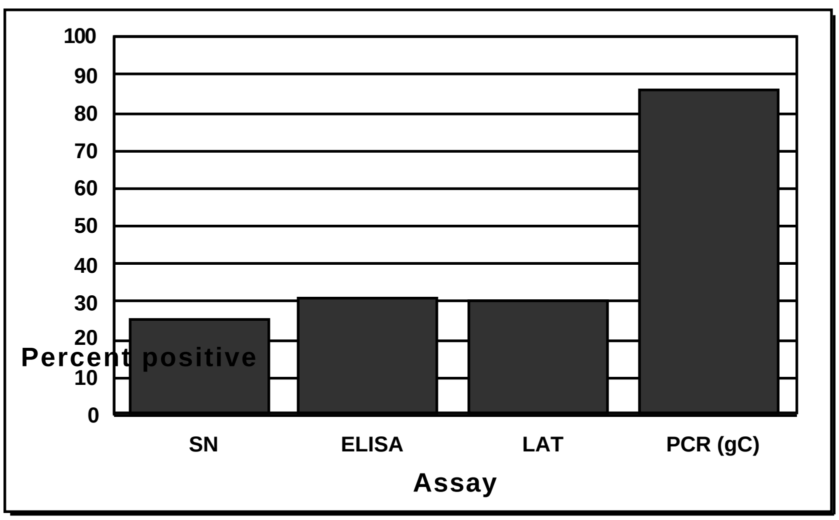


Figure 1. Prevalence of PRV infection detected by serological methods and PCR for gC. Sera were tested for PRV by conventional serology and for viral DNA by PCR using primers within the gene for gC.

When we compared the frequency of detected infections for the feral swine samples grouped by age, we got some surprising results. Detection of infection by PCR did not vary with age. The age distribution of the prevalence of PCR-detected viral DNA and the age-dependency of anti-PRV antibody are shown in Figure 2.

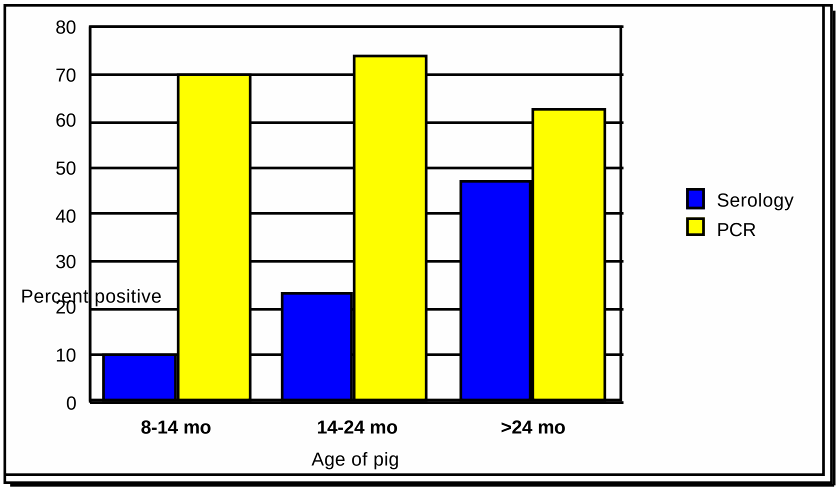


Figure 2. Age distributions of PRV in wild swine detected by serology and PCR. Viral DNA was amplified from samples of tonsils. Results of the PCR-based detection method were compared with serology for individual feral pigs.

In this experiment, the seroprevalence was low in young feral pigs and increased with age, however, the frequency of infected pigs detected by PCR was constant at about 70% regardless of the age of the pigs. Repeatedly, in other studies we have always found that if a population is infected, we can find many more pigs that have viral DNA in them than pigs that have detectable antibody as measured by either the latex agglutination test or by other serological methods. Samples from herds that have no history or evidence of infection have been negative for viral DNA. So, we feel that the PCR technology is sensitive enough to pick up the virus in infected animals, even though there may not be detectable levels of antibody. We must, however, question why wild pigs are infected with these feral strains of virus without detectable antibody and what is the significance of this?

This is not the only time that we have found high prevalence of viral DNA in endemic populations of feral swine. We have done similar experiments in Texas a couple of times, and we have done this with pig material, provided by Jay Levenstein's team, from captured wild swine originating in Florida, and then moved to Texas to the slaughterhouse. The frequency of infected pigs that were positive by PCR was twice that of those detected by serology. In addition, we found several seronegative animals that seroconverted in transit. We believe that this indicates that there are seronegative animals that do harbor virus that can reactivate under stressful conditions.

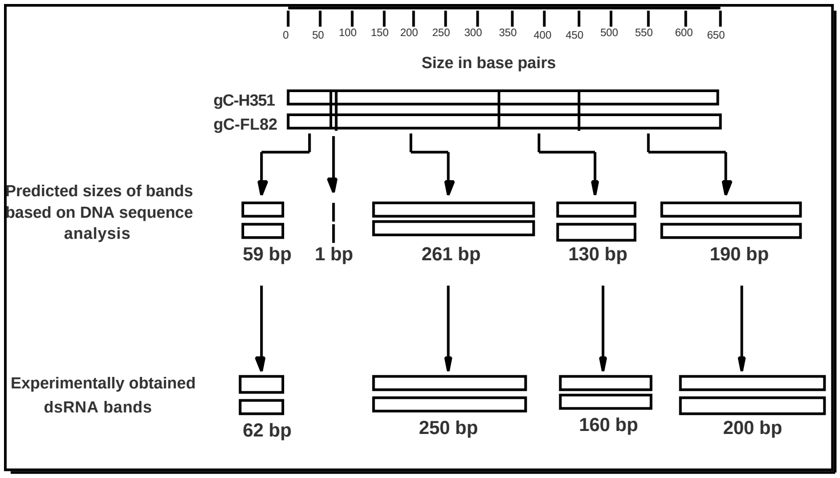


Figure 3. Comparison of gC from two strains of PRV using NIRCA and DNA sequencing.

Molecular comparison of viral isolates is possible in two ways. If the virus is isolated and replicating, it is possible to do a restriction fragment length analysis of the entire genome. With PCR technology, it is often possible to amplify viral DNA, even if the virus cannot be reactivated. Our approach is to look at the molecular level and actually compare the pattern of single base pair changes within a gene as a way to mark and follow particular viral genotypes.

Figure 3 is an example of a comparison of two ways to uncover the microheterogeneity within the gene. The gene for gC was completely sequenced for two virus strains and the location of basepair differences was determined. These differences were used to predict the fragments that would result from cleavage at the points of mismatch. An easier method is based on a nonisotopic RNA cleavage assay (NIRCA), in which amplified gC DNA is used to synthesize RNA. The RNA from different strains is annealed. Where it does not match, the hybrid RNA can be cleaved. We use enzymes that cleave the RNA at these places of mismatch so we can detect exactly where single base pair changes are located and use that as a molecular marker. Figure 3 shows the predicted areas where you would see mismatches according to sequence corresponding with the cleavage sites found in the NIRCA.

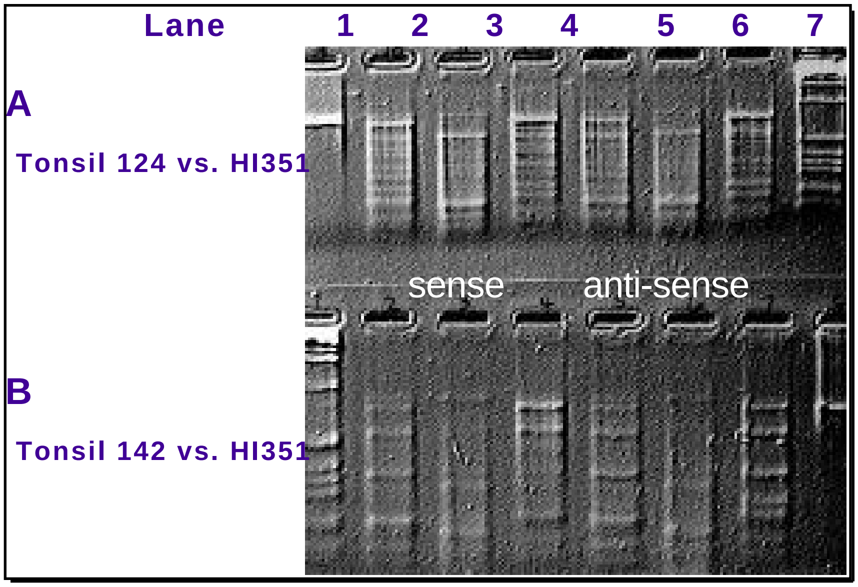


Figure 4. NIRCA comparing two feral pig PRV PCR products. DNA was extracted from tonsils, amplified by PCR and assayed by hybridization and cleavage to a transcribed RNA from a third PCR product from a viral isolate. Lane A1 & B8: undigested hybrid; A8 and B1: MW stds.

Figure 4 is an actual picture of one of these RNA cleavage patterns. Shown on these gels are the fragments caused by digestion of the RNA copies at those sites where there are mismatches. So, without having to sequence the entire gene and wait a week or two to get the results, we can determine at how many places the two strains are the same and how many places they are different with the NIRCA in a couple of days. We have looked at about 25 feral pig isolates and about 50 domestic pig isolates, so that we are beginning to know where the sites of variation are in the gene for glycoprotein C.

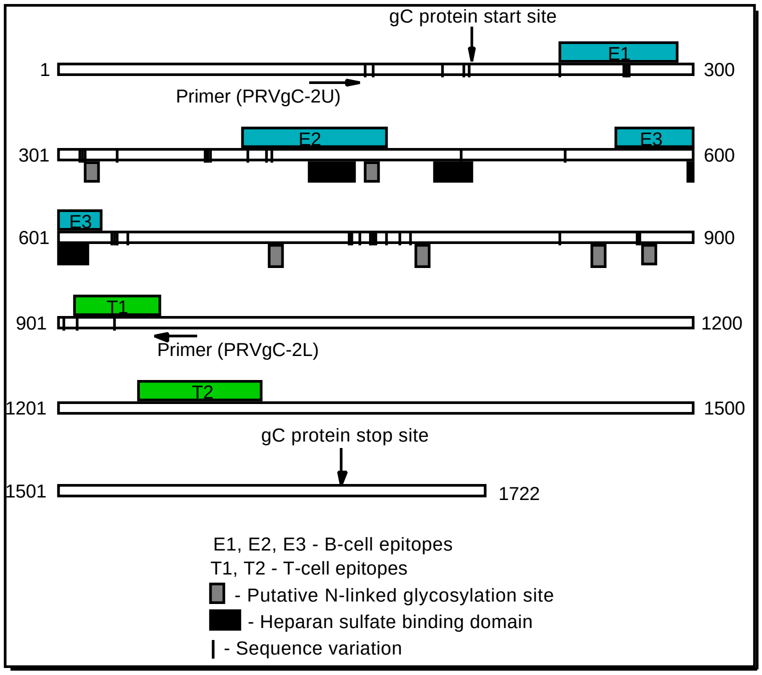


Figure 5. Location of mutation in gC. Base pair changes are indicated as vertical lines on the genetic map of the gene. Various features are indicated. Each mutation represents an area of mismatch among the glycoprotein genes of several PRV strains.

Figure 5 is a cartoon of the entire gene for gC. Areas include receptor domains where the viral glycoprotein binds to the heparan sulfate cellular receptor. Also shown are the B-cell and T-cell domains as determined by Ober et al. (1998). These are the antigenic sites of the virus where antibodies and cellular immune reactions direct attack on the glycoprotein. Each vertical line indicates a mutational deviation from the consensus sequence. Many of the mismatches cluster together. One large cluster is in the middle of the B-cell epitope E1. Another cluster is just downstream of E3. These mutations probably arose as a cluster because they are areas of the molecule where antibody pressure by the host is selecting for particular viral mutants. One cluster of mutations at around 740 seems to be far from an epitope. These may influence immunogenicity by causing conformational folding of the molecule. With only one exception, these base-pair changes never occurred inside the receptor regions of the virus. These protected areas must involve the virus' conservation of the receptor conformation.

With the described molecular techniques, it is now possible to characterize and distinguish virus from feral swine and obtain this information regardless of whether virus can be isolated. It is also clear that the virus is capable of changing; this has consequences both for detection of virus in feral swine and also implies that development of vaccine resistance is possible.

Another feature of the feral swine viruses concerns their potential for recombination. We have been asking the question of whether these viruses of feral origin can recombine with domestic virus or with vaccines. This is significant because one proposed strategy for control of PRV in wild swine is through introduction of vaccines into wild species.

We have been studying vaccine excape into wildlife, outside of farms in Illinois. Our focus has been to look at wild mice, *Peromyscus* and *Mus*, raccoons and other animals, where we are finding anti-PRV antibody and viral DNA by PCR. Because of the apparent spill over of virus into wildlife, we have examined wild mice as a reservoir where recombination might occur. We have infected wild mice with strains of virus and characterized the recombinants for loss of markers, changes in virulence, loss of vaccine characteristics, and so on. Results in Table 1 indicate the recombinants found between Norden vaccine, which has a gE deletion marker, and Florida 81, which is missing a restriction site. *s* and *Mus* mice.

Table 1

Recombination with loss of vaccine marker

Co-Infection	Number of recombinants	Number with WT pattern
in vitro	38	5
IP Peromyscus	12	0
IP Mus	25	0
IC Peromyscus	13	0
IC Mus	25	3

Number of recombinants with *BamH* I patterns that resembled a wildtype pattern. Two marker strains were co-infected in vitro or into wild mice by intraperitoneal (IP) route or intracerebrally (IC).

The position of the markers in the genetic map of PRV is shown in Figure 6. We have infected cells in cultures and have gotten recombinant viruses that look like wildtype and those that are double markers which means that they look both like a vaccine and like a feral strain. A similar spectrum of recombinants resulted from co-infections, intracerebrally (IC) and intraperitoneally (IP), in *Peromyscu*

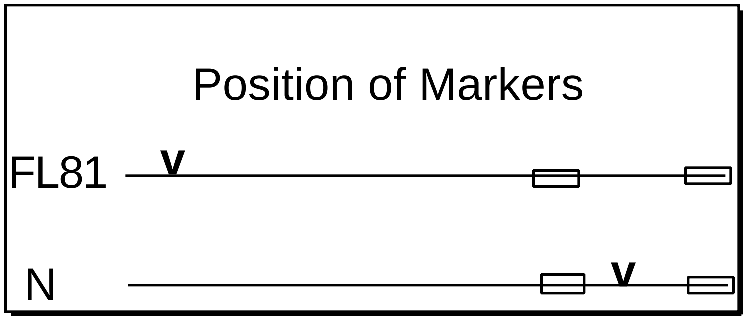


Figure 6. Position of genetic markers used for recombination studies.

Recombinants also have been characterized in terms of virulence. A number of costly pig virulence studies have shown previously that the virus isolates from feral pigs are quite attenuated compared to domestic pigs, often to the extent of being asymptomatic. Pig experiments are costly, so we have shifted to using a chick virulence assay (Mettenleiter et al., 1988). This assay mimics the relative virulence in the pig system by using a much cheaper and much more rapid system.

Table 2

Chick virulence assay

Virus	LD_{50}
FL81	8,912
Norden	2.3
IC1-2	112

Day-old chicks were inoculated intracerebrally with dilutions of each strain, with 5 chicks per group. Chicks were observed three times daily for disease. Endpoints were calculated by the method of Reed and Muench.

Table 2 shows a comparison of the two original parental strains, Florida 81, which is a feral isolate, the Norden vaccine strain, and a recombinant, IC1-2. On the right is shown the LD_{50}, determined in chicks. The Florida 81 virus, compared to the Norden vaccine strain, required considerably more infectious virus to kill a chick than the vaccine strain. The feral strain was over 1,000 times more attenuated than the parental Norden vaccine. That is a rather high degree of attenuation. However, when we looked at the recombinant, the LD_{50} was 112, an 80-fold increase in virulence after this recombination event.

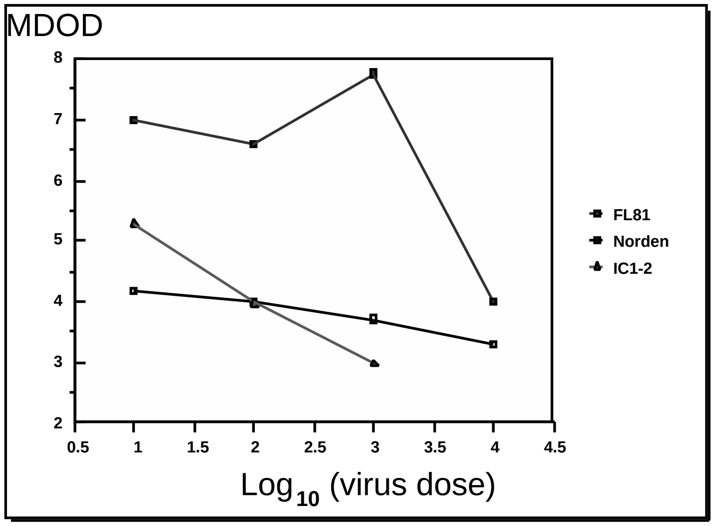


Figure 7. Mean day of death at different doses of virus. The MDOD was determined for the two parental strains and the recombinant.

Another way of quantifying relative virulence is by measuring the mean day of death (MDOD). In Figure 7, the MDOD is plotted for various doses of the parental and recombinant strains. It would appear that the recombinant strain has acquired increased virulence from the vaccine at the same time that it picked up the markers that make it look either like a vaccine or not like a vaccine.

We also wanted to know whether the recombinants that resembled vaccine really did have the appropriate missing gE (gI) gene. PCR for gE was performed on isolates obtained from the chicken virulence assays. In Lanes 2 and 3 are Norden vaccine which lacks the gene for gE, but in the recombinant, which is in Lane 4, presence of the gene for gE is noted, as in the wildtype (lane 5). The recombinant, with increased in virulence, has picked up the gene for gE.

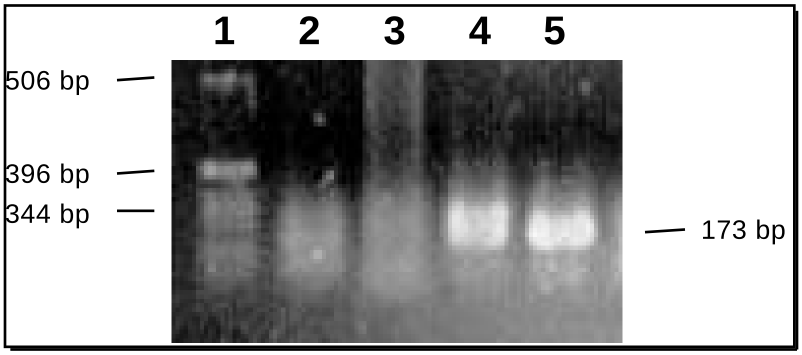


Figure 8. Presence of gE in the wildtype/vaccine recombinant. The recombinant strain was probed with labeled DNA for a portion of the gene for gE. Lane 1, MW standard; 2 & 3, Norden; 4, IC1-2 recombinant; 5, FL81.

I think these data are indicating that there are many wild swine that are infected with PRV but go undetected because we can detect, by PCR, viral DNA in seronegative pigs. I think this is a consequence of the extreme attenuation of the virus where the virus is able to sneak in and not cause a lot in the way of an immune response. In a situation where you have high levels of maternal antibody, I think the virus can infect the piglets in spite of passive immunity but not induce a renewed immune response until the virus reactivates during sexual maturity or some other type of stress. I also believe that we may have to consider that all wild pigs may be infected with PRV, at least in endemically infected populations. We have looked at populations of pigs that have no evidence of PRV infection and never found any PCR-positive results in those animals, so the assay is working and not detecting false positives. I can assert that we have the established molecular methods to detect and trace, with or without virus isolation, viruses that are moving from one population to another; namely, from feral to domestic pigs or even visa versa.

The other information that we have to consider is the idea that pseudorabies might be a transient disease of wildlife, perhaps not restricted just to pigs. Heavy use of vaccine in Illinois, for example, has resulted in spilling out of virus into wildlife. These animals, infected with these very attenuated viruses, are not necessarily dead-end hosts. Even if they die of virulent infection, diseased or dead animals are always are eaten by another animal. The virus can find its way into wild pigs or into domestic swine. Mice, of course, are running in and out of farms. The important preventive measure against transmission is improved biological control. The consequence of this recombination is that there can be changes in virulence new viruses that look like a vaccine or a vaccine that looks like a wild type genotype, able to maintain itself in a population. So, where do we need to go? I think, as others have said, we need to find other ways to continue the molecular characterization of the persistent feral swine infections. This will enable us to track both frank and silent infections. The other question is have we ever really proven that transmission of virus from wild to domestic pigs has taken place? We have the technology to prove this suspected route of transmission, if someone can provide some virus, even tonsils. We can type it and show that the virus from outside the fence is in the domestic pigs. It is also important to determine the significance of the PCR-positive seronegative swine, because this poses a potential risk for reactivation and spread to domestic animals.

REFERENCES

Corn JL, Swiderek PK, Blackburn BO, Erickson GA, Thiermann AB, Nettles VF. (1986) Survey of selected diseases in wild swine in Texas. J Am Vet Med Assoc 189(9):1029-32.

Firkins LD, Weigel RM, Biehl LG, Hahn EC. (1997) Field trial to evaluate the immunogenicity of pseudorabies virus vaccines with deletions for glycoproteins G and E. American Journal of Veterinary Research 58:976-984.

Hahn EC, Page GR, Hahn PS, Gillis KD, Romero CH, and Gibbs EPJ (1997) Mechanisms of transmission of Aujeszky's disease virus in feral swine in USA. Veterinary Microbiology 55:123-130.

Mettenleiter TC, Schreurs C, Zuckermann F, Ben-Porat T, Kaplan AS. (1998) Role of glycoprotein gIII of pseudorabies virus in virulence. J. Virol. 62:2712-27-17.

Ober BT, Summerfield A, Mattlinger C, Wiesmüller K-H, Jung G, Pfaff E, Saalmüller A, Rziha H-J. (1998) Vaccine-induced, pseudorabies virus-specific, extrathymic $CD4^+CD8^+$ memory T-helper cells in swine. J Virol. 72(6):4866-73.

Pirtle CE, Sacks JM, Nettles VF, Rollor EA 3rd. (1989) Prevalence and transmission of pseudorabies virus in an isolated population of feral swine. J. Wildlife Dis. 25:605-607.

Romero, CH, Meade P, Santagata J, Gillis K, Lollis G, Hahn EC, Gibbs EPJ (1997) Genital infection and transmission of pseudorabies in feral swine. Veterinary Microbiology 55:131-139.

Van der Leek ML, Becker HN, Pirtle, EC, Humphrey P, Adams CL, All BP, Erickson, Belden GA, Frankenberger WB Gibbs, EPJ. (1993) Prevalence of Pseudorabies (Aujesky's Disease) Antibodies in Feral Swine in Florida. J. Wildl. Dis. 29(3):403-409.

Eradication Efforts for Brucellosis and Pseudorabies In a Captive Wild/Feral Swine Herd (Hardscrabble Hunt Lodge)

Clarence J. Wheeler, DVM
Veterinary Medical Officer
USDA-APHIS-VS
Saluda, South Carolina

This project began when a Jersey Dairy was tested for re-certification on August 30, 1993. A cow on the annual test was BAPA+, Card +, and Rivanol 8. The herd was 100% brucellosis Calfhood vaccinated. Because Jerseys sexually mature very young, they occasionally become infected with the Strain 19 vaccine. The assumption was this was a heifer just added to the milking herd and had a vaccine Strain 19 titer or infection. Normally the test charts are quite complete and accurate since the owner's wife keeps the records on test day. However, this year the wife was not there and the ages and identification were not as accurate or complete as in the past.

Contact with the owner and practitioner revealed this cow was not a heifer, but a second calf cow having tested negative the previous year. With this information, it was realized that this cow did not have a Strain 19 related titer.

On September 23, 1993, the titered Jersey cow was retested collecting both serum and individual quarter milk samples (for culture). During this visit the owner stated that David Rainey (Hardscrabble Hunt Lodge) had a pen of captured feral swine in an area adjacent to the dairyman's back pasture where the dry cows were kept. He was concerned because he had seen wild hogs in contact with his cows. The Jersey cow by her nature of being extremely curious and friendly would get in close contact with these swine even though they were in a large field.

With the fact that feral swine did contact the dairy herd, the milk samples were submitted to the Brucellosis Laboratory in Jacksonville, Florida for culture (specifically for *Brucella suis*).

On October 1, 1993, a telephone call from the laboratory confirmed *Brucella suis* in one of the quarter milk samples.

On October 5, 1993, the Jersey cow was branded, tagged with a reactor tag and double tagged with red tissue collection tags and sent to Brown Packing Plant, a federal inspected slaughter plant. The veterinarian at the packing plant was notified when the cow would arrive and that tissues were to be collected. A VS 1-27 was completed with all the above information and sent with the cow.

Tissues were needed to help confirm that we did have *Brucella suis* and that we did not have a dual infection with Brucella abortus also.

To make a long story short, the federal meat inspection service at the plant failed to collect tissues from the cow. If we had not had the one (1) quarter culture positive for *Brucella suis* we would not have had any concrete reason to test the adjoining swine.

If the cow had not been bled for certification purposes we may not have known what we were dealing with. If the cow had been culled without a blood test on the farm, and a slaughter sample collected resulting in a MCI traceback, a complete herd test would have revealed nothing.

Hardscrabble Hunt Lodge is located in the northwestern part of South Carolina in an extensive stretch of woods bordering the Savannah River Valley.

Hardscrabble operates out of 4 sites. The first two sites – The BiLo Barn, and the Lower Field are devoted to breeding and rearing pigs. The next site is the 5-acre holding pen, with a parlor, where the off spring are taken to be raised until they are mature. This is where clients of Hardscrabble pay to select a hog to be hunted. Once a hog is selected, it is taken to the last site, the Hunt Pen, which is 75 acres of woods and under brush in a fenced enclosure. Here the client hunts the animal with legal methods, where he is video-taped stalking and running to and from the quarry until the kill is made.

On October 13, 1993, David Rainey, owner of Hardscrabble Hunt Lodge, was contacted and notified that all of his swine were quarantined and that a test would be required. The question was raised whether the cow had contacted the *Brucella suis* from free roaming feral swine in the area not belonging to David Rainey or from the adjacent pen of captured feral swine.

With Mr. Rainey’s assistance and cooperation a mini task force of state and federal personnel tested and identified all test eligible swine connected with Hardscrabble Hunt Lodge on October 19 and 20, 1993.

Laboratory personnel were also at the farm to test samples for Brucellosis and Pseudorabies as the swine were bled. The samples were tested on the farm so if there were positive reactions the swine could be identified and separated while they were still caught.

A total of 188 swine were tested at three (3) locations. Fifty-three (53) were serological positive to Brucellosis (28%). Fifty-five (55) were serological positive to Pseudorabies (29%). Not necessarily the same swine were both Brucellosis and Pseudorabies positive. However, 30 were both Brucellosis and Pseudorabies positive.

These were feral swine and as such did not fall under the federal guidelines governing Brucellosis as found in the Uniform Methods and Rules. However, the State Veterinarian, Dr. Jones Bryan wanted the serological positive swine to Brucellosis and Pseudorabies depopulated and a program or plan developed and initiated to clean up or totally depopulate the herd.

David Rainey had acquired some Euro-Asian breeding stock and had developed a very desirable feral swine herd. Being feral swine they had no slaughter market value. Since there was *Brucella suis* infection, it would be impossible to find a slaughter plan to kill the swine. No indemnity monies were available for depopulation. We had a herd of feral swine quarantined and infected with *Brucella suis* and PRV with no slaughter value and no indemnity.

Since Mr. Rainey operated a hunting reserve, an agreement was set up for him to dispose of all serological positive swine (BR and PRV) through his hunting reserve (by hunter kill). Mr. Rainey gave his clients a pamphlet concerning Swine Brucellosis and only he and his employees were to field dress the reactors to Brucellosis. Mr. Rainey was made aware of all the ramifications of slaughtering swine that were Brucellosis reactors.

Mr. Rainey ‘s hunting did not really begin until February, after the close of deer season. Due to the large number of sero positives, Dr. Bryan allowed until April 1, 1994 for their depopulations. During this period of depopulation, the known Brucellosis reactors were separated from the negative swine.

South Carolina does not allow the use of PRV vaccine. However, since this was a unique situation dealing with Euro Asian type Feral Swine, and not a commercial domesticated herd, Dr. Bryan allowed the PRV Vaccine to be used as a tool for herd clean up in a research project format. Dr. Tommy Dees, S.E. Regional Swine Epidemiologist, developed a research project and obtained research funds for the Hardscrabble Hunt Lodge Project. Since research funds were not readily available, Syntro Vet Labs generously donated Syntro Vet Marker Gold Pseudo Rabies Virus Vaccine to be used in the project.

On November 16, 1993, all test eligible swine which Mr. Rainey wished to salvage as a nucleus-breeding herd were tested. These swine were separated from all sero positive brucellosis swine and other swine designated to be hunter killed. Thirty (30) head were tested. Two (2) were brucellosis positive which were negative October 19, 1993 on the initial test. This test also included a few swine captured since the October 19, 1993 test. Seven (7) head were PRV positive. Of these 7, 6 were positive on October 19, 1993 and 1 caught since October 19, 1993. At this time, all suckling pigs were given intranasal one half cc PRV vaccine in each nostril and all other swine give 2 cc I.M.

Since the October 19 test several sows had aborted. On the serum from the November 16 test, 6 pooled test of 5 samples each were tested for Leptospirosis. Lepto Brataslava positive at 1:50 in all pools. Lepto pomona positive at l:l600 to l:3200.

It was also observed the herd had a problem with neonated pig death and clinical symptoms of respiratory problems were evident in the young stock.

Thirty-one (31) head in the breeding herd were tested December 15, 1993. There were no brucellosis reactors 6 PRV positive (2 negative November 16, 1993 and 4 positive November 16, 1993).

David Rainey had added several positive PRV sows and boars to the breeding herd for genetic reasons. By using the PRV vaccine we hoped to suppress the shedding of PRV and provide immunity in the negative swine. The positive PRV animals were genetically valuable feral swine and we hoped to obtain negative off spring from them with a minimum or no spread of the PRV before disposing of them.

On December 15, 1993, all swine were vaccinated with Syntro Vets Market Gold PRV Vaccine. Also, a herd health vaccination program was initiated. All sows and boars received parvo and .5 strains of Lepto vaccine (not Lepto Brotislava). The pigs were given a combination of haemophilus, pasteurella, erysipelas and bordetella vaccine. All swine was given an injectable wormer.

At this time the breeding herd was divided into 2 sites, the BiLo Barn and the Farm House. Two (2) miles separated the sites. The positive pseudorabies breeders were all put at one site so as to cut down on exposure. These offspring were then taken to another new area – the Dairy Barn

On February 17, 1994, 34 test eligible swine were retested. No brucellosis reactors and 8 PRV positive (6 of 8 positive December 16, 1993 and the other 2 –this was their first test). All vaccinations were repeated. The owner reported no new abortions and a dramatic improvement in pig mortality. The herds nutritional program was also discussed.

At the Dairy Barn they were either tested negative for breeding purposes or sent to the 5 acre pen for hunter selection. The 5 acre pen was also completely killed out and left vacant for 1 month. This eliminated possibility of a hog constantly circulating the virus through new additions.

Also at this time, Mr. Rainey and his employees had greatly reduced the free feral / wild swine population in the vicinity of Hardscrabble Hunting Lodge by trapping or hunting, helping to eliminate the introduction of re-infection from the outside.

On May 26, 1994, forty (40) head in the breeding herd were retested with no brucellosis reactors five (5) PRV positive (all positive on February 17, 1994). Two (2) mature male feral swine recently captured free roaming in the area tested brucellosis positive, with one (1) negative to PRV and insufficient serum to test the other. These 2 boars never had contact with the breeding herd and were immediately depopulated by hunter kill.

Again the vaccination protocol was carried out. On July 12, 1994, a part of the breeding herd was tested so it could be released to a new site of 100 acres enclosed behind the hunting lodge. Eleven (11) head were tested with no brucellosis reactors and 2 PRV reactors that were previously positive. There were a large number of sucking pigs included in this group. All vaccinations were repeated.

As more negative PRV sows and boars are added to the breeding herd the PRV positive animals are disposed of.

We feel the Syntro Vet Market Gold PRV Vaccine has helped control the PRV along with the frequency of the application.

Mr. Rainey, at this time, noted that his swine were reaching heavier weights and in a much shorter time.

There have been no more Brucellosis reactors since November 16, 1993.

A SUMMARY OF THE TESTING DONE SINCE JULY 12, 1994 IS AS FOLLOWS:

On December 15, 1994	
10 Head at Bi Lo Barn	1 PRV positive
25 Head at Pasture behind Lodge	2 PRV positive –
	1 new positive
20 Head at Farm House	PRV negative
All swine vaccinated and wormed	
On March 30, 1995	
6 Head at Bi Lo Barn	3 PRV positive – previously positive
53 Head at Dairy Barn	PRV negative
5 Head at Farm House	PRV negative
All swine vaccinated and wormed	
On September 26, 1996	
25 Head at Pasture behind Lodge	10 PRV positive
All swine vaccinated and wormed	
All PRV positives are hunter killed as quick as they can be replaced by animals from the Farm House.	
All vaccinations discontinued at the end of 1996.	
On January 30, 1997	
7 Head at Bi Lo Barn	4 PRV positive - (previously positive)

Bi Lo Barn depopulated and now the source of replacement is the Farm House only.	
On February 20, 1997	
11 Head at Farm House	PRV negative
On April 30, 1997	
28 Head at Farm House	PRV negative
On October 24, 1997	
8 Head at Farm House	PRV negative
On June 8, 1998	
12 Head at Farm House	PRV negative
On July 31, 1998	
21 Head at Farm House	1 PRV suspect
(All swine given NOBL-Optivac orally on June 29, 1998)	
On April 30, 1999	
28 Head at Farm House	PRV negative
(All swine given NOBL-Optivac orally on April 9, 1999)	

Because feral swine are extremely difficult to capture and restrain there is a need to develop a vaccine oral delivery system for pseudorabies.

On June 29, 1998 at Hardscrabble Hunt Lodge, the breeding herd at the farm house was given an oral PRV vaccine. Twenty-one (21) swine ranging in size 20 to 300 lbs. were given a mixture of 2 gallons of cracked pecan hulls, 2 gallons of cracked corn and 20 doses of NOBL Laboratories Optivac PRV vaccine mixed in 2 quarts of non-fat dry milk.

On July 31, 1998, the 21 swine were tested. All were negative except for 1 sample which was 1:8 SN.

Again on April 9, 1999, 28 swine at the farm house were given the oral PRV vaccine trial. This time, 1 cup cracked corn per hog (28 cups) was layered in the feed troughs. A layer of cracked pecan hulls, one half cup per hog (14 cups) was layered on top of the cracked corn. Finally, 30 doses of NOBL Labs. Optivac PRV vaccine was mixed with 1 quart of non-fat dry milk and sprinkled on top of the layered cracked corn and cracked pecan hulls.

On April 30, 1999, the 28 swine were tested. All tested negative to the Elisa PRV Test.

Since we got no appreciable titers from the oral vaccine trials, the next trial will consist of giving orally each swine 2 or 3 times as much vaccine instead of just the one dose and administering at 2 to 3 days consecutively.

The epidemiology on the source of David Rainey's infection revealed the following.

On July 16, 1988, 4 sows and 2 boars were tested for interstate movement from David Rainey's. All 6 were brucellosis and PRV negative.

In 1990, an individual in Augusta, GA, who trapped, traded and hunted wild swine had both positive brucellosis and Pseudorabies swine. Some originated from Ossabaw Island off Georgia's coast and the Savannah River Bomb Plant, Aiken, S. C. Both areas area known to have Pseudorabies and Brucellosis. He depopulated the infected swine voluntarily and tested negative 6 months later and was released from quarantine

The Augusta, GA individual at this time (1990) acquired possession of a Euro Asian Boar. David Rainey wanting to improve his genetic base took at least 2 sows to Augusta to be bred to this boar. In exchange David Rainey gave the Augusta man 2 swine for breeding his sows. (Stud Fee)

The 2 sows David had bred in Augusta were brucellosis and Pseudorabies positive on the 1993 test at Hardscrabble. We again tested the Augusta connection in 1994 since the two sows were positive that had been there. The two (2) swine left for stud fee at Augusta were negative in 1994 to brucellosis and PRV when tested in Augusta. Some of the other swine were positive for both BR and PRV at Augusta. The Augusta connection had added swine since his 1990 release which were also positive to brucellosis and PRV.

We also tested in 1994, 4 individuals who had acquired swine from David Rainey in the past. All were brucellosis and PRV negative.

The swine tested in 1988 which were negative were either captured from the wild or exposed to wild captured swine in the Hardscrabble Hunt Lodge area.

It would appear David Rainey's infection originated from the premise in Augusta in 1992 coming from Ossabaw Island and the Savannah River Bomb Plant, Aiken, S. C. Also, the free-roaming swine around Hardscrabble Hunt Lodge were probably negative until he introduced infection into his loosely confined herd in 1992.

ISSUES OF CONCERN CONNECTED WITH THE HARDSCRABBLE INFECTION

1. Feral / wild swine can and do create economic losses for domestic livestock owners. Example – Dairyman lost a valuable cow.
2. Wild / feral swine populations are often infected by man transporting infected swine unknowingly.

3. Brucellosis and PRV can be eliminated and prevented by using vaccines and good management.
4. Because of the difficulty in catching and restraining feral swine, there is the need to develop an oral delivery method for the PRV vaccine that is effective and safe environmentally.
5. Need to reach out to the hunters, traders, trappers, breeders, etc. of wild / feral swine about brucellosis and PRV infections – need their cooperation in preventing new infections.
6. Public health concern in the slaughter dressing of wild / feral swine with brucellosis infections.

Vaccine Delivery Methods for Feral Swine Now and in the Future

Philip H. Elzer, PhD
Associate Professor of Veterinary Science and Veterinary Immunology
Louisiana State University, Baton Rouge, LA

The Louisiana Agricultural Experiment Station's Department of Veterinary Science with the collaborative efforts of Virginia Tech and the USDA is continuing its investigation into novel delivery methods for vaccines for feral swine. The feral swine population continues to pose a problem to brucellosis eradication, especially in the southeastern United States. Today's technological advances in genetic analysis and vaccine development will contribute to the solution of these problems. With the cooperation of local, state, and federal officials and the concerned general public, the goal of eradication should become a reality.

Earlier studies utilizing RB51 have shown the vaccine capable of eliciting partial protection against virulent B. suis challenge. RB51 vaccinates, whether orally via pecans or parenterally exposed, have fewer dead piglets and increased litter size as compared to saline controls. An efficacious vaccine that can be delivered in a practical manner to the feral population will contribute to the reality of a Brucella-free swine population.

Results of three separate experiments with a total of 46 pigs indicate that oral vaccine doses of between 1 x 10^9 colony forming units (CFU) and 1 x 10^{13} CFU of strain RB51 may be sufficient to expose feral pigs to strain RB51 organisms. Oral vaccination resulted in both humoral immune response and short-term colonization of the regional lymph nodes. However, a viscous liquid such as Karo corn syrup in association with pecans which scarify the oral mucosa are necessary when placing the live vaccine directly onto corn or other food rations. This method may allow both an efficient and economical means to vaccinate feral swine for brucellosis.

In conjunction with Louisiana and USDA veterinarians, we have been able to obtain swine herds that have been slated for depopulation due to potential brucella exposures. A majority of these of animals have a mixed genetic background with feral and domestic traits. Therefore, these animals are an excellent model for feral swine vaccination research. These animals have been used in various studies to determine the effects of administration of Brucella abortus and suis rough vaccines (RB51 and VTRS-1).

Specifically in one study, 12 mature barrows and 6 non-gravid sows were orally inoculated a number of times with varying doses of vaccine. The oral inoculum was prepared by mixing the vaccine diluted in PBS with an equal volume of Karo corn syrup and mixing the resulting slurry with whole pecans, pecan shells and corn. It was proposed that the pecans would scarify the oral mucosa while Karo syrup would help insure adherence to the oral mucosa. The 18 pigs were divided into six equal groups of three animals each. Each group received either 1 x 10^{10} or 1 x 10^{9} CFU of strain RB51 either one, two, or three times. At 27 days post-vaccination the animals were euthanized and samples obtained as previously described. Sera was analyzed for strain RB51 specific antibodies by western immunoblot.

All tissue specimens were homogenized in sterile 0.9% NaCl and plated onto Farrell's selective medium containing 5% bovine blood. The plates were incubated for 14 days at 37^{o}C in a 5% CO2 atmosphere. Strain RB51 was identified by the ability to grow on rifampin-containing plates (250 (g / ml), and rough colony morphology. (The mandibular, submandibular, and retropharyngeal lymph nodes from each orally vaccinated pig were ground and plated together as primary lymph nodes while the remaining lymph nodes were combined as secondary lymph nodes. Liver and spleen samples were also cultured for the presence of RB51.

Serum was analyzed for Brucella O-polysaccharide specific antibodies by the card test and western immunoblot. Strain RB51 and Brucella O-polysaccharide specific antibodies were detected by western immunoblot utilizing cell lysates from O-polysaccharide containing B. abortus strain 2308 and O-polysaccharide free rough strain RB51, as described previously.

Instead of the labor-intensive job of placing the vaccine inside whole pecans, the vaccine was mixed with Karo corn syrup and then laid on top of the normal corn feed along with whole and cracked pecans. For the study, two different doses of 1 x 10^{10} and 1 x 10^{9} CFU were used along with one, two or three vaccine exposures. Based on comparisons of western immunoblots, approximately 56% of the animals mount a humoral immune response following vaccination with strain RB51 while an additional 28% were weak positives for strain RB51 antibodies (Table 1). Interestingly, out of the three animals that received 1 x 10^{10} CFU of strain RB51 three times, only one animal (number 142) was a strong positive for anti-RB51 antibodies. In contrast, the six animals that received either 1 x 10^{10} or 1 x 10^{9} CFU of strain RB51 only one time had either strong serologic reactions (67%) or were weakly positive (33%) (Table 1). The vaccine was not cultured from the 18 pigs nor were anti-O-polysaccharide antibodies detected based on western immunoblot.

These studies indicate that oral vaccination of feral swine with strain RB51 should be possible by using a high vaccine dose in association with a viscous media such as Karo syrup and an oral scarification agent like pecan shells.

These studies support our laboratories ongoing cooperative efforts with field trials of this novel vaccine delivery system.

References:

Alton, G.G., Jones, L.M., Angus, R.D., Verger, J.M. (Eds.), 1988. Techniques for the brucellosis laboratory. INRA, Paris.

Alton, G.G., 1990. *Brucella suis*. In: Nielsen, K., Duncan, J.R. (Eds.), Animal Brucellosis. CRC Press, Boca Raton, FL, USA, pp. 411-422.

Cheville, N.F., Olsen, S.C., Jensen, A.E., Stevens, M.G., Palmer, M.V., Florance, A.M., 1996. Effects of age at vaccination on efficacy of Brucella abortus strain RB51 to protect cattle against brucellosis. Am. J. Vet. Res. 57, 153-1156.

Colby, L.A., 1994. The humoral immune response of elk (Cervis elaphus) and mice to vaccination with Brucella abortus strain RB51. Blacksburg, Virginia, USA: Virginia Polytechnic Institute and State University, College of Veterinary Medicine, Thesis (Master Science).

Davis, D.S., 1990. Brucellosis in Wildlife. In: Nielsen, K., Duncan, J.R. (Eds.), Animal Brucellosis. CRC Press, Boca Raton, FL, USA, pp.321-334.

Edmonds, M.D., Schurig, G.G., Samartino, L.E., Hoyt, P.G., Walker, J.V., Hagius, S.D., Elzer, P.H., 1999. Biosafety of Brucella abortus strain RB51 for vaccination of mature bulls and pregnant heifers. Am. J. Vet. Res. (In press).

Elzer, P.H., Edmonds, M.D., Hagius, S.D., Walker, J.V., Gilsdorf, M.J., Davis, D.S., 1998. Safety of Brucella abortus strain RB51 in bison. J. Wild. Dis. 34, 825-829. Elzer, P.H., Enright, F.M., Colby, L., Hagius, S.D., Walker, J.V., Fatemi, M.B., Kopec,

J.D., Beal, V.C., Schurig, G.G., 1998. Protection against infection and abortion induced by virulent challenge exposure after oral vaccination of cattle with Brucella abortus strain RB51. Am. J. Vet. Res. 59, 1575-1578.

Farrell, I.D., 1974. The development of a new selective medium for the isolation of Brucella abortus from contaminated sources. Res. Vet. Sci. 16, 280-286.

Lord, V.R., Cherwonogrodzky, J.W., Schurig, G.G., Lord, R.D., Marcano, M.J., Melendez, G.E., 1998. Venezuelan field trials of vaccines against brucellosis in swine. Am. J. Vet. Res. 59, 546-551.

Palmer, M.V., Olsen, S.C., Cheville, N.F., 1997. Safety and immunogenicity of Brucella abortus strain RB51 vaccine in pregnant cattle. Am. J. Vet. Res. 58, 472-477.

Schurig, G.G., Roop, R.M., Bagchi, T., Boyle, S., Buhrman, D., Sriranganathan, N., 1991. Biological properties of RB51; A stable rough strain of Brucella abortus. Vet. Micro. 28, 171-188.

Stevens, M.G., Olsen, S.C., Palmer, M.V., Pugh, G.W., 1996. Immune responses and resistance to brucellosis in mice vaccinated orally with Brucella abortus RB51. Infect. Immun. 64, 4534-4541.

Winter, A.J., Schurig, G.G., Boyle, S., Sriranganathan, N., Bevins, J., Enright, F.M., Elzer, P.H., Kopec, J., 1996. Protection of BALB/c mice against homologous and heterologous species of Brucella by rough strain vaccines derived from Brucella melitensis and *Brucella suis* biovar 4. Am. J. Vet. Res. 57, 677-683.

Acknowledgments:

USDA/APHIS/VS - Drs. Gilsdorf, Van Tiem, Taft, Ragan, Dees, Robison, and Hollier; Virginia Tech - Drs. Schurig and Boyle; Louisiana - Drs. Lea and Cox; LSU - Drs. Enright, O'Reilly, and Hoyt; Sue Hagius, Joel Walker, William Flahive, Todd Fulton, and Matt Edmonds

Table 1

Detection by western immunoblot of Brucella abortus strain RB51 specific antibodies 27 days following oral vaccination of 18 mature pigs with strain RB51

Animal No.	Dose per Vaccination	No. of Vacc.	Serologic Response a,b,c A B C			Sex A B C		
140-142	1 x 1010 CFU	3 x	-d	-	+	Me	M	M
143-145	1 x 1010 CFU	2 x	-	+/-	+	M	M	M
146-148	1 x 1010 CFU	1 x	+	+	+/-	M	M	M
150, 151, 156	1 x 109 CFU	3 x	+	+	+/-	F	M	M
155, 157, 158	1 x 109 CFU	2 x	+	+/-	+	F	M	F
152-154	1 x 109 CFU	1 x	+	+/-	+	F	F	M

a-Western immunoblot utilizing strain RB51 cell lysate.

b-All animals were negative for O-polysaccharide specific antibodies by both western immunoblot and card test.

c-All animals were culture negative for strain RB51 organisms.

d-+ = Positive detection of strain RB51 specific antibodies, +/- = weak positive, - = negative.

e-M= barrow male, F= sexually mature female.

Brucella suis in Feral Swine

Terry H. Conger, D.V.M.
State Epidemiologist
Texas Animal Health Commission

Edward Young, M.D.
Professor, Baylor College of Medicine

Richard A. Heckmann, Ph.D.
Professor, Brigham Young University

Free-ranging and growing populations of feral swine (Sus scrofa) are present in at least 23 states in this country. Some experts estimate their numbers to be well over two million. In Texas, there are no restrictions on the harvesting of these wild swine since they are considered to be a non-game species by the Texas Parks and Wildlife Department, and they are considered to be a "pest" by the agricultural community. In Europe, however, their meat is savored over that of domestic swine because of the "wild" connotation linked with the meat. Feral swine are known to serve as a reservoir for two diseases, brucellosis and pseudorabies which are economically important to the livestock industry. One of these diseases is also of a significant zoonotic importance to a specific segment of the human population that may be exposed to the infected animals or contaminated carcasses. *Brucella suis*, biovarieties 1 & 3, is highly pathogenic for man, causing a variety of nonspecific clinical signs. The clinical picture that the patient usually presents is a fever of unknown origin and general malaise. Without an adequate history, arriving at a definitive diagnosis becomes very challenging. This study expands on the brucellosis problem in the feral swine of Texas, as well as describes selected human cases.

INTRODUCTION

True, wild swine (of the Class Mammalia, Family Suidae, and Order Artiodactyla) are not native to the Western Hemisphere. Sus scrofa , or feral swine, are the wild-living descendants of domestic swine (Sus scrofa domesticus) that have interbred to a varying extent with the Eurasian wild boar (Sus scrofa spp.), both of which escaped or were released by the Europeans after they immigrated to the New World in early colonial times (Mayer and Brisbin, 1991). Through the process of evolutionary adaptation, they have flourished and multiplied and expanded their domain to where they now have been documented to exist in at least 23 states (Mayer and Brisbin, 1991). Their population is now estimated to be over 2 million (Rollins, 1997). They have become an integral part of the Southern lore. The University of Arkansas in Fayetteville, for instance, even adopted the "razorback hog" as its mascot. They are both revered by those who enjoy the challenge of hunting them (Rollins, 1994) and scorned by the farmers who have to compete with them for a livelihood (Synatke, 1979).

Hogs in Texas are believed to have been initially introduced in 1542 by the Spanish explorer, Hernando DeSoto (Benke, 1973). In the late 1670's, domestic swine were brought north from Mexico by the Spanish missionaries and colonists and allowed to roam freely around their settlements (Towne and Wentworth, 1950). Since 1900, farmers and ranchers in Texas have free-ranged their hogs on large tracts of open range, some of which have reverted to the wild (Springer, 1975). Over the passage of time, the range of wild hogs has expanded considerably in the Lone Star State; they are now reported to exist in 185 (73%) of Texas' 254 counties (Rollins, 1994). Their population is now estimated to be well over one million (Rollins, 1997). Their highest concentration (at a density of ten or more per square mile) are in 40 counties in south and east Texas (Taylor, 1995).

In Texas, even though they are considered to be a non-game species by the Texas Parks and Wildlife Department, there are hundreds of ranch properties that offer the chance to hunt wild hogs. Many charge a fee for this privilege. The revenues from this enterprise vary, depending on the size and quantity of hogs killed. These animals also represent a significant potential source of wild meat. Many are trapped and taken to feral swine holding facilities, and then transported to an abattoir where they are processed for human consumption (Bach and Conner, 1994). When the pork prices bottomed out in the Spring of 1999, the European market for feral swine meat remained stable. Their popularity on the export market is apparently fostered by their "wild" appeal and lower fat / cholesterol content of the meat product (Pate, 1999).

UNIQUE CHARACTERISTICS

Members of the species Sus scrofa are generally defined as any domestic swine that are running free in the wild. However, through the process of natural selection over the years, distinctive anatomical characteristics have evolved which generally define the species. Feral swine skulls are characterized by a longer muzzle and snout and a more shallow dorsal cranium than that of the domestic variety. This adaptation apparently facilitates a greater ability to root in the soil and under logs and rocks in their search for insects larvae, annelids, and tubers. They have developed longer legs and shallower bodies to allow a more rapid movement over land to catch small mammals and avoid danger. Feral swine have a larger range of hair shaft lengths than their domestic counterparts, but they average about the same length. Longer, and light-tipped, hair bristles are a characteristic of feral swine. Domestic swine generally have longer ear and tail lengths, and larger body weights on an age scale (Mayer and Brisbin, 1991, 1994).

Feral swine also have developed behavioral adaptations that enhance their survival in the wild. They are more aggressive when they are threatened by humans and other animals, and have a tendency to attack and devour small livestock. They are more active nocturnally, presumably to keep unwanted encounters with humans to a minimum.

ZOONOTIC DISEASE RISK

Feral and domestic swine are susceptible to a wide variety of infectious and parasitic diseases. Over 25 of those diseases can be transmitted to man (Shapiro, 1999). From a zoonotic disease perspective, probably the most important of these conditions is brucellosis, caused by *Brucella suis* bacteria.

BRUCELLOSIS IN SWINE

Six species of Brucella have been identified, of which *B. suis* biovarieties 1, 2, and 3 are specifically infectious for swine. Brucellosis in swine was first described in Indiana swine herds (Traum, 1914). For several years, it was thought to be a specific pathogenic strain of Brucella abortus, but it was later identified and named as a separate species of Brucellae (Huddleson, 1929).

The distinctive characteristic of *B. suis* on bacteriological culture in contrast to that of B. abortus, is an enhanced CO_2 environment is not required for growth. The colonial morphology is smooth. Isolates from pigs can be presumptively identified as Brucellae on the serological agglutination test with anti-smooth Brucella antibody or monospecific anti-serum. Species and biovariety identification is accomplished by routine typing tests such as the production of hydrogen sulfide (characteristic of biovar 1) and growth in the presence of dyes. All three grow with thionine, but only a few strains of biovar 1, and all strains of biovar 3 grow in the presence of basic fuchsin, and with phage typing techniques(Alton, 1990).

The most common route at which infection enters into a domestic swine herd is when a infected animal (male or female) is added. Other modes of spread involve the communal use of an infected boar, or direct contact with roaming infected feral swine. In contrast to that of Brucella abortus, the disease can be transmitted venereally from an infected boar. The most general route of animal-to-animal transmission is by oral contact with contaminated reproductive products from an infected sow (Alton, 1990).

Brucellosis in swine may be asymptomatic so the owner of an infected swine herd may be unaware of a problem. In the pregnant sow, the most obvious symptom is abortion which may occur at any time during gestation. Early abortion may go unnoticed by the owner so the presumption may be of an infertility rather than an infectious problem. In contrast with the disease in cattle, symptoms may occur that are not related to reproduction such as lameness and swollen joints, and if abscessation puts pressure on the spinal cord in the lumbar region, posterior paresis may also occur (Alton, 1990).

In those pigs that do contract the infection, the pathogenesis is similar to brucellosis infection in other animals. After oral or venereal invasion, the organisms will localize and multiply in regional lymph node(s) for one week to ten days. Then, a bacteremia results which may last as long as 34 weeks (Alton, 1990). The incubation period is the defined as the period of time from exposure to the manifestation of a positive serological test or the development of clinical signs. The incubation period is highly variable, extending from 2 weeks to several months.

An effective vaccine for porcine brucellosis has not been developed, and there is no known cure. The most effective method of eradicating the disease from an infected swine herd is by complete depopulation of all sexually intact animals from the herd. The traditional method of cleaning a herd up has been the "test and slaughter" method which is the process of identifying the infected animals through serological testing, and removing them from the herd. In lieu of depopulation procedures, the criteria for achieving quarantine release are three, consecutive, complete herd negative tests, with the last test conducted at least 150 days from when the last infected animal was removed from the herd (Texas Administrative Code, Title 4, Part II, Chapter 35.46, and USDA's "Uniform Methods and Rules for Swine Brucellosis).

PREVALENCE OF *BRUCELLA SUIS* IN FERAL SWINE

In Hawaii (Nichols, 1962), 24% of 42 feral hogs that were tested displayed serological agglutination titers to *B. suis*. Brucellosis in feral swine was first definitively confirmed by culture isolation of *B. suis* biovar 1 in a South Carolina (Wood, 1976). In that study, 18% of 255 of the feral swine tested were serological reactors as determined by the card, complement fixation, and the rivanol tests. In Florida (Becker, 1978), 95 feral pigs were tested on the card, standard tube, complement fixation, and rivanol tests, and 50 were disclosed as reactors, nine of which *B. suis*, biovar 1 was isolated. In southeastern Texas (Lawhorn, 1984), it was reported that 10.5% (8 out of 76) of the feral swine tested positive for brucellosis. In an eastern Texas privately managed feral swine herd in 1997 (Pate, 1999) six out of 25 (24%) animals tested positive for the disease. In consideration of the aforementioned data, the overall incidence rate of *Brucella suis* in feral swine has not been firmly established, but it can be surmised that it is substantial (from 10 to 25%).

BRUCELLOSIS IN HUMANS

Four brucella species have been documented to affect humans. In decreasing order of virulence, Brucella melitensis (from goats), *B. suis* (from swine and reindeer), B. abortus (from cattle, bison, and elk), and B. canis (from dogs), have been shown to be pathogenic in man. The disease is transmitted to humans through the consumption of contaminated and unpasteurized milk and milk products, and by direct contact with infected animals, animal carcasses, or with contaminated reproductive products. On a global perspective, millions of individuals are at risk of infection, especially in the Third World, where sanitation and hygienic conditions are often not optimal. In the Mediterranean Region, the Middle East, southern Europe, and South America, the infection rate is up to 78 cases per 100,000 in the population. In the United States, brucellosis is primarily a zoonotic disease risk to a small segment of the general population: veterinarians, farmers and ranchers, slaughterhouse workers, laboratory technicians and hunters. (WHO / OMS, 1998).

The incubation period associated with the disease in humans is usually one to three weeks, but it may extend for up to several months. The illness may be mild and self-limiting or severe. It may have either a sudden or insidious onset, and is always accompanied by a continuous, intermittent, or irregular fever. The clinical picture is like any other febrile disease, with a marked effect on the musculoskeletal system as evidenced by generalized aches and pains with the associated fatigue, prostration and mental depression. Without antibiotic treatment, the duration of the infection and / or disease may be indefinite (WHO / OMS, 1998).

BRUCELLA SUIS IN HUMANS

The risk of contracting brucellosis from swine is greater than that from other animals because of the potentially protracted bacteremic phase (of up to 34 weeks) associated with the disease in swine in which all tissues (as opposed to just the lymphatic system, reproductive tract, or lactating glands in other animals) are contaminated with the microorganism. *Brucella suis* biovarieties 1 and 3 are both very pathogenic for man.

In some South American countries, *B. suis* is a major cause of brucellosis in humans (Alton, 1990). In Argentina, for example, during the period from 1965 to 1983, Brucella abortus accounted for 49 cases, B. melitensis, 19 and *B. suis*, 79 (Garcia-Carrillo, C., Turovetzky, & Lucero, 1985). An epidemiological investigation in Florida (Bigler, W.J., G.L. Hoff, W.H. Hemmert, J.A.. Tomas, and H.T. Janowski, 1977) disclosed that 22% (6 out of 27) of the human cases during the 1974-1975 period was attributable to hunter contact with feral swine. In March of 1993, the National Institute for Occupational Safety and Health (NIOSH) investigated the incidence of human brucellosis at a pork processing plant in North Carolina. They found that 19% (30 out of 154 surveyed) of the workers on the kill floor had experienced a signs consistent with the case definition for brucellosis (MMWR, 1994).

In Texas, during the period from 1989 to the third quarter of 1998, the proportion of human brucellosis cases attributed to *B. suis* , (Schuermann, 1999) were:

Year	Total # of Cases	Cases due to B. suis
1989	23	6*
1990	18	0
1991	36	1
1992	27	2
1993	34	0
1994	29	0
1995	19	0
1996	23	1
1997	19	0
1998	10	1
Total	**238**	**11 (or 4.6 %)**

*swine processing plant cases (Schuermann, 1999)

After reviewing this table, it is apparent that there is a significant number of human brucellosis cases attributed to *Brucella suis*, many of which are due to exposure to feral swine.

The typical case of undulant fever (due to *B. suis*) is presented to the general practitioner clinically as an insidious "fever of unknown origin" (FUO). The patient presents a picture of intermittent fever, "night sweats", with general malaise, myalgia and arthralgia. As the case advances into chronicity, complications such as edema of joints, back pain, orchitis, endocarditis, and even a psychotic element due to the toxic effect of the endotoxin on the CNS, may occur (McCullough, 1974,) Generally, a definitive diagnosis is not made, and the patient does not respond to a general regimen of broad spectrum antibiotics. Therefore, at that point, the case is usually referred to an internist.

CASE STUDIES OF HUMAN BRUCELLOSIS DUE TO EXPOSURE TO FERAL SWINE

Without a history of possible exposure to swine, and / or appropriate serological and microbiological assays, a definitive diagnosis cannot be made.

Case #1:

- Feral swine hunter, Liberty City, TX; 22-year-old white male
- Kills and cleans a feral hog, cutting hand in the process
- 3 1/2 weeks later, visits his family physician with complaints of intermittent fever (to as high as 103 degrees F), body aches, and night sweats
- Upon examination, patient exhibits a temp of 101.2 degree F, a palpable spleen; but otherwise normal on physical exam

Clinical Pathology

- pancytopenia (depressed, white blood cell count- - -2,000 / mm^3)
- platelets below normal (140,000 / mm^3)
- mild liver dysfunction (SGOT, 63; SGPT, 191).
- The patient was treated with an antibiotic combination of ampicillin and amoxicillin for several weeks without a perceptible improvement in the clinical picture; then, the antibiotic was changed to augmentin for another week, again without a response. During the period of antibiotic therapy, the patient had lost 20 pounds in body weight, so he was hospitalized;

Upon hospitalization

Serology:

(a) Standard Tube Agglutination (SAT): Positive at 1:640 serum dilution

(b) 2-Mercaptoethanol (2-ME) Test: Positive at 320 serum dilution

Bacteriology:

(a) Three blood cultures, negative

(b) Bone marrow culture yielded *Brucella suis*

The patient was put on the World Health Organization (WHO) recommended regimen of antibiotic therapy (Doxycycline and Rifampin) for 6 weeks.

There has been no known relapse.

Case #2:

- 40-year-old Hispanic male; feral swine hunter in south Texas, kills and cleans a feral hog without gloves, cutting hand in the process
- 3 weeks later, visits his physician with the general complaints of fever, night sweats, and malaise
- Upon examination, patient displays a fever of 102.2 degrees F; otherwise normal

Clinical Pathology:

- Leucopenia ([WBC]=3,500 / mm^3)
- Mild liver dysfunction

Upon hospitalization:

Serology:

(1) SAT: Positive at 1:2560

(2) 2-ME: Positive at 1:2560

Bacteriology:

(1) Bone marrow yielded *Brucella suis*

Patient was put on the following therapeutic antibiotics: Doxycycline for 6 weeks

Streptomycin for 3 weeks

No known relapse

Case #3:

- Family kills and butchers a feral hog in Florida
- One week later, 3 family members become ill, displaying fever, sweats, malaise, and fatigue

Upon hospitalization:

Serology:

(1) SAT: Positive at 1:640

(2) 2-M<E: Positive at 1:320

Bacteriology:

(1) *Brucella suis* was grown out of all blood cultures

Appropriate antibiotic therapy was initiated and completed and the problem was resolved.

Case #4:

Swine producer (family) in Arkansas

Feral swine located in the area of farm

Reproductive problems occurred in domestic swine herd, and brucellosis is diagnosed; the most probable source for infection was determined to be the feral swine.

Over the subsequent 6 month period, all of the family members (except for the toddler) became ill at varying times, displaying the signs of fever, night sweats, fatigue, and back pain.

A diagnosis of brucellosis (due to *B. suis*) was made, and the appropriate regimen of antibiotic therapy was administered.

SUMMARY AND CONCLUSIONS

The feral swine population continues to grow and spread in the temperate areas of the United States because they adapt well to a wide variety of environmental conditions and climates, and they have no natural predators or mortal diseases or parasites. The expanding feral swine population has a number of detrimental effects on agricultural production, such as crop and pasture damage, grain consumption, small livestock loss, and general nuisance, etc.... In addition to those problems, a significant percentage of them harbor brucellosis (*Brucella suis)* which is of public health importance.

The incidence of human brucellosis due to *B. suis* is declining as the incidence of the disease in domestic swine herds is reduced. However, the zoonotic risk of feral swine for a particular segment of the population (hunters, farmers and ranchers, and abattoir workers) will continue. It is estimated that the incidence of *B. suis* in feral swine is between 10 and 25%, and there is no effective control of the disease in that particular reservoir. The problem can be minimized through an educational effort to enhance the awareness of the zoonotic risk involved with handling feral swine.

Human brucellosis presents a diagnostic dilemma to the physician because the symptoms and clinical signs are so nonspecific. A history of exposure to swine or swine carcasses, and appropriate serology and bacteriology, are required to make a definitive diagnosis. Brucella organisms are not susceptible to the traditional broad spectrum antibiotics. A combination of long term Doxycycline or tetracycline in combination with rifampin or streptomycin is required to achieve a cure (WHO, 1998, and McCullough, 1974).

BIBLIOGRAPHY

Alton, G.G. (1990). "*Brucella suis*", in Animal Brucellosis, edited by K. Nielsen and J.R. Duncan, CRC Press, Inc.

Bach, J.P. and Conner, J.R., (1994). "Economics and Human Interactions of the Wild Hog in Texas", Proceeding from the Feral Swine Symposium, Texas A & M.

Becker, H.N., Belden, R.C., and Brualt, T (1978). "Brucellosis in Feral Swine in Florida", Journal of American Veterinary Medical Association, 173:1181.

Benke, A. (1973). "The Ugliest Texans". Texas Parks and Wildlife. 31, (1) 6-9.

Bigler, W.J., Hoff, G.L., Hemmert, W.H., Tomas, J.A., and Janowski, H.T. (1977). "Trends of Brucellosis in Florida, an Epidemiologic review", American Journal of Epidemiology, 105(3): 245.

Garcia-Carrillo, C., (1987). "La Brucelosis de los Animales en America y su Relacion con la Infeccion Humana". O.I.C., Paris.

Garcia-Carrillo, C., Turovetzky, A., and Lucero, N. (1985). "Especies y Bbiotipos de Brucella aislados del hombre en la Argentina", Medicina, Buenos Aires, 45-20

Huddleson, I.F. (1929). "The Differentiation of the Species of the Genus Brucella; Bulletin of the Michigan Agricultural Experiment Station, No., 100.

Mayer, J.J. and Brisbin, I.L. (1991) Wild Pigs of the United States, their History, Morphology, and Current Status. The University of Georgia Press, Athens and London.

Mayer, J.J. and Brisbin, I.L. (1994). Proceedings of the Feral Swine Symposium, Texas A & M.

McCullough, N.B. (1974). Clinical picture associated with Undulant Fever, personal communication.

MMWR (1994). Brucellosis Outbreak at a Pork Processing Plant-- North Carolina, 1992. CDC. :43(07): 113-116.

Nichols, L., Jr. (1962) Ecology of the Wild Pig. Hawaii Divison of Fish and Games, PR Project W5-R-13, p20.

Pate, R. (1999) Feral Swine Specialist of the Texas Animal Health Commission, personal communications.

Rollins, D., (1994). "Statewide Attitude Survey on Feral Hogs in Texas". Feral Swine Symposium Proceedings.

Rollins, D., (1997). "Statewide Attitude Survey on Feral Hogs in Texas, Feral Swine Sypmosium Update". Texas A & M Internet site.

Schuermann, J. (1999). Incidence of human cases in Texas, Texas Department of Health, personal communication.

Shapiro,D.(1999).Zoonotic Diseases Carried by Pigs. http://medicine.bu.edu/dshapiro/zoopig.htm

Springer, M.D. (1975). "Food Habits of Wild Hogs on the Texas Gulf Coast", M.S. thesis, Texas A & M University, internet site.

Synatzke, D.R., (1979). "Status of the Feral Hog in Texas". Unpublished report, Texas Parks and Wildlife, 9 pages.

Taylor, R., feral swine expert of the Texas Parks and Wildlife (1998).

Towne, C.W., and Wentworth, E.N.(1950). "Pigs from Cave to Cornbelt. University of Oklahoma Press, Norman.

Traum, J. (1914). "Report of the Chief of Animal Industry", USDA, Washington, D.C.; 30.

WHO/OMS(1997). Brucellosis, Fact Sheet N 173, July.

Wood, G.W., Hendricks, J.B., and Goodman, D.E. (1976). "Brucellosis in Feral Swine", Journal of Wildlife Diseases. 12,579.

Impacts of Feral Hogs on Corporate Timberlands in the South Eastern U.S.

David B. Whitehouse
Wildlife Biologist
International Paper Company
Nacogdoches, TX

A survey was sent in early May, 1999, to eighteen timber company biologists in the southeastern U.S. to gather responses regarding feral swine impacts on corporate timberlands. Sixteen surveys were returned for an 89% response rate.

The one page survey (Appendix 1) consisted of 9 questions identifying the presence of feral hogs on corporate forest lands and the impacts and attitudes about the animals.

Fourteen out of 16 respondents (88%) reported feral hogs on their property. When asked if their company has problems with feral hogs, 11 out of 16 (69%) reported yes. Hog numbers were reported as decreasing on one (6%) of the land holdings, stable on 2 (13%), increasing on 12 (75%), and unknown on 1 (6%). Nine out of fourteen (64%) of the respondents reported their companies have written policies prohibiting stocking hogs. Three respondents (20%) reported feral hogs being designated as game animals in their state, while another 3 reported them as stock and 9 (60%) considered hogs as non game.

Eleven of thirteen (85%) respondents reported their company allows hog trapping by club members. Twelve of thirteen (92%) respondents allow hog hunting with dogs.

Respondents were asked to list problems encountered with feral hogs on their lands. Eight reported plantation damage, 5 reported damage to equipment such as feeders and hunting stands, twelve reported direct competition with game species, and 12 reported damage to wildlife food plots. One respondent reported their hourly employees are afraid to work in the woods where feral hogs are known to range. Another reported problems with improved pasture damage on neighboring land.

Comments regarding recommended changes to state laws included: 1) allow hunting over bait (outside of turkey season) or night hunting in Alabama, 2) make it illegal to stock hogs in Alabama, 3) educate landowners and hunting clubs in Louisiana about controlling numbers and the potential problems with competition with other wildlife, 4) enable more population reduction measures in Arkansas and Oklahoma, 5) change stock laws in Louisiana, make them nongame statewide, open season and no bag limits, and 6) delete game status in Virginia and West Virginia to prevent certain range expansion.

Several respondents made comments regarding state laws that help them manage hogs on their property, including: 1) allowed to hunt and trap with no limits year-round in Texas, 2) unlimited hunting in South Carolina on private lands, 3) no season or limit in Georgia, and 4) good opportunity to shoot, trap, and kill in Mississippi.

Other comments included: 1) there appears to be less emphasis on customers trying to stock hogs in Texas, 2) awareness of their productivity and damage potential is higher than in the past in Texas, 3) hogs are viewed as another big game animal, hunters love them, 4) hunting with dogs works, but trespass becomes an issue, and 5) hunters will not shoot early in deer season thinking they'll scare away the big buck, resulting in lost opportunity (hogs and deer).

Hog numbers appear to be increasing throughout the majority of the Southeast. Hunters seem to love hogs while land managers want more control over them. Respondents living in states where hog hunting is controlled would like to see those controls removed. Land managers that operate in states with no restrictions on hog harvest are still having problems.

APPENDIX 1.

FERAL HOG SURVEY

Please feel free to elaborate on any point

1. Are feral hogs present on your land? yes ___ no ___
2. Does your company have problems with feral hogs on your lands? yes __ no __
3. Regarding feral hog numbers on your land, are they:
   Decreasing ___
   Stable ___ Increasing ___ ?
4. Do you have a written policy prohibiting stocking hogs? yes ___ no ___
5. In your state, are feral hogs designated as: game animals ___
   noontime ___ stock ___
   Do these designations help or hinder you in controlling feral hogs?
   help ___ hinder ___
   What state ___
   How so? ___________________________________
6. What changes would you recommend in your state game laws to help control hogs? ________________________

7. What major problems have you encountered with feral hogs?
plantation damage ___ equipment damage (vehicles, 4 wheelers) ___ competition with other wildlife ___ equipment damage (feeders, stands) ___ food plot damage ___
other ______________________________________

8. Do you allow trapping by club members? yes ______ no ______

9. Do you allow club members to hunt hogs with dogs? yes ______ no ______

Comments ____

Marketing Feral Swine Meat

Jim Weems
Manager
Frontier Meats
Division of Beltex Corporation

OVERVIEW

- The meat from feral swine suffers from its name.
- In order to be marketable, we first change its marketing name to wild boar on the basis that the feral swine in Texas is a mixed breed animal with vestiges of the Russian wild boar bloodlines that were introduced into Texas shooting and hunting clubs over the past century. With this sexier marketing name in place we can then examine the consumer base that will have an interest in the meat from these animals.
- Traditionally, the wild boar is a game animal hunted and served in the Northern and Eastern European countries. A taste for this meat remains in Europe. Therefore, Europe is a targeted market for the distribution and sale of the Texas feral swine meat.
- In the United States, the wild boar meat is viewed as an exotic meat served at game meat restaurants, or as a source meat for sausage and jerky products. Therefore, meat brokers catering to the game meat restaurant trade and producers who make a further processed added value meat product are targeted for sales efforts.
- A fledgling marketing opportunity also exist in the United States. Direct marketing of wild boar meats through grocery store chains is being tried in a few test markets to test the interest that may exist in this country for the direct sale of individually packaged branded name wild boar meat.

BENEFITS

- In addition to the traditional marketing efforts related to creating brand loyalty and standardized meat cut recognition, the character and quality of the meat is emphasized.
- The laboratory testing of the meat derived from the Texas feral swine indicates that on average it tends to carry less fat than normal domestic swine, making the nutritional information labels look more inviting to a health conscious consumer.
- By the use of large slaughter and cutting plants such as ours in North Texas and that of Southern Wild Game in South Texas, the quality of

the meat and the cuts can be monitored more closely and presented to the customer in a pleasing format that makes the product more easily ready for presentation to a final consumer.

APPLICATIONS

- In Europe the demand for the wild boar meat is focused on the end of each year during the holiday seasons. Bone-in legs and loins have a focused demand for use as holiday meals. During the rest of the year, the European demand is softer.
- In the United States, the demand for wild boar is spread more evenly through the year, with peaks during the summer for such products as baby back ribs and spareribs for barbecues. The restaurant demand does not see such peaks as those in Europe for the end of the year, but are a menu item that is just starting to grow.
- In both the United States and Europe, demands for the trimmings produced during the cutting process exists for the making of goulash and sausage. These demands appear to be relatively steady throughout the year with some peaking in the cool weather months when a heartier meat dish is more likely to be served.

PRICING

- The pricing of wild boar meat is a function, in our pricing model, of several fundamental and practical factors.
- The cost of acquiring the live animals from trappers throughout the state.
- The cost of transporting the live animals from the trapping sites to our slaughter facility.
- The assumption of the losses in the trapped live animal group from death loss and from weight shrink between the date of purchase and the date of slaughter.
- The overhead and cost of producing the meat in plants that are subject to both USDA and to European Union regulation and inspection.
- The cost of storage of the finished meat product prior to shipment.
- Shipping costs; and
- Advertising expenses.
- Finally, of course, pricing is always a dance between seller and buyer to find the highest price that the buyer is willing to pay before we lose a customer to a competitor.

AVAILABILITY

- With a meat derived from a wild animal population, availability is always subject to the vagaries of weather, population movements and migration, as well as competition with other producers for the limited number of animals available in the wild. In Texas at the present time, however, there appears to still be an adequate number of feral swine to meet the current market demands.
- Our company sees the possibility for the continued use of the Texas feral swine population for meeting theexpanding the demand for the meat in the United States. As a demands in Europe and for company, it is our hope that the feral swine will continue to proliferate in Texas as a healthy game species for the future.

Feral Swine In Georgia

C. Carter Black, III, DVM
Associate State Veterinarian
Georgia Department of Agriculture
Atlanta, GA

The Georgia Department of Agriculture has made an effort to create a working relationship with segments of feral swine enthusiasts.

SHOOTING PRESERVES

Several years ago, provisions were made to establish feral swine shooting preserves. These preserves may only have barrows and boars. It is not a breeding operation. The facilities must be a minimum of one and one half miles from any domestic swine operation. The enclosure must be fenced with 47 inch woven wire with high tinsel electric fence at the top and the bottom. The two strands of electric fence must have separate chargers

Feral animals are confined in a secure enclosure and released in the preserve the morning of the hunt. Animals not killed must be recaptured within 72 hours.

Shooting preserves are required to account for all animals, date received, date harvested, etc. These facilities are inspected quarterly for compliance and inventory.

HOG DOG FIELD TRIALS (BAYING PENS)

Hog dog field trials have become very popular. These populations are confined in secure facilities a minimum of one and one half miles from any domestic swine operation. Only barrows and boars are permitted in these facilities. These populations are tested annually and all animals are identified with special identification. The animals are not allowed to be moved to other locations. These facilities are inspected quarterly for compliance and inventory. Each facility must apply to the State Veterinarian's office for a permit prior to a field trail.

HUNTER EDUCATION INFORMATION

The Georgia Department of Agriculture and USDA has been supplying a feral swine brochure to be included in hunter safety education packets supplied by the Georgia Department of Natural Resources. Approximately 22,000 potential hunters receive hunter safety education courses in Georgia each fall. The parents frequently look through the information. Many parents call with concerns about feral swine and the disease which they transmit. This is a means to educate a younger generation about movement of feral swine and the prevention of diseases.

Conserving a Resource

Maurice Chambers
Rancher and Real Estate Broker
Sabinal, TX

> I came here today to talk to you about harvesting and marketing measures, and the resulting economic benefits of the wild hog in Texas. I first began hunting the wild boar in Texas in the late 1960's. Right away, I began to come to the realization of the economic benefits. Because I was a bowhunter and was around other bowhunters, the question would always come up about a place to hunt wild hogs. At that time, I did not know of any place in Texas that a bowhunter could hunt wild hogs, although there were lots of hogs.

At that time, I was rodeoing with a fella named Butter Crain, and we had been up to the Mesquite rodeo and were returning home in the wee hours of the morning, when we began to talk about fencing some country, filling it full of hogs, and going into business to accommodate some of these bowhunters. I'll never forget the words Butter spoke that night that put us over the ridge and started us in the business. He said, "You know, this idea is crazy enough, it just might work."

We did fence a space on the Crain Ranch, near the Hondo Creek, brought in hogs and ran our first bowhunting ad in the Houston Post-- and the unbelievable happened – we were covered up with gun hunters. Somehow, it was unfathomable to us that anyone would pay good money to shoot a wild hog with a gun, but they did. We started charging them $35 a head and guaranteeing everyone a hog. Right away, we went up to $50, then to $75, and finally, to $100 within the first year and still could not keep up with the demand.

From that day until now, demand still continues to overwhelm us. Although more and more outfits come on the market each year to service these hunters, we still can't keep up with the numbers who want to come to Texas to hunt wild hogs.

Beginning in September each year, we start filling up our ranch, and it stays full every day up into May before it lets up. We only cater to bowhunters and take only 10 hunters per day, charging $75 per day, 2-day minimum, with no guarantees of taking a boar. We continue to turn away numbers of hunters because our capacity is limited by the size of our ranch.

Hunters come from literally every state in the Union, plus we have had them come from as far away as Alaska, Canada, France, Australia, Italy, and Germany. The point I am trying to make here, folks, is that these people are coming to our state by the thousands. They come in cars, pick-ups, and airplanes. They bring money to buy food, gas, equipment. They rent motel rooms and eat at restaurants.

The Internet has a web site called , "The Bowsite." In the big game section, under Wild Hog, (now this is "archery only") the owner of the web site tells me the following facts: Since coming on the Internet in 1996, the Bowsite has had 881,038 hits by hunters looking for a space to hunt hogs. In my speech to the Wild Hog Compendium in 1993, I stated that our average income for every wild hog that left the ranch was $500. For your benefit, I decided to average this year's month of May, only, to see if we were still close. That figure turned out to be well over $500 per head.

I called the Texas Parks & Wildlife Department and talked to Julie, as I was writing this speech, to ask about license sales for non-resident, five-day permits, which is the license most non-resident hunters purchase to hunt hogs. In 1988, 13,480 permits were sold. In 1998, 30,512 permits were sold. The permits cost $35 each. For 1998, Texas generated $1,067,920.00 in revenue off of permit sales.

Let me give you some figures:

Jeffrey Massey takes 300-400 bowhunters per year on the King Ranch, Phil Lyne takes 250-300 bowhunters on the Baylor Ranch, Wayne and Jared Peeples take 600-700 bowhunters per year on the King Ranch, our ranch takes 400+ bowhunters per year. These are all "archery only" outfits, so we are talking about a little bitty portion of the market. If we just total the hunters that go to these four places, you have 2000 or so. With each hunter staying for an average of three days, and paying the outfitter approximately $300 for this hunt, you are looking at well over one half of a million dollars. Let me say again, we're just a very small portion of the outfits out there selling hog hunts. There are many, many more, all with similar stories. The point I am trying to make here is that hog hunting income for the State of Texas, at this time, is already in the millions and millions of dollars. If this figure doesn't get your attention, I'll encourage you to do a market analysis study on the resource. Go down to Wal Mart, buy one of those $4 calculators, and multiply that $500 we are getting for every hog that leaves the ranch, times the one to two million we now have in Texas, and that should really blow your mind.

It's like winning the lotto, it's having your ship come in, or finding money in the road. The best analogy I can think of is, "It's like having $100 bills running around in your pasture.".. They are already here and they are free. We don't have to go to China or Taiwan for our products. They are already here, and all we have to do is market 'um and take the money.

Feral Hog Control Methods

Mark E. Mapston
Director Supervisor
Texas Wildlife Damage Management Service
USDA-APHIS Wildlife Services
Uvalde, TX

Feral hogs are increasing across their range. This has been particularly evident in the sheep and goat producing regions of Texas. The tendency of feral hogs to cause damage and the threat of disease transmission have resulted in an increased interest in controlling feral hog movements and populations (Mapston, 1997).

There are several techniques and control methodologies available for use on feral hogs. These consist of both lethal and nonlethal methods dependent upon the management objective. Because of the mandates of the Texas Wildlife Damage Management Service, our program utilizes lethal control when dealing with animals such as feral hogs. We also provide technical assistance to those interested in controlling feral hogs on their own.

Exclusion methods are used to discourage feral hogs from ingress into unwanted areas. The use of guard animals is a tried method that can work against canine predators in the right situation. Generally it is not practical against hogs in the large, brushy, rugged pasture situations in sheep and goat country where large numbers of feral hogs occur in Texas (Littauer, 1993).

A number of fence designs have been described for controlling hog movements. Nonelectric fences must be of net wire or diamond mesh construction with six-inch or less spacing to be effective (Littauer, 1993). To be hog-proof in sheep and goat producing areas , net wire fencing must have spacing of four inches or less, or twelve inches or more between vertical wires to prevent livestock from sticking their heads (Littauer, 1993). The fences must also be at least thirty-six inches tall and be tightly stretched with the bottom wire on the ground surface or buried to be effective against hogs (Littauer, 1993). This is difficult to achieve and is an expensive proposition in rugged terrain.

Electric fencing is another nonlethal alternative and may help to repel feral hogs. Electrifying existing fencing may be less costly in most cases. Tests with fencing designs showed that hogs could be repelled with electric fences in the right conditions. The most successful designs employed an electric stand-off wire on the pig side of the fence with the main fence being grounded (Littauer, 1993). Electric fences can require substantial amounts of maintenance and generally are not practical in rough terrain.

Control methods used by the Texas Wildlife Damage Management Service include: snaring, trapping, shooting, trailing dogs, and aerial hunting. The control option(s) that is / are selected depends upon several variables including: the damage situation, locale, number of depredating animals, kind and amount of livestock, terrain, season of the year, wishes of the cooperator, etc. The method used may also be dependent upon whether the control work is for preventive or corrective reasons. Preventive control as the name implies, is control work done to prevent hog damage from occurring. Corrective control is action taken after hog damage has occurred or is currently taking place (Mapston, 1997).

In FY 1998 the Texas program removed over four-thousand six-hundred feral hogs. This is an increase in take over past years due to the increased presence of feral hogs across the state. In the Uvalde District which I am located, District personnel took over two thousand feral hogs during this same time frame. These hogs were taken using all of the above mentioned methods of use by the Service.

The most important tool used by the Texas Wildlife Damage Management Service in controlling feral hogs is the snare. The snare accounted for over thirty-eight percent of the feral hogs removed in FY 1998 (TWDMS Annual Report, 1998).

The snare consists of a loop of galvanized aircraft cable 3/32-inches or 1/8-inch in size. A sliding lock device allows the loop to close easily but not open. A heavy swivel is used on the tie end of the snare for connection to an anchor to minimize twisting and breakage. Snares are available commercially but the Service makes our own. We prefer 1/8-inch cable and locks made from cut and drilled 3/4-inch angle iron because of their strength (Littauer, 1993).

Snares are generally set in holes or “crawls” underneath fences. These sites can be found by looking for tracks, drag marks on the ground by fence stays, hair on fences, or arched-up spots on fences. In the Service we rarely use trail snare sets for hogs due to the increased hazard to nontarget animals.

The advantage to snare use is the lower cost and minimal maintenance that is required if a snare is set properly. One disadvantage is that only one animal can be taken at a time. Also, hogs that don’t travel through or under fences won’t be caught; large hogs can break snares; and nontarget animals may be caught.

Cage or pen traps accounted for over eleven percent of the feral hog take by the Service in FY 1998. These devices can be used as lethal or a nonlethal control method. Most designs are based on a basic box shape with some type of a gate door (Littauer, 1993). They may be used for single or multiple animal catches. Traps may have spring-loaded gates (Taylor, 1991), trip gates, drop gates, or hinged gates depending upon the trap-maker’s preference (Littauer, 1993).

The TWDMS uses a cage trap made of heavy guage stock panels welded to a steel tubing frame to make it rigid. Four panels are wired together to make a pen if a large trap is needed. Smaller and more portable traps are made with all parts welded together making a permanent pen. The gate consists of a rectangular hinged door, hinged at the top to allow the hogs to "root" the door open and allow access into the trap. Once inside a trapped hog will generally attract others who push the gate open and enter (Littauer, 1993).

Bait is needed to attract hogs to the trap. Soured grain , usually fermented corn, is a highly preferred bait. Carrion can be used but is more effective in the cool season. Prebaiting the trap is important in order to achieve the maximum effectiveness of a cage trap. Letting the hogs become comfortable in and around the trap greatly increases the chance for multiple catches. The availability of natural foods may decrease attractiveness of trap baits and hence will hinder trap success. This is particularly true in the warm months of the year (Littauer, 1993).

Other problems with cage traps are that other animals may be attracted to the trap bait and set off the trap. Traps can also be heavy and cumbersome to move and are difficult to use or set up in rugged terrain. Some hogs become trap shy and with several hogs caught at one time, some may climb on top of others and escape over the side of the trap (Littauer, 1993).

Hunting with dogs is an ancient control method that can be effective for feral hogs. Many factors come into play for this method to be successful. The experience of the dogs, the hunter, and the hogs are all important. There are a wide variety of opinions on the best hog dog breeds, dog characteristics, and training of hog dogs. Many different breeds and cross breeds of dogs have proven satisfactory to hunters (Littauer, 1993). Over four percent of the hogs taken in the state program were taken with the use of dogs in FY 1998 (TWDMS Annual Report, 1998).

As with all methods, the use of dogs has its disadvantages as well. Poorly trained dogs, inexperienced hunters, hot weather, injuries, and the cost of good dogs and their care are all negatives.

Aerial hunting accounted for over thirty-five percent of the feral hogs taken by the Service in FY 1998 (TWDMS Annual Report, 1998). Helicopters are the primary aircraft used for aerial hunting of feral hogs in Texas. This is a very selective method and depredation problems can be stopped quickly. Large numbers of feral hogs can be taken in a single aerial hunting operation .

The disadvantages to aerial hunting are the high costs and the inherent hazards of low-level flight. Weather, heavy cover, and rough terrain also work to limit aerial hunting success.

At present no toxicants are registered for use against feral hogs in the U. S. This could be a very cost effective control method as evidenced by foreign studies if research and development were implemented here (Littauer, 1993). The use of toxicants is a low priority item due to the high costs of toxicant registration and the current lack of interest.

In conclusion, agricultural producers in need of feral hog control should consider the benefits versus the costs of control. In most cases, an integrated approach to solving feral hog damage is the best solution. With feral hog numbers and damage increasing, a combination of control methods would sustain maximum success in a management campaign.

Literature Cited

Annual Report, 1988. Texas Wildlife Damage Management Service, San Antonio.

Littauer, Gary A., 1993. Control Techniques for Feral Hogs, Feral Swine: A Compendium for Resource Managers. Texas Agricultural Extension Service, San Angelo. PP 139-148.

Mapston, Mark E., 1997. Feral Hog Control in Texas, Proceedings National Feral Swine Symposium, Industry Section, Riverdale. PP 1-3.

Taylor, Rick, 1991. The Feral Hog in Texas, Texas Parks and Wildlife Department Federal Aid Report Series Number 28, Austin. 20 PP.

Feral/Wild Swine Surveillance for Foreign Animal Diseases and Some Field Study Projects on Brucellosis and Pseudorabies in the Southeastern USA

Tommy Dees, DVM
Epidemiologist
Southeastern Region, USDA-APHIS-VS
Avon Park Air Force Range, Florida

This military instillation is the site of demographic studies on deer, feral/wild (F/W) swine, turkeys, and to a lesser degree, quail. The animal populations are monitored with regard to precipitation, natural mast crop, and in the case of swine, the seroprevalence of swine brucellosis (SB) and pseudorabies (PRV). (Please see the excellent, detailed report presented elsewhere in this proceedings by Mr. Pat Walsh.)

CASE CONTROL STUDY - SWINE BRUCELLOSIS AND PSEUDORABIES

Questionnaires from 185 domestic swine herds in Florida, of which 18 (9.7%) had a history of being infected with SB and 25 (13.5%) with PRV, were entered into EPI INFO. This is a computer program furnished by the CDC and used by Veterinary Services to assist with epidemiologic investigations. Analysis of the data showed that owners who added F/W swine to their domestic herds were 2.8 (P=0.06; CI=0.88-8.7) times more likely to have SB and 8.9 (P=0.00; CI=3.3-24.9) times more likely to have PRV than those who did not add F/W swine to the herds. While the SB implications are not quite of statistical significance ($P < 0.05$), the PRV cannot be ignored. Simply having F/W swine in the neighborhood was not significant (P=0.57; OR=1.44; CI=0.4-4.5) for SB but showed that it increased the risk of having PRV in the herd by 3.1 times (P=0.017; CI=1.2-8.0). The study will be terminated this year but it is expected that after a closer match of cases to controls, the F/W swine will show a recognized and significant impact on the domestic swine industry with regards to SB as well as the already apparent PRV. (Data collected by numerous field personnel and analyzed by Larry Warden, AHT, USDA-APHIS-VS.)

OKEECHOBEE PEN TRIALS WITH RB51

Florida F/W swine captured from citrus groves and range land were penned in 3 groups. One group of 16 received 1 - 3.4 X 10^9 viable RB51 organisms subcutaneously once behind one ear. Another group of 13 received 2 - 6.8 $X10^{10}$ RB51 live bacteria orally each day for 3 days. This was mixed with corn syrup and poured over a corn and pecan shell vaccine oral delivery system (VODS) for the swine to consume (The VODS is a variation of the method developed at the Dept. of Veterinary Science, LSU). A third group of 13 received only the VODS for 3 consecutive days. At the end of 21-27 days, all swine were bled and tested for response to the RB51 antigens using the Western Blot (LSU). Though the swine used in the trial were test negative to SB using the Card test, they came from an infected population and several showed titers to field strain Brucella sp. when tested on the Western Blot. They were eliminated from the trial. Results of the Western Blot in the Oral Group, showed that 9 of 10 seroconverted to RB51 while 9 of 13 showed on the Sub Q Group. None of 3 seroconverted to RB51 in the control group (10 animals were eliminated because of seroconversion to field strain during the trial).

(Investigators were AHTs with USDA-APHIS-VS : Norman Barnes, Wayne Chandler, Mike Holmes, and Gary Marsh.)

GREEN SWAMP/HANOVER, FL

South Florida Water Management District has swine on most of the millions of acres of land that it owns and/or manages the water rights. Two such tracts, Green Swamp and Hanover, are the sites of an ongoing trial to evaluate the effects of RB51 brucellosis vaccine at reducing the seroprevalence of SB found in the F/W swine on both tracts. The vaccine was injected into trapped swine that were bled, marked and released back onto the Hanover tract (>8,000 acres). Green Swamp (>37,000 acres) is the non-vaccinated control. Results are pending the collection and processing of hunter-kill blood samples to be taken during the 1999-2000 hunting season. (Keith Weems, AHT, USDA-APHIS-VS, remaining principal investigator)

HARDSCRABBLE, SC

This semi-domesticated Eurasian boar X feral swine herd was found when an adjacent dairy tested positive for brucellosis on the annual Certification and Accreditation test. *Brucella suis* was isolated from the udder of one of the cows and the infected swine herd was soon located. SB (seroprevalence of ~44%) was quickly eradicated through test and slaughter (hunter-kill) but PRV, because the system could not handle the high volume of reactors from both diseases and SB was considered the greater threat, remained in the herd longer than necessary. A gI gene deleted PRV vaccine (Syntrovet) was donated by the company for use in the herd. It was used only 3 times before the herd testing stopped because of logistical problems. The herd, though incomplete, had tested negative prior to cessation of testing.

(Dr. Jack Wheeler, USDA-APHIS-VS, principal investigator)

HICKORY HAMMOCK, FL

This South Florida site (>4700 acres) is 10-12 miles from Avon Park Air Force Range (>116,000 acres) which is serving as the negative control. F/W swine were orally vaccinated in September of 1998 using approximately 2 X 10^{10} RB 51 and the modified VODS (LSU) each day for 3 days per each estimated hog. To help prevent non-target species from eating the VODS and vaccine, sour corn was used in the VODS and leaves from the cabbage palm (Sabal palmetto) were utilized as a biodegradable bait receptacle and cover. Repeat vaccination was due in December 1998 and March 1999 but was prevented due to lack of funds and eventual loss of key personnel. The project may still be salvageable if vaccine can be delivered to the swine on a 3-4 times a year schedule. (Dave Munyan, AHT, USDA-APHIS-VS, is the remaining principal investigator)

HOBCAW BARONY, SC

Over 1200 F/W swine were trapped and euthanized, (with many being bled) on this peninsular facility (>17,000 acres) during 1998 and 1999. Oral vaccination with RB51 using VODS (LSU) of the remaining swine began in May 1999. Three more vaccinations, equally spaced, are due before the project will be terminated by a final trapping and bleeding in May of 2000. A uniquely situated and relatively isolated portion of the facility, called Old Clubhouse Corner, is the non-vaccinated control. SB seroprevalence has run 44% and PRV has been 55% on the principal area up until vaccination. (Dr. Mike Duffy, USDA-APHIS-VS and Jimmy Bessinger, Biologist, Belle Baruch Foundation, are the principal investigators)

FAD SURVEILLANCE

Florida - Every 5th tube of blood which is submitted to the State Brucellosis Lab, after serology for the detection of antibodies to SB and PRV, is sent to the National Veterinary Services Lab (NVSL) for African swine fever (ASF) and classical swine fever (CSF) (known also as hog cholera) antibody detection. Tonsil biopsies from some hunter-kill animals (Hickory Hammock) have been sent, also, to NVSL for CSF virus investigation.

Texas - Three plants in Texas are slaughtering F/W swine from several states. These animals receive ante mortem and post mortem inspection by FSIS or State Inspectors. Suspicious cases would be reported and investigated. Work is underway to attempt to have blood and tissue samples routinely submitted to NVSL from these facilities.

Texas Rolling Plains Feral Swine Disease Survey

Bruce Lawhorn, DVM, MS
Associate Professor/Extension Swine Veterinarian
Texas Agricultural Extension Service
Department of Large Animal Medicine & Surgery
Texas A& M University System

From June 1996 through February 1999, cooperative efforts between the Texas Agricultural Extension Service, Texas A&M University College of Veterinary Medicine, Texas Parks and Wildlife, Texas Animal Health Commission, Texas State-Federal Diagnostic Laboratory, Texas Veterinary Medical Diagnostic Laboratory (TVMDL) System, and USDA Agricultural Research Service have resulted in a survey of diseases important in feral swine. Samples were taken from swine in Cottle, Dickens, King, Motley, and Foard counties in the Texas Rolling Plains. Of the total number of samples, 29 %, 8%, 78%, and 12% were taken in 1996, 1997, 1998, and 1999, respectively. Blood samples were tested for pseudorabies (PRV), swine brucellosis, porcine reproductive respiratory syndrome (PRRS); blood and tissue samples were tested for evidence of the parasite Trichinella spiralis.

MATERIALS AND METHODS:

Personnel of Texas Parks and Wildlife harvested, collected, preserved, recorded data, and shipped feral swine serum samples to the Texas Agricultural Extension office of Veterinary Extension at the College of Veterinary Medicine, Texas A&M University. These serum samples were submitted to the State-Federal Diagnostic Laboratory in Austin and the Texas Veterinary Medical Diagnostic Laboratory in Amarillo. Texas Parks and Wildlife personnel also shipped serum and 10 % formalin-fixed tongue samples to USDA Agricultural Research Service Laboratory, Beltsville, Maryland.

The State-Federal Diagnostic Laboratory in Austin performed the enzyme linked immunosorbant assay (ELISA) test for pseudorabies antibody. Any positives were sent to the Texas Veterinary Medical Diagnostic Laboratory in College Station for confirmatory serum virus neutralization (SN) testing.

The State-Federal Diagnostic Laboratory in Austin performed the brucellosis card test and particle concentration immunofluorescence assay (PCFIA) for swine brucellosis antibody.

The Texas Veterinary Medical Diagnostic Laboratory in Amarillo performed the ELISA test for PRRS virus antibody.

The USDA Agricultural Research Service Laboratory of Dr. Ray Gamble in Beltsville, Maryland performed the ELISA test for Trichinella antibody on feral swine sera and the muscle digestion test for Trichinella cysts on tongue samples.

RESULTS:

Of the 133 serum samples tested for pseudorabies antibody by ELISA, 122 were negative, 2 were positive and confirmed positive by the serum virus neutralization (SN) test (2 PRV reactors; 60+ month-old, 254 lb boar in excellent body condition) and 13-week-old, 15 lb gilt in good body condition), and 1 was positive by ELISA but negative by the SN test (PRV suspect; 40-week-old, 100 lb gilt in excellent body condition). Eight out of 133 sera were contaminated and could not be tested for PRV.

Evaluation of 134 feral swine sera by the brucellosis card and PCFIA demonstrated 134 and 131 were negative, respectively; 3 sera were untestable by PCFIA.

One of 135 sera was positive by PRRS ELISA. The reactor was a twenty-month-old, 155 lb boar (no body condition given).

A total of 162 feral swine were tested for Trichinella by ELISA and/or muscle digestion (most were tested by both tests);142 sera tested by ELISA to detect Trichinella antibody and 145 tongue samples tested by muscle digestion to detect Trichinella larvae were all negative.

DISCUSSION:

This feral swine disease survey is important because: (A) it alerts ranchers and hunters in these counties to the livestock and human disease dangers potentially carried by feral hogs, and (B) samples feral hogs close to the Texas panhandle, the location of the major expansion area for domestic swine production in our state.

From 1985 through 1995, pseudorabies was confirmed positive in 2538/8747 feral swine (29%) in 50 Texas counties; 0/185 were positive in 19 other counties (1). Past and recent PRV quarantines of domestic swine herds in Texas have been associated with feral hog contact (2, 3). Pseudorabies also occurs sporadically as a fatal disease in "hog dogs" in Texas and Louisiana, as well as other states; the only reasonable source of PRV for such sporting dogs is contact with pseudorabies-infected, shedding feral swine. "Hog dog" owners occasionally ask veterinarians to vaccinate their dog for pseudorabies. No pseudorabies vaccine is approved for use in dogs.

This survey shows an apparently low prevalence of PRV in those feral swine sampled. It was interesting that both PRV positives and suspect were from one ranch, in one year, 1998. An old boar that had undoubtedly been reproductively active for many years was one of the positives, and the PRV suspect was a gilt of breeding age (40 weeks old, non-pregnant). Pseudorabies virus is known to be transmitted in body fluids such as saliva, nasal mucus and semen. During the act of mating, an infected feral boar exposes a gilt or sow in heat to all of these sources of PRV.. One of the most feared sights by a domestic swine producer is a feral boar in contact with some of his herd females in heat. If such a producer is lucky enough to kill the feral boar, a blood sample from the intruder can help predict whether or not his breeding herd has been exposed to PRV..

Pseudorabies virus is also of concern if transmitted to cattle, sheep, dogs, cats, rabbits, and other mammals since it causes fatal encephalitis called "Mad Itch" Offal from cleaned feral swine should not be fed to dogs or other pets; bury or burn the offal. Transmission from feral swine to feedlot cattle and show calves has occurred in Texas. Experimental PRV-infection of peccaries has resulted in only an antibody response and viral shedding, but no apparent disease(4). PRV has not produced disease in humans and pork from PRV positive swine is not a human health risk.

Recent brucellosis quarantines of domestic swine herds in other areas of Texas have been associated with feral swine contact (2). From 1984 through 1995, swine brucellosis was confirmed positive in 597/6932 feral swine (8.6%) in 18 Texas counties; 0/2053 were positive in feral swine in 51 other counties (1). Although no positives were found in this current survey, disposable gloves should be worn while cleaning feral swine to avoid contact with *Brucella suis*, which if present, can cause serious human disease. Avoid contact with reproductive organs and blood. Wash hands thoroughly with antiseptic cleanser and clean and disinfect instruments used to dress and/or process feral swine. Bury or burn the offal. Thorough cooking destroys the swine brucellosis organism. Transmission of brucellosis between swine is through contact with infected body fluids associated with aborted pigs (caused by brucellosis) and through semen from infected boars. Depopulation of infected domestic herds is the only practical way to eliminate swine brucellosis since *Brucella suis* causes persistent infection or infection that cannot be eliminated with drugs. Swine brucellosis rarely affects cattle.

PRRS is a devastating disease in the commercial and show swine industry in Texas. No one knows how the PRRS virus was introduced into domestic swine in the US in the mid-to-late 1980s and then into Texas domestic swine in 1989 and the early 1990s, but feral swine could be likely culprits. This survey demonstrates only 1/135 feral swine samples was positive (positive found in 1998). In a US survey of feral swine sera collected between 1976 and 1993, only 2 positives were found in 1994 (5). These data suggest that PRRS virus has moved from the domestic swine population to feral swine, and not vice versa. PRRS virus does not produce disease in other livestock, pets or humans. There is no known adverse affect on pork quality in swine recovered from PRRS (5).

Since feral swine will dine on just about any form of life, it seems reasonable that trichinae infection could be common in feral swine since they consume rodents and other wildlife that may harbor Trichinella cysts. This survey showed no positives (most samples by two different tests) in 162 samples taken over 4 years. This means that any wildlife that the feral swine in this survey consumed were probably not infected with Trichinella cysts. For general food safety precaution, the USDA recommends cooking fresh pork to an internal temperature of 170 degrees F, which is higher than the 140 degrees F at which Trichinella cysts, if present, are killed. Note that cooking to 170 or 180 degrees F internal temperature in microwaves may not inactivate Trichinella cysts due to uneven heating. Freezing at normal home freezer temperature (O to 4 degrees F) for 30 days will inactivate Trichinella cysts prior to cooking (6).

REFERENCES:

(1) Wild Swine Data Bases on Swine Brucellosis and Pseudorabies, Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine, The University of Georgia, Athens, Georgia, 30602, May 10, 1995.

(2) Dr. Max Coats, personal communications, February and March, 1999.

(3) Lawhorn B, Evaluation of a Modified-Live, Gene Deletion Mutant Pseudorabies Virus Vaccine for Field Use in Swine (MS Thesis). Texas A&M University, August 1989.

(4) Crandell RA, Robinson RM, and Hanon PG, Pseudorabies Infection in Collared Peccaries (Tayassu tajacu). The Southwestern Veterinarian. Vol 37, No. 3, 1986, 193-195.

(5) 1998 PRRS Compendium, National Pork Producers Council.

(6) Gamble HR. Pre-Harvest Control of Trichinellosis, Proceedings of 1997 Allen D. Leman Swine Conference, Minneapolis, MN, 82-86.

Conclusion

Rick Smathers
Program Records Director
Texas Animal Health Commission

In conclusion, facilitators and participants of the Feral Swine Symposium separated into three Breakout Sessions to discuss strategic plans and goal setting options related to feral swine concerns for future meetings and action. The findings are as follows.

Strategic Planning and Goal-Setting Breakout Sessions

Session #1

INDUSTRY INTERESTS AND PERSPECTIVES

Facilitator - Rebecca Parker
Denton County Extension Agent - Agriculture

PURPOSE

Develop list of most important issues that need to be addressed regarding feral swine from an industry standpoint.

Develop Action Plans.

ISSUES

- Positive Economics
- Predation
- Crop Loss
- Disease Issues (Real or Perceived) as trade Barriers
- Control
- Prevent Spread of Disease between Feral & Domestic Swine
- Fewer Regulations
- No Total Control of Feral Swine
- Feral Hog Population & Damage Control
- Funding for Hog Control
- Control Expansion
- Methods of Control
- Population Growth and Expansion
- Damage
- Health Issues
- Coexistence
- Health
- How to Best Utilize the Feral Swine (Profitable)
- Protect Domestic Industry
- Funding for Research & Development
- Property Damage

FINAL ISSUES COMPILED

- Positive Economics
- Health Issues (Disease)
- Coexistence
- Disease Issues (Real or Perceived) as Trade Barriers
- Control
- Property Damage
- Protect Domestic Industry
- Wiser Regulations
- Funding for Research & Development
- Funding for Hog Control

TOP 7 ISSUES

1. Wiser Regulations
2. Health Issues
3. Coexistence
4. Funding of Research& development
5. Funding for Hog Control
6. Disease Issues (Real or Perceived) as Trade Barriers
7. Protect Domestic Industry

ISSUE # 1. WISER REGULATIONS

GOALS:

Federal & State entities will work cooperatively to establish effective & enforceable regulations.

OBJECTIVES:

Incremental planning process is put into action from bottom up.

State legislature and industry groups will appoint lead agency to establish feral swine regulations.

ACTION STEPS:

Educational Process - Consumer & constituency awareness - Industry driven programs

Compliance with regulations.

Time Frame - one year at the least.

ISSUE # 2. HEALTH ISSUES

GOALS:

The Domestic Livestock Industry will be protected from health issues in Feral Swine and vice versa.

Disease Issues (real or perceived) as trade barriers.

Human Health

OBJECTIVES:

Monitoring disease compliance

Maintain separation between domestic & feral swine population.

ACTION STEPS:

Charge state entities to carefully define domestic vs. feral swine & eliminate “gray” area.

Adequate surveillance techniques compatible with detection of various diseases.

Education of constituents.

ISSUE # 3. COEXISTENCE

GOALS:

All affected parties (property owners, hunters, farmers, feral swine supporters, livestock producers) will coexist in a mutually tolerant climate.

OBJECTIVES:

Control of populations.

ACTION STEPS:

Maintenance of separate populations in commerce as well as production.

Education component. - delivered by Extension Service, Parks & Wildlife, Animal Health Control. - for legislators, landowners, hunters, farmers, ranchers.

Develop effective plans for managing properties for economic or intrinsic benefit

Control of range and expansion.

Research -toxicants, population control

ISSUE # 4. FUNDING FOR HOG CONTROL

GOALS:

Secure adequate funding to acquire control and monitoring of feral swine.

OBJECTIVES:

Minimize damage costs caused by feral swine

Reduce exposure to domestic swine.

ACTION STEPS:

Lobby legislature

Tax incentives for producers or tax break (Money spent on control measures, repairs).

“Fees for service” from producers.

Industry support

Tax Incentives for other than large land owners to utilize control measures.

ISSUE # 5. FUNDING FOR RESEARCH & DEVELOPMENT

GOALS:

Secure adequate funding to support a comprehensive research & development program.

OBJECTIVES:

Conduct accurate on-going assessment for population and disease status.

ACTION STEPS:

Funding sources from government and industry

Marketing of results to develop Action Plans and obtain necessary funding.

Provide data to interested parties

Risk assessment for livestock industry

ISSUE # 6. DISEASE ISSUES (REAL OR PERCEIVED) AS TRADE BARRIERS

- Due to time limitations, issue was not discussed

ISSUE # 7. PROTECT DOMESTIC INDUSTRY

- Due to time limitations, issue was not discussed

Strategic Planning and Goal-Setting Breakout Sessions

Session #2

GOVERNMENTAL/REGULATORY ACTIONS

Facilitator - Neil Pugsley
Decatur, Texas

PURPOSE

Develop list of most important issues that need to be addressed regarding feral swine from a governmental/regulatory standpoint.

Develop Action Plans.

ISSUES

- Rapid growth and spread of feral swine population
- Diseases of Feral Swine (not limited to psuedorabies virus and swine brucellosis)
  - Diseases other than psuedorabies virus and swine brucellosis
  - Feral swine movement concerns
  - Regulatory
  - Foreign Animal Disease
- Regulations that allow both Domestic Swine producers and feral swine to exist together and prosper
- Statistics on reproduction of Feral Swine
- Populations control
  - Controlling/curtailing the expansion and range of the feral swine population
- Regulatory operations must address all concerns while providing the best science - applicable or feasible
- Vaccine Delivery system for feral swine regulations
  - Disease control/vaccine delivery
  - Keeping wild swine away from domestic swine
  - Develop and/or aid alternative markets for wild swine

- Movement Regulations
  - Criteria for moving domestic swine in a dominated state.
  - Regulating movement of feral swine
  - Less / more regulations on movement
- Application for designated pens for pseudorabies virus and brucellosis testing feral swine to allow movement to destination other than slaughter.
  - Designated pens to be inspected by Texas Animal Health Commission personnel.
- Public Education
  - How to best implement an awareness effort to inform all concerned persons about feral swine good and bad points and to start some form of control program to minimize disease transmission and damage while preserving a segment of sport
  - Increased range
- Permit movement to terminal destinations (i.e. hunting and game ranches).
- Increased range
- Have hunting people realize that other people are impacted by feral swine

TOP 5 ISSUES COMPILED

1. Population Control
2. Public Education
3. Diseases of feral swine, not limited to Pseudorabies Virus & Swine Brucellosis
4. Movement Restrictions
5. Regulatory operations must address all concerns while providing the best science - applicable or feasible.

ISSUE # 1. POPULATION CONTROL (ISSUE)

GOALS:

Limit uncontrolled expansion

OBJECTIVES:

Inventory feral swine numbers

Reduce crop loss caused by feral swine

Oral contraceptive research

Initiate a bounty ($) on feral swine

Movement restrictions and controls (under current laws)

Educate hunting clubs on harvest numbers

ACTION STEPS:

Due to time restrictions, were not able to cover

ISSUE # 2. PUBLIC EDUCATION (ISSUE)

GOALS:

Increase awareness

OBJECTIVE:

Public forums

Distribute printed materials

Produce a video (is available)

Trade and interest publications

Media releases

Contacts with local leadership

Legislative contacts

Share resources across state lines

ACTION STEPS:

Utilize existing groups (i.e., trade schools, hunting extravaganzas)

Extension agents

Livestock markets

Personal contacts with hunting groups

Distribute printed material with hunting license

Hunters education classes

Educate through sporting goods stores

ISSUE # 3. DISEASES OF FERAL SWINE NOT LIMITED TO PSEUDORABIES VIRUS & BRUCELLOSIS (ISSUE)

GOALS:

Identify diseases prevalence in feral swine

OBJECTIVES:

Define diseases

Define distribution

Rank diseases by economic impact

Transmission concern

Identify diseases of public health interest

Define quarantine diseases

Respond to findings

ACTION STEPS:

Serologic surveillance

Tissue samples

Secure funding

Slaughter - spot checks at hunting camps

ISSUE # 4. MOVEMENT RESTRICTIONS (ISSUE)

GOALS

- Prevent animals from moving. (goal)
- Establish classes of animals and criteria for movement (goal)
  - Define Feral Swine (objective)
  - Establish criteria for pre-approved Feral Swine facility (objective)
  - Recommend minimum standards for restricted swine facilities to United States Animal Health Association (USAHA) (action step)
  - Meet with hunting clubs, trappers, etc. (action step)
- Establish enforcement (goal)
  - Establish consequences (objective)
  - Establish guidelines for approval, inspection and movement (action step)
- Establish regulatory authority (goal)
  - Coordinate with federal authority. (objective)
  - Review current guidelines (action step)

ISSUE # 5. REGULATORY OPERATIONS MUST ADRESS ALL CONCERNS WHILE PROVIDING THE BEST SCIENCE - APPLICABLE OR FEASIBLE.

GOALS

- Due to time restrictions, were not able to cover

Strategic Planning and Goal-Setting Breakout Sessions

Session #3

RESEARCH, FIELD STUDIES AND SPECIAL PROJECTS

Facilitator: Dr. Dick Shepherd
USDA--VS

PURPOSE

Develop list of most important issues that need to be addressed regarding feral swine from a research, field studies and special projects standpoint.

Develop Action Plans.

ISSUES

- Population dynamics,
- Oral Pseudorabies virus vaccine;
- Oral vaccine delivery systems;
- Birth, sterilization in sows & boars;
- Potential effects of feral hog diseases on other wildlife species;
- Establish a database of Pseudorabies virus molecular
- What does the public want us to do with wild hogs?;
- Toxicant control;
- Understand dynamics of disease in wild pigs;
- Hi-tech/low cost control (i.e. introducing disease, etc.);
- Wildlife depredation;
- Pseudorabies virus vaccination to reduce venereal transmission;
- Pseudorabies virus infection related to age - control strategies;
- Quantify risk of feral swine pseudorabies virus to domestic swine;
- Feral swine as Foreign Animal Disease (FAD) surveillance models;
- Disease modification strategies;
- Improved ways of conducting surveillance;

- Determine competitive relationships with deer & other wild animals;
- Vectors/host of zoonotic parasitic disease (i.e., SPR) - Is it really a threat?;
- Pseudorabies virus: Are there different types of pseudorabies virus in feral swine;
- Understand movements of wild pigs by humans - What, where, why?;
- Determine significance of Pseudorabies virus viral DNA in seronegative wild swine;
- Quantify risk of feral swine Pseudorabies virus to domestic swine;domestic swine & other species risk of infection from feral swine Pseudorabies virus;
- Specific diagnosis of Pseudorabies virus from feral swine; other reservoirs for Pseudorabies virus/brucella;
- Potential effects of feral hog diseases on other wildlife species (including humans);
- Pseudorabies Virus: modes of transmission to domestic pigs;
- Pseudorabies Virus: can we develop an oral/bait vaccine using DNA technology;
- Document economics of wild pig control/eradication methods including sport hunting; effective technologies for maintaining separation;
- Waste food feeders, interactions w/feral swine; newly invaded state;
- Determine who is releasing wild hogs.......;
- Aerial infrared detection;

TOP 7 ISSUES

1. Population dynamics;
2. Population control;
3. Disease epidemiology;
4. Disease modification strategy
5. Economical & environmental impact;
6. Wildlife depredation;
7. Waste feeder impact;

SELECTED ISSUES

ISSUE # 1. POPULATION DYNAMICS

Improved ways of conducting surveillance

Understand movements of wild pigs by humans (what, where, why?)

GOAL:

Predict / determine change in response to environment and human influence

OBJECTIVE:

- Develop standardized census method
- Determine dispersal rates
- Understanding carrying capacities
- Determine age specific recruitment and survival rate

RESOURCES:

- Find long term research site
- Cooperative efforts
- Ongoing studies:
  - Noble foundation
  - Welder wildlife foundation
  - Hunting organizations / outfitters

ACTION PLAN/TIME LINE:

Long term studies on multiple sites -- 10 years

FUNDING:

- Noble foundation
- Welder wildlife foundation
- Other private sectors
- Dept. of interior
- McIntire-Stennis

ISSUE # 2. ECONOMICAL POPULATION CONTROL METHODS

GOALS:

Develop systems to economically control population of feral swine

OBJECTIVE:

- New methodology
- Evaluate existing methods of control

RESOURCES:

- Wildlife Services
- National Wildlife Research Center
- Berryman Research Institute

ACTION PLAN/TIME LINE:

- Evaluate existing methods of control
  - Data study, 1-3 years
- New methodology
  - Basic research of National Wildlife Center, long term 5-10 years

FUNDING:

*(No suggestions made)

ISSUE # 3. DISEASE EPIDEMIOLOGY

GOAL:

Define mechanism and risk of transmission of pseudorabies

OBJECTIVE:

- Biological and molecular characterization of Pseudorabies Virus from feral swine
- Conduct transmission studies

RESOURCES:

- Universities
- Texas Animal Health Commission
- Animal & Plant Health Inspection Services (APHIS)
- Texas Parks & Wldlife

ACTION PLAN/TIME LINE:

- Laboratory studies, 3-5 years

FUNDING:

- None Identified

ISSUE # 4. DISEASE MODIFICATION STRATEGY

GOAL:

Prevent transmission of pseudorabies virus and brucellosis to domestic swine and other species

OBJECTIVE:

- Develop suitable vaccine and delivery system for feral swine
- Develop risk factor related control strategy

RESOURCES:

- Universities

ACTION PLAN/TIME LINE

- Continued research, 3-10 years

FUNDING:

- Biological company

ISSUE # 5. ECONOMICAL AND ENVIRONMENTAL IMPACT

GOAL

Create model to predict possible economical and environmental impact

OBJECTIVE: (PROS AND CONS)

- Determine the value of the feral hog as a game species
- Determine the value of the feral hog as a food commodity
- Determine the agricultural destruction and environmental damage
- Determine the negative impact on other species

RESOURCES:

- National Wildlife Services
- National Agricultural Statistical Survey
- Farm surveys
- National Animal Health Management Services (NAHMS)
- Outfitters
- National Resources Conservation Service (NRCS)
- Extension service
- Farm Services Association
- Experiment stations

ACTION PLAN/TIME LINE:

- Surveys, ongoing
- Data tabulations, ongoing

FUNDING:

Multiple - Any and all of the entities that are impacted

ISSUE # 6. WILDLIFE DEPREDATION

- Due to time restrictions, was not covered

ISSUE # 7. WASTE FEEDER IMPACT

- Due to time restrictions, was not covered

Participant List

Mr. William Alford
Bodean's Hog Hunt
1432 Spicewood
Mesquite, TX 75181
(Phone) 972-222-4157

Mr. Egypt Allen
Texas Animal Health Commission

Mr. Joe Arms
USDA Wildlife Services
2800 N Lincoln Blvd
Oklahoma City, OK 73105
(Phone) 405-521-4039
(FAX) 405-525-5991

Dr. Doug Baird
Tyson Foods Inc-The Pork Group
1225 Hudson Road
Rogers, AR 72757
(Phone) 501-986-1312
(FAX) 501-986-1364

Dr. Reg Barrett
University of California
151 Hilguard Hall
Berkeley, CA 94720
(Phone) 510-642-7261

Ms. Jennifer Barrow
Texas Parks / Wildlife Dept
121 CR 3131
Decatur, TX 76234
(Phone) 940-627-5475
(FAX) 940-627-6558

Dr. Terry Beals
Texas Animal Health Commission

Mr. Regan Beck
Texas Farm Bureau
P O Box 2689
Waco, TX 76702

Mr. Robert Belden
Florida Game / Fish Comm
4005 S Main Street
Gainesville, FL 32601
(Phone) 352-955-2230
(FAX) 352-376-5359

Dr. J Bell
Texas Animal Health Commission

Mr. Robert Bishop
Bishop Hereford Ranch
Route 1 Box 195
Hearne, TX 77859
(Phone) 409-279-2807

Dr. C Black III
Georgia Department of Ag
Department of Animal Health
19 Capitol Square Rm 105
Atlanta, GA 30334
(Phone) 404-656-3667
(FAX) 404-651-5332

Mr. Curtis Bowman
FT Worth Nature Center
9601 Fossil Ridge Rd
Fort Worth, TX 76135
(Phone) 817-237-0427

Mr. Jim Braithwait
Missouri Conservation Dept
RR 2 Box 247
Camdenton, MO 65020
(Phone) 573-346-2210

Dr. Jones Bryan
Clemson LPHD
P O Box 102406
Columbia, SC 29224
(Phone) 803-788-2260
(FAX) 803-788-8058

Mr. Jose Cano JR
Texas Parks / Wildlife
406 N Ave R
Clifton, TX 76634
(Phone) 254-582-2719
(FAX) 512-582-2719

Mr. Lionel Chambers
1301 W 7th
Fort Worth, TX 76102

Mr. Bruce Chandler
Texas Animal Health Commission

Dr. Donald Cheatham
USDA APHIS VS AL
23 Pine Forest Drive
Wetumpka, AL 36093
(Phone) 334-223-7141
(FAX) 334-223-7352

Mr. Simon Cleal
Southern Wild Game Inc
P O Box 1140
Devine, TX 78016
(Phone) 800-034-4263

Dr. Max Coats
Texas Animal Health Commission

Dr. Terry Conger
Texas Animal Health Commission

Mr. V Cooper
Oklahoma Animal Disease Lab
P O Box 7001
Stillwater, OK 74076
(Phone) 405-744-6623
(FAX) 405-744-8612

Dr. Barbara Corso
USDA APHIS VS
CEAH
555 S Howes Street
Fort Collins, CO
80521
(Phone) 970-490-7938
(FAX) 970-490-7999

Mr. Bobby Crozier
Texas Animal Health
Commission

Mr. Dale O'Daniel
Texas Animal Health
Commission

Dr. Donald Davis
Texas A & M
University
Dept of Veterinary
Pathobiology
Vet Research Bldg Room
109
College Station, TX
77843
(Phone) 409-862-4402
(FAX) 409-862-1088

Mr. Jerry Davis
Ouachita National
Forest
P O Box 1270
Hot Springs, AR
71902
(Phone) 501-321-5201
(FAX) 501-321-5353

Dr. Tommy Dees
USDA APHIS VS
P O Box 624
Thomaston, GA 30286
(Phone) 706-647-2631
(FAX) 706-647-2631

Mr. David Dudley
USDA Aphis Wildlife
Ser
HC 67 Box 900
Antlers, OK 74523
(Phone) 580-298-3817
(FAX) 580-298-3817

Mr. Joe Dunn
Texas Animal Health
Commission

Dr. Thomas Ellis
USDA APHIS VS
27 Robertson Road
Blue Springs, MS
38828
(Phone) 662-841-0516

Dr. Phil Elzer
LA State University
Dept of Veterinary
Science
111 Dalrymple Building
Baton Rouge, LA
70803
(Phone) 225-884-4763
(FAX) 225-884-4890

Dr. Gene Eskew
OK Dept of Agri
2800 N Lincoln Blvd
Oklahoma City, OK
73105
(Phone) 405-521-3864
(FAX) 405-522-0756

Dr. Brian Espe
USDA APHIS VS
4020 N Lincoln Blvd
Suite 101
Oklahoma City, OK
73105
(Phone) 405-427-9413
(FAX) 405-427-9451

Mr. Mitch Essey
USDA APHIS VS
384 Inverness Drive
Englewood, CO 80012
(Phone) 303-784-6200
(FAX) 303-784-6222

Mr. Tim Evans
Anderson-Tully Co
P O Box 38
Vicksburg, MS 39181
(Phone) 601-629-6722

Ms. Carla Everett
Texas Animal Health
Commission

Dr. Thurman Fancher
Texas Animal Health
Commission

Mr. Johnny Franklin
Ranch
Route 1 Box 61
Mt Calm, TX 76673
(FAX) 254-993-4800

Dr. Phil Gipson
KS Coop Fish / Wildlife
Kansas State
University
205 Leasure Hall
Manhatten, KS 66506
(Phone) 785-532-6070

Mr. Jim Goodhart
Ark Game & Fish
Comm'n
#2 Natural Resources
Drive
Little Rock, AR 72205
(Phone) 501-223-6327
(FAX) 501-223-6463

Mr. K Goza
Bar O
6445 Fm Road 3116
Anson, TX 79501
(Phone) 915-823-3914

Dr. Michael Greenlee
USDA APHIS VS
100 W Pioneer Pkwy
Suite 100
Arlington, TX 76010
(Phone) 817-276-2209
(FAX) 817-276-2220

Mr. Keith Guyse
Alabama Game & Fish
Div
64 North Union Street
Montgomery, AL
36130
(Phone) 334-242-3469
(FAX) 334-242-3032

Dr. Thomas Hagerty
MN Board of Animal Health
119 Agriculture Building
90 West Plato Boulevard
St. Paul, MN 55107
(Phone) 651-296-2942
(FAX) 651-296-7417

Dr. Edwin Hahn
College of Vet Medicine
University of Illinois
2001 South Lincoln Ave
Urbana, IL 61802
(Phone) 217-333-8234
(FAX) 217-244-7421

Mr. Charles Hamilton
International Paper
P O Box 131610
Nacogdoches, TX 75963
(Phone) 409-564-8375

Mr. Keith Hand
USDA APHIS VS
4700 River Road
Riverdalle, MD 20737
(Phone) 301-734-4866

Dr. Bob Harbison
AR Livestock / Poultry Comm
#1 Natural Resourses Dr
Little Rock, AR 72205
(Phone) 501-225-5138
(FAX) 501-225-9727

Mr. Jimmy Harden
Texas Animal Health Commission

Mr. Fred Harrod JR
Ark Game & Fish Comm'n
#2 Natural Resources Dr
Little Rock, AR 72205
(Phone) 501-223-6384
(FAX) 501-223-6459

Dr. Greg Hawkins
Texas Animal Health Commission

Dr. Burke Healey
OK Dept of Agriculture
Animal Industry Division
2800 N Lincoln Blvd
Oklahoma City, OK 73105
(Phone) 405-521-3891
(FAX) 405-522-0756

Mr. William Heatherly
Mo Dept of Conservation
P O Box 180
Jefferson City, MO 65102
(Phone) 573-751-4115
(FAX) 573-526-4663

Dr. Eric Hellgren
Oklahoma State University
Dept of Zoology
Stillwater, OK 74078
(Phone) 405-744-9671
(FAX) 405-744-7824

Dr. Billy Higginbotham
Texas Agricultural Ext Service
Drawer 38
Overton, TX 75684
(Phone) 903-346-6191

Mr. Gregg Hitchings
Mo Dept of Conservation
P O Box 473
Ironton, MO 63650
(Phone) 573-697-5713

Dr. Dale Hollier
USDA APHIS VS
5825 Florida Blvd #1140
Baton Rouge, LA 70806
(Phone) 225-389-0436
(FAX) 225-389-0524

Mr. Cliff Holubec
6000 Sun Vista
Austin, TX 78749
(Phone) 512-892-2338

Ms. Delores Holubec
Texas Animal Health Commission

Mr. Ken Horton
Texas Pork Producers Assn Inc
P O Box 10168
Austin, TX 78766
(Phone) 512-453-0615
(FAX) 512-451-5536

Mr. Tom Hutton
Missouri Conservation Dept
P O Box 180
Jefferson City, MO 65102
(Phone) 573-751-4115

Dr. Harry Jacobson
MS State University
Dept of Wildlife / Fisheries
10661 Davis Lake
Athens, TX 75751
(Phone) 903-675-4586

Mr. Steve Jester
Texas Parks / Wildlife
301 Main Street Ste D
Brownwood, TX 76801
(Phone) 915-643-5977
(FAX) 915-643-6192

Mr. Jon Johnson
Texas Farm Bureau
P O Box 2689
Waco, TX 76702
(Phone) 254-751-2266
(FAX) 254-751-2671

Mr. Joe Kelsey
Texas Animal Health Commission

Dr. David Larimer
USDA, Veterinary Services
1498 Klondike Road
Conyers, GA 30094
(Phone) 770-922-7560
(FAX) 770-483-9000

Dr. Bruce Lawhorn
Texas Agri Extension Service
TAMU VMD-6
Rm #2, College of Vet Medicine
College Station, TX 77843
(Phone) 409-845-4353
(FAX) 409-862-3795

Mr. Charles Lee
Kansas State University
Room 127 Call Hall KSU
Manhattan, KS 66506
(Phone) 785-532-5734
(FAX) 785-532-5681

Dr. Tom Lee
VA Dept of Agri
1100 Bank Street, #602
Richmond, VA 23113
(Phone) 804-786-2483
(FAX) 804-371-2380

Mr. Jay Levenstein
FL Dept of Ag/Consumer Svcs
Mayo Building Room 328
Tallahassee, FL 32399
(Phone) 850-887-7182
(FAX) 850-873-3641

Mr. Jan Loven
Wildlife Services
501 W 10th St Rm B10
Fort Worth, TX 76102
(Phone) 817-978-3146
(FAX) 817-978-0037

Dr. William Luce
Oklahoma Pork Council
Livestock Exchange Bldg
2501 Exchange Office 146
Oklahoma City, OK 73108
(Phone) 405-232-3781
(FAX) 405-232-3862

Dr. Mike Mabry
Texas Animal Health Commission

Dr. Rex Maddox
P O Box 216
Grandview, TX 76050
(Phone) 817-866-3635

Mr. Mark Mapston
USDA APHIS Wildlife Service
122 North East Street
Uvalde, TX 78801
(Phone) 830-278-4464
(FAX) 830-278-1472

Dr. Bret Marsh
Indiana Board of Animal Health
805 Beachway Drive Ste 50
Indianapolis, IN 46224
(Phone) 317-227-0300
(FAX) 317-227-0330

Dr. Karen Martin
PA Dept of Agriculture
2301 N Cameron Street
Harrisburg, PA 17110
(Phone) 814-946-7315
(FAX) 814-946-7354

Mr. Lanham Martin
Texas Animal Health Commission

Mr. John Maruska
Texas Animal Health Commission

Mr. Greg Mathis
AR Game/Fish Comm
SW Regional Office
P O Box 6740
Terryton , AR 71801
(Phone) 877-777-5580
(FAX) 870-777-3032

Dr. Jack McBride
Texas Animal Health Commission

Mr. Ron McNeely
Missouri Conserv Dept
312 W Van Buren
Gallatin, MO 64640
(Phone) 816-663-2086

Mr. Scott McWilliams
Missouri Conservation Dept
P O Box 138
West Plains, MO 65775
(Phone) 417-256-7161

Mr. Paul Meade
University of Florida
2014 SW 16th Ave Bldg 1017
Gainesville, FL 32610
(Phone) 352-392-4700
(FAX) 352-392-1910

Mr. Steven Meek
Texas Wildlife Dam/Mgmt Services
10056 Marsh Lane, B101
Dallas, TX 75229
(Phone) 214-904-3054
(FAX) 214-904-3080

Dr. Taber Megers
4533 Livingston
Dallas, TX 75205
(Phone) 214-521-7237
(FAX) 214-521-9170

Dr. Mark Michalke
Texas Animal Health Commission

Mr. Kent Miller
Big Bend National Park
P O Box 52
Big Bend Nat'l Park, TX 79834
(Phone) 915-477-2419

Mr. Gary Nunley
TX Animal Damage Control Serv
3700 Fredericksburg Road
San Antonio, TX 78201
(Phone) 210-472-5451
(FAX) 210-472-5446

Mr. Clint Nygaard
NC Dept of Agricutlture
Veterinarian Division
P O Box 26026
Raleigh, NC 27611
(Phone) 919-733-7601
(FAX) 919-733-2277

Dr. Charles Partin
USDA APHIS VS
903 San Jacinto Blvd
Room 220
Austin, TX 77801
(Phone) 512-916-5558
(FAX) 512-916-5197

Dr. Robert Pate
Texas Animal Health Commission
Rt 4 Box 225
Center, TX 75935
(Phone) 800-658-6559
(FAX) 409-399-9541

Dr. Ronald Pemberton
USDA APHIS VS
198 WildWood Drive
Decatur, TX 76234
(Phone) 940-627-6825

Mr. Milton Peterson
Texas Farm Bureau
P O Box 2689
Waco, TX 76708

Mr. Don Petty
Texas Farm Bureau
P O Box 2689
Waco, TX 76702
(Phone) 254-751-2263
(FAX) 254-751-2671

Mr. Larry Preather
Texas Animal Health Commission

Mr. Stan Priest
Anderson-Tully Co
P O Box 38
Vicksburg, MS 39181
(Phone) 601-629-6721

Mr. Ken Rebizant
Manitoba Wildlife Ranch
200 Saulte Aux Crescent
Winnipeg , Canada R3W3J3
(Phone) 204-945-7753
(FAX) 204-945-3077

Mr. Ronald Rhoades
Wildlife Services
501 W 10th St Rm B10
Fort Worth, TX 76102
(Phone) 817-978-3146
(FAX) 817-978-0037

Mr. Jack Rhyan
National Wildlife Research Center
4101 LaPorte Ave
Fort Collins, CO 80521
(Phone) 970-266-6140
(FAX) 970-266-6138

Mr. Bob Richardson
Kroked River
2702 County Road 484
Anson, TX 79501
(Phone) 915-823-2066

Mr. Chad Richardson
USDA Wildlife Service
232 Ackert Hall
Manhattan, KS 66506
(Phone) 785-532-1549
(FAX) 785-532-2149

Mr. Morgan Richardson
International Paper Company
P O Box 278
Sheridan, TX 72150
(Phone) 870-422-2738

Dr. Walter Riggs
USDA APHIS VS
903 San Jacinto Blvd
Room 220
Austin, TX 78701
(Phone) 512-916-5552
(FAX) 512-916-5197

Mr. Dale Rollins
Texas Agricultural Extension Service
7887 US Hwy North
San Angelo, TX 76901
(Phone) 915-534-4576

Dr. Carlos Romero
University of Florida
College of Vet Medicine
2014 SW 16th Ave Bldg 1017
Gainesville, FL 32610
(Phone) 352-392-4700
(FAX) 352-392-1910

Dr. John Sanders JR
USDA APHIS VS
Partners Bldg 1 #2500
1017 Main Campus Drive
Raleigh, NC 27606
(Phone) 919-513-2917
(FAX) 919-513-3013

Mr. John Schultheiss
Lonesome Dove Ranch
106 Woodhall Dr
Victoria, TX 77904
(Phone) 361-572-8411
(FAX) 361-572-0258

Ms. Donna Schultheiss
Lonesome Dove Ranch
106 Woodhall
Victoria, TX 77904
(Phone) 361-572-8411
(FAX) 361-572-0258

Dr. Andy Schwartz
Texas Animal Health
Commission

Mr. Dwaine Scott
USDA Wildlife Services
3710 N 49th
Durant, OK 74701
(Phone) 580-924-5857

Mr. R Shepherd
1909 Highland Park
Circle
Denton, TX 76205
(Phone) 940-382-4578

Mr. Robert Simes
Texas Farm Inc
4200 S Main
Perryton, TX 79070
(Phone) 806-434-9033
(FAX) 806-435-1195

Mr. Gary Simpson
Simpson Farms
4391 WCR 45
Ault, CO 80610
(Phone) 970-834-2467
(FAX) 970-395-0997

Mr. Raymond Skiles
Big Bend National Park
P O Box 129
Big Bend National Park,
Tx 79834
(Phone) 915-477-1145
(FAX) 915-477-1153

Mr. Rick Smathers
Texas Animal Health
Commission

Mr. David Stallknecht
SE Coop Wildlife
Disease Study
University of Georgia
College of Vet Medicine
Athens, GA 30602
(Phone) 706-542-1741
(FAX) 706-542-5865

Mr. Bill Stanley
North Central Texas
College
1525 W California
Street
Gainesville, TX 76240
(Phone) 940-668-8717
(FAX) 940-668-6049

Mr. Mike Staten
Anderson-Tully Co
P O Box 761
Lake Village, AR
71653
(Phone) 870-265-2747
(FAX) 870-265-3929

Mr. John Steuber
USDA Wildlife Services
2800 N Lincoln Blvd
Oklahoma City, OK
73105
(Phone) 405-521-4039
(FAX) 405-525-5951

Mr. Russell Stevens
Samuel Roberts Noble
Found'n
Sam Noble Parkway
P O Box 2180
Ardmore, OK 73402
(Phone) 580-223-5810
(FAX) 580-221-7320

Dr. Lewis Stiles
Stiles Ranch
Route 1 Box 576
Broken Bow, OK
74728
(Phone) 580-584-6588

Mr. William Stiver
Great Smoky Mtns.
Nat'l Park
107 Park Headquarters
Road
Gatlinburg, TN 37738
(Phone) 423-436-1251
(FAX) 423-436-1220

Dr. Brad Stroud
6601 Granbury Hwy
Weatherford, TX
76087
(Phone) 817-599-7721
(FAX) 817-596-5548

Dr. Paul Sundberg
National Pork
Producers Council
P O Box 10383
Des Moines, IA 50306
(Phone) 515-223-2764
(FAX) 515-223-2646

Dr. Gary Svetlik
USDA APHIS VS
Homer Thornberry Bldg
903 San Jacinto Blvd
Room 220
Austin, TX 78701
(Phone) 512-916-5552
(FAX) 512-916-5197

Dr. Arnold Taft
USDA APHIS VS
NAHMS
12408 Rockledge Drive
Bowie, MD 20715
(Phone) 301-734-4916
(FAX) 301-734-7964

Mr. Rick Taylor
Texas Parks & Wildlife
Dept
P O Box 5207
Uvalde, TX 78801
(Phone) 830-789-9151

Dr. George Teagarden
Kansas Animal Health Dept
708 S Jackson
Topeka, KS 66603
(Phone) 785-296-2326
(FAX) 785-296-1765

Mr. Doug Updike
CA Dept of Fish & Game
1416 Ninth Street
Sacramento, CA 95814
(Phone) 916-653-1937
(FAX) 916-653-1019

Mr. Margarito Vega
Texas Animal Health Commission

Dr. Gary Walch
USDA APHIS VS
P O Box 536
Bellville, TX 77418
(Phone) 409-865-5194

Dr. Pat Walsh
Avon Park Air Force Range
29 South Boulevard
Avon Park, FL 33825
(Phone) 941-452-4254
(FAX) 941-452-4221

Dr. David Warner
USDA APHIS VS
7022 NW 10th PL
Gainesville, FL 32605
(Phone) 352-333-3120
(FAX) 352-333-6849

Mr. Dan Watson
I-Diamond-I LLC
P O Box 919
Route 2 Box 287
Goldthwaite, TX 76844
(Phone) 915-938-5403
(FAX) 915-938-5403

Mr. Jim Weems
Frontier Meats
2180 CR 120
Morton, TX 79346
(Phone) 806-254-4221

Dr. C Wheeler
USDA APHIS VS
Route 2 Box 556
Saluda, SC 29138
(Phone) 864-445-2372
(FAX) 864-445-4665

Mr. David Whitehouse
International Paper
P O Box 631310
Nacogdoches, TX 75963
(Phone) 409-564-8375
(FAX) 409-564-0503

Mr. Smokey Wilson
Texas Animal Health Commission

Dr. Michael Wooten
USDA APHIS VS
1017 Main Campus Dr # 2500
Raleigh, NC 27606
(Phone) 919-513-4170
(FAX) 919-513-4446