THE HUMAN DIMENSIONS OF WILD PIG MANAGEMENT IN TEXAS

A Thesis

by

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ABSTRACT

Wild pigs (*Sus scrofa*) are a widespread exotic, invasive species that poses ecological, agricultural, and human health risks in their invaded range. Wildlife managers must manage wild pig abundance and range expansion to mitigate these risks. The diversity of stakeholders involved in the issue of wild pig management complicates efforts to manager the species, and, to be successful, wildlife professionals must consider the human dimensions associated with wild pig management. The prevalence of privately-owned lands in Texas necessitates cooperation to enact effective management policies. In this thesis, I investigate the factors that affect an individual's likelihood to participate in wild pig hunting activities, the impact of hunter motivations on wild pig harvest quantity, and whether Texas A&M AgriLife Extension Service education efforts have successfully inspired change in wild pig management on private lands.

Multiple factors impact participation in wild pig hunting activities. Participation in other types of big game hunting increased likelihood of participation in wild pig hunting. Results suggest that wild pig hunting does not deter individuals from participating in other types of hunting activities. Additionally, perceptions of wild pigs are important in determining the likelihood of participation in wild pig hunting. The diversity of wild pig hunters in Texas necessitates that wildlife managers understand the desires of the public as well as natural resource needs.

Motivations driving wild pig hunting are similarly diverse. While the majority of wild pig hunters in Texas are motivated by trophy value, meat-motivated hunters harvest more wild pigs per day afield. Results suggest that hunting alone is not sufficient to

reduce wild pig abundance and range expansion. Alternatively, wildlife managers should develop plans that include various management techniques to control wild pig population growth and damage. Education and outreach will continue to be important for involving private landowners in effective wild pig management.

Texas A&M AgriLife Extension Service has provided education on wild pig management and damage abatement for 30 years. This study finds that Extension wild pig seminar attendees harvest more wild pigs than non-attendees. Further, attendees continue to employ several suggested management techniques for wild pig trapping. Extension education specialists may improve technique adoption by reducing barriers to adoption among Texas landowners.

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CHAPTER I

INTRODUCTION

Literature Review

Understanding the human dimensions of wildlife

The field of wildlife conservation and management has historically addressed issues of wildlife population sizes and how to manage them, understanding systems between biotic and abiotic components of the ecosystem, and the management of natural resources (Manfredo 2008, Garton et al. 2012). Increasingly, managing human-wildlife conflicts has become an important part of a wildlife manager's job (Manfredo 2008). Human-wildlife conflict existed long before wildlife conservation emerged as a field of science and has been addressed in a variety of ways, ranging from non-lethal deterrents to annihilation of problematic animals and populations (Manfredo 2008, Frank and Conover 2015). As human populations grow and settlements expand into previously uninhabited areas, human-wildlife conflicts will likely continue (Manfredo 2008). However, there are many factors to consider when deciding how to mitigate such conflicts. It is important for wildlife managers to cooperate with local stakeholders, and to consider the sentiments of the general public when choosing a management action (Manfredo 2008).

Decker and Enck (1996) assert that "the fundamental value of human dimensions inquiry is to develop an understanding of people who stand to benefit from or be negatively affected by management decisions and actions." In this sense, wildlife managers may consider individuals or groups who impact or may be impacted by management decisions stakeholders (Decker et al. 1996). Differing stakeholder groups may maintain different positions in wildlife management decisions, and managers must

decide which positions to emphasize in the decision making process (Decker et al. 1996). Modern wildlife managers and decision-makers must use interdisciplinary approaches and social science tools to understand the scope of differing public positions on wildlife management issues (Manfredo 2008).

Many efforts to undertake social research in the field of wildlife management and conservation utilize close-ended surveys and questionnaires (Manfredo 2008). These quantitative methods seek to explore human behavior, attitudes, or perceptions using standardized categories (Drury et al. 2011). The Theory of Planned Behavior is frequently used to study human dimensions in wildlife sciences due to its predictive validity and focus on explicit attitudes, because individuals are consciously aware of these attitudes and can report them (Manfredo 2008). Values, beliefs, attitudes, and norms are important factors within the cognitive hierarchy that help individuals to form behaviors in response to an object or idea (Fulton et al. 1996). The Theory of Planned Behavior holds that attitudes, norms, and perceptions of behavioral control are factors that affect an individual's behavior (Ajzen 1985, 1991, 2002; Manfredo 2008).

Attitudes are personal evaluations of an object or behavior (Ajzen 1985, 1991, 2002; Manfredo 2008). Attitudes have been examined in many aspects of human dimensions research because salient attitudes are predictive of behavior, easily accessed by respondent self-awareness, and are foundational to more complex psychological constructs (Manfredo 2008). Beliefs, which are basic thoughts held about objects and their attributes (Fishbein and Ajzen 1975), are important in constructing attitudes and may be used to better understand the attitudes surrounding wildlife management issues (Manfredo 2008). Norms and perceptions of behavioral control are less frequently

examined in human dimensions of wildlife management applications. Norms are the social pressures that individuals perceive concerning their actions toward an object or behavior (Ajzen 1985, 1991, 2002; Manfredo 2008). Perceptions of behavioral control describe the extent to which an individual feels they may act on a specific behavior (Ajzen 1991, 2002, Manfredo 2008). Together, attitudes, norms, and perceptions of behavioral control are evaluated to form behavioral intention, which then leads to action or inaction (Ajzen 1985, 1991, 2002, Manfredo 2008).

Attitudes and norms are formed from broad, overarching cognitive constructs known as values (Manfredo 2008). Values guide a person's interpretation of the world and affect attitudes and behavior through the hierarchy of cognitions (Manfredo 2008, Teel and Manfredo 2010). Value orientations are useful in identifying underlying stakeholder attitudes toward wildlife (Fulton et al. 1996). Tynon (1997) suggested the definition of a quality hunting experience was highly variable among hunters with different harvest expectations based upon their value orientations. Different stakeholders may possess different value orientations and thus perceive different benefits from their experiences with wildlife, affecting their attitudes toward the species. Values shift as cultures and groups develop or change over time (Manfredo 2008). Deruiter and Donnelly (2002) suggested that familial socialization, experience, and place play large roles in influencing wildlife value orientations. Additionally, hunting interest and experience strongly impact wildlife value orientations (Teel and Manfredo 2010). Recognizing the variation in stakeholder values is important in understanding the differences in their attitudes and behaviors toward wildlife.

Human dimensions of invasive species management

Stakeholder attitudes are an important factor in determining public support for and participation in exotic invasive species management (García-Llorente et al. 2008). Exotic, non-native, or alien species are species that exist in any ecosystem where they are not native (Executive Order 13112 1999). Exotic species may be introduced intentionally or incidentally (Pimentel et al. 2005). Exotic species often provide benefits and humans use many exotic species for agriculture, hunting, and aesthetic purposes (Pimentel et al. 2005), but are considered invasive when they threaten their invaded ecosystem or human health (Executive Order 13112 1999). Exotic invasive species cause both ecological and economic damage in the United States (Perrings et al. 2002, Pimentel et al. 2005). Invasive species pose threats to native wildlife through predation and competition and to the environment through the disruption of ecosystem services (Perrings et al. 2002, Pimentel et al. 2005). Exotic invasive agricultural pests and pathogens cost the United States billions of dollars in crop losses and pest management efforts each year (Pimentel et al. 2005). The extensive damage caused by invasive species necessitates management action, which often involves the participation of various stakeholder groups.

Environmental and economic impacts are strong motivations for stakeholder participation in invasive species management efforts (Ford-Thompson et al. 2012). However, support for invasive species management is affected by personally experienced impact and individuals may not be willing to contribute to the management of a species unless they are directly affected (García-Llorente et al. 2008). Invasive species impacts also may include realized or potential benefits, which are often underreported (Bonanno

2016). Individuals who identify benefits related to an invasive species may be less willing to contribute to management of the invasive species (García-Llorente et al. 2008). Additionally, support for invasive species management is influenced by knowledge and risk perception, and value orientations also play a strong role when direct impacts are not experienced (Sharp et al. 2011). When knowledge or personal experience are lacking and concrete rationale cannot be formed, emotion impacts support for lethal management of invasive species as well (Larson et al. 2015). However, even when attitudes are positive toward lethal control of invasive species, other barriers may affect management participation. For example, low perceptions of behavioral control due to a lack of knowledge and method difficulties lead to apathy toward invasive species management and the belief that it is unimportant among institutions and the general public (Prinbeck et al. 2011).

The dilemma of invasive wild pig management

The issue of wild pig management provides an interesting opportunity to investigate attitudes toward an exotic invasive species that is valued differently by different stakeholder groups. Wild pigs were initially introduced to the United States in the 1500s and have spread across the landscape of the country from their various points of introduction (Taylor 2003, Timmons et al. 2011*a*, Bevins et al. 2014, Snow et al. 2017). Wild pigs affect the natural environment in many ways, including degrading water quality (Kaller et al. 2007, Timmons et al. 2011*a*), damaging forested and grassland areas (Cushman et al. 2004, Chavarria et al. 2007, Siemann et al. 2009, Timmons et al. 2012*a*), and predating upon native wildlife (Seward et al. 2004, Mapston 2007, Wilcox and Vuren

2009, Jolley et al. 2010, Timmons et al. 2011*d*). In addition to environmental concerns, wild pigs pose threats to livestock and human health by harboring and transmitting disease and parasites (Seward et al. 2004, Hartin et al. 2007, Mapston 2007, Wyckoff et al. 2009, Timmons et al. 2011*b*, Jack et al. 2012, Pedersen et al. 2012, Corn et al. 2013), and to crop production and storage through consumption (Seward et al. 2004, Campbell et al. 2010).

In some areas, genetic evidence suggests humans have moved wild pigs great distances to colonize new areas; thus, current regulations and fees may not be strict enough to deter the illegal movement of wild pigs (Caudell et al. 2016, Hernández et al. 2018). The anthropogenic spread of wild pigs raises questions about which groups might benefit from the population increase or range expansion of wild pig populations and to what extent those groups benefit from the presence of the species, both financially and otherwise (Tabak et al. 2017, Hernández et al. 2018). Wild pigs affect many different stakeholder groups: farmers, ranchers, hunters, entrepreneurs, lease owners, etc. However, wild pigs impact these different groups of people in different ways (Conover 2007, Weeks and Packard 2009, Frank and Conover 2015). For example, hunters may benefit by having a population to hunt closer to their home (Tolleson et al. 1995*a*); guided hunting companies have another type of hunting experience to sell; lease owners can increase hunting opportunities for leaseholders; and some individuals may just enjoy seeing wild pigs on their property. However, a nearby rancher may suffer extensive range damage due to wild pig foraging activities; a farmer may lose a significant portion of his crop; and residents in a local neighborhood may have to deal with property damage as the pigs move through their yards. Understanding the perspectives of different

stakeholder groups and the impacts that wild pigs have on them is important in developing outreach and education programs to mitigate wild pig damage and in developing plans to manage wild pigs that consider both the positive and negative qualities associated with the species (Bath 1998).

Invasive wild pigs have various uses in different areas of their invaded range. If an invasive species becomes important to local livelihoods, it cannot be assumed their negative impacts on the native ecosystem outweigh the positive impacts perceived by stakeholders because not all stakeholders value environmental impacts equally (Pejchar and Mooney 2009). For example, wild pigs in Hawaii are culturally and religiously important, even though the species causes environmental problems and promotes the spread of disease (Pejchar and Mooney 2009). In other parts of the species' invaded range, wild pigs are used as a resource for subsistence and recreational hunting (Rosa et al. 2018). Wild pigs replace bushmeat as the game of choice in the Pantanal region of Brazil and the resulting reduced hunting pressure on native wildlife is beneficial to those populations (Desbiez et al. 2011). Local residents in impoverished communities use wild pigs as a resource for meat and oil (Desbiez et al. 2011). Hunters refrain from harvesting pregnant females and castrate male wild pigs and allow them to mature, then fatten before harvesting (Desbiez et al. 2011). Understanding both the positive and negative aspects of invasive wild pigs is important in understanding stakeholder attitudes and beliefs toward the species and developing an acceptable management plan (Novoa et al. 2018).

The issue of wild pigs in Texas

Texas harbors the greatest number of invasive wild pigs in the United States (Mayer 2014). Despite continued efforts by various organizations to control wild pig populations, their numbers climb as the animals expand their range across the state of Texas into previously uninhabited areas (Taylor 2003, Timmons et al. 2012*b*, Bevins et al. 2014, Snow et al. 2017). Current education and outreach programs serve to educate stakeholders on wild pig biology and management practices to mitigate wild pig damage and control population growth. Previously, Feral Hog Appreciation Days held by the Texas A&M AgriLife Extension Service (AgriLife Extension) encouraged participants to consider ways that wild pigs may be used as a resource as well as the negative impacts of the species (Rollins et al. 2007). Since 2006, AgriLife Extension's Feral Hog Abatement Program has provided educational resources and technical assistance to landowners in wild pig management efforts (Higginbotham et al. 2008).

Despite the negative impacts of the species, wild pigs could be viewed as an "untapped resource" in Texas and could provide benefits such as income from lease hunting and market sale (Tolleson et al. 1995*a*). In Texas, wild pigs are not managed as game animals and provide a year-round resource for hunting with no harvest limits (Timmons et al. 2011*c*). However, private for-fee hunting may incentivize the maintenance of a viable wild pig population (Zivin et al. 2000). An optimal management program for wild pigs may strive to strike a balance between the damages incurred by the species and the revenue generated by maintaining populations for hunting use (Zivin et al. 2000).

Human dimension factors change over time and differences in losses and benefits between stakeholder groups often create difficulties in agreeing on management action (Frank and Conover 2015, Novoa et al. 2018). Texas is comprised of over 95% privately owned lands, making it essential to involve stakeholders in attempts to make decisions about wild pig management. Differences in public attitudes, risk perceptions, and values have the potential to cause conflict when creating management plans (Estevez et al. 2014). In areas where wild pigs hold cultural importance or provide local benefits, resident stakeholders value these animals differently than wildlife managers do and the selection of a management plan may be challenging and necessitate cooperation and mutual understanding (Weeks and Packard 2009). For example, in the Big Thicket National Preserve area of East Texas, local residents believe that wild pigs belong in invaded environments and should not be eradicated (Weeks and Packard 2009). Here, conflict occurs between resident stakeholders and wildlife managers over decisions concerning wild pig management methods and intensity, especially in regard to wasteful culling of the animals and non-local hunting efforts (Weeks and Packard 2009).

Lethal management options such as trapping, poisoning, and shooting are the only methods that have proven to reliably reduce wild pig populations and intense harvest rates are required to manage wild pig population numbers (Klinger et al. 2011, Massei et al. 2011). Factors such as perceived population reduction need, management effectiveness, and moral acceptability are important in determining public support for lethal management efforts (Selge et al. 2011). Public support for lethal wildlife management is strong when management goals are to protect human safety and agricultural resources (Reiter et al. 1999). In general, stakeholders prefer methods with

low risk to humans, minimal animal suffering, and high effectiveness (Reiter et al. 1999). Stakeholders who are impacted directly by wildlife damage are more likely to accept lethal control methods than those who are not (McIvor and Conover 1994). However, landowners may hold different attitudes toward wild pig management practices dependent upon their experience with the species on their property, hunting participation, and income threatened by wild pig damage (Watkins et al. 2019). To craft successful management plans for wild pig populations, wildlife managers need to understand the goals of local landowners and stakeholders.

Investigating the costs and benefits of wild pigs in Texas

Researchers in Texas have investigated human dimensions of wild pig management in the past. However, existing research includes inquiry into limited stakeholder groups on the subject, which may lead to management decisions that neglect other important attitudes, such as hunters and non-hunting recreationists. Existing research in Texas is restricted to landowners, land managers, and pesticide applicator license holders at AgriLife Extension educational seminars (Adams et al. 2006, Kubecka 2016). Further, data are limited in geographic extent (Adams et al. 2006, Kubecka 2016) and may not be representative of diverse publics within the state. Wild pigs impact many stakeholder groups and may have differing importance to different groups of individuals; further research is needed to include a more complete selection of stakeholders involved in the issue of wild pigs. In particular, comprehensive knowledge of hunter attitudes and motivations on the subject of wild pigs is not available (Beasley et al. 2018).

Additionally, I found no information on knowledge or attitudes toward wild pigs of non-hunting recreationists during this literature review.

Existing research documents the negative economic impacts of wild pigs in Texas (Adams et al. 2006, Kubecka 2016). However, the economic benefits of wild pigs have not been fully investigated (Beasley et al. 2018). Research into revenue generated through the sale of hunting licenses, wild pigs for meat, lease fees, outfitting services, and other activities would be beneficial in fostering a more holistic understanding of the issue.

Additional research should seek to assess the efficacy of these outreach programs in influencing changes in wild pig management methods by evaluating which methods have been adopted and continuously employed by participants. It is important to assess the efficacy of outreach communication and education efforts in order to understand how extension services affect public knowledge and perceptions of wild pigs (U.S. Department of Agriculture Animal and Plant Health Inspection Service 2017). Educational programs are important in communicating novel management tools and methods that may advance and improve wild pig management efforts (Beasley et al. 2018). Assessing educational program effectiveness will allow for improvements in outreach efforts. However, knowledge transfer alone does not always result in the adoption of new behavior (McLeod et al. 2015). While education and outreach programs are successful in increasing knowledge about wild pigs (Kubecka 2016), we must determine the extent to which this knowledge influences stakeholder management activities for the species. Investigations into how knowledge influences management

activity and method selection will be useful in understanding how education and outreach efforts may be more effective.

Research Objectives

To make better sense of various differing public viewpoints, a survey of a cross-section of different stakeholder groups offers valuable information for developing educational and management strategies for wild pigs. This research seeks to understand the human dimensions that influence the management of wild pigs in the state of Texas. This study aims to provide insight into the effectiveness of wild pig educational programs for increasing the public's knowledge of wild pig management practices, and to improve understanding of the selection of and success of different methods used to manage wild pigs, the perceived costs or benefits associated with maintaining wild pig populations between different stakeholder groups, and the changing success rates, motivations, and levels of effort devoted to wild pig management between stakeholder groups, spatially and temporally, in the state. Specifically, this research seeks to understand (1) the costs and benefits associated with wild pigs across stakeholder groups in Texas; (2) the extent and intensity that Texas hunters use wild pig populations as a resource for recreational and/or meat hunting; and (3) the motivations behind wild pig hunting in Texas. Ultimately, management decisions must be made that consider the greatest good to society, natural resources, and the economy, perhaps to the detriment of a minority who may benefit from wild pigs.

This study will help wildlife biologists and decision makers understand the reasons for the continued growth of wild pig populations despite education efforts, and

thus consider methods to improve education efforts so that stakeholders enact better management of wild pigs. The data also will provide important information regarding hunters' interests in wild pigs such as their use of the species as a resource, expenditures on wild pig hunting, preference for wild pig hunting opportunities in relation to other big game hunting opportunities, and why such a preference may exist. This research will help to answer questions about how the presence of wild pigs in Texas affects different types of hunting activities and what revenue may be generated through wild pig hunting activities.

CHAPTER II

TOWARD A TYPOLOGY OF WILD PIG HUNTERS IN TEXAS

Wild pigs (*Sus scrofa*) are a widespread exotic species, considered among the most invasive in the world (Lowe et al. 2000). The species is acclimated to a broad array of ecological conditions and boasts powerful invasion potential in many regions (Sales et al. 2017). Management is a necessity to mitigate ecological and agricultural damage resulting from wild pigs in much of the species invaded range (Rollins et al. 2007). However, wild pigs pose both threats and potential benefits to various stakeholder groups in these invaded areas. Thus, the issue of wild pig management provides an ideal opportunity to investigate attitudes toward an exotic, invasive species that is both valued as a hunting resource and is the subject of human-wildlife conflict.

Wild pig populations are established in several areas in North America, allowing many opportunities for both human use and conflict (Lewis et al. 2019). Since Spanish explorers initially introduced domestic pigs to North America in the 1500s, the species has since spread across the landscape of the continent from various points of introduction (Taylor 2003, Timmons et al. 2012*b*, Bevins et al. 2014, Snow et al. 2017). Subsequent introductions of European wild boar for hunting purposes further contributed to the distribution of the species across North America (Bevins et al. 2014). Both domestic swine and European wild boar belong to the species *Sus scrofa*, and, in areas of joint introduction and invasion, a hybrid of feral pigs and wild boar exists. These exotic, invasive wild pigs affect environmental health and natural resources in many ways, including degrading water quality (Kaller et al. 2007, Timmons et al. 2011*a*), damaging

forested and grassland areas (Cushman et al. 2004, Chavarria et al. 2007, Siemann et al. 2009, Timmons et al. 2012*a*), and predating upon native wildlife (Seward et al. 2004, Mapston 2007, Wilcox and Vuren 2009, Jolley et al. 2010, Timmons et al. 2011*d*). In addition to environmental concerns, wild pigs pose threats to human and animal health by harboring and transmitting disease and parasites (Seward et al. 2004, Mapston 2007, Timmons et al. 2011*b*, Jack et al. 2012, Pedersen et al. 2012), and to crop production and storage through consumption (Seward et al. 2004, Campbell et al. 2010).

Wild pigs have both positive and negative impacts on various stakeholder groups (Conover 2007, Weeks and Packard 2009, Frank and Conover 2015). For example, hunters may perceive a benefit because wild pigs provide hunting opportunities closer to their home (Tolleson et al. 1995*c*), while a nearby rancher may suffer extensive range damage due to the same wild pigs' foraging activities that destroy crops and pastures (Mengak 2012). Although wildlife management goals may differ between stakeholder groups, wildlife managers must develop plans that meet various demands, both biologically and socially defined. The management of exotic, invasive species that are valued differently by various stakeholder groups illustrates this complicated management paradigm. Recognizing both the positive and negative aspects of invasive wild pigs is important in understanding stakeholder attitudes and beliefs toward the species and developing a publicly acceptable and ecologically appropriate management plan (Novoa et al. 2018).

Human use and value of wild pigs varies widely across their present range. For example, wild pigs in Hawaii are culturally and religiously important, even though the species causes environmental problems and promotes the spread of disease (Pejchar and

Mooney 2009). In other parts of the species invaded range, wild pigs are a resource for subsistence and recreational hunting (Rosa et al. 2018). As such, wild pigs have the potential to become important in local livelihoods and cultures. Wild pigs replace bushmeat as the game of choice in the Pantanal region of Brazil and the resulting reduced hunting pressure on native wildlife is beneficial to those populations (Desbiez et al. 2011). When an invasive species becomes important to local livelihoods, wildlife managers cannot assume the negative impacts on the native ecosystem outweigh the positive impacts perceived by stakeholders, regardless of actual ecosystem damages, because not all stakeholders value environmental impacts equally (Pejchar and Mooney 2009). The duality of this issue necessitates a deep understanding of both positive and negative drivers toward wild pig use and management among stakeholders.

Stakeholder diversity and statewide wild pig presence in Texas provide an ideal opportunity to investigate the complexity of wild pig management. Texas harbors the greatest number of invasive wild pigs in the United States (Mayer 2014), and, despite continued efforts by various organizations to control wild pig population abundance and range expansion, the species is now found in all but one county in the state (Taylor 2003, Timmons et al. 2012*b*, Bevins et al. 2014, Snow et al. 2017, History of Feral Swine in the Americas 2018). Texas Administrative Code classifies wild pigs as free-roaming, domestic livestock (Texas Adminstrative Code 2019). Due to legally designated landowner ownership of resident wild pigs, these populations provide a year-round resource for hunting with no harvest limits (Timmons et al. 2011*c*). As Tolleson et al. (1995) foresaw, wild pigs now benefit landowners who lease hunting rights for the animals or trap and sell them to meat processors. Consequently, private lease hunting

opportunities likely incentivize the expansion and persistence of wild pig populations for their continued use (Zivin et al. 2000). Landowners may hold different attitudes toward wild pigs dependent upon their experience with the species on their property, hunting participation, and income threatened by wild pig damage (Watkins et al. 2019). However, stakeholders who access the benefits of wild pig presence may tolerate the risks associated with higher wild pig abundance, making it difficult to manage the species on private lands where they are considered a resource rather than a nuisance.

Differences in losses and benefits incurred by stakeholders in wildlife management decisions create potential for conflict as various groups may have contrasting acceptance capacities for wildlife populations (Decker and Purdy 1988). Stakeholder wildlife acceptance capacity describes the maximum size of a species population that is acceptable to a stakeholder group (Carpenter et al. 2000, Riley and Decker 2000*a*). While biological carrying capacity is influenced by habitat factors, stakeholder wildlife acceptance capacity is determined by socio-cultural factors such as attitudes, values, and risk perceptions (Riley and Decker 2000*b*, Zinn et al. 2000). Stakeholder wildlife acceptance capacity suggests that different stakeholder groups may tolerate different population sizes due to their perceptions of risks and benefits associated with a species (Decker and Purdy 1988, Zinn et al. 2000, Lischka et al. 2008).

In areas where wild pigs provide local benefits or hold cultural importance, resident stakeholders may tolerate wild pig presence despite their ecologically undesirable impacts (Weeks and Packard 2009). In such cases, the development of a management plan necessitates cooperation and mutual understanding between wildlife managers and various stakeholder groups. Given that 95% of land in Texas is privately

owned (Anderson et al. 2014), stakeholder involvement and support is necessary to achieve wild pig management goals. Stakeholder attitudes, risk perceptions, and values change over time and differences in losses and benefits between groups have the potential to cause conflict when creating management plans (Estevez et al. 2014, Frank and Conover 2015, Novoa et al. 2018). An optimal management program for wild pigs must strike a balance between the damages caused by the species and the revenue generated by maintaining populations for hunting use and market sale (Zivin et al. 2000).

Although a critical need for effective management, existing research on wild pig use and management in Texas focuses on landowners, land managers, and pesticide applicator license holders at Texas A&M AgriLife Extension Service educational seminars (Adams et al. 2006, Kubecka 2016). Further, data are limited in geographic extent, and may not be representative of diverse publics within the state. In particular, comprehensive knowledge of hunter attitudes and motivations on the subject of wild pigs is not available (Beasley et al. 2018). To create a wild pig management plan that is acceptable to various stakeholder groups, wildlife managers must understand and identify wild pig hunters as key stakeholders in the issue.

In this study, I identified factors that influence participation in wild pig hunting activities to generate a greater understanding of wild pig hunters in Texas. Specifically, I created a model for participation in wild pig hunting activities using hunter demographics, knowledge, attitudes, and habit-based factors. I employ the stakeholder wildlife acceptance capacity concept to develop a model that incorporates the effect of differing stakeholder group membership on wild pig hunting participation. I end with

implications for those seeking to manage wild pig abundance in the context of recreational harvest.

Methods

This study is part of a larger survey designed to assess the human dimensions of wild pig management in Texas. I developed the online version of the Texas A&M Human Dimensions of Wild Pigs Survey using Qualtrics Survey Software (Qualtrics 2005). I developed a paper version of the survey to mirror the online version as closely as possible to accommodate respondents with limited internet access or technological proficiency. The survey contains 79 questions, although instructions direct respondents to answer only the questions applicable to them.

I acquired contact information from the Texas Parks and Wildlife Department for Texas hunting license holders in 2018. Following Dillman's Tailored Design Method (Dillman et al. 2008), I contacted potential respondents through both email and physical mail. I selected all Texas hunting license holders above the age of 18 who provided an email address as potential respondents in the email group (n = 169,619). I also obtained mailing addresses for a randomly-selected subset of 2,615 licensed Texas hunters who did not provide an email address as potential respondents in the physical mail group. Members of the email group received an email invitation to participate in the online survey on 4 June 2019. I sent reminder email messages to email group non-respondents 3 and 5 days after the initial invitation (7 June and 10 June, 2019). I contacted potential physical mail group respondents through an invitation letter sent on 5 June, 2019. I followed the invitation letter with a reminder postcard to 1,000 randomly-selected mail

group non-respondents 21 days later on 26 June, 2019. The survey remained open for response submissions from both email and mail respondents until 9 July, 2019.

The survey asked respondents to answer questions related to their hunting activity, landownership status, their attitudes toward and knowledge about wild pigs in Texas, several demographic variables, and their area of residence. I developed a relational database to organize and manage response data using FileMaker Pro (FileMaker 2019). I manually entered paper survey responses into the database as I received the completed survey packets. I downloaded electronic response data to the database on 9 July, 2019 for cleaning and analyses. I conducted data analyses in Program R (R Core Team 2018, FileMaker 2019).

Data Analyses

I asked respondents to rank the animals they hunted most often in Texas. I used these responses to identify hunters who participated in wild pig hunting as well as hunting other types of game. Respondents reported their preference for wild pig population numbers in the state (Appendix A, Question 38). I also collected demographic variables such as age, gender, annual household income, education level, and ethnicity.

I analyzed responses to 7 Likert items and developed a scale measuring respondent attitudes toward wild pig management. Respondents reported their level of agreement from completely disagree to completely agree for 7 statements about wild pigs in Texas (Appendix A, Questions 53 through 59; Cronbach's alpha = 0.86). I conducted a principal component analysis (PCA) on the 7 attitude items with VARIMAX rotation. I

calculated eigenvalues for each factor in the data. I calculated respondent scores on 3 factors that emerged from the PCA for use in regression analysis.

Respondents answered a series of 10 true/false questions regarding their knowledge of wild pig biology, ecology, distribution, and legal status in Texas (Appendix A, Questions 42 through 51; Cronbach's alpha = 0.66). I determined the number of questions each respondent answered correctly and tallied this number as a knowledge score. Thus, knowledge scores could range from 0, indicating all incorrect answers, to 10, all correct answers.

To approximate the spatial distribution of hunters, I asked respondents to provide the ZIP code for their primary residence. I used U.S. Department of Housing and Urban Development (HUD) United States Postal Service ZIP Code Crosswalk Files data (HUD USPS ZIP Code Crosswalk Files 2018) to match ZIP codes to Texas counties. I then sorted each respondent into one of 10 natural regions of the state by county (Gould et al. 1960). To assess non-response bias in the data, I calculated the number of days to survey completion for each respondent and regressed 4 key questions on days to respond (Lindner et al. 2001).

Following the stakeholder wildlife acceptance capacity concept, I created a candidate model which included 13 variables and various interactions based on stakeholder group membership. I hypothesized that landownership or management status would be an important covariate on hunter attitudes toward wild pigs and wild pig population preference in the models. I also hypothesized that ecoregion of residence would affect landowner or land manager participation in wild pig hunting. I used logistic regression to model participation in wild pig hunting using demographic variables, game

preference, attitudes, and knowledge variables. I used stepwise AIC procedures to select the most parsimonious model for predicting wild pig hunting participation (Burnham and Anderson 2002). I calculated McFadden's pseudo-r^2 to assess the explanatory power of the selected model (McFadden 1973). I calculated odds ratios to understand the effects of model variables on wild pig hunting participation among Texas licensed hunters (Field 2013).

Results

Survey response

I successfully contacted 159,420 licensed hunters through email and 2,494 through conventional mail methods (total n = 161,914). I received 37,225 total responses to the survey for a combined response rate of 23.0%. Participants in the email contact group responded 23.2% to the survey while those in the conventional mail group responded 7.1%. Of all survey respondents, 93.6% indicated that they hunted in Texas (n = 34,827); 77.8% of those who identified themselves as hunters also identified as wild pig hunters (n = 27,100); 93.3% of wild pig hunters also reported hunting other big game animals in Texas; and 50.9% of wild pig hunters reported owning or managing land in Texas. I report additional respondent demographic and locality response results in Table II.1. I report respondent preferences for wild pig population numbers in Texas in Table II.2.

To test for non-response bias, I regressed several key questions on the number of days to response. While responses were different by the number of days to response ($P < 0.05$), effect sizes were very small ($r^2 = 0.0003$). I therefore concluded there was no

significant effect of non-response bias and the results could be generalized to the target population.

Table II.1. Hunter response to demographic and locality variables.

	Total (N = 34,827)
Age, years	
Mean (sd)	51.548 (13.8)
Median	53
Range	10 – 117
Unknown	7833
Gender	
Female	1,164 (4.3%)
Male	25,983 (95.7%)
Unknown	7,680
Education Level	
High school graduate, diploma or GED	5,418 (20.0%)
Some college, no degree	2,208 (8.2%)
Associate degree	2,058 (7.6%)
Trade/technical/vocational training	1,703 (6.3%)
Bachelor's degree	1,0209 (37.7%)
Master's degree	3,805 (14.1%)
Doctoral degree	1,644 (6.1%)
Unknown	7,782
Ethnicity	
White	24,444 (90.9%)
Spanish, Hispanic, or Latino	1,460 (5.4%)
Other	976 (3.6%)
Unknown	7,947
Income	
Less than $35,000	726 (2.8%)
$35,000 to $49,999	1,106 (4.3%)
$50,000 to $74,999	3,127 (12.2%)
$75,000 to $99,999	3,926 (15.3%)
Over $100,000	16,782 (65.4%)
Unknown	9,160
Ecoregion	
Blackland Prairies	2,973 (12.4%)
Cross Timbers	3,519 (14.7%)
Edwards Plateau	4,183 (17.4%)
Gulf Prairies	3,003 (12.5%)
High Plains	857 (3.6%)
Piney Woods	4,460 (18.6%)
Post Oak Savannah	2,899 (12.1%)
Rolling Plains	696 (2.9%)
South Texas Plains	1,283 (5.3%)
Trans-Pecos	135 (0.6%)
Unknown	10,819

Table II.2. Hunter response to Question 38[a].

Response	Total (N = 27100)
Unknown	3764
I do not know	1,318 (5.6%)
Completely removed	3,819 (16.4%)
Reduced	14,098 (60.4%)
Increase	505 (2.2%)
Remain the same	3,596 (15.4%)

[a]Question 38: What change would you like to see in wild pig population numbers in the state of Texas? (See Appendix A)

Principal Component Analysis

Two factors had eigenvalues larger than 1 (Kaiser 1960) and a third factor had an eigenvalue of 0.93. I selected the 3 factors that individually explained the largest percent of variance for further analyses (Table II.3). Combined, the 3 selected factors explained 75.7% of the variance in the data. I report the factor loadings after rotation in Table II.4.

Table II.3. Eigenvalues for all components of Principal Components Analysis

Component	Eigenvalues
1	5.88
2	1.15
3	0.93
4	0.80
5	0.65
6	0.62
7	0.48

Table II.4. Factor loadings for selected components of Principal Components Analysis

	Principal Components		
Items	1	2	3
Q53*[a]	-0.35	-0.53	-0.22
Q54	-0.40	0.49	-0.55
Q55*	-0.37	-0.54	0.03
Q56	-0.46	0.29	0.09
Q57*	-0.45	-0.13	0.08
Q58	-0.28	0.21	-0.08
Q59*	-0.30	0.22	0.79

[a]Asterisk indicates the response is reverse coded.

Factor loadings suggest that PC1 represents broad attitudes toward wild pigs. High values of PC1 indicate the respondent holds an overall positive perception of wild pigs. A hunter with high value in PC1 may, for example, agree that wild pigs do belong in Texas and do provide benefits that outweigh the harm they cause in the state. PC2 represents hunter perceptions of the utilitarian value of wild pigs. High values of PC2 indicate the respondent appreciates the utilitarian value of wild pigs. Respondents with high values of PC2 would agree that wild pigs are a valuable resource for recreation, meat, or income in Texas and do provide benefits that outweigh the harm they cause in the state. Finally, PC3 represents hunter tolerance of wild pigs. Respondents with low values of PC3 do not believe that wild pigs have the right to exist wherever they occur and agree the harm caused by the species outweighs the benefits of having them in Texas.

Factors affecting participation in wild pig hunting

I selected all respondents who identified themselves as Texas hunters for analysis. I removed all incomplete records from analysis, leaving 21,843 records. In the regression analysis, I attempted to predict participation in wild pig hunting using knowledge score,

PC1, PC2, PC3, landowner status, preference for wild pig population change, age, gender, income, education, ethnicity, big game hunter status, and ecoregion of residence. Stepwise AIC procedures indicated that Model 4 was the most parsimonious predictor of licensed Texas hunter's participation in wild pig hunting activities (Table II.5). The McFadden's pseudo-r^2 value of top performing model was 0.38 (*df* =44). I calculated odds ratios for each indicator variable (Table II.6).

Table II.5. Stepwise AIC output.

Model	K[a]	AICc	Delta AICc[b]	AICc weight	log-Likelihood
Model 4	44	12411.63	0.00	0.54	-6161.72
Model 3	45	12412.78	1.15	0.30	-6161.29
Model 2	46	12414.45	2.83	0.13	-6161.13
Full model	52	12417.69	6.07	0.03	-6156.72
Null model	1	19805.35	7393.73	0.00	-9901.68

[a]K denotes the number of parameters within the model.
[b]AICc: Akaike information criterion with penalty for additional complexity.

Table II.6. Odds ratios for factors in Model 4.

	Odds Ratio	β Estimate	SE	z value	Pr(>|z|)
(Intercept)	0.18	-1.69	0.44	-3.86	< 0.001
Knowledge score	1.24	0.21	0.02	13.09	< 0.001
PC1: Perception	1.20	0.18	0.01	12.42	< 0.001
Q31: Landowner status	1.21	0.19	0.22	0.86	0.390
PC2: Utilitarian	1.34	0.29	0.03	9.12	< 0.001
PC3: Tolerance	1.04	0.04	0.03	1.62	0.105
Q38: Completely removed	1.44	0.37	0.16	2.26	0.024
Q38: Reduced	1.83	0.60	0.14	4.43	< 0.001
Q38: Remain the same	3.23	1.17	0.18	6.62	< 0.001
Q38: Increase	3.13	1.14	0.34	3.33	< 0.001
Q73: Age, years	0.98	-0.02	0.01	-2.74	0.006
Q74: Male	1.01	0.01	0.41	0.02	0.981
Q76: Spanish, Hispanic, or Latino	0.82	-0.20	0.11	-1.90	0.057
Q76Other	1.20	0.18	0.14	1.29	0.196
Q77: $35,000 to $49,999	1.65	0.50	0.17	3.02	0.002
Q77: $50,000 to $74,999	1.59	0.46	0.14	3.30	< 0.001
Q77: $75,000 to $99,999	1.54	0.43	0.14	3.14	0.002
Q77: Over $100,000	1.81	0.59	0.13	4.63	< 0.001
Big game hunter status	13.40	2.60	0.23	11.09	< 0.001
Ecoregion: Blackland Prairies	1.07	0.07	0.12	0.56	0.575
Ecoregion: Cross Timbers	1.15	0.14	0.12	1.19	0.234
Ecoregion: Edwards Plateau	0.91	-0.10	0.11	-0.83	0.404
Ecoregion: Gulf Prairies	1.02	0.02	0.12	0.17	0.868
Ecoregion: High Plains	0.64	-0.45	0.18	-2.56	0.010
Ecoregion: Post Oak Savannah	1.19	0.17	0.15	1.17	0.242
Ecoregion: Rolling Plains	0.57	-0.57	0.22	-2.56	0.010
Ecoregion: South Texas Plains	1.10	0.10	0.19	0.51	0.609
Ecoregion: Trans-Pecos	0.37	-0.99	0.37	-2.71	0.007
Q31 * PC2.Utilitarian[a]	0.87	-0.14	0.04	-3.06	0.002
Q31 * Q38Completely removed	1.29	0.26	0.22	1.15	0.249
Q31 * Q38Reduced	0.93	-0.07	0.21	-0.35	0.727
Q31 * Q38Remain the same	0.67	-0.39	0.27	-1.47	0.141
Q31 * Q38Increase	0.39	-0.93	0.51	-1.81	0.069

Table II.6 Continued

	Odds Ratio	β Estimate	SE	z value	Pr(>|z|)
Q73: Age, years * Q74Male	0.99	-0.01	0.01	-1.72	0.085
Q74: Male * Big game hunter status	2.98	1.09	0.24	4.54	< 0.001
Q31 * Ecoregion: Blackland Prairies	1.07	0.07	0.18	0.37	0.709
Q31 * Ecoregion: Cross Timbers	0.86	-0.15	0.17	-0.87	0.386
Q31 * Ecoregion: Edwards Plateau	0.81	-0.21	0.16	-1.37	0.171
Q31 * Ecoregion: Gulf Prairies	1.03	0.03	0.18	0.19	0.853
Q31 * Ecoregion: High Plains	0.81	-0.21	0.25	-0.82	0.413
Q31 * Ecoregion: Post Oak Savannah	1.10	0.09	0.19	0.48	0.629
Q31 * Ecoregion: Rolling Plains	2.81	1.03	0.30	3.44	< 0.001
Q31 * Ecoregion: South Texas Plains	0.79	-0.24	0.24	-0.99	0.324
Q31 * Ecoregion: Trans-Pecos	1.94	0.66	0.56	1.19	0.235

[a]Asterisk indicates an interaction between 2 variables.

Each correct response to a knowledge question about wild pigs increased likelihood of hunting them (odds ratio = 1.2; $P < 0.05$). Hunters who held generally negative perceptions about wild pigs were less likely to hunt them (odds ratio = 0.8; $P < 0.05$). Hunters who did not ascribe utilitarian value to wild pigs were less likely to hunt them (odds ratio = 0.7; $P < 0.05$). Tolerance was not an important indicator for participation in wild pig hunting (odds ratio = 1.0; $P > 0.05$).

Having any kind of population preference for wild pigs increased the likelihood of hunting them and preferring the wild pig population to remain the same was the strongest predictor of wild hunting participation ($P < 0.05$). Hunters who wished to see wild pig

populations remain the same were 3.2 times more likely to participate in wild pig hunting than those who did not report a preference for wild pig population change. Hunters who desired an increase in wild pig population numbers were 3.1 times more likely to hunt them. Hunters who desired a reduction in wild pig population numbers were 1.8 times more likely to hunt them and those who wanted pigs completely removed were 1.4 times more likely to hunt them.

Age was a significant predictor of wild pig hunting participation and the likelihood of participation decreased with age (odds ratio = 1.0; $P < 0.05$). For each additional year of age, hunters were 1.826% less likely to participate in wild pig hunting. Gender alone was not a significant indicator and females were not different from males in likelihood to participate in wild pig hunting (odds ratio = 1.0; $P > 0.05$). However, male big game hunters were 3.0 times as likely as female big game hunters to participate in wild pig hunting (odds ratio = 3.0; $P < 0.05$). Hunters who hunted other types of big game animals were more likely to hunt wild pigs than those who did not (odds ratio = 13.4; $P < 0.05$).

Individuals who identified as Spanish, Hispanic, or Latino were 18.4% less likely to hunt wild pigs that those who identified as white (odds ratio = 0.8; $P = 0.056$). Income levels were all significant indicators of wild pig participation. Hunters who made over $100,000 per year in household income were significantly more likely to participate in wild pig hunting (odds ratio = 1.8; $P < 0.05$) and were 80.8% more likely to participate than individuals who made less than $35,000 per year. Hunters whose household income was $35,000 to $49,999 were 65.1% more likely to hunt wild pigs than hunters whose

annual household income was less than $35,000; $50,000 to $74,999 were 58.5% more likely; and $75,000 to $99,999 were 53.9% more likely.

Hunters in the High Plains, Rolling Plains, and Trans-Pecos ecoregions were significantly less likely to hunt wild pigs than hunters in the Piney Woods ecoregion ($P < 0.05$). Hunters in the High Plains ecoregion were 36.2% less likely; Rolling Plains ecoregion were 43.2% less likely; and Trans-Pecos ecoregion were 62.8% less likely to participate in wild pig hunting than hunters in the Piney Woods ecoregion ($P < 0.05$). Hunters in the Blackland Prairies, Cross Timbers, Edwards Plateau, Gulf Prairies, Post Oak Savanah, and South Texas Plains ecoregions were equally likely to participate in wild pig hunting compared to hunters in the Piney Woods ecoregion.

Neither landownership nor management status was not an important overall indicator of participation in wild pig hunting ($P > 0.05$). However, there was an important interaction effect of landownership and management status on hunters' utilitarian perceptions of wild pigs and their ecoregion of residence. Landowners and managers who held low utilitarian values toward wild pigs were more likely than to hunt them those who did not (odds ratio = 1.1; $P < 0.05$). For each one unit decrease in utilitarian values of wild pigs, landowners or land managers were 14.6% more likely to hunt wild pigs. While landowners or managers residing in other ecoregions were not significantly more or less likely to participate in wild pig hunting that those in the Piney Woods ecoregion, landowners and managers in the Rolling Plains ecoregion were 2.8 times more likely to hunt wild pigs ($P < 0.05$). The interaction of landownership and management status on wild pig population preference did not significantly change the odds of participation in wild pig hunting ($P > 0.05$).

Discussion

Participation in other types of big game hunting

Findings suggest that participation in other types of big game hunting is a very strong indicator of participation in wild pig hunting. Big game hunters are much more likely to participate in wild pig hunting than hunters who do not hunt other big game species. Thus, one may consider wild pig hunting as an additive, rather than compensatory, activity among Texas licensed hunters. The addition of wild pig hunting as an available hunting activity in Texas may improve hunter satisfaction in the state. Because hunters do not hold the same universal motivations for participation in big game hunting, Manfredo et al. (2004) suggested that variation in big game hunting opportunities allows for greater satisfaction among hunters. In Texas, hunters may pursue wild pigs using many different methods in any season, at any time of the day or night, and in a wide variety of landscapes. Thus, the availability of wild pigs as a quarry for Texas hunters may improve overall hunter satisfaction and contribute to greater hunter recruitment and retention (Larson et al. 2014).

Wild pig hunter habits may impact Texas hunting license sales following recent changes in license requirements. In 2018, when this survey was issued, Texas law required a hunting license to hunt wild pigs. During the 2019 hunting season, however, hunters were not required to possess a Texas hunting license to hunt wild pigs. Results suggest that wild pig hunting does not replace other types of big game hunting. This finding may reflect the patterns that hunters use to take wild pigs. Hunters may harvest both native game and invasive wild pigs in the same trip; that is, hunters appear to

harvest wild pigs opportunistically while primarily pursuing other types of game animals. Only 3.3% of licensed hunters surveyed reported exclusively hunting wild pigs in Texas. Thus, Texas may expect to see only marginal decreases in hunting license sales and revenue due to the recent change in license requirements.

Knowledge of wild pigs

Hunters with higher wild pig knowledge scores were more likely to hunt them than those with lower scores. Nevertheless, findings elucidate a clear deficiency in knowledge of wild pig biology, natural history, and legal regulation among licensed hunters. The knowledge statements that hunters most typically answered incorrectly illustrate deficiencies in information dissemination related to wild pigs.

Very few hunters (1%) correctly identified wild pigs as belonging to the same species as domestic pigs and only 10% of hunters correctly identified that wild pigs are not native to Texas. This may be due to the long history of wild pig presence in the state leading to generational amnesia concerning their introduction (Papworth et al. 2009). This should cause concern among wildlife managers seeking to mitigate exotic, invasive wild pig damage and range expansion. As with invasive species issues in other areas (García-Llorente et al. 2008, Papworth et al. 2009, Schüttler et al. 2011, Speziale et al. 2012, Clavero 2014), the issue of wild pigs in Texas may illustrate a shifting baseline among hunters for Texas ecosystems where hunters fail to recognize wild pigs as a longstanding invasive species in the state. In areas of the state where wild pigs have existed since the 1800s (Taylor 2003), hunters may accept them as part of their invaded ecosystems (Weeks and Packard 2009). Thus, Texas hunters may encounter difficulties

identifying wild pigs as a non-native species due to the length of time since the species introduction (Warren 2007). Ultimately, hunter failure to identify wild pigs as an invasive species may prove problematic in efforts to manage them and may, in fact, lead Texans to value the species similarly to native fauna (Weeks and Packard 2009, Schüttler et al. 2011).

Hunters were largely unaware of legal regulations on harvest and movement of wild pigs. Only 14% of hunters were aware that wild pigs are not considered game animals in Texas and only 13% were aware of legal restrictions on live wild pig transportation, release, and holding in the state. Hunter misinformation regarding these regulations is problematic because it suggests that improper handling of live wild pigs may be prevalent among hunters who are not aware of relevant laws. Further, hunters who do not understand the legal restrictions on transporting live wild pigs may unwittingly assist in the introduction of the species to new areas. In Europe, hunting opportunities incentivize the introduction and spread of invasive species used as game animals (Carpio et al. 2017). Similarly, wild pig range expansion in the United States is associated with human translocations (Caudell et al. 2016). The human-aided spread of invasive wild pigs to new habitats for hunting purposes poses a challenge for wildlife managers, who must disincentivize the introduction and spread of invasive and ecologically dangerous species.

Movement of wild pigs to new areas carries important implications not only for ecological damages related to the species, but also for animal and human health. Strikingly, only 34% of hunters sampled correctly reported that wild pigs can carry diseases that can be transmitted to humans. Wild pigs vector several zoonotic diseases,

including swine brucellosis, tularemia, anthrax, Hepatitis E, and leptospirosis, among others (Meng et al. 2009). These diseases pose significant health risks to hunters who do not take proper precautions. These findings highlight the need for more effective communication about zoonotic diseases present in wild pig populations and proper personal protective equipment that hunters should use when handling wild pigs. Despite more than 30 years of education by various government agencies in Texas (Rollins et al. 2007), hunter knowledge of wild pigs and associated risks remains rudimentary.

Hunter perceptions and population preference

I found that hunters tend to participate in wild pig hunting if they hold any population preference for wild pigs. Hunters who preferred the wild pig population remain the same or increase were more likely to hunt wild pigs than those who preferred a lower population number or complete removal of wild pigs in Texas. However, few hunters wished to see increased numbers of wild pigs (Table II.2). Respondents who expressed no preference for wild pig numbers were least likely to be wild pig hunters, suggesting that hunters who experience positive or negative interactions with wild pigs hold stronger opinions about the future management of the species. Population preferences for wild pigs were not significantly impacted by landowner or land manager status. This suggests that hunters may be generally satisfied with the number of wild pigs present where they typically encounter them. This finding also may suggest that hunters who own or manage land may tolerate wild pig damage on their land when they have access to the population and engage in hunting of these animals. By the same token, it is possible that landowners pursuing pigs as quarry do not perceive themselves as hunting, but rather managing

damage. For those seeking to reduce overall wild pig numbers in the long term, additional work could elucidate the bounds of what hunters consider acceptable wild pig numbers.

Results indicate that hunter perceptions of wild pigs and their utilitarian value affect the likelihood of hunting them. Succinctly, hunters who held more positive perceptions of wild pigs and attribute utilitarian value to them are more likely to hunt them. Unsurprisingly, land ownership or management influenced perceptions and hunting participation. I found that hunters who own or manage land and do not identify utilitarian value associated with wild pigs are more likely to hunt them than those who do identify value. This may be an indicator of the economic value that wild pig hunting or trapping opportunities provide to some landowners. Generally, those hunters who did not own or manage land ascribe higher utilitarian value to wild pigs, likely because they do not have first-hand experience with costly wild pig damage. Landowners or land managers, however, may fail to identify benefits associated with wild pigs due to greater losses suffered to wild pig damage. There likely exists a threshold of tolerance, above which landowners no longer perceive benefits associated with wild pigs due to the damage they cause. The same may be true below a threshold where negative impacts of wild pigs appear negligible to landowners who access benefits associated with the species. These findings suggest that 2 types of wild pig hunters exist in Texas: recreational hunters and management hunters. Non-landowning hunters likely hold higher utilitarian values for wild pigs because the species benefits them and presents minimal observable risks. They do not perceive wild pig damages in the same way as landowners, given that damages pose no financial risk to them. These non-landowning hunters are therefore more likely to hunt wild pigs for recreational purposes. Conversely, landowning hunters may be more

likely to hunt wild pigs as a means of controlling their population or mitigating damage. It should be noted that landowners may be recreational hunters, and non-landowners may hunt purely for management. The disconnect between perceptions and actions presents a challenge for those managing wild pigs when some stakeholders may consider them a resource.

Hunter locality and demographics

Today, wild pigs cover nearly the entire land area of Texas. Nevertheless, the history of wild pig range expansion and population densities within the state should reasonably influence differences in hunter participation based on locality. Hunters in the High Plains, Rolling Plains, and Trans-Pecos Ecoregions were significantly less likely to hunt wild pigs than hunters in the Piney Woods ecoregion ($P < 0.05$), where wild pigs have existed the longest in Texas (Timmons et al. 2012*b*). This may reflect differences in wild pig population densities in those ecoregions. Wild pigs may exist at lower densities in the High Plains and Trans-Pecos regions due to lower availability of suitable habitat (Timmons et al. 2012*b*). Lower densities of wild pigs may present less opportunity to hunt them in these regions, so they are hunted less often. In general, hunters in the Rolling Plains ecoregion are significantly less likely to hunt wild pigs. However, hunters in the Rolling Plains ecoregion who own or manage land were 2.8 times more likely to hunt wild pigs than those in the Piney Woods ecoregion (Table II.6). This suggests that landowners or managers in the Rolling Plains ecoregion may not offer lease hunting opportunities for wild pigs and, instead, hunt them on their own properties. Such hunting effort likely represents concerted landowner efforts to manage wild pig damage. Perhaps

the Rolling Plains ecoregion exists at the nexus of a threshold of action: enough pigs for hunting to be necessary to manage damage, but not enough to incentivize economic gain from wild pigs. It should be noted, however, that I received relatively small numbers of responses from hunters in the Rolling Plains, Trans-Pecos, and High Plains ecoregions (Table II.1). It is possible that fewer hunters in those ecoregions participated in this survey due to limited experience with wild pig damage or hunting opportunities involving wild pigs, or relatively lower human population in these regions.

Just as geography affects respondents' attitudes about wild pigs, demographic factors also affect hunter participation in wild pig hunting; these factors include age, ethnicity, and income. Survey respondents are typically older than the sampled population (Dillman et al. 2008, Lesser et al. 2011) and, in general, younger individuals are more likely to purchase a hunting license (Floyd and Lee 2002). Overall, the median age of hunters who participated in the survey was greater than the median age for Texas hunting license holders above 18 years old in 2018 (50 years and 46 years, respectively; TPWD, unpublished data). Further, as hunters increased in age, they were less likely to participate in wild pig hunting. The median age for wild pig hunters in the respondent group was 3 years younger than hunters in general (50 years and 53 years, respectively). This suggests that wild pig hunting activities may attract younger hunters. This may be due to motivational differences among younger and older hunters, where younger hunters may hold different motivational drivers more suited to wild pig hunting than do older hunters.

I found that hunters with annual household incomes exceeding $100,000 were more likely to be wild pig hunters than those with lower annual household income

earnings. Thus, wild pig hunting appears to be practiced primarily by wealthier, license-holding hunters. As higher income earners are generally more likely to purchase a hunting license (Floyd and Lee 2002), recreational wild pig hunting may be particularly inaccessible to lower-income individuals. However, because individuals managing wild pig damage were not legally required to purchase a hunting license at the time of this survey, I may have failed to capture response data from those involved with wild pigs in a purely management context. As wild pig hunters are no longer required to hold a hunting license to hunt wild pigs in Texas (Texas Parks and Wildlife Department Code 2019), recreational wild pig hunting may become more popular among individuals who previously did not hold a hunting license.

Few studies to date have explicitly considered the racial or ethnic composition of the wild pig hunting public. Unfortunately, I had too few responses from African American, Asian American, or other ethnic groups to make inference as to their participation in wild pig hunting. Hunters who identified as Spanish, Hispanic, or Latino were significantly less likely to participate in wild pig hunting than those who identified as white. This is consistent with the finding that, in general, hunters are more likely to be white than any other ethnic group (Floyd and Lee 2002). This result suggests that wild pig hunting is not sought out by, or not available to, Hispanic hunters. Lopez et al. (2005) notes that Hispanic households in Texas generally do not generate as much annual income as white households. Given that I found wild pig hunters to be typically wealthier hunters, Hispanic hunters may be excluded from participation in wild pig hunting activities due to costs of access. Nevertheless, it also is possible that cultural factors exist that this survey did not consider and that impact Hispanic and Latino hunter participation

in wild pig hunting, such as a greater tendency to hunt wild pigs solely for damage management or preferential take of wild pigs through trapping efforts. Hispanic or Latino is the largest minority group in Texas (39.6%; Quick Facts n.d.) and further research into Hispanic hunters' perceptions and use of wild pigs will become important as Hispanic populations continue to grow in both Texas and the United States.

While gender did not appear to significantly influence hunters' wild pig hunting participation on its own, male big game hunters were significantly more likely to hunt wild pigs than were female big game hunters. Although males are generally more likely to purchase a hunting license than females (Floyd and Lee 2002), and Texas hunters are overwhelmingly male (95.7% male; 4.3% female), the lower proportions of female big game hunters participating in wild pig hunting (Table II.1) suggests this activity is not sought out by and/or not accessible to the female big game hunter. Given that females are often socialized into hunting participation by males (Heberlein et al. 2008), it is possible that female recruitment into wild pig hunting is not facilitated as often as it is for other types of big game hunting. However, the data cannot definitively determine the causal factor of the strikingly low rate of participation among females who already hunt other big game.

Conclusions

This study represents an effort to understand the identity of the modern wild pig hunter. These findings provide information useful in developing a typology of wild pig hunters in the context of recreational hunting activities. Succinctly, modern wild pig hunters are predominantly middle-aged, white, male, and high-income earners. Importantly, wild pig

hunters often hunt other big game animals as well. Additionally, individual perceptions of the species are important factors contributing to wild pig hunting activity. Wild pig hunters tend to perceive the species positively, and attribute a degree of utilitarian value to them, specifically when they do not experience damages associated with them.

This research contributes to the growing understanding of human dimensions in the issue of invasive wild pig management, which involves unraveling a complicated dichotomy of perceptions, risks, and benefits among wild pig resource users and damage managers. Even within wild pig hunters, differences in utilitarian attitudes toward wild pigs exist between landowners and non-landowners and in different regions of the state. Moving forward, those tasked with managing wild pigs for the ecological and public good must decide which stakeholder interests to favor in the contexts of risks and opportunities associated with the species.

Results suggest that those aiming to educate hunters about wild pigs face a largely uninformed public that does not hold the same perceptions, values, or tolerance levels of the species. This study demonstrated that wild pig hunters poorly understand wild pigs and their impacts on human health, agricultural production, and ecological processes. I suggest that efforts be made to more accurately convey information on ecological, agricultural, and economic risks associated with wild pigs to the public in meaningful education campaigns aiming to adjust public perceptions at a broad scale. Education efforts targeting hunters should include information regarding wild pig natural history, relevant zoonotic disease risks, and legal regulations at state level. Future education efforts concerning wild pigs will be important in shaping public perceptions in ways that favor ecologically appropriate management activities for the species.

The issue of wild pig management is dynamic, including both realized and potential risks and benefits among multiple stakeholder groups. I sought to better understand wild pig hunters, given their status as a key stakeholder group in understanding the human dimensions of wild pig management. Although it does not appear that wild pig hunting replaces hunting of native big game, wild pigs are a popular hunting quarry among Texas hunters. However, because wild pig hunters were not required to purchase a hunting license to control wild pigs for damage mitigation at the time of this survey, I was unable to capture response data from those who may have hunted wild pigs in a damage management context without a hunting license. At the time of this publication, wild pig hunters are no long required to hold a hunting license to hunt wild pigs in Texas, thus recreational wild pig hunting may become more popular among individuals who did not purchase a hunting license prior to this research. Therefore, positive perceptions of the species may increase as hunters identify benefits related to wild pigs, such as increased hunting access, and may, therefore, be less willing to support management of the species. Potential changes in hunter use and perceptions of wild pigs in Texas as this new license requirement takes effect will be informative for other states and agencies considering adopting or modifying wild pig hunting regulations to better manage the species.

As a wider variety of management options become available to mitigate wild pig damage, wildlife managers will be tasked with deciding which positions to emphasize in the decision-making process while also incorporating ecological knowledge to meet both human and wildlife needs. Modern wildlife managers and decision-makers must use interdisciplinary approaches and social science tools to understand the human dimension

factors of wildlife management issues where differing stakeholder groups may maintain different positions on management options. The issue of wild pig management in Texas may serve to further illustrate the necessity of such interdisciplinary research in future management efforts for widespread, exotic, invasive species which involve a diversity of stakeholder groups.

CHAPTER III

HUNTER MOTIVATIONS AND USE OF WILD PIGS IN TEXAS

Hunters are primary benefactors of wildlife management efforts in the United States and generate funds for conservation through the sale of hunting licenses and the Federal Aid in Wildlife Restoration Act of 1937 (Pittman-Robertson Act; Mahoney 2009). Only 11% of Americans participate in hunting and the number of hunters nationwide has steadily declined since 1980 (Brown et al. 2000, U.S. Fish and Wildlife Service 2016). Urbanization, including land use changes, the movement of rural Americans to urban areas, and fragmentation of private hunting lands into smaller parcels or suburban residences, has contributed to the decline of hunting participation in the United States (Brown et al. 2000). Further, urbanization fosters social and cultural changes that limit the ability of older hunters to introduce younger hunters to the practice (Brown et al. 2000, Ryan and Shaw 2011). Social and cultural groups are important in forming an individuals' attitudes toward hunting and facilitating recruitment of new hunters, specifically within family groups (Ryan and Shaw 2011).

Factors such as hunter demographics, satisfaction, and motivations affect hunter recruitment and retention (Ryan and Shaw 2011). Individual hunters often pursue multiple satisfactions based on personally valued motivational aspects of their hunt (Decker and Purdy 1988, Bissell et al. 1998, Gigliotti et al. 2000). Hunters who hold multiple motivations may gain satisfaction from multiple values and are, thus, more likely to continue hunting (Bissell et al. 1998). These motivational aspects may include the number of animals harvested, the perceived availability of trophy animals, the

presence or absence of other hunters, or, simply, time spent in nature (Decker and Purdy 1988). Hunter motivations also may lead to differential harvest success. For example, Bhandari et al. (2006) finds that motivations are strong predictors of doe or buck harvest success among Pennsylvania deer hunters. Further, management and food motivations are important determinants of doe hunter success while effort was the most important determinant of success among buck hunters, who likely spent more time afield selecting a trophy animal. Research by Holsman and Petchenik (2006) illustrates that hunter effort alone is not a successful indicator of white-tailed deer harvest magnitude. Hunters willing to harvest antlerless deer achieved higher harvest numbers than those motivated to harvest bucks – increased hunter effort does not always translate to increased harvest, but may, instead, be influenced by hunter motivations. Thus, information about hunter motivations allow wildlife managers to inform policy regarding harvest limits that maintain hunter satisfaction levels and improve recruitment and retention.

Hunting has long been considered both a tool for wildlife management and a benefit of successful wildlife management programs. However, as Brown et al. (2000) predicted, many game animals that were traditionally managed in the context of low population densities are now overabundant in some areas of their range. Further, hunters who are motivated by trophy value may not harvest animals important in population management efforts (Brown et al. 2000). For example, hunters seeking trophy bucks may not readily harvest does, which are important reproductive units in the population. While bucks may be important to hunter satisfaction and recruitment due to their trophy value, buck harvest offers little in the vein of population management within overabundant deer herds. The management of wild pigs in their invaded range illustrates a similar paradox

in which wild pigs may be a desirable hunting quarry, but hunting alone fails to reduce wild pig abundance, leading to undesirable ecological and agricultural impacts.

The issue of wild pigs in Texas provides an opportunity to investigate hunter motivations for participating in hunting activities involving an exotic, invasive animal. Because wild pigs may act as both a pest and a resource in the state, hunters may participate in wild pig hunting activities for multiple different reasons. Further, wild pig hunters' motivations may impact their harvest success. As wild pigs number in the millions and cause an estimated $52 million in damages each year to Texas agricultural production, landowners and managers have utilized management hunting in an attempt to reduce wild pig abundance and mitigate damage (Higginbotham et al. 2008, Timmons et al. 2012*b*). On the other hand, the maintenance of wild pig populations for recreational, meat, and trophy hunting use may foster greater wild pig abundance and broader spread of the species. While wild pigs may be a desirable exotic quarry for Texas hunters, wildlife managers and decision makers must understand wild pig hunters' motivations and harvest success in order to properly assess their impacts on wild pig management efforts in the state. Ultimately, an optimal management program for wild pigs must strive to strike a balance between the damages caused by the species and the revenue generated by maintaining populations for hunting use and market sale (Zivin et al. 2000).

Although a critical need for effective management, existing research on wild pig use and management in Texas is restricted to landowners, land managers, and pesticide applicator license holders at Texas A&M AgriLife Extension Service educational seminars (Adams et al. 2006, Kubecka 2016). Further, data are limited in geographic extent (Adams et al. 2006, Kubecka 2016) and may not be representative of diverse

publics within the state. In particular, comprehensive knowledge of hunter attitudes and motivations on the subject of wild pigs is not available (Beasley et al. 2018). To create a wild pig management plan that is acceptable to various stakeholder groups, wildlife managers must understand wild pig hunters as key stakeholders in the issue.

This study analyzes wild pig hunter motivations to generate a greater understanding of those motivations' impact on effort and wild pig harvest in Texas. Specifically, this study categorizes and describes wild pig hunters by their motivational attributes and compares hunter effort and wild pig take between these motivational groups. This study ends with implications for those seeking to manage wild pig abundance through hunter harvest.

Methods

This study is part of a larger survey designed to assess the human dimensions of wild pig management in Texas. I developed the online version of the Texas A&M Human Dimensions of Wild Pigs Survey using Qualtrics Survey Software (Qualtrics 2005). I developed a paper version of the survey to mirror the online version as closely as possible to accommodate respondents with limited internet access or technological proficiency. The survey contains 79 questions, although instructions direct respondents to answer only the questions applicable to them.

I acquired contact information for Texas hunting license holders in 2018 from the Texas Parks and Wildlife Department. Following Dillman's Tailored Design Method (Dillman et al. 2008), I contacted potential respondents through both email and physical mail. I selected all Texas hunting license holders above the age of 18 who provided an

email address as potential respondents in the email group. I also obtained mailing addresses for a randomly-selected subset of 2,615 licensed Texas hunters who did not provide an email address as potential respondents in the mail group. Members of the email group received an email invitation to participate in the online survey on 4 June, 2019. I sent reminder email messages to email group non-respondents 3 and 5 days after the initial invitation (7 June and 10 June, 2019). I contacted potential mail group respondents through an invitation letter sent on 5 June, 2019. I followed the invitation letter with a reminder postcard to 1,000 randomly-selected mail group non-respondents 21 days later on 26 June, 2019. The survey remained open for response submissions from both email and mail respondents until 9 July 2019.

The survey asked respondents to answer questions related to their hunting activity, landownership status, their attitudes toward and knowledge about wild pigs in Texas, area of residence, and several demographic variables. I developed a database to organize and manage response data using FileMaker Pro (FileMaker 2019). I manually entered paper survey responses into the database as I received the completed survey packets. I downloaded response data to the database on 9 July 2019 for cleaning and analyses. I conducted data analyses in Program R (R Core Team 2018, FileMaker 2019).

Data Analyses

I asked respondents to rank the animals they hunted most often in Texas. I used these responses to identify hunters who participated in wild pig hunting. I asked wild pig hunters to rate 5 motivation categories on the level of importance each category represented to their motivations for participation in wild pig hunting activities from 1,

representing a motivation that was "not at all important" to the respondent, to 5, representing a motivation that was "very important" to the respondent (Appendix A, Question 3). I asked hunters to report the number of days they spent hunting wild pigs and how many wild pigs they harvested in 2018 (Appendix A, Questions 4 & 5). I used responses to these questions to calculate the number of wild pigs each hunter harvested per day spent afield in 2018. To control for respondent over-reporting and reporting errors, I removed responses that exceeded the 99th percentile of wild pig harvest and days spent afield for wild pig (Appendix A, Questions 4 & 5). I then removed all incomplete responses from analysis.

I analyzed wild pig hunters' responses to the motivational categories using K-means cluster analysis methods. I identified an optimal number of clusters in the data using elbow and silhouette methods. I clustered hunters into groups based on their responses to the motivational items and described the groups based on the group average responses to each item. I created a negative binomial regression model to compare the differences in wild pig harvest among hunters in different motivational groups. I conducted a chi-squared test on the estimated marginal means of wild pig hunter harvest numbers in each motivational group and followed with a Tukey test to detect differences between the groups.

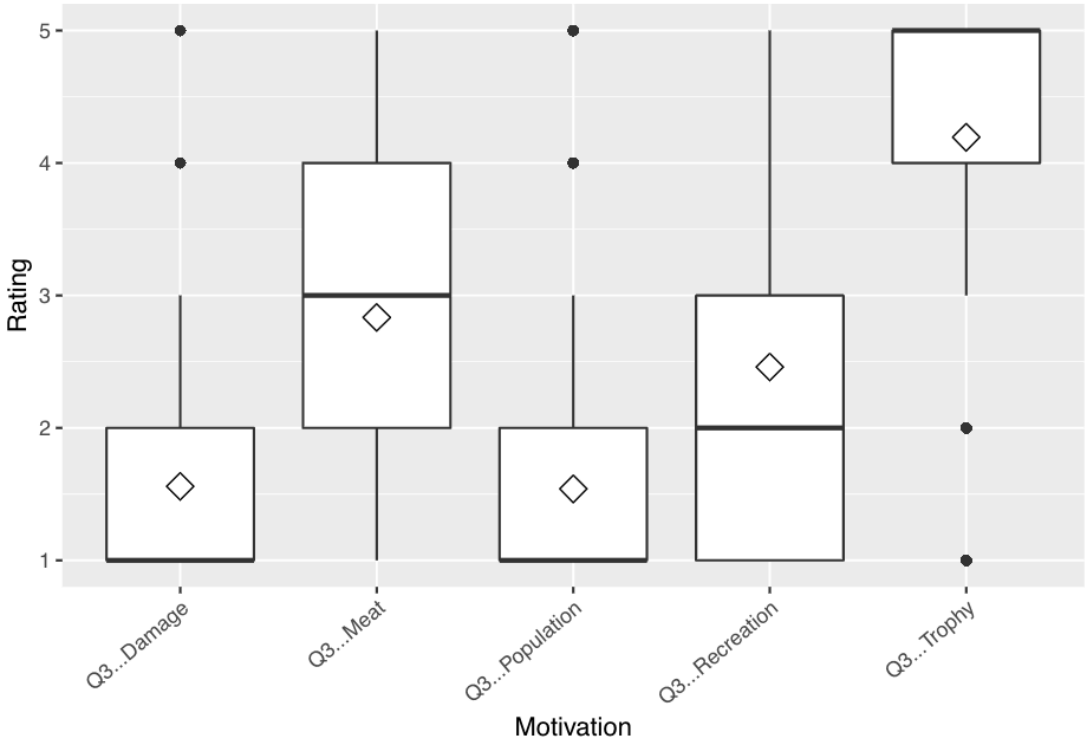
Results

Survey response

I successfully contacted 159,420 licensed hunters through email and 2,494 through conventional mail methods (n = 161,914). I received 37,225 total responses to the survey

for a combined response rate of 23.0%. Participants in the email contact group responded 23.2% to the survey while those in the conventional mail group responded 7.1%. Of survey respondents, 93.6% indicated hunting in Texas (n = 34,827) and 77.8% of hunters also identified as wild pig hunters (n = 27,100). After removing outliers and incomplete records, 21,031 complete responses from wild pig hunters were available for use in further analysis. Hunter responses to motivations for participation in wild pig hunting activities are summarized in Figure III.1.

To test for non-response bias, I regressed several key questions (Appendix A, Questions 1, 31, 73, and big game hunter status) on the number of days to response by each respondent. While responses were different by the number of days to response ($P < 0.05$), effect sizes were very small ($r^2 = 0.0003$). I concluded there was no significant effect of non-response bias on the data used in these analyses and the results could be generalized to the target population.



[a]Mean denoted by ◊.

Figure III.1. Motivation ratings among licensed wild pig hunters.

Cluster analysis

Elbow and silhouette cluster identification tests indicated that 6 clusters existed within the data. I used K means cluster analysis to categorize respondents into 1 of 6 clusters. I calculated the mean response for each motivational item within each cluster (Table II.1). I defined and described each cluster group based on the mean response to each motivational item by hunters within each group.

Table III.1. Mean rating of each motivational category by group.

	Motivational Category					
Group	Meat	Trophy	Recreation	Population management	Damage management	n
1	2.0	3.9	2.1	3.6	3.7	2,901
2	2.0	4.6	1.6	1.3	1.3	5,268
3	2.1	4.7	3.7	1.4	1.3	4,301
4	4.6	4.4	2.1	1.2	1.2	5,522
5	4.4	4.8	4.6	1.1	1.1	2,730
6	1.0	2.4	1.7	1.4	1.4	3,273

Group 1 represents wild pig management hunters. Hunters in this group are fairly strongly motivated by both managing wild pig population numbers and wild pig damage as well as the animals' trophy value. Group 2 represents trophy hunters. Hunters in this group are highly motivated by wild pig trophy value but are not highly motivated by other factors. Group 3 represents recreational trophy hunters. Hunters in this group are highly motivated by wild pig trophy value and fairly motivated by recreational value. Group 4 represents non-recreationally motivated, use-based hunters. Hunters in this group are highly motivated by trophy and meat value, but not recreational value. Group 5 represents recreational, use-based hunters. Hunters in this group are highly motivated by wild pig meat, trophy, and recreational value. Finally, Group 6 represents low-motivation, use-based hunters. Hunters in this group are not highly motivated by any category presented in this survey but are somewhat motivated by meat and trophy value.

Differences between groups

I created a negative binomial model to understand the effect of motivational group on the number of wild pigs taken per hunter in 2018. I included an interaction term between

motivational group and the number of days spent afield hunting wild pigs. I calculated the estimated marginal means for the annual take of wild pigs for hunters within each group. Table III.2 displays the average number of wild pigs taken and days spent hunting wild pigs in 2018 per hunter in each motivational group.

Table III.2. Wild pigs harvested and days afield in 2018 per hunter within each motivational group.

		Wild pigs harvested			Days afield		
Group	n	Mean	SD	Median	Mean	SD	Median
1	2,591	6.8	20.8	2.0	13.5	28.2	5.0
2	3,208	16.4	47.7	5.0	17.6	33.0	8.0
3	3,673	17.9	50.5	5.0	36.8	58.9	10.0
4	2,970	13.4	42.8	4.0	20.2	38.6	10.0
5	3,971	10.5	32.8	3.0	18.6	39.7	7.0
6	4,618	9.6	29.0	3.0	15.6	30.0	7.0

A chi-squared test indicated differences in wild pig harvest between motivational groups when days afield are held constant ($df = 5$; standard deviance = 681.5; residual df = 20,961; residual deviance = 24,002; $P < 0.001$). Table III.3 displays the average number of wild pigs harvested per hunter within each motivational group when controlling for days afield. Tukey post-hoc tests indicated that, when controlling for days afield, differences in wild pig harvest exist between all motivational groups except between groups 2 & 3 and groups 4 & 5 (Table III.4).

Table III.3. Wild pigs harvested per hunter within each group, controlled by days afield[a].

	Wild pigs harvested			
Group	Mean	SE	LCL[b]	UCL[b]
1	5.5	0.14	5.2	5.8
2	7.4	0.13	7.1	7.6
3	7.4	0.15	7.1	7.7
4	10.4	0.18	10.0	10.7
5	10.9	0.28	10.4	11.5
6	8.2	0.18	7.8	8.5

[a]Wild pig harvest estimated per hunter within each group at a constant value of 17.7 days afield.

[b]LCL: lower confidence limit; UCL: upper confidence limit

Table III.4. Tukey post-hoc comparisons of wild pig harvest between groups[a].

Contrast	Ratio	Std. error	z ratio	*P* value
1 / 2	0.75	0.02	-9.27	< 0.001
1 / 3	0.75	0.02	-8.981	< 0.001
1 / 4	0.53	0.16	-20.50	< 0.001
1 / 5	0.51	0.18	-18.79	< 0.001
1 / 6	0.68	0.02	-11.52	< 0.001
2 / 3	1.00	0.03	-0.08	1.00
2 / 4	0.71	0.02	-13.62	< 0.001
2 / 5	0.68	0.02	-12.42	< 0.001
2 / 6	0.90	0.03	-3.51	0.006
3 / 4	0.71	0.02	-12.75	< 0.001
3 / 5	0.68	0.02	-11.89	< 0.001
3 / 6	0.91	0.03	-3.28	0.013
4 / 5	0.95	0.03	-1.62	0.585
4 / 6	1.27	0.04	8.49	< 0.001
5 / 6	1.34	0.05	8.51	< 0.001

[a]Wild pig harvest estimated per hunter within each group at a constant value of 17.7 days afield.

Discussion

Texas wild pig hunters illustrate the wide diversity of motivations among a single subset of a much broader stakeholder group. Among licensed Texas wild pig hunters, K-means cluster analyses identified 6 unique motivational groups, offering insight into why wild

pigs have become and remain popular hunting quarry in the state. Hunters in only 1 group (Group 1) reported high motivations to manage wild pig damages or population numbers. However, hunters within 4 of these motivational groups held high trophy-oriented motivations for participating in wild pig hunting activities. Trophy hunters (Group 2) were strongly motivated by trophy value and did not hold strong motivations for any other factor. Similarly, recreational trophy hunters (Group 3) were strongly motivated by trophy value and held moderate motivation for recreational value. Two groups were highly motivated by both meat and trophy value and were divided by their motivation to hunt wild pigs for recreation. Non-recreationally motivated, use-based hunters (Group 4) held high meat and trophy motivations, but did not hold high recreational motivations. Recreationally motivated, use-based hunters (Group 5) held similarly high values for meat and trophy motivations and held high recreational motivations as well. Low-motivation, use-based hunters (Group 6) held overall low motivations for participating in wild pig hunting activities and held only slighter higher motivations for meat and trophy value. The motivations of each of these groups, as well as their size as a proportion of wild pig hunters, affect their efficacy as a tool in wild pig management, either positively or negatively affecting the abundance and range of wild pigs in Texas.

Trophy hunters (Group 2) made up the largest motivational group among Texas wild pig hunters (Table III.1). In general, trophy value was the highest-rated motivation among licensed Texas wild pig hunters (Figure III.1). Hunters in groups 2, 3, 4, and 5 all report high trophy motivations for participation in wild pig hunting activities. However, wild pig harvest differed significantly among groups with high trophy motivations.

When controlling for days afield, hunters in groups 2 and 3 harvested significantly fewer wild pigs than hunters in groups 4 and 5, who report both high meat motivations, as well as high trophy motivations. Trophy-motivated hunters are more selective and spend more time seeking animals that meet trophy desirability, typically larger, male individuals with antlers, horns, or tusks (Festa-Bianchet and Lee 2009). Thus, trophy-motivated hunters may be expected to selectively harvest larger, male wild pigs. Hunters selectively harvesting mature males fail to reduce recruitment rates within species exhibiting polygynous mating habits (Milner et al. 2007). As wild pigs can begin breeding as early as 6 months of age (Taylor 2003), trophy-motivated hunters may fail to harvest young, female wild pigs that are important reproductive units in the population. Conversely, young, female wild pigs are often desirable quarry for hunters highly motivated by meat harvest opportunities.

Use-based hunters (Groups 4 and 5), who hold high motivations for both meat and trophy, harvest significantly more wild pigs than do hunters in any other group (Table III.3, Table III.4). This finding suggests that meat-motivated wild pig hunters may remove more wild pigs from the landscape than those motivated by trophy, recreation, or management factors alone. Ryan and Shaw (2011) note that, even when wild game meat is not less expensive to procure than commercially-available meat, hunters may value it for reasons beyond subsistence needs. Peterson et al. (2009) explain that cultural and social norms may be strong motivators for meat hunters. Wild pig hunters motivated by meat harvest opportunity may value the ability to provide food for their families from local sources or non-commercial environments. However, as Holsman and Petchenik (2006) explain, hunters may hold personal limitations on the number of animals they

wish to harvest. These personal harvest thresholds may make meat-motivated hunters resistant to harvesting more animals than they feel is necessary for their own use, even when legal bag limits allow for harvest beyond personal harvest thresholds. Ultimately, as trophy hunters may selectively harvest older, male animals, and meat hunters may self-limit their harvest, these 2 broad hunting motivation groups may not be effective in reducing the species' abundance or range in the state.

Management-motivated hunters (Groups 1), unfettered by personal harvest limitations, who do not selectively target trophy animals may be more effective in wild pig population management. Unfortunately, management-motivated wild pig hunters (Group 1) harvest significantly fewer wild pigs than hunters in any other group (Table III.3, Table III.4). Notably, hunters in this group harvested approximately 67.6% fewer wild pigs than low-motivation hunters (Group 6) who spent the same number of days afield. Importantly, this finding illustrates that, among licensed Texas hunters, management-motivated hunters take significantly fewer wild pigs off the landscape than even low-motivation hunters do. While this result seems somewhat counter-intuitive, I propose the low harvest rate among management-motivated hunters may be due to the lack of highly-motivated management hunters who purchase hunting licenses to control wild pig damage and population numbers in the state. Analyses in Chapter II illustrate the importance of land ownership in hunter perceptions of the utilitarian value of wild pigs (Table II.6). Licensed wild pig hunters who do not own or manage land in Texas ascribe higher utilitarian value to wild pigs because they are largely unaffected by the damages caused by the species. These non-landowning wild pig hunters largely hold the species is more beneficial than it is detrimental in the state. Alternatively, those who do

own or manage land in Texas fail to identify such benefits associated with wild pigs because they are personally affected by the damage the species can cause. Additionally, because wild pig hunters were not required to purchase a hunting license to control wild pigs exclusively for damage mitigation at the time of this survey, I was unable to capture response data from those who may have hunted wild pigs in a purely management context without a hunting license. This suggests that individuals highly motivated to manage wild pig populations or damage are not licensed hunters. Thus, it is possible that highly management-motivated hunters exist outside the population of licensed hunters in Texas and these hunters may have different harvest success than low-motivation management hunters.

Private citizen take of native wildlife has traditionally been a large part of management solutions. In Texas, both wild pigs and white-tailed deer (*Odocoileus virginianus*) are popular quarry among licensed hunters. As in white-tailed deer management, hunters both generate funding for and actively participate in the management and research of white-tailed deer populations (Hewitt 2015). White-tailed deer hunters spearheaded early conservation efforts that supported the species' population growth and continue to foster responsible hunting cultures to maintain those populations for continued hunting use. Similar to wild pig populations, white-tailed deer populations have become overabundant in many areas, due largely to the success of those early conservation programs and selective hunter harvest focused on mature bucks, thereby necessitating changes in hunting culture and activities to reduce their abundance. Efforts to increase doe harvest effectively involve white-tailed deer hunters in these management programs. While encouraging doe harvest among white-tailed deer hunters was initially

challenging, educational efforts and incentives for antlerless deer harvest have successfully engaged hunters to help manage these overabundant populations (Hewitt 2015). However, wild pigs, as a much more prolific species, require intensive, constant harvest pressure to manage population growth (Timmons et al. 2012*b*).

Similar to the issues associated with white-tailed deer management, intensive efforts to manage wild pigs could engender conflict among hunters and managers in efforts to increase wild pig removals to the levels needed to effect population-level change. Private hunters and landowners will continue to be key participants in broad scale efforts to reduce wild pig abundance and range in Texas. Therefore, those seeking to manage wild pig damage, range expansion, and abundance must look critically at the influence of wild pig hunting today and how they may actively shape hunter habits to aid management efforts in the future. Clearly, incentivizing hunting of wild pigs with no season lengths, bag limits, or sex and age restrictions has not created a harvest dynamic resulting in population reductions of wild pigs. I therefore recommend encouraging hunters to harvest more wild pigs, more often, and to foster a wild pig hunting culture that transcends trophy motivations or personal harvest limitations. Those interested in using wild pig hunters as management tools should strive to promote a management and meat-oriented hunting culture that utilizes edible portions of wild pigs, but also continues to remove the animals long after they meet their own limits for personal meat use. This type of wild pig hunter may identify a primary ethical obligation to remove wild pigs for population management and damage mitigation. Thus, wild pig hunters may fulfil meat and recreation motivations secondarily.

Based on the results of this study, one may logically conclude that licensed hunters alone were largely ineffective at harvesting the numbers required for broad scale reductions in wild pig abundance in Texas. Similarly, hunters were unable to remove adequate numbers of wild pigs to reduce abundance even when incentivized by a bounty program (Ditchkoff et al. 2017). Successful wild pig eradication efforts often involve multiple lethal wild pig management activities, including trapping, professional gunning, and extensive fencing (Seward et al. 2004, McCann and Garcelon 2008, Parkes et al. 2010). Ultimately, managers must achieve landscape-scale removal of wild pigs using various methods if they seek long-term abatement of ecological and agricultural damages due to wild pigs.

Conclusions

This study represents an undertaking to understand the relationships between hunter motivation, effort, and harvest success among Texas wild pig hunters. I describe a variety of motivational factors driving participation in wild pig hunting activities. This research finds that wild pig harvest differs significantly among motivational groups. While the majority of wild pig hunters in Texas hold high trophy motivations, meat-motivated hunters harvest more wild pigs than any other motivational group. Selective trophy harvest and self-imposed limits among meat hunters may lead to inadequate removal of wild pigs to accomplish population reduction goals. These results suggest that hunting alone may not be effective in wild pig population management efforts in Texas. Instead, hunter harvest should be combined with other management methods to remove more wild pigs and avoid male-selective harvest. More detailed information on

hunter wild pig harvest, including age and sex ratios, is necessary to better understand the current population-level impact of recreational, meat, and trophy hunters on wild pig populations in their invaded range.

As wild pigs continue to spread across the continent and into novel habitats, sound management efforts will be become increasingly important. Wildlife managers may best protect natural resources by employing multiple methods to remove wild pigs. However, wildlife managers must consider the dynamic issue of wild pig management, including both realized and potential risks and benefits among multiple stakeholder groups, when selecting a management plan for the species.

CHAPTER IV

IMPACTS OF EXTENSION EDUCATION ON WILD PIG MANAGEMENT

Wild pigs (*Sus scrofa*) are a widespread exotic species, considered among the most invasive in the world (Lowe et al. 2000). Wild pigs cause an estimated $1.5 trillion in damages and management costs annually in United States alone (Bevins et al. 2014). Texas harbors the greatest number of invasive wild pigs in the country (Mayer 2014), and, despite continued efforts by various organizations to control wild pig population abundance and range expansion, the species is now found in all but one county in the state (Taylor 2003, Timmons et al. 2012*b*, Bevins et al. 2014, Snow et al. 2017, History of Feral Swine in the Americas 2018). Intensive population management is a necessity to mitigate ecological and agricultural damage due to wild pigs in much of the species' invaded range (Rollins et al. 2007). Texas is comprised of over 95% privately owned lands, making it essential to involve stakeholders in decisions about wild pig management.

Environmental and economic impacts are strong motivations for stakeholder participation in invasive species management efforts (Ford-Thompson et al. 2012). However, support for invasive species management is affected by personally experienced impact and individuals may not be willing to contribute to the management of a species unless they are directly affected (García-Llorente et al. 2008). Invasive species impacts also may include realized or potential benefits, which are often underreported (Bonanno 2016). Individuals who identify benefits related to an invasive species may be less willing to contribute to management of the invasive species (García-Llorente et al. 2008).

However, even when attitudes are positive toward control of invasive species, other barriers may affect management participation. For example, low perceptions of behavioral control due to a lack of knowledge and method difficulties lead to apathy toward invasive species management and the belief that it is unimportant among institutions and the general public (Prinbeck et al. 2011).

Educational programs are important in communicating novel management tools and methods that may advance and improve wild pig management efforts (Beasley et al. 2018). By providing land owners and managers with knowledge on both wild pig impacts and novel management techniques, outreach educators can indirectly improve management efforts across privately-owned lands. In Texas, current outreach programs serve to educate stakeholders on wild pig biology and management practices to mitigate wild pig damage and control population growth. Programs focused on wild pigs began in Texas in 1990; Texas A&M AgriLife Extension Service (AgriLife Extension) and its predecessor agencies have conducted the vast majority of these education efforts in the state (Higginbotham et al. 2008). Previously, Feral Hog Appreciation Days encouraged participants to consider ways that wild pigs may be used as a resource as well as evaluate the negative impacts of the species (Rollins et al. 2007). Since 2006, AgriLife Extension's Feral Hog Abatement Program has provided educational resources and technical assistance to landowners in wild pig management efforts (Higginbotham et al. 2008). AgriLife Extension education and outreach programs on wild pigs are successful in increasing knowledge about wild pigs (Kubecka 2016). However, knowledge transfer alone does not always result in the adoption of new behavior (McLeod et al. 2015). It is important to assess the efficacy of outreach communication and education efforts to

understand how extension services affect public knowledge and perceptions of wild pigs and improve land manager techniques in wild pig population management and damage abatement (U.S. Department of Agriculture Animal and Plant Health Inspection Service 2017). Assessing educational program effectiveness will allow for improvements in outreach efforts and more efficient implementation of programs that rely on public funds.

To improve educational programming on wild pig management, extension educators must understand the long-term impact of existing programs in facilitating changes in management practices to reduce wild pig damage among Texas landowners and land managers. Although it is a critical need for effective management, existing research on wild pig management practices does not include long-term data to evaluate the impacts of AgriLife Extension Wild Pig Programs. This study analyzes the impact of AgriLife Extension educational seminars on landowner management technique adoption. Specifically, this study compares wild pig trap success and financial losses due to wild pig damage between seminar attendees and non-attendees to better understand how extension educational seminars affect wild pig population management and damage abatement efforts. This study ends with implications for educators seeking to improve wild pig management and abatement efforts on private lands.

Methods

This study is part of a larger survey designed to assess the human dimensions of wild pig management in Texas. I developed the online version of the Texas A&M Human Dimensions of Wild Pigs Survey using Qualtrics Survey Software (Qualtrics 2005). I developed a paper version of the survey to mirror the online version as closely as possible

to accommodate respondents with limited internet access or technological proficiency. The survey contains 79 questions, although instructions direct respondents to answer only the questions applicable to them.

I contacted members of AgriLife Extension Service county mailing lists through County Extension Agents (CEAs). Following Dillman's Tailored Design Method (Dillman et al. 2008), CEAs were asked to send an invitation and 2 reminders to members of their mailing lists. The survey remained open for response submissions from both email and mail respondents until 9 July 2019.

The survey asked respondents to answer questions related to their management efforts, landownership status, their use of AgriLife Extension educational resources, several demographic variables, and their area of residence. I developed a database to organize and manage response data using FileMaker Pro (FileMaker 2019). I manually entered paper survey responses into the database as I received the completed survey packets. I downloaded response data to the database on July 9, 2019 for cleaning and analyses. I conducted data analyses in Program R (R Core Team 2018, FileMaker 2019).

Data Analyses

Respondents were asked to identify themselves as Texas land owners or land managers, and I restricted analyses to responses collected from those who indicated they were Texas land owners or land managers. Landowners identified the most common type of wild pig damage they experienced. Landowners answered open-ended questions concerning the number of wild pigs trapped and the amount of money lost due to wild pig damages in 2018. To control for respondent over-reporting and reporting errors, I removed responses

that exceeded the 99th percentile within these open-ended numerical questions. I then removed all incomplete responses from analysis.

Respondents identified whether or not they had attended an AgriLife Extension seminar on wild pigs. To compare wild pig trap success and financial losses due to wild pigs between attendees and non-attendees, I created 2 separate negative binomial models for each hypothesis. Each model included reported acreage as a covariate to account for variation due to differences in land holding sizes. I calculated the estimated marginal means and compared them using 2-sample z tests to describe the differences in responses between attendees and non-attendees.

I asked seminar attendees to report which wild pig damage abatement practices they planned to adopt, actually adopted, and continued to use following the seminar. Additionally, I asked seminar attendees to mark reasons why they failed to adopt or discontinued use of these suggested practices. I describe the percentages of attendees who employed these suggested practices as well as the percentages of attendees reporting various reasons for discontinuing the practices.

Results

Survey response

I successfully contacted 41,629 AgriLife mailing lists in 161 counties. I received 5,420 total responses to the survey for an overall response rate of 13.0%. I selected respondents who identified themselves as landowners or managers for further analysis. 3,847 respondents owned or managed land in Texas (71.0%). On average, landowners managed 363.7 acres of land in Texas (SD = 822.8, median = 122.5). Negative impacts

of wild pigs within the previous year were reported by 3,337 landowners or managers to have occurred on their property (86.7%), and 3,121 reported economic losses due to wild pigs in 2018 (81.1%). Only 27.8% of landowners or managers reported earning income by leasing wild pig hunting rights in 2018 (n = 1,070). Landowners who earned income by leasing wild pig hunting rights in 2018 earned a mean of $812.52 (SD = $901.46, median= $500). Landowners who suffered economic losses due to wild pigs in 2018 lost an average of $4,462.67 (SD = $7,944.35, median = $1,500). Landowners most frequently reported damages to pastures due to wild pigs (Figure IV.1). Landowners most commonly employ owner/employee hunting and trap-and-destroy methods to control pigs on their property (Figure IV.2).

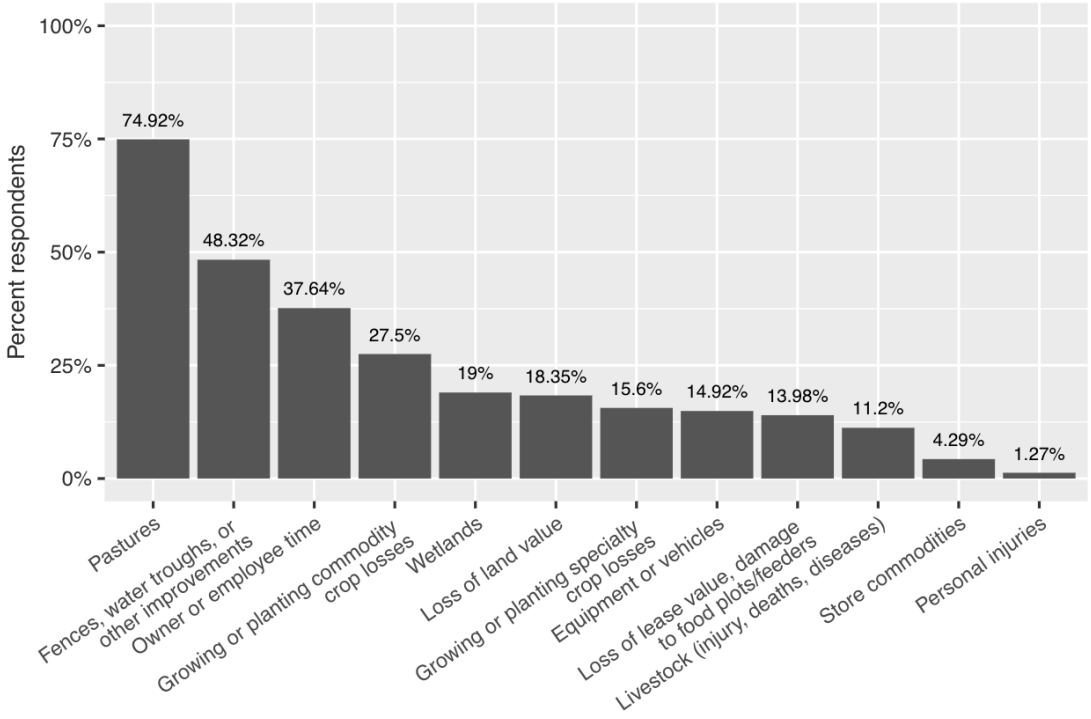


Figure IV.1. Reported areas of wild pig damage among Texas landowners.

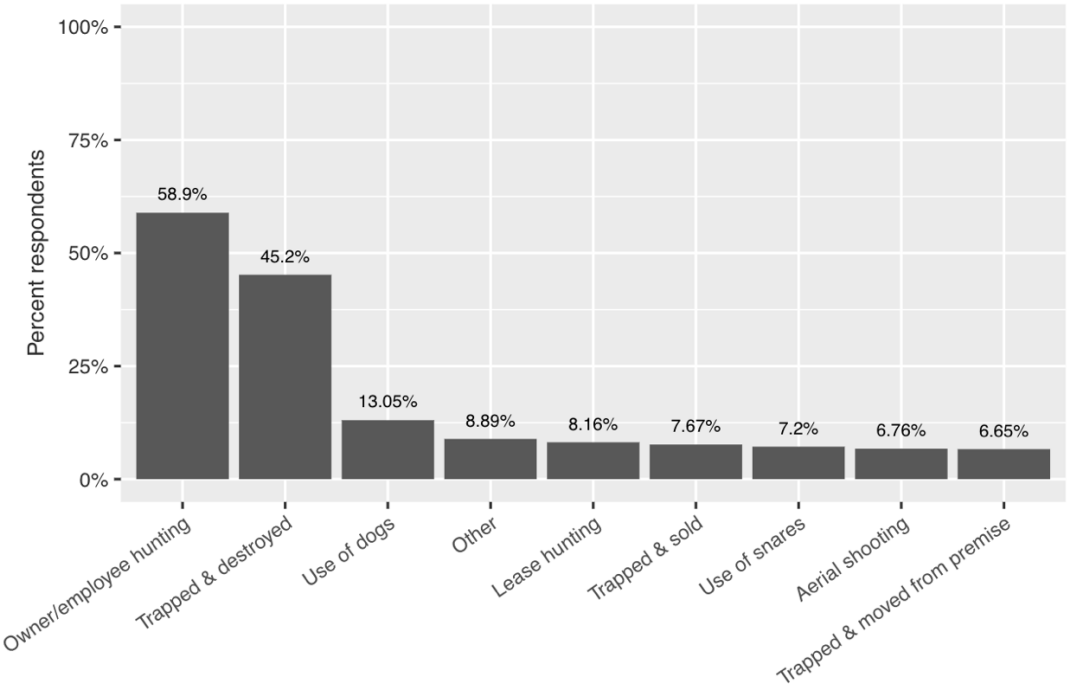


Figure IV.2. Reported wild pig control methods used among Texas landowners.

To test for non-response bias, I regressed several key questions on days to respond (Appendix A, Questions 1, 31, 73, and big game hunter status) against the number of days to response to each respondent. While responses were different by the number of days to response ($P < 0.05$), effect sizes were very small ($r^2 = 0.0003$). I concluded there was no significant effect of non-response bias on the data used in these analyses and the results could be generalized to the target population.

Differences between attendees and non-attendees

Attendees of an AgriLife educational seminar lost a mean of $3,892 to wild pigs in 2018 (SD = $7,719, median = $1,000). Non-attendees lost a mean of $2,562 in damages to wild pigs in 2018 (SD = $5,759; median = $500). Comparisons of the estimated marginal means indicated that, given equal property size, attendees lost more money to wild pigs in

2018 (Table IV.1; $P < 0.001$). Attendees of an AgriLife educational seminar trapped a mean of 27.2 wild pigs in 2018 (SD = 81.8, median = 6.00). Non-attendees trapped a mean of 18.4 wild pigs in 2018 (SD = 64.3; median = 5.0). Additional comparisons indicated that attendees trapped more pigs than non-attendees, given equal property size (Table IV.2; $P < 0.01$).

Table IV.1. Total economic losses[a] due to wild pigs per landowner, controlled by acres owned.

	Total economic losses due to wild pigs			
Group	Mean	SE	LCL[b]	UCL[b]
Non-attendees	$2,414	$159	$2,121	$2,747
Attendees	$3,471	$225	$3,057	$3,940
	Contrast			
	Ratio	SE	z ratio	*P* value
Non-attendees / Attendees	0.66	0.06	-3.93	< 0.001

[a]Dollars lost due to wild pigs in 2018 estimated per landowner within each group at a constant landholding value of 363.2 acres.
[b]LCL: lower confidence limit; UCL: upper confidence limit

Table IV.2. Total wild pigs trapped[a] per landowner, controlled by acres owned.

	Wild pigs harvested by trapping or snaring			
Group	Mean	Std. error	LCL[b]	UCL[b]
Non-attendees	18.3	1.52	15.6	21.6
Attendees	25.4	1.84	22.0	29.3
	Contrast			
	Ratio	SE	z ratio	*P* value
Non-attendees / Attendees	0.72	0.08	-2.96	0.003

[a]Wild pigs harvested by trapping or snaring in 2018 estimated per landowner within each group at a constant landholding value of 423.2 acres.
[b]LCL: lower confidence limit; UCL: upper confidence limit

Wild pig abatement technique adoption

Seminar attendees reported which suggested techniques they adopted and continue to employ to improve wild pig abatement on their property. Results are reported in Table IV.3. Attendees also reported which factors prevented them from continuing to employ the practices they adopted following a seminar. Results are displayed in Table II.1. I discuss implications of these results in the following section.

Table IV.3. AgriLife wild pig seminar attendees' adoption of suggested management practices for wild pig management.

Management practice	Response			
	Planned to adopt	Adopted	Continue to use	*Unknown*
Use larger traps	346 (41.8%)	157 (19.0%)	324 (39.2%)	434
Use baits with scent appeal	232 (32.0%)	170 (23.4%)	324 (44.6%)	535
Vary/change baits at different locations	236 (36.0%)	168 (25.6%)	251 (38.3%)	606
Set traps whenever fresh sign appears	223 (28.8%)	179 (23.1%)	372 (48.1%)	487
Pre-bait traps	186 (24.6%)	200 (26.5%)	370 (48.9%)	505
Scout for pig sign	118 (12.8%)	246 (26.7%)	559 (60.6%)	338

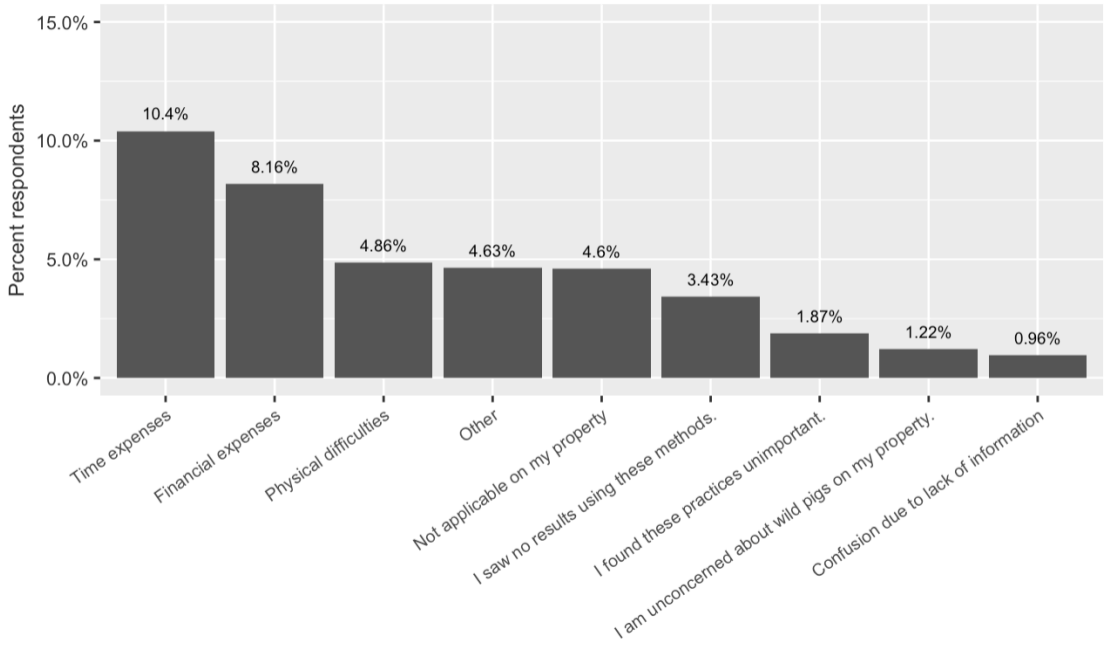


Figure IV.3. AgriLife Extension wild pig seminar attendees' reported barriers to adoption of suggested management practices for wild pig management.

Discussion

Wild pig damage abatement is important to many agricultural producers in Texas. AgriLife Extension seminars on wild pigs present an effort to better equip landowners and land managers with the most efficient tools to reduce damage and revenue lost due wild pigs. This study finds that AgriLife Extension wild pig program attendees lost more money due to wild pig damage than non-attendees in 2018 (Table IV.1). However, this result likely reflects audience self-selection favoring landowners who suffer greater losses due to wild pig damage. Individuals who suffer greater losses to wild pig damage are be more likely to support management of the species (García-Llorente et al. 2008) and, therefore, may be more likely to seek assistance or information regarding population management and damage abatement strategies. Because longitudinal data for seminar

attendees is not available, I was unable to estimate the efficacy of AgriLife Extension programs in reducing revenue lost due to wild pig damage. Future AgriLife Extension education programs should consider enrolling attendees in a longitudinal survey effort across multiple years to determine the impact of seminar attendance on reducing losses due to wild pig damage. This improvement upon existing strategies with regard to wild pig educational activities would allow for rigorous self-evaluation of translation of successful education into successful wild pig management and/or eradication efforts.

Successful wild pig eradication efforts involve multiple lethal wild pig management activities, including trapping, professional gunning, and extensive fencing (Seward et al. 2004, McCann and Garcelon 2008, Parkes et al. 2010). Over half (58.9%) of the land managers included in this survey reported using owner or employee hunting as a management method for wild pig population control and damage abatement (Figure IV.2). However, hunting alone is unlikely to successfully reduce wild pig population densities (Ditchkoff et al. 2017). Alternatively, sustained hunting pressure may be effective in deferring damages to other areas (Geisser and Reyer 2004). Trapping is both a time- and cost-efficient method for mitigating wild pig damage (Massei et al. 2011, Gaskamp et al. 2018). Trapping is most effective in areas of high wild pig population density and can be used to remove entire sounders of wild pigs in a short period of time (Massei et al. 2011). Further, trapping programs may remove more female wild pigs than males, hindering the population's growth after intensive trapping efforts (Choquenot et al. 1993).

Trap style, size, location, and baiting habits all impact wild pig trapping success (Choquenot et al. 1993, Mersinger and Silvy 2007, Massei et al. 2011, Williams et al.

2011). My results suggest that AgriLife Extension wild pig programs effectively improve wild pig trapping success among landowners and land managers (Table IV.2). AgriLife Extension suggests scouting for wild pig sign and setting traps in areas with fresh signs of wild pigs. Additionally, traps may need to be used in different areas seasonally, following wild pig behavioral and foraging activities (Mersinger and Silvy 2007). Results of this survey illustrate that AgriLife Extension wild pig programs effectively facilitate the adoption and continuation of these techniques by almost half of attendees (Table IV.3). The most commonly continued practice among seminar attendees is to scout for pig sign (60.6%). Additionally, 48.1% of attendees report continuing to set traps whenever fresh sign appears. Scouting for and setting pig traps in areas with fresh pig sign is important to continued trap success and requires a dedication to control efforts. Given that some report requisite time necessary to trap as a barrier to practice adoption, this result shows promise in adoption of better management methods by participants.

AgriLife Extension suggests using traps at least 20 feet wide and 30 feet long to trap entire groups of wild pigs in a single trapping session. 39.2% of attendees indicated continuing to use larger traps for wild pigs. However, it is unclear what size trap attendees used prior to the seminar and those already using appropriately-sized traps would likely not increase the size further. While corral-style traps exist in a variety of configurations, most landowners still use small, box-style traps. Thus, use of larger traps may indicate a shift toward corral-style traps, regardless of configuration.

AgriLife Extension seminars suggest prebaiting trap sites to acclimate wild pigs to entering the trap and using different types of scented bait at different trap sites.

Almost half (48.9%) of attendees report continuing to prebait trap sites for wild pigs. Additionally, 44.6% of attendees continue to use scented bait and 38.3% continue to vary bait at different trap sites. The use of bait is important in incentivizing wild pigs to enter traps. Prebaiting allows land managers to wait until the entire sounder is reliably entering the trap before setting it, increasing efficiency by removing large numbers of wild pigs at once. Such widespread adoption of methods and techniques to improve efficacy in wild pig management contribute to an image of success in these efforts, yet not all participants adopt and maintain these practices due to some barrier.

Barriers to adoption and continuation of suggested wild pig damage abatement practices highlight areas where Extension educators may better facilitate cooperation among land managers to improve cooperative efforts to mitigate wild pig damage. For any program that serves the public interest, critical assessment of the elements that present success is a crucial component in improving overall program effectiveness. Wild pig program attendees most commonly report time expenses (10.4%) and financial expenses (8.2%) as barriers to continuing suggested wild pig abatement practices. Although these comprise a minority of participants, one must recognize that some suggested practices, such as building larger traps or setting traps whenever fresh bait appears may demand greater time and financial investment by the individual land manager. Nevertheless, a certain amount of investment, both in time and finances, as well as the cultivation of trapping skillsets, is required of a highly effective wildlife damage manager. Cooperation in wild pig trapping efforts among neighboring landowners, stakeholder groups, and state and federal agencies may alleviate the time and financial burdens on individual land managers (May 2014). Such cooperatives, similar in

structure to other local landowner cooperative groups, would increase peer-teaching and expertise among neighboring land managers. Cooperative wild pig management efforts also may defray the cost of some highly effective, yet expensive, control technologies. Improved cooperation among neighboring landowners also may eliminate available refuge habitats for wild pigs, reducing the likelihood of wild pig populations re-establishment after removal efforts (Gaskamp et al. 2018).

Importantly, few seminar attendees reported they were unconcerned about wild pigs on their property (1.2%), found the suggested practices unimportant (1.9%), or experienced confusion due to lack of information (1.0%) as barriers to suggested technique continuation (Figure IV.3). This finding suggests that AgriLife Extension wild pig programs effectively convey information about the impacts of wild pigs and management techniques for the species to affected land managers, preventing low perceptions of behavioral control among affected landowners (Prinbeck et al. 2011). For any entity seeking to effectively educate the public, this is a key indicator that education was both broad and thorough, such that it held against real-world experience in employing knowledge taught. Additionally, personally-experienced economic impacts among land managers dealing with wild pig damage likely motivates wild pig damage and population management efforts (García-Llorente et al. 2008, Ford-Thompson et al. 2012). Overall, AgriLife Extension programming on wild pig abatement strategies appears successful in educating land managers suffering high financial losses to wild pig damage and providing information and facilitating technique adoption to improve wild pig damage abatement efforts.

In areas experiencing wild pig damages, education efforts should focus on improving trapping techniques among land managers and facilitating cooperation between neighbors, agencies, and other stakeholder groups to improve wild pig population management efforts at a larger scale. Cooperative management must occur across private landholdings, and landowners should form active cooperative groups to share in peer teaching and defray financial burden associated with an activity that ultimately benefits all. As wild pigs encroach upon new environments across the United States, population and damage management efforts will remain important to prevent the species' establishment in newly invaded areas. Additionally, continued education regarding the economic and ecological consequences associated with increasing wild pig range and abundance should strive to discourage tolerance of wild pigs among landowners and land managers. I recommend that AgriLife Extension educators offer information on the impacts of wild pig damage to land managers with small wild pig problems to encourage proactive response and prevent development into larger, more costly wild pig problems. Once wild pigs have become established in an area, eradication becomes highly unlikely. AgriLife Extension educators will continue to be an important resource for land managers facing wild pig damages, especially in sharing novel technologies and methods for wild pig population management and damage abatement.

Conclusions

This study represents an effort to appraise the success of Texas A&M AgriLife Extension Service wild pig damage and abatement programs. The issue of wild pig management is dynamic, including both realized and potential risks and benefits among multiple

stakeholder groups. Land managers suffering from wild pig damage on their properties have a variety of management options. As a trusted public resource within the state, AgriLife Extension Service must continue to advise Texans on practical, cost-effective wild pig management techniques. This study describes the success of wild pig educational programing in Texas at improving wild pig management by heavily affected land managers. Further, this study provides evidence that educational seminars are effective means to enact long-term change in damage abatement strategies among land managers dealing with wild pig damage.

All AgriLife Extension education efforts aimed at improving management of wild pigs must continually self-assess to remain relevant and meet changing landowner needs to present novel technologies. After 30 years of dedicated education activities about wild pig management, Texas A&M AgriLife Extension Service must look toward the future to new methods of improving the long-term adoption of wild pig management strategies among a diverse group of landowners.

CHAPTER V

SUMMARY

This research contributes to a greater understanding of the human dimensions of wild pigs in Texas. The issue of exotic, invasive wild pigs in Texas is an important system for understanding how different stakeholders interact with a wide-spread, destructive species. This research examines wild pig hunters as key stakeholders in this issue. I first analyze the factors that contribute to hunter likelihood for participation in wild pig hunting. I then investigate the association between wild pig hunter motivations and harvest magnitude. Finally, I examine the efficacy of Texas A&M AgriLife Service educational efforts in fostering positive change in wild pig management activities among Texas landowners. The finding presented herein are useful in developing educational tools for hunters and landowners interacting with wild pigs and for creating management plans for wild pigs which consider both the risks and benefits associated with wild pig presence.

Chapter II represents an effort to understand the identity of the modern wild pig hunter. These findings provide information useful in developing a typology of wild pig hunters in the context of recreational hunting activities. Succinctly, modern wild pig hunters are predominantly middle-aged, white, male, and high-income earners. Importantly, wild pig hunters often hunt other big game animals as well. Additionally, individual perceptions of the species are important factors contributing to wild pig hunting activity. Wild pig hunters tend to perceive the species positively, and attribute a degree of utilitarian value to them, specifically when they do not experience damages associated with them. Although it does not appear that wild pig hunting replaces hunting of native big game, wild pigs are a popular hunting quarry among Texas hunters.

Chapter III presents an investigation to understand the relationships between hunter motivation, effort, and harvest success among Texas wild pig hunters. I describe a variety of motivational factors driving participation in wild pig hunting activities. This research finds that wild pig harvest differs significantly among motivational groups. While the majority of wild pig hunters in Texas hold high trophy motivations, meat-motivated hunters harvest more wild pigs than any other motivational group. Selective trophy harvest and self-imposed limits among meat hunters may lead to inadequate removal of wild pigs to accomplish population reduction goals. These results suggest that hunting alone may not be effective in wild pig population management efforts in Texas. Instead, hunter harvest should be combined with other management methods to remove more wild pigs and avoid male-selective harvest.

Chapter IV represents an effort to appraise the success of Texas A&M AgriLife Extension Service wild pig damage and abatement programs. This study describes the success of wild pig educational programing in Texas at improving wild pig management by heavily affected land managers. Further, this study provides evidence that educational seminars are effective means to enact long-term change in damage abatement strategies among land managers dealing with wild pig damage. As a trusted public resource within the state, AgriLife Extension Service must continue to advise Texans on practical, cost-effective wild pig management techniques.

Results of this research suggest that those aiming to educate hunters about wild pigs face a largely uninformed public that does not hold the same perceptions, values, or tolerance levels of the species. This study demonstrated that wild pig hunters poorly understand wild pigs and their impacts on human health, agricultural production, and

ecological processes. I suggest that efforts be made to more accurately convey information on ecological, agricultural, and economic risks associated with wild pigs to the public in meaningful education campaigns aiming to adjust public perceptions at a broad scale. Education efforts targeting hunters should include information regarding wild pig natural history, relevant zoonotic disease risks, and legal regulations at state level. Future education efforts concerning wild pigs will be important in shaping public perceptions in ways that favor ecologically appropriate management activities for the species.

All AgriLife Extension education efforts aimed at improving management of wild pigs must continually self-assess to remain relevant and meet changing landowner needs to present novel technologies. After 30 years of dedicated education activities about wild pig management, Texas A&M AgriLife Extension Service must look toward the future to new methods of improving the long-term adoption of wild pig management strategies among a diverse group of landowners.

As wild pigs continue to spread across the continent and into novel habitats, sound management efforts will be become increasingly important. Wildlife managers may best protect natural resources by employing multiple methods to remove wild pigs. However, wildlife managers must consider the dynamic issue of wild pig management, including both realized and potential risks and benefits among multiple stakeholder groups, when selecting a management plan for the species. Wildlife managers will be tasked with deciding which positions to emphasize in the decision-making process while also incorporating ecological knowledge to meet both human and wildlife needs. Modern wildlife managers and decision-makers must use interdisciplinary approaches and social

science tools to understand the human dimension factors of wildlife management issues where differing stakeholder groups may maintain different positions on management options. The issue of wild pig management in Texas may serve to further illustrate the necessity of such interdisciplinary research in future management efforts for widespread, exotic, invasive species which involve a diversity of stakeholder groups.

This research contributes to the growing understanding of human dimensions in the issue of invasive wild pig management, which involves unraveling a complicated dichotomy of perceptions, risks, and benefits among wild pig resource users and damage managers. Even within wild pig hunters, differences in utilitarian attitudes toward wild pigs exist between landowners and non-landowners and in different regions of the state. Moving forward, those tasked with managing wild pigs for the ecological and public good must decide which stakeholder interests to favor in the contexts of risks and opportunities associated with the species.

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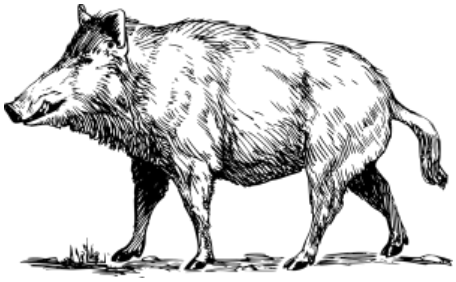
APPENDIX A

TEXAS A&M AGRILIFE EXTENSION SERVICE HUMAN DIMENSIONS OF WILD PIGS SURVEY PACKET

TEXAS A&M AGRILIFE EXTENSION

Human Dimensions of Wild Pigs
Survey Packet



Principal Investigators: Dr. John Tomeček and Dr. Maureen Frank

Welcome to the Texas A&M AgriLife Human Dimensions of Wild Pigs Survey!

We thank you for choosing to help us in our research!

You are one of a small number of participants who were randomly selected to participate in our survey. This study is designed to allow Texas A&M AgriLife Extension Service to better understand hunter, landowner, and stakeholder opinions about wild pigs and management practices for the species.

Please review the following information sheet and before proceeding to the survey.

Then, please complete the questions contained in this survey booklet and return the survey in the postage-paid return envelope provided.

In this survey, the term "wild pig" refers to any free-roaming and free-living swine. Other names for wild pigs include feral swine, feral pig, wild hog, and wild boar. The term "wild pig" does not include native wild animals, such as the collared peccary, also known as the javelina.

If you have any problems completing the survey, please contact Rachael Connally for assistance. You can reach Rachael by phone at 979-583-2205 or by email at Rachael.Connally@tamu.edu.

Your responses are important to use and we hope that you enjoy completing our survey and the chance to voice your opinions about wild pigs!

Thank you for your time and participation.

John M. Tomecek

John M. Tomeček, Ph.D.
Principal Investigator
Assistant Professor &
Extension Wildlife Specialist

Maureen G. Frank

Maureen G. Frank, Ph.D.
Co-Investigator
Assistant Professor &
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Rachael L. Connally

Rachael L. Connally
Graduate Research Assistant

Texas A&M University Human Research Protection Program

Information Sheet

Title of Research Study: Human Dimensions of Wild Pigs
Investigators: Dr. John Tomeček and Dr. Maureen Frank

Why am I being asked to take part in this research study?

You are invited to participate in this study because we are trying to learn more about hunter, landowner, and stakeholder opinions about wild pigs and management practices for the species.

You were selected as a possible participant in this study through a random sample of individuals within stakeholder groups, such as hunting, agricultural, and environmental interest groups. You must be 18 years of age or older to participate in this survey.

Why is this research being done?

The study is designed to allow researchers to better understand stakeholder perceptions and knowledge about wild pigs and their management in the state of Texas.

How long will the research last?

The questionnaire is expected to take approximately 30 minutes to complete.

What will I be asked to do in this study?

You will be asked to answer a series of questions about your thoughts and opinions on the resource use, economic impacts, and management of wild pigs.

What happens if I do not want to be in this research?

Your participation in this study is voluntary. You can decide not to participate in this research and it will not be held against you. You can leave the study at any time.

Are there any risks to me?

No risks are expected to participants in the study. There are no sensitive questions in this survey that should cause discomfort. However, you can skip any question you do not wish to answer, or exit the survey at any point.

Are there any benefits to me?

No benefits are expected to participants in the study.

What happens to the information collected for the research?

Efforts will be made to limit the use and disclosure of your personal information, including research study and other records, to people who have a need to review this information. We cannot promise complete privacy. Organizations that may inspect and copy your information include the TAMU HRPP and other representatives of this institution. No identifiers linking you to this study will be included in any sort of report that might be published.

Who can I talk to?

Please feel free to ask questions regarding this study. You may contact the Principal Investigator, John Tomeček, by phone at 325-650-3520 or by email at tomecek@tamu.edu.

For questions about your rights as a research participant; or if you have questions, complaints, or concerns about the project, you may call the Human Research Protection Program at Texas A&M University (which is a group of people who review the research to protect your rights) by phone at 1-979-458-4067, toll free at 1-855-795-8636, or by email at irb@tamu.edu.

1. Do you hunt in Texas?

○ Yes ○ No

If you do not hunt in Texas, please skip to Question #21.

2. Which types of animals do you hunt in Texas?

Please rank all that apply, with **1** being the animal you hunt **most often**.
Please include **all** animals that you hunt for both recreational and management purposes.

	Wild pigs		Exotics (axis, black buck, fallow, elk, etc.)
	White-tailed deer		Migratory game birds (dove, duck, goose, etc.)
	Mule deer		Upland game birds (quail, turkey, pheasant, etc.)
	Javelina		Other (fur-bearing animals, predators, rabbits, etc.)
	Pronghorn		

If you do not hunt wild pigs, please skip to Question #21.

3. What are the most important reasons that you hunt wild pigs?

Please rate the following reasons from "not at all important" to "very important".

	Not at all important	Not very important	A little important	Fairly important	Very important
Meat	○	○	○	○	○
Trophies (skull, etc.)	○	○	○	○	○
Recreation	○	○	○	○	○
Controlling wild pig population	○	○	○	○	○
Controlling wild pig damage	○	○	○	○	○

4. How many wild pigs did you harvest while hunting in 2018?

_____ wild pigs

5. How many days did you spend hunting wild pigs in Texas in 2018?

_____ days

6. How many days did you spend hunting other large game animals in Texas in 2018?

Please include days that you hunted deer, exotics, and any big game animals except wild pigs.

_____ days

7. Which statement best describes the majority of your hunting trips?

- ○ I exclusively hunt wild pigs on most of my hunting trips.
- ○ I primarily hunt wild pigs, but will harvest a native game animal if I see one.
- ○ I hunt wild pigs and native game animals about equally during the same trip.
- ○ I primarily hunt native game animals, but will harvest a wild pig if I see one.
- ○ I exclusively hunt native game animals and do not hunt wild pigs on most of my hunting trips.

8. How much money did you spend on wild pig hunting-related purchases in 2018?

Please estimate the costs of the following items to a whole dollar amount.

Hunting lease(s) or access fees	$		.00 (dollars only)
Tour operator or guide fees	$		.00 (dollars only)
Overnight accommodations	$		.00 (dollars only)
Transportation	$		.00 (dollars only)
Meals	$		.00 (dollars only)
Ammunition	$		.00 (dollars only)
Bait / Attractant	$		.00 (dollars only)
Processing or taxidermy	$		.00 (dollars only)
Hunting tools / guns and accessories	$		.00 (dollars only)
Other, please specify:	$		.00 (dollars only)

9. How would you describe the present size of the wild pig population in the areas where you most often hunt them?

○ Too low ○ About right ○ Too high

10. What type of property do you typically use to hunt wild pigs?

Please select all that apply.

- ☐ Personal property
- ☐ Family-owned or friend's property
- ☐ Leased property
- ☐ Property I manage
- ☐ Public land
- ☐ Private property while on a guided hunt
- ☐ Private property by landowner request
- ☐ Other, please specify:

11. During which times of the year do you typically hunt wild pigs?

Please select all that apply.

- ☐ Spring
- ☐ Summer
- ☐ Fall
- ☐ Winter

12. Where do you typically hunt wild pigs?
Please select all that apply.

- ☐ Rangeland
- ☐ Agricultural fields
- ☐ Pastures
- ☐ Roads or wildlife openings
- ☐ Near artificial food sources (livestock feeders, etc.)
- ☐ Near natural or artificial water sources
- ☐ Thick brush or forests
- ☐ Other, please specify: _____

Please indicate the level to which you agree with the following statements by writing the corresponding number in each box.

		Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
13.	Wild pigs increase hunting opportunities for me and my family.	○	○	○	○	○
14.	I would go hunting for other animals more if wild pigs were less available to hunt.	○	○	○	○	○
15.	I prefer to hunt wild pigs even when other animals are available for me to hunt.	○	○	○	○	○
16.	Wild pigs are less enjoyable to hunt than other animals.	○	○	○	○	○
17.	I started hunting wild pigs before I became interested in hunting other animals.	○	○	○	○	○
18.	I devote more time to hunting wild pigs than other animals.	○	○	○	○	○
19.	I only purchase my hunting license to hunt wild pigs.	○	○	○	○	○

20. Which of the following personal protective equipment do you use when handling wild pigs?
Please select all that apply.

- ☐ Rubber gloves
- ☐ Protective eyewear
- ☐ Face mask
- ☐ Tick repellant
- ☐ Soap
- ☐ Knife and surface disinfectant
- ☐ Long sleeves and pants
- ☐ None
- ☐ Other, please specify: _____

21. What types of traps do you use for wild pigs?
Please select all that apply.

- ☐ Snares
- ☐ Cage traps
- ☐ Box traps
- ☐ Corral traps
- ☐ Figure 6 traps
- ☐ Figure "C" traps
- ☐ Drop-style traps
- ☐ I do not use any traps for wild pigs.
- ☐ Other, please specify: _____

If you do not use traps for wild pigs, please skip to question #29.

22. How many wild pigs did you harvest by trapping or snaring in 2018?

[ ] wild pigs

23. Have you ever trapped and sold live wild pigs?

○ Yes ○ No

If you have never trapped and sold wild pigs, please skip to question #26.

24. How many wild pigs did you sell in 2018?

[ ] wild pigs

25. How much income did you make by trapping and selling pigs in 2018?

$ [ ] .00 (dollars only)

26. What type of property do you typically use to trap wild pigs?

Please select all that apply.

- ☐ Personal property
- ☐ Family-owned or friend's property
- ☐ Leased property
- ☐ Property I manage
- ☐ Public land
- ☐ Private property while on a guided hunt
- ☐ Private property by landowner request
- ☐ Other, please specify: _____

27. During which times of the year do you typically trap wild pigs?

Please select all that apply.

- ☐ Spring
- ☐ Summer
- ☐ Fall
- ☐ Winter

28. Where do you typically trap wild pigs?

Please select all that apply.

- ☐ Rangeland
- ☐ Agricultural fields
- ☐ Pastures
- ☐ Roads or wildlife openings
- ☐ Near artificial food sources (livestock feeders, etc.)
- ☐ Near natural or artificial water sources
- ☐ Thick brush or forests
- ☐ Other, please specify: _____

29. Did you provide any wild pig guide or outfitting services to paying hunters in 2018?

○ Yes ○ No

If you did not provide these services, please skip to Question #31.

30. How much income did you make by providing wild pig guide or outfitting services to paying hunters in 2018?

$ [ ] .00 (dollars only)

31. Do you own or manage land in Texas?

○ Yes ○ No

If you do not own land in Texas, please skip to Question #38.

32. What are the uses of the land you own or manage in Texas?

Please rank all that apply by importance, with **1** being the **most important**.

	Private residence		Personal recreation (hunting, fishing, leisure, etc.)
	Farming or crop production		Lease hunting (include guide services, outfitting, etc.)
	Ranching - Domestic livestock		Natural gas or oil extraction
	Ranching – Native wildlife (deer, quail, etc.)		Timber production
	Ranching – Exotic wildlife		Other, please specify: _____

33. What is the size of the largest property you own or manage in Texas?

[ ] acres

34. 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

35. Please mark all of the control methods you use on your property(s).

☐ Trapped & destroyed	☐ Owner/Employee hunting	☐ Use of snares
☐ Trapped & moved from premise	☐ Lease hunting	☐ Aerial shooting
☐ Trapped & sold	☐ Use of dogs	☐ Other

36. Please estimate your total economic losses due to wild pigs in 2018 on all your property(s).

$ [ ] .00 (dollars only)

37. How much income did you make by leasing wild pig hunting rights in 2018?

$ [ ] .00 (dollars only)

38. What change would you like to see in wild pig population numbers in the state of Texas?

○ Completely removed ○ Reduced ○ Remain the same ○ Increase ○ I do not know.

39. Which of the following types of wild pig control methods do you think are, or would be, **effective**?

Please indicate the level of effectiveness for each method on the scale below.

	Completely ineffective	Somewhat ineffective	Neutral	Somewhat effective	Completely effective
Trap and lethally remove	○	○	○	○	○
Trap and sell	○	○	○	○	○
Use of a safe, humane toxicant	○	○	○	○	○
Use of dogs	○	○	○	○	○
Use of snares	○	○	○	○	○
Non-lethal deterrents	○	○	○	○	○
Lease hunting	○	○	○	○	○
Owner/employee hunting	○	○	○	○	○
Government or agency hunting	○	○	○	○	○
Aerial shooting	○	○	○	○	○

40. Which of the following types of wild pig control methods are, or would be, personally **acceptable** to you?

Please indicate the level of acceptability for each method on the scale below.

	Completely unacceptable	Somewhat unacceptable	Neutral	Somewhat acceptable	Completely acceptable
Trap and lethally remove	○	○	○	○	○
Trap and sell	○	○	○	○	○
Use of a safe, humane toxicant	○	○	○	○	○
Use of dogs	○	○	○	○	○
Use of snares	○	○	○	○	○
Non-lethal deterrents	○	○	○	○	○
Lease hunting	○	○	○	○	○
Owner/employee hunting	○	○	○	○	○
Government or agency hunting	○	○	○	○	○
Aerial shooting	○	○	○	○	○

41. Please indicate your level of concern for the following types of damage caused by wild pigs.

	No concern	Low level of concern	Moderate level of concern	High level of concern	Very high level of concern
Crop losses	○	○	○	○	○
Stored commodity losses	○	○	○	○	○
Damage to pastures	○	○	○	○	○
Damage to wetlands	○	○	○	○	○
Habitat degradation	○	○	○	○	○
Damage to water quality	○	○	○	○	○
Damage to personal property	○	○	○	○	○
Loss of land value	○	○	○	○	○
Loss of lease value	○	○	○	○	○
Livestock injury or disease	○	○	○	○	○
Wildlife competition or predation	○	○	○	○	○
Human disease or injury	○	○	○	○	○

Based on your current knowledge of wild pigs, please mark each of the following statements as either true or false.

		True	False	I am unsure.
42.	Wild pigs can carry diseases that can be spread to domestic animals.	○	○	○
43.	Wild pigs are native to Texas.	○	○	○
44.	Wild pigs can carry diseases that can be spread to humans.	○	○	○
45.	Wild pigs are a different species than domestic pigs.	○	○	○
46.	Wild pigs can breed year-round in Texas.	○	○	○
47.	Wild pigs have an average of 12 piglets per litter.	○	○	○
48.	Wild pigs kill livestock and wildlife as a primary source of food.	○	○	○
49.	Wild pigs are present in less than 70% of Texas counties.	○	○	○
50.	Wild pigs are regulated as a game animal in the state of Texas.	○	○	○
51.	There are legal restrictions on the transportation, release, and holding of live wild pigs in Texas.	○	○	○

52. How has each of the following affected the number of wild pigs in the county where you live?

	Substantially Decreased	Somewhat Decreased	No Change	Somewhat Increased	Substantially Increased	I am unsure.
Hunting of wild pigs	○	○	○	○	○	○
Neighbor's agriculture practices	○	○	○	○	○	○
Trapping of wild pigs	○	○	○	○	○	○
Predators	○	○	○	○	○	○
Release or escape of domestic pigs	○	○	○	○	○	○
Release or transfer of wild pigs for hunting	○	○	○	○	○	○
Natural movement of wild pigs	○	○	○	○	○	○
Availability of food sources for wild pigs	○	○	○	○	○	○
Absentee landowners	○	○	○	○	○	○

Please indicate the level to which you agree with the following statements by writing the corresponding number in each box.

		Completely disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely agree
53.	Wild pigs increase my overall quality of life.	○	○	○	○	○
54.	The harm caused by wild pigs outweighs any benefits of having them in Texas.	○	○	○	○	○
55.	Wild pigs are a valuable resource for recreation, meat, or income in Texas.	○	○	○	○	○
56.	Wild pigs do not belong in Texas.	○	○	○	○	○
57.	Overall, my feelings about wild pigs in Texas are generally positive	○	○	○	○	○
58.	Wild pigs are a nuisance.	○	○	○	○	○
59.	Wild pigs have the right to exist wherever they may occur.	○	○	○	○	○
60.	It should be legal to release live wild pigs anywhere in Texas in order to hunt them.	○	○	○	○	○
61.	It should be legal to transport live feral hogs anywhere in the U.S. without restrictions.	○	○	○	○	○
62.	I would feel comfortable using a safe, humane toxicant to control wild pig populations.	○	○	○	○	○
63.	I would feel comfortable consuming the meat of a wild pig if safe, humane toxicants were used near where the animal was harvested.	○	○	○	○	○

64. Please tell us more about your position on a safe, humane toxicant for wild pigs.

65. Have you ever attended an AgriLife educational seminar on wild pigs?

○ Yes ○ No ○ I am not sure.

If you have not attended an AgriLife educational seminar on wild pigs, please skip to Question #67.

66. Please mark all practices that you planned to adopt, adopted, and continue to use in order to better manage wild pigs on your property after attending an AgriLife educational seminar.

	Planned to adopt	Adopted	Continue to use
Use larger traps	☐	☐	☐
Use baits with scent appeal	☐	☐	☐
Vary/change baits at different locations	☐	☐	☐
Set traps whenever fresh sign appears	☐	☐	☐
Pre-bait traps to encourage consistent pig visits	☐	☐	☐
Scout for pig sign (tracks, wallows, rubs, hair)	☐	☐	☐
Wear eyewear and gloves during field dressing	☐	☐	☐
Market trapped pigs to processors to recoup losses	☐	☐	☐

67. Please indicate the reasons why you do not continue to use the suggested practices that you adopted following an AgriLife education seminar.

Please check all that apply.

☐ Financial expenses

☐ Time expenses

☐ Physical difficulties

☐ Confusion due to lack of information

☐ Not applicable on my property

☐ I am unconcerned about wild pigs on my property.

☐ I found these practices unimportant.

☐ I saw no results using these methods.

☐ I still employ all methods that I initially intended to employ.

☐ Other, please specify:

_____

68. What AgriLife Extension Service resources have you used to learn about wild pigs?
Please select all that apply.

- ☐ Communication with AgriLife Extension agents
- ☐ Educational seminars
- ☐ Social media
- ☐ Online videos
- ☐ Articles or publications
- ☐ Webinars
- ☐ I have not used any AgriLife resources.
- ☐ Other, please specify: _____

69. What other resources have you used to learn about wild pigs?
Please select all that apply.

- ☐ Communication with state wildlife professionals (TPWD)
- ☐ Educational seminars
- ☐ Local newspaper or news broadcast
- ☐ Social media (Facebook, Twitter, Instagram, etc.)
- ☐ Online videos
- ☐ Communication with federal wildlife professionals (APHIS, USDA, USFWS, etc.)
- ☐ Communication with other hunters, landowners, farmers, or ranchers
- ☐ Articles or publications
- ☐ Hunting or wildlife magazines
- ☐ I have not used any other resources.
- ☐ Other, please specify: _____

70. Which of the following best describes why you use social media for wild pig hunting content?
Please select only one.

- ○ To learn new hunting techniques
- ○ To get ideas about where to hunt
- ○ To watch wild pigs get harvested
- ○ To learn about wild pigs
- ○ To be entertained
- ○ To remind me of my memorable hunts

If you do not watch wild pig hunting videos, please skip to Question #70.

71. What resources would you <u>trust</u> to learn about wild pigs?
Please select all that apply.

- ☐ Communication with state wildlife professionals (TPWD)
- ☐ Communication with AgriLife Extension agents
- ☐ Educational seminars
- ☐ Local newspaper or news broadcast
- ☐ Social media (Facebook, Twitter, Instagram, etc.)
- ☐ Online videos
- ☐ Communication with federal wildlife professionals (APHIS, USDA, USFWS, etc.)
- ☐ Communication with other hunters, landowners, farmers, or ranchers
- ☐ Articles or publications
- ☐ Hunting or wildlife magazines
- ☐ None
- ☐ Other, please specify: _____

To help us better understand how to share educational information and knowledge on wild pigs in the future, please answer the following questions about yourself.

72. What is your ZIP code of primary residence?
Please enter your 5-digit ZIP code, such as "77843"

73. In what year were you born?
Please enter your 4-digit birth year, such as "1965"

74. What is your gender?

- ○ Male
- ○ Female

75. What is the highest level of education you have obtained?

- ○ Did not graduate high school or receive GED
- ○ High school graduate, diploma or GED
- ○ Some college, no degree
- ○ Associate degree
- ○ Trade/technical/vocational training
- ○ Bachelor's degree
- ○ Master's degree
- ○ Doctoral degree

76. Please specify your ethnicity.

- ○ White
- ○ Black or African American
- ○ American Indian or Alaska Native
- ○ Spanish, Hispanic, or Latino
- ○ Asian
- ○ Native Hawaiian or Pacific Islander
- ○ Other

77. Please indicate your average household income.

- ○ Less than $20,000
- ○ $20,000 to $34,999
- ○ $35,000 to $49,999
- ○ $50,000 to $74,999
- ○ $75,000 to $99,999
- ○ Over $100,000

78. From the list below, please select all of the wildlife, environmental, or agricultural interest groups of which you are a member.

- ☐ Texas Farm Bureau
- ☐ Texas and Southwestern Cattle Raisers Association
- ☐ Texas Sheep and Goat Raisers Association
- ☐ Texas Pork Producers
- ☐ Texas Hog Hunters' Association
- ☐ Quail Forever
- ☐ Ducks Unlimited
- ☐ Exotic Wildlife Association
- ☐ Texas Wildlife Association
- ☐ Dallas Safari Club
- ☐ Audubon Society
- ☐ Texas Ornithological Society
- ☐ Texas Master Naturalists
- ☐ Native Plant Society of Texas
- ☐ The Nature Conservancy
- ☐ Texas Land Conservancy
- ☐ Texas Corn Producers
- ☐ Texas Cotton Association
- ☐ Texas Pecan Growers Association
- ☐ Texas Forestry Association
- ☐ Texas Trophy Hunters Association
- ☐ Pheasants Forever
- ☐ National Turkey Federation (Texas Chapter)
- ☐ Texas Deer Association
- ☐ Texas Dove Hunters Association
- ☐ Houston Safari Club
- ☐ Lone Star Chapter of the Sierra Club
- ☐ Texas Master Gardeners
- ☐ Native Prairies Association of Texas
- ☐ Big Thicket Association
- ☐ Environment Texas
- ☐ I am not a member of any of wildlife, environmental, or agricultural groups.
- ☐ Other, please specify _____

79. If you have any comments you would like to leave about this survey, please write them here.

Thank you for completing our survey!

We appreciate your time and contributions to our research.

Please return this questionnaire in the enclosed postage-paid envelope.

Should you have any questions or comments regarding this survey, please contact Rachael Connally by email at rachael.connally@tamu.edu or by phone at 979-583-2205.

Thanks again,

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