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A Comprehensive Nine-Year Case History of Texas A&M AgriLife Extension's Educational Impacts on Wild Pig Damage Abatement in Texas

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ABSTRACT: Texas has the largest wild pig population in the nation, estimated at 2.6 million animals. Damage to agronomic enterprises was conservatively estimated in 2004 at \$52 million annually with total economic damage to agriculture and the environment in urban, suburban, and rural Texas possibly reaching 10 times that figure. In response to damage caused by this invasive exotic species, the Texas A&M AgriLife Extension Service increased educational programming efforts of wild pigs and damage abatement. From 2006-2014, project funding from multiple sources facilitated the development and deployment of Texas A&M AgriLife Extension Service-led landowner education via one-on-one contacts, group meetings, demonstrations, and publications. Website availability and mass media contacts, including television and radio interviews and newspaper and magazine articles, were also utilized to increase public awareness and education on wild pigs and damage abatement. Participants ($n = 21,752$) attending Extension educational events were surveyed ($n = 13,054$) to characterize damage and control efforts as well as measure the impacts of education efforts. The most commonly reported negative impacts by landowners were pastures/hay meadows (72%) and owner/employee time (38%), while the most commonly used control technique prior to participation in an educational event was trap and destroy (51%). The average amount of losses attributable to wild pigs in the year prior to attending an educational program was \$4,764 each and their predicted loss after participation decreased to \$3,565. Over 98% of respondents indicated they increased their knowledge of wild pigs and damage abatement and planned to adopt an average of three new management practices each, with the most commonly cited new practices being using larger traps and pre-baiting wild pigs. A Net Promoter Score of 60.4% indicated that survey respondents were very pleased with the information they received by attending an Extension educational event directed at wild pigs and the abatement of their damage. This educational model can serve as a template for other states dealing with wild pigs as an emerging issue whenever their negative impacts on agriculture, the environment, and human health and safety occur.

KEY WORDS: control techniques, damage abatement, education, Extension, *Sus scrofa*, swine, Texas, wild pigs

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INTRODUCTION

The term "wild pig" is the common name used to describe North American populations of feral pigs, feral hogs, feral swine, wild boars, and other populations of the family Suidae (Mayer and Brisbin 1991). Wild pigs are considered an invasive species in Texas, with approximately 2.6 million head occupying 85% or more of the counties in Texas (Higginbotham et al. 2008). Rollins et al. (2007) reported Texas has the largest population of wild pigs of any state in the United States. European wild hogs and European-feral crossbreeds are the types of wild pigs located in Texas (Taylor 1991). Texas landowners need information on how to best manage wild pigs on their property (Adams et al. 2005). Studies have shown the population of wild pigs in Texas has more than doubled from one million (Taylor 1991) to over two million (Rollins et al. 2007) in 15 years. As of 2013, there were an estimated five million wild pigs in the U.S., with the largest concentrations of wild pigs located in the western and southern states (Plasters et al. 2013). Today there may be as many as eight million wild pigs in the U.S. (John Mayer, pers. comm.).

Wild pigs negatively impact many resources in Texas. Wild pigs can have a detrimental effect on water quality by increasing levels of waterborne bacteria (Kaller et al. 2007). Rooting by wild pigs can result in two to eight inches of soil being plowed up; several acres can be damaged by a group of wild pigs in a short time period

(Pierce 2009). The rooting and wallowing tendencies of wild pigs can result in holes and ruts that can lead to equipment damage as well as pose a threat to equipment operators or unwary individuals traversing the fields (Hamrick et al. 2011). Management of wild pigs that are damaging crops can have distinct issues such as difficulty in seeing wild pigs in the crops due to dense foliage cover, proximity of crops to heavy cover such as brush or woods which enhances the ability to escape, and the likelihood of wild pigs running into adjacent properties owned by other landowners who may not allow access onto their property (Muir and McEwen 2007). Seward et al. (2004) state that wild pigs cost the U.S. approximately \$800 million in agricultural crop damage per year. This estimate is likely conservative because it does not include other effects wild pigs have on their environment (Seward et al. 2004). In 2011, it was reported that wild pigs cause more than \$1 billion in crop damage and predation of livestock (Bevins et al. 2014). In Texas, 75% of participants in a survey identified damage to agricultural crops as their most significant concern in relation to wild pigs (Seward et al. 2004). Higginbotham et al. (2008) estimated that wild pigs cause \$52 million in agricultural damage in Texas each year.

Wild pigs are opportunistic omnivores and will feed on nearly anything, especially when resources are scarce. According to Giuliano (2010), this competition creates a limiting factor for other species. Wild pigs have been

known to prey upon the nests and young of herpetiles such as turtles, ground-nesting birds, and mammals such as deer fawns (Giuliano 2010). Young domestic livestock have also been predated upon by wild pigs. Almost any agricultural crop is susceptible to wild pig foraging, as are tree seeds and seedlings (Mapston 2007, Giuliano 2010).

Wild pig impacts on humans are well known, although direct attacks on humans are rare. Vehicle, train, and aircraft collisions with wild pigs have been documented. Vehicle collisions are the most common, and they can be potentially very serious due to the size and low center of gravity of wild pigs. Single pig collisions are the most common, although it has been reported that in one collision 23 animals were involved. Accidents can occur year-round and at any time during a 24-hour period, but they are more likely to take place in the fall and winter and at night.

Wild pigs are known to harbor “bacterial and viral diseases that can infect wild animals, livestock, and humans” (Centner and Shuman 2014). The Centers for Disease Control and Prevention state that disease contraction can occur when field dressing, butchering, or eating undercooked wild pigs. Swine brucellosis is a zoonotic disease but can be avoided by wearing proper safety equipment, such as gloves and eye protection, and washing hands when field dressing a wild pig. Brucellosis and pseudorabies can also be passed on to other animals and livestock (Centner and Shuman 2014, Hill et al. 2014).

Numerous states that have never had a wild pig problem are being gradually invaded. This is largely due to the illegal transportation and release of wild pigs. Often, these translocations are for hunting purposes (Lang 2007). In Texas, the transportation, holding, and release of wild pigs is regulated by the Texas Animal Health Commission. The Texas Parks and Wildlife Department has jurisdiction over sport hunting of wild pigs. Certified holding facilities can legally hold for up to seven days in secure pens or trailers (Timmons et al. 2011). Perceived incentives of introducing wild pigs are instrumental in the spread of wild pig populations. These incentives often include increased hunting opportunities and the resulting monetary gains (Plasters et al. 2013). The last 20 years in particular have seen a dramatic expansion of wild pig ranges across the U.S. (Hamrick et al. 2011).

In Texas, wild pigs are a non-native species and thus can be harvested year-round. Toxicant control, however, is currently illegal in Texas and throughout the U.S. The U.S. Department of Agriculture’s Animal and Plant Health Inspection Service/Wildlife Services (USDA APHIS WS) is working with agencies in Australia to research a toxicant that could potentially be used to control wild pigs. This research is also being analyzed to identify the effects of the toxicant on non-target species in Texas (Aaronson 2011). Other research in Texas regarding the effect toxicants, especially sodium nitrite, have on non-target species has been conducted in an effort to secure more cost-effective wild pig control measures (Foster 2011). The USDA APHIS WS is also conducting research on sodium nitrite as a potential wild pig toxicant. Contraceptive vaccines are also being researched as a potentially species-specific method to reduce wild pig populations with minimal collateral damage (Samoylova et al. 2012).

Legal wild pig control methods in Texas include

trapping, snaring, shooting, and dogging. Trapping is the most commonly used method due to its relative effectiveness as a control technique (Stevens 2010, Williams et al. 2011). Advances in wireless technology have resulted in the development of corral traps with gates that have the ability to be monitored and controlled from a remote device such as a computer or cellular device (Tyson 2013). Higginbotham (2010) reported that there are at least 5 companies that offer this technology; however, the high up-front costs (\$2,500-\$10,000+) associated with remote trigger trapping technology may inhibit adoption of this methodology by many landowners.

Several studies have assessed the impact of education on invasive species management. A Portugal study evaluated human perception of invasive plant species. Identification and control of invasive plant species, as well as competition between native and invasive species, were covered in a workshop; then, a year later a questionnaire was sent to participants. This questionnaire revealed an increase in workshop participants’ knowledge, suggesting that practical informal education activities may be effective educational tools (Reis et al. 2011).

An on-line citizen science teaching method was conducted in order to increase data collection and monitoring of invasive species. However, it was determined that on-line training may not be sufficient for imparting the knowledge and skills the training was hoping to accomplish (Newman et al. 2010). An educational program that sought to increase the scientific literacy of citizen volunteers saw some success in the use of multi-item contextual instruments (Cronje et al. 2011).

The Texas A&M AgriLife Extension Service provides quality, relevant, research-based educational information to the people of Texas. These educational efforts (relative to wild pig damage abatement) were delivered to the public through county Extension agents via the subject-matter specialist(s) at the county, multi-county, regional, and state levels. The Texas A&M AgriLife Extension Service is the only state agency uniquely positioned to address the educational aspects focusing on wild pigs and their damage to Texas agriculture.

In 2005, the Texas Department of Agriculture (TDA) issued a request for proposals for projects that could address wild pig damage abatement issues in Texas. Texas A&M AgriLife Extension (which includes Texas Wildlife Services) was successful in obtaining funds to conduct a pilot project that encompassed both education of and direct assistance/service to landowners negatively impacted by wild pigs.

The Wild Pig Damage Abatement Pilot Project was conducted over a two-year span beginning in January 2006 with funding provided by the Texas Department of Agriculture. Higginbotham et al. (2008) defined direct control as “on-site technical assistance.” Indirect control was identified as group educational events that stressed the use of effective landowner established control methods (Higginbotham et al. 2008).

The focus of the Wild Pig Damage Abatement Project was not necessarily the reduction of wild pig population size; rather, the true determinant of whether a control program was viewed as successful was the reduction of the economic impacts of wild pigs. This program sought to

utilize both direct and indirect control methods of wild pigs and resulted in significant monetary savings over the span of the program. However, many wild pig control programs have been unsuccessful due to inadequate funding, lack of clear objectives, unrealistic objectives, and fragmented control programs (Campbell and Long 2009).

Extension-led educational efforts relative to wild pig damage abatement can be separated into two categories: 1) a proactive approach requiring the ability to recognize sign of wild pigs' presence (e.g., tracks, wallows) before damage occurs, and 2) reaction to the damage they cause (e.g., rooting in pastures and greenspaces, crop depredation). In Texas, landowners can have a significant wild pig impact on their property but never see the pigs in the daytime. This nocturnal behavior and ability to move over long distances in search of food is often found where unsuccessful control efforts have been conducted in the past. Failure to react to the sign wild pigs leave behind will ultimately result in their dealing with damage. Extension educational efforts emphasize a proactive approach to wild pig control followed by the adoption of Best Management Practices if and when control efforts become necessary.

METHODOLOGY

The study was a quantitative study with a survey research design. Data from the Statewide Wild Pig Damage Abatement Pilot Project (Appendix 1), conducted from 2006-2007, as well as data collected subsequently using the modified Pilot Project instrument (Appendix 2) were analyzed. The purpose of this study was to determine knowledge gained and plans to adopt practices for wild pig control in the framework of Rogers' (2003) theory of diffusion of innovations, Ajzen's (1985) Theory of Planned Behavior, and Knowles' (1980) Theory of Andragogy.

The Wild Pig Damage Abatement Pilot Project was the impetus for additional funding to be granted to the Texas A&M AgriLife Extension Service, which is the state agency in Texas best suited to educate landowners on wild pigs and the agricultural damage they cause (Higginbotham et al. 2008). The objectives of this study are as follows: 1) describe the negative impacts caused by wild pigs on respondents' property in the past year; 2) describe the control methods used by landowners prior to the program; 3) determine total economic losses on property(s) due to wild pigs during the year prior to the program; 4) determine landowner estimates of future losses on property(s) due to wild pigs during the year after the program; 5) quantify income made by landowners by trapping and selling wild pigs and/or leasing hog hunting rights in the year prior to the program; 6) determine whether landowners perceive they gained knowledge of wild pigs and their control from attending the program; 7) describe the change in landowners' knowledge in the areas of wild pig biology, legal control options, efficient trap/bait techniques, and types/extent of hog damage after taking the program; 8) describe landowners' planned adoption of innovations to manage wild pigs after participating in the program; and 9) describe landowners' likelihood of recommending the Texas A&M AgriLife Extension Service (including Wildlife Services) to family and friends as a contact for information on wild pigs and their control.

Data Collection and Instrumentation

Data collected during the Statewide Wild Pig Damage Abatement Pilot Project from 2006-2014 was used for the purposes of this study. In 2007, the survey instrument (Appendix 1) utilized by the Wild Pig Damage Abatement Pilot Project was modified with the addition of four questions (Appendix 2): How much income did you make by trapping and selling hogs and/or leasing hog hunting rights last year? Did you increase your knowledge of feral hogs and their control by attending this program? Rate your knowledge before and after the program on these four subjects (wild pig biology, legal control options, efficient trap/bait techniques, and types/extent of wild pig damage) and mark only one number for each answer choice with 1 = no/little knowledge, 3 = some knowledge, 5 = high level of knowledge; Mark all practices (use larger traps, use baits with scent appeal, vary/change baits, set traps when sign appears, pre-bait traps, scout for pig sign, wear protective gear during field dressing and/or market trapped pigs to processors) that you plan to adopt in order to better manage wild pigs on your property; and, based on the information provided at the program, what is the likelihood that you would recommend Texas A&M AgriLife Extension Service to your family and friends as a control contact for information on feral hogs and their control?

The Net Promoter Score (NPS) is a measure of an entity's or program's growth engine and efficiency (Riechheld 2006). A Likert scale ranging in value from 0 to 10 is used to identify a company's or agency's program promoters (defined here as the percent of clientele rating the Texas A&M AgriLife Extension Service as a 9 or 10) minus the program detractors (defined as the percent of clientele rating A&M AgriLife Extension as a 6 or below) using the previously described Likert Scale. Companies, agencies, and programs with the most efficient growth engines and high customer satisfaction receive Net Promoter Scores of 50% or higher from their customers and/or clientele.

Data Analysis

The data were analyzed through the use of Statistical Package for the Social Sciences (SPSS) version 22. Descriptive statistics allow a multitude of scores to be represented by a select few indices (Fraenkel and Wallen 2009). Due to the nature of this study and the large amount of data available, descriptive statistics were useful in the analysis and reporting of pertinent information.

Regression analyses were conducted in order to test the effects of the independent variables on the dependent variable. Fraenkel and Wallen (2009) state that a regression line is a line that comes closest to all of the scores found in a scatterplot. This line can then be used to predict future scores. A regression analysis is used to predict a dependent variable based on its relationship to one or more independent variables.

Further, the study used a correlational research design to accomplish several of the objectives. Correlation seeks to identify relationships among variables (Fraenkel and Wallen 2009). However, it is important to note that a correlation between two variables does not determine a causal relationship between those two variables. Correlation coefficients express the degree of relationship

between two variables; they can also be used as measures of reliability and validity.

Inferential statistics encompass methods of analyzing data that allow the researcher to make inferences about a population based on data collected from a sample. In this study, there were several independent variables that impacted the dependent variable, adoption of wild pig control practices. In cases where there are more than one independent variable, an ANOVA, or analysis of variance, can be used to determine if there are significant differences between the means of more than two groups" (Fraenkel and Wallen 2009).

RESULTS

A sample of $n = 21,752$ landowners had participated in the study from 2006-2014. Of those, aggregate data was available at the regional level for 13,054 participants (2006-2014) ("Feral Hogs Tableau Application," n.d.). The data analyzed at the individual level in this study resulted from 10,721 completed individual surveys from 275 programs conducted from calendar year 2008 to 2014 (Paul Pope, pers. comm.). The educational programs consisted of "group education events" (Higginbotham et al. 2008). Educational events occurred statewide and focused on indirect control, including information on wild pig life history, behavior, and landowner-initiated control techniques. Educational events were a minimum of one hour in length. Participants were administered a survey immediately post-program to determine overall impact of the initiative.

The target population of this study included all landowners in Texas. Convenience sampling was used to collect data for this study. This type of sample consists of individuals who are easy to access (Fraenkel and Wallen 2009). Data from 2006-2007 were available in summarized form at the county level only; data from 2008-2014 were available on an individual basis. As such, data from 2008-2014 was analyzed using SPSS; data from the first year (2006-2007) were analyzed separately at the aggregate level and then compared to the aggregated data from the following years (2008-2014). Since data for the first two years of the program were not available at the individual level, aggregate data were analyzed in order to make comparisons across all years.

The total response rate for all years of the Extension program indicate that over half of participants completed a survey ($n = 21,752$, $f = 13,054$, 60.0%). However, in many instances, survey respondents did not answer all nine questions.

Of the damage types reported, pasture damage was reported by 72% of survey respondents, followed by loss of landowner/employee time (38%), damage to fences, water troughs or other improvements (37%), commodity crop losses (26%), loss of land value (21%) loss of wildlife lease value, damage to food plots/feeders (20%), damage to wetlands (20%), damage to equipment or vehicles (17%), specialty crop losses (14%), livestock losses (10%), stored commodities (4%), and personal injuries (3%).

The most frequent control method employed by survey respondents was trap and destroy (51% of survey respondents) followed by landowner or employee hunting

(49%), use of dogs (17%), trap and sell (13%), trap and move (11%), lease hunting (8%), and "other" which included aerial gunning and snaring (8%).

Program participants were asked to estimate their economic losses attributable to wild pigs during the previous 12 months before participating in an Extension-led program. Sixty-three percent ($n = 8,285$) of the survey respondents reported economic losses totaling \$39,465,953, or a mean economic loss of \$4,764 each.

Program participants were then asked to estimate what they believed their economic loss would be in the upcoming 12 months based on what information they learned as a result of participating in the Extension-led wild pig program. Slightly over half (54%, $n = 7,055$) of survey respondents answered this question, and the total estimated damage in the year to come was \$24,730,885, or a mean economic loss estimated to be \$3,505 each.

The difference in the damage estimates prior to/after attending an Extension program was \$14,735,068 for a decline in damage of 37%. This value was utilized as a qualitative measure of program impacts based on the program participants value of the information received.

Respondents surveyed from 2008-2014 were asked if they increased their knowledge of wild pigs and their control by attending an Extension meeting. The vast majority of participants ($n = 9,804$, 98.8%) reported a perceived increase in their knowledge after program completion. Only 7.4 % ($n = 795$) did not answer this question.

Another question asked of survey respondents from 2008-2014 described the change in landowners' knowledge (pre- vs. post-program) in the specific areas of wild pig biology, legal control options, efficient trap/bait techniques, and understanding of the types/extent of wild pig damage after participating in the program. Each topic was scored on a Likert scale of 1 to 5 with 1 = little knowledge, 3 = some knowledge, and 5 = high level of knowledge. Percent knowledge change was calculated by $(\text{postmean} - \text{premean})/4 \times 100$.

The average reported score of knowledge prior to the program for efficient trap/bait techniques had the highest percent change from mean pre-program knowledge to post-program knowledge (44.7%, 2.64 vs. 4.43). Legal control options (43.5%, 2.68 vs. 4.42) and feral hog biology (43.2%, 2.54 vs. 4.27) had the next highest levels of percent change in knowledge based on pre and post means. Types/extent of wild pig damage (34.0%, 2.64 vs. 4.43) resulted in the lowest percent change in knowledge.

Another objective was to describe participants' planned adoption of practices to manage wild pigs after participating in the Extension program. This construct was measured using a multiple choice question where participants marked which of the eight possible methods they planned to adopt. Participants could mark none or all of the options, or any combination therein. Using larger traps ($n = 5,464$, 51.0%) was the most likely practice participants planned to adopt as a result of the program. Pre-bait traps to encourage consistent hog visits ($n = 5,073$, 47.3%) and scout for hog signs ($n = 5,027$, 46.9%) were the second- and third-most identified practices that participants planned to adopt as a result of the program. Participants indicated that wearing eyewear and gloves

during field dressing would be the least likely practice adopted ($n = 1,788$, 16.7%). This may have been due to the small percentage of respondents planning to process wild pigs for human consumption.

The items earning the highest scores for practices planned to adopt as a result of the program were use larger traps ($x = 0.51$, $SD = 0.50$) and pre-bait traps to encourage consistent hog visits ($x = 0.47$, $SD = 0.50$). Scout for hog sign (tracks, wallows, rubs, hair) ($x = 0.47$, $SD = 0.50$) and market trapped hogs to processors to recoup losses ($x = 0.37$, $SD = 0.48$) were the next highest scoring items. Use baits with scent appeal ($x = 0.35$, $SD = 0.48$) and set traps whenever fresh sign appears ($x = 0.33$, $SD = 0.47$) scored on the lower end for practices planned to adopt. The items earning the lowest scores were vary/change baits at different locations ($x = 0.28$, $SD = 0.45$) and wear eyewear and gloves during field dressing ($x = 0.17$, $SD = 0.37$).

The total number of practices planned to adopt by ($n = 10,721$) participants scored ($x = 2.96$, $SD = 2.35$). Of the eight wild pig control practices included in the survey, participants planned to adopt approximately three new practices each. There was a fairly high amount of variation, with as few as zero practices and as many as six practices falling within one standard deviation of the mean.

There was a wide range in number of practices participants planned to adopt. The largest percentage of the survey respondents ($n = 10,721$) planned to adopt zero practices ($n = 1,912$, 17.8%). The next largest percentage of practices planned to adopt was two ($n = 1,644$, 15.3%), followed by one ($n = 1,630$, 15.2%), three ($n = 1,506$, 14.0%), and four ($n = 1,288$, 12.0%). Participants who planned to adopt five practices ($n = 946$, 8.8%), six ($n = 698$, 6.5%), seven ($n = 558$, 5.2%), and eight practices ($n = 539$, 5.0%) made up the lowest frequencies of practices planned for adoption.

The last objective was to determine the likelihood of wild pig program attendees recommending the Texas A&M AgriLife Extension Service to others for information on wild pigs. This is a measure of customer satisfaction and results in the calculation of a Net Promoter Score (NPS). Over half of respondents scored the program a 10, "likely to recommend" ($n = 6,066$, 58.7%). The items that had the next highest frequencies were eight ($n = 1,413$, 13.7%) and nine ($n = 1,375$, 13.3%). The anchors subsequently indicated by the respondents were seven ($n = 615$, 5.9%), five ($n = 351$, 3.4%), and six ($n = 279$, 2.7%). In general, the lower half of the measurement scaled represented a very small percentage of answers from participants. Anchor four ($n = 82$, 0.8%), three ($n = 55$, 0.5%), zero, not likely to recommend Extension ($n = 44$, 0.4%), two ($n = 34$, 0.3%), and one ($n = 27$, 0.3%) made up this lower quadrant of participants.

On the 11-point scale used to measure participants' likelihood to recommend an Extension program, the average response was ($x = 8.96$, $SD = 1.68$). The reported mean indicates participants are likely to recommend an Extension program to those who are wanting to learn about wild pig control. In total, 11,401 respondents contributed to the calculation of the NPS. The percentage of promoters (scoring a 9 or 10) and detractors (scoring <7) were used to calculate the NPS. The number and percentage of promoters ($n = 8,012$, 70.3%) were greater than the

number of detractors ($n = 1,129$, 9.9%). When the difference was calculated between the percentage of promoters and detractors, a net promoter score of 60.4% resulted across all years in which a program was conducted. NPS scores above 50% are considered to be excellent and characteristic of meeting clientele needs and expectations (Reichheld 2006).

LITERATURE CITED

- Aaronson, B. 2011. Hogs can't fly, but a Texas bill allows their hunters to. Newspaper article, P. A23 in: New York Times, May 12, 2011, New York, NY.
- Adams, C. E., B. J. Higginbotham, D. Rollins, R. B. Taylor, R. Skiles, M. Mapston, and S. Turman. 2005. Regional perspectives and opportunities for wild pig management in Texas. *Wildl. Soc. Bull.* 33(4):1312-1320. doi: 10.2193/00917648(2005)33[1312:RPAOFF]2.0.CO;2.
- Ajzen, I. 1985. From intentions to actions: a theory of planned behavior. Pp. 11-39 in: J. Kuhl and J. Beckmann (Eds.), *Action control: from cognition to behavior*. Springer-Verlag, Berlin, Germany. doi: 10.1007/978-3-642-69746-3.
- Bevins, S. N., K. Pedersen, M. W. Lutman, T. Gidlewski, and T. J. Deliberto. 2014. Consequences associated with the recent range expansion of nonnative feral swine. *BioScience* 64(4):291-299. doi: 10.1093/biosci/biu015
- Campbell, T. A., and D. B. Long. 2009. Feral swine damage and damage management in forested ecosystems. *Forest Ecol. Manage.* 257(12):2319-2326. doi: 10.1016/j.foreco.2009.03.036.
- Centner, T. J., and R. M. Shuman. 2014. Governmental provisions to manage and eradicate feral swine in areas of the United States. *Ambio.* 44(2):121-130. doi: 10.1007/s13280-014-0532-9.
- Cronje, R., S. Rohlinger, A. Crall, and G. Newman. 2011. Does participation in citizen science improve scientific literacy? A study to compare assessment methods. *Appl. Envir. Educ. Commun.* 10(3):135-145. doi: 10.1080/1533015X.2011.603611.
- Foster, J. 2011. Effects of sodium nitrite on feral swine and non-targets. Texas Parks and Wildlife. Retrieved at https://tpwd.texas.gov/huntwild/wild/research/highlights/taxa/publications/Foster_2011_SodiumNitrateSwine.pdf.
- Fraenkel, J. R., and N. E. Wallen. 2009. *How to Design and Evaluate Research in Education*, 7th Ed. McGraw Hill, Boston, MA. 704 pp.
- Giuliano, W. M. 2010. Wild hogs in Florida: ecology and management. WEC77, IFAS Extension, University of Florida. 9 pp. Retrieved at <https://edis.ifas.ufl.edu/pdf/files/UW/UW32200.pdf>.
- Hamrick, B., M. Smith, C. Jaworowski, and B. Strickland. 2011. A landowner's guide for wild pig management: practical methods of wild pig control. Publ. ANRE-1397, Alabama Cooperative Extension System. 43 pp. Retrieved at <http://msucare.com/pubs/publications/p2659.pdf>.
- Higginbotham, B., G. Clary, L. Hysmith, and M. Bodenchuk. 2008. Statewide wild pig abatement pilot project, 2006-2007. Final Report, submitted to Texas Dept. of Agriculture. TAMU AgriLife Extension, College Station, TX. 46 pp. Retrieved at <http://feralhogs.tamu.edu/files/2010/05/06-07-Feral-Hog-Abatement-Pilot-Project.pdf>

- Higginbotham, B. 2010. Selecting a manual gate trigger for wild pig trapping. Texas AgriLife Extension Service. 8 pp. Retrieved at <http://feralhogs.tamu.edu/files/2010/04/Selecting-a-Manual-Pig-Trap-Trigger.pdf>.
- Hill, D. E., J. P. Dubey, J. A. Baroch, S. R. Swafford, V. F. Fournet, D. Hawkins-Cooper, D. G. Pyburn, B. S. Schmit, H. R. Gamble, K. Pedersen, L. R. Ferreira, S. K. Verma, Y. Ying, O. C. H. Kwok, H. Feidas, and G. Theodoropoulos. 2014. Surveillance of feral swine for *Trichinella spp.* and *Toxoplasma gondii* in the USA and host-related factors associated with infection. *Vet. Parasitol.* 205(3):653-665.
- Kaller, M. D., J. D. Hudson III, E. C. Achberger, and W. E. Kelso. 2007. Wild pig research in western Louisiana: expanding populations and unforeseen consequences. *Human-Wildl. Confl.* 1(2):168-177.
- Knowles, M. S. 1980. *The Modern Practice of Adult Education: From Pedagogy to Andragogy*. Cambridge Adult Education, Englewood Cliffs, NJ. 400 pp.
- Lang, M., and M. T. Mengak. 2007. Managing wildlife damage: Feral swine (*Sus scrofa*). Publ. ANRE-1397, Alabama Cooperative Extension Service. 2 pp. Retrieved at <http://www.forestry.uga.edu/outreach/pubs/pdf/wildlife/WDS%20No%206%20-%20Feral%20hogs.pdf>.
- Mapston, M. 2007. Feral hogs in Texas. Texas AgriLife Extension Service. 26 pp. Retrieved at http://oaktrust.library.tamu.edu/bitstream/handle/1969.1/87218/pdf_1911.pdf?sequence=1&disAllowed=y.
- Mayer, J. J., and I. L. Brisbin. 1991. *Wild Pigs of the United States: Their History, Morphology and Current Status*. Univ. of Georgia Press, Athens, GA. 313 pp.
- Muir, T., and G. McEwen. 2007. Methods and strategies for managing wild pig damage in grain production areas in central Texas. Pp. 445-450 in: *Managing Vertebrate Invasive Species: Proceedings of an International Symposium* (G. W. Witmer, W. C. Pitt, and K. A. Fagerstone, Eds). USDA APHIS WS, National Wildlife Research Center, Fort Collins, CO.
- Newman, G., A. Crall, M. Laituri, J. Graham, T. Stohlgren, J. C. Moore, K. Kodrich, and K. A. Holfelder. 2010. Teaching citizen science skills online: implications for invasive species training programs. *Appl. Environ. Educ. Commun.* 9(4):276-286. doi: 10.1080/1533015X.2010.530896.
- Pierce, R. 2009. Feral hogs in Missouri: damage prevention and control. *Agricultural MU Guide*, University of Missouri Extension. 4 pp. Retrieved at <http://extension.missouri.edu/p/G9457>
- Plasters, B., C. Hicks, R. Gates, and M. Titchenell. 2013. Feral swine in Ohio: Managing damage and conflicts. Ohio State University Extension. Retrieved from <http://ohioline.osu.edu/w-fact/pdf/W-26-13.pdf>
- Reichheld, F. F. 2006. *The Ultimate Question: Driving Good Profits and True Growth*. Harvard Business Press, Boston, MA. 224 pp.
- Reis, C. S., H. Marchante, H. Freitas, and E. Marchante. 2011. Public perception of invasive plant species: assessing the impact of workshop activities to promote young students' awareness. *Intl. J. Sci. Educ.* 35(4):690-712. doi: 10.1080/09500693.2011.610379.
- Rogers, E. M. 2003. *Diffusion of Innovations*, 5th Ed. Free Press, New York, NY. 576 pp.
- Rollins, D., B. J. Higginbotham, K. A. Cearly, and R. N. Wilkins. 2007. Appreciating wild pigs: extension education for diverse stakeholders in Texas. *Human-Wildl. Confl.* 1(2):192-197.
- Samoylova, T. I., A. M. Cochran, A. M. Samoylov, B. Schemera, A. H. Breitenicher, S. S. Ditchkoff, V. A. Petrenko, and N. R. Cox. 2012. Phage display allows identification of zona pellucida-binding peptides with species-specific properties: novel approach for development of contraceptive vaccines for wildlife. *J. Biotechnol.* 162(2-3):311-318. doi: 10.1016/j.jbiotec.2012.10.006.
- Seward, N. W., K. C. VerCauteren, G. W. Witmer, and R. M. Engeman. 2004. Feral swine impacts on agriculture and the environment. *Sheep & Goat Res. J.* 19:34-40.
- Stevens, R. 2010. *The feral Hog in Oklahoma*, 2nd Ed. The Samuel Roberts Noble Foundation, Ardmore, OK. 19 pp. <http://hughesccd.webs.com/Feral%20Hogs%20in%20Oklahoma.pdf>
- Taylor, R. 1991. The feral hog in Texas. Publ. PWD BK W7000-195. Texas Parks and Wildlife Department, Austin, TX. 20 pp.
- Timmons, J., J. C. Cathey, N. Dictson, and M. McFarland. 2011. Wild pig transportation regulations in Texas. Website eXtension. Retrieved at <http://feralhogs.tamu.edu/files/2011/08/Feral-Hog-Transportation-Regulations.pdf>
- Tyson, M. 2013. High tech hog trapping: incorporating technology into feral hog trapping. Website. Wild Wonderings, Texas AgriLife Extension Service. Retrieved at <http://wild-wonderings.blogspot.com/2013/08/high-tech-hog-trapping-incorporating.html>.
- Williams, B. L., R. W. Holtfreter, S. S. Ditchkoff, and J. B. Grand. 2011. Trap style influences wild pig behavior and trapping success. *J. Wildl. Manage.* 75(2):432-436. doi: 10.1002/jwmg.64.

You recently heard discussions about feral hog life history, behavior and control information at a program hosted by Texas Cooperative Extension. Please take a minute to complete the following so we can gauge the economic impact feral hogs in Texas and the value of information you received. Please return the completed survey as soon as possible. Your response will assist us in planning future educational programs and possibly to obtain resources for programs to control feral hog populations in Texas.

Possible Area of Loss	Please check all areas that apply
Growing or planting commodity crop losses	
Growing or planting specialty crop losses	
Stored commodities	
Pastures	
Wetlands	
Livestock (deaths, diseases, etc.)	
Fences, water troughs, or other improvements	
Equipment or vehicles	
Personal injuries	
Loss of land value	
Loss of lease value, damage to food plots, or wildlife feeders.	
Owner and/or employee time	

Control measure	Please check all areas that apply
Trapped & destroyed	
Trapped & moved from premise	
Trapped & sold	
Owner & employee hunting	
Lease hunting	
Use of dogs	
Other:	

- 0 1 2 3 4 5 6 7 8 9 10
Not Likely Likely

MARKING INSTRUCTIONS

CORRECT: ☐ INCORRECT: ☐ ☐ ☐ ☐ ☐

WILD PIG DAMAGE AND CONTROL SURVEY

You have recently participated in a program on wild pig life history, behavior and control information hosted by Texas A&M AgriLife Extension Service. Please complete the following on the economic impact of wild pigs and the value of information you received. Your survey will assist us in planning future programs.

1. Please mark all of the areas in which wild pigs had negative impacts on your property in the past year.
☐ Growing or planting commodity crop losses	☐ Fences, water troughs, or other improvements
☐ Growing or planting specialty crop losses	☐ Equipment or vehicles
☐ Stored Commodities	☐ Personal injuries
☐ Pastures	☐ Loss of land value
☐ Wetlands	☐ Loss of lease value, damage to food plots/feeders
☐ Livestock (injury, deaths, diseases)	☐ Owner or employee time

2. Please mark all of the control methods you use on your property(s).
☐ Trapped & destroyed	☐ Trapped & Sold	☐ Lease hunting
☐ Trapped & moved from premise	☐ Owner/Employee hunting	☐ Use of dogs
☐ Other (snares, aerial gunning)		

3. "Please estimate your total economic losses due to wild pigs during the previous year on all your property(s). This includes all items marked above in Question 1. \$.00
(dollars only)

4. What do you expect your losses due to wild pigs to be during the upcoming year AFTER implementing what you learned at Texas A&M AgriLife Extension Service workshop(s)? \$.00
(dollars only)

5. How much income did you make by trapping and selling pigs and/or leasing wild pig hunting rights last year? \$.00
(dollars only)

6. Did you increase your knowledge of wild pigs and their control by attending this program? ☐ Yes ☐ No

7. Rate your knowledge before and after the program on these subjects. Mark only one number for each answer choice with 1 = no little knowledge, 3 = some knowledge, 5 = high level of knowledge.

TOPICS	Before the Meeting	After the Meeting
a. Wild pig biology	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
b. Legal control options	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
c. Efficient trap/bait techniques	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
d. Types/extent of pig damage	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

8. Please mark all practices that you plan to adopt in order to better manage wild pigs on your property:
☐ Use larger traps	☐ Pre-bait traps to encourage consistent pig visits
☐ Use baits with scent appeal	☐ Scout for pig sign (tracks, wallows, rubs, hair)
☐ Vary/change baits at different locations	☐ Wear eyewear and gloves during field dressing
☐ Set traps whenever fresh sign appears.	☐ Market trapped pigs to processors to recoup losses
9. Based on the information provided at the program, what is the likelihood that you would recommend Texas A&M AgriLife Extension Service (includes Wildlife Services) to your family and friends as a contact for information on wild pigs and their control? Mark one number below with 0 = not likely and 10 = likely.
- ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10
- Not Likely Likely