NATIONAL DISTRIBUTION OF FERAL HOGS AND

RELATED STAKEHOLDER ATTITUDES

By

Edith Parks Fogarty

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Edith Parks Fogarty

Approved:

Kevin M. Hunt Associate Professor of Wildlife and Fisheries Co-Major Professor (Director of Thesis)	Bruce D. Leopold Professor/ Head, Department of Wildlife and Fisheries Graduate Program Coordinator
Richard B. Minnis Assistant Professor of Wildlife and Fisheries Co-Major Professor	George M. Hopper Dean of the College of Forest Resources
Stephen C. Grado Professor of Forestry Committee Member	

Name: Edith Parks Fogarty

Date of Degree: December 14, 2007

Institution: Mississippi State University

Major Field: Wildlife and Fisheries

Major Professors: Dr. Kevin M. Hunt and Dr. Richard B. Minnis

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Candidate for Degree of Masters of Science

Feral hog distribution (*Sus scrofa*) has increased to 38 states due to high fecundity rates, an omnivorous diet, and translocation by humans; affecting various stakeholders. To assess stakeholder attitudes and feral hog distribution in the United States and within Mississippi, self-administered mail questionnaires were sent to district level state wildlife biologists nationwide (n = 614) and to Mississippi Farm Bureau county presidents (FBCP; n = 79). I used the Wildlife Stakeholder Acceptance Capacity theory to assess what factors (e.g., species presence, perceived density, stakeholder land usage, risk belief, attitudes toward the species) influenced stakeholder preferences for a specific future population trend (i.e., increase or decrease). Wildlife biologists were influenced by attitudes and occupational risk beliefs. Influential factors of FBCP attitudes could not be assessed because no producers wanted an increase in future hog populations.

Key words: stakeholder attitudes, distribution, feral hog, Mississippi, Wildlife Stakeholder Acceptance Capacity

DEDICATION

I dedicate my thesis to my parents, Enoch Moore Parks III and Lucy Parks Fuller, who instilled in me a love for learning and science, and to my husband, Jarrod, who has brought tremendous joy and happiness to my life. I dedicated this to Carrie Hodges, my favorite high school English teacher, who is the life long learner and educator that I aspire to be. Finally, I dedicate this to my grandmother, Evelyn Conger Flint, who still encourages me to do my best.

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CHAPTER I

INTRODUCTION

Found throughout the world, feral hogs (*Sus scrofa*), were brought to North America almost 500 years ago as domestic hogs by early settlers and European explorers. Because domestic hogs were known to be hardy survivors, they were abandoned on islands and coastal lands to serve as a source of fresh meat for future explorers (Mayer and Brisbin 1991, USDA–APHIS 1992, Kammermeyer et al. 2003). Eventually, domestic hogs established successful breeding populations in the wild. Open range farming also contributed to the spread and population growth of feral hogs (Hellgren 1993, Barret and Birmingham 1994). High fecundity rates, omnivorous diet, lack of natural predators, large litter size, and illegal transportation and release of hogs has further contributed to their present distribution (Hellgren 1993, Higgenbotham 1993, Miller 1993, Taylor and Hellgren 1997). More recently, feral hogs have been an increasing concern as an invasive exotic species that can seriously affect the public, landowners, hunters and agricultural producers (Tolleson et al. 1995).

In 2001, the United States feral hog population was conservatively estimated to be approximately 4 million (Pimentel and McNair 2001). Population management, removal, and containment have presented a challenge to various stakeholders, including private landowners, industries, agricultural producers, and state and federal agencies (Miller 1993, Burns 1998, Rollins 1999). Few attitudinal studies about feral hogs and affected stakeholder groups existed at the time of my study, therefore it was important to determine not only the current feral hog distribution, but also to identify factors that influenced stakeholder attitudes. Feral hog distribution has increased dramatically in past decades, and information about newly established populations, possible extirpation of established populations, and determination of factors affecting stakeholder attitudes toward feral hogs may be useful in developing more effective management.

Objectives

There were 3 objectives to my study. First, I wanted to estimate the current distribution of feral hogs in the United States. Second, I wanted to determine factors, including hog presence, attitudes toward hogs, and risk beliefs, that affected wildlife biologists' desire for an increase or decrease in future feral hog populations in their jurisdiction. Third, I wanted to determine factors that affected agricultural producers attitudes toward hogs. Specifically, I wanted to determine if feral hog presence or absence affected attitudes toward feral hogs, and if there was a difference in attitudes based on production type: livestock or cash crop.

The conceptual framework of my study was based on the Wildlife Stakeholder Acceptance Capacity (WSAC) theory which is built from the Wildlife Acceptance Capacity (WAC) theory (Decker and Purdy 1988, Decker 1991, Riley and Decker 2000). WAC theory was defined as the "maximum wildlife population level in an area that was acceptable to people" (Decker and Purdy 1988:53). WSAC theory extended the definition to include problems and benefits, perceived and actual, that a species may cause stakeholders, and how wildlife management affects stakeholders (Carpenter et al.

2000). The WSAC theory states that stakeholder attitudes toward a species depend on multiple factors including aesthetic value, presence, perceived population density, economic benefits and liabilities, and land usage (i.e., farming, aquaculture, hunting) (Carpenter et al. 2000). The management of wildlife, a public resource, may create complex situations when considering the management goals and desires for various stakeholders. Management plans may be more effective and palatable to a majority of stakeholders if the plan considers various factors that influence stakeholder preferences toward a species. To determine distribution of and factors influencing attitudes toward feral hogs, I developed self-administered mail questionnaires which were sent to district level state wildlife biologists (n = 614) in the United States, and to Mississippi Farm Bureau county presidents (n = 79).

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CHAPTER II

NATIONAL DISTRIBUTION AND STATUS OF FERAL HOGS

Historical Introduction

Domestic pigs (*Sus scrofa domestica*) first were brought to the West Indies in 1493 by Christopher Columbus, and later introduced to North America by Hernando Desoto in 1539 (Barrett and Birmingham 1994, Kammermeyer et al. 2003). During the exploration of North America domestic hogs were brought as a food source, but escaped and established feral populations (Gipson et al. 1998). Other factors perpetuated their spread, including Native Americans stealing domestic pigs from explorers for food or for their own breeding stock (Gipson et al. 1998). Rene-Robert de La Salle first introduced domestic pigs to Texas in 1685 (Tolleson et al. 1995). Hanson and Karstad (1959) reported that feral hogs were found in the southeastern United States along the coasts of Georgia and South Carolina as early as the 1700s, but established populations were not confirmed until the early 1900s. Feral hog populations were reported in Ohio, Kansas, and Missouri during the 1700s and 1800s when domestic hogs escaped from pioneers and settlers (Gipson et al. 1998). In 1769, the western United States, domestic hogs were released in California for open range farming and escapees spread east (Kammermeyer et al. 2003). Wild European Hogs or Russian hogs (*Sus scrofa*) were imported to New Hampshire in the 1890s for specialized hunting opportunities and to the

Appalachians, Tennessee, New York, and the Carolinas during the early 1900s (Hanson and Karstad 1959, Silver 1974, Dickson et al. 2001). Some European hogs were kept in hunting enclosures whereas others were released into local forests. Enclosures often were breeched, allowing European hogs to escape and interbreed with local feral hogs, creating a hybrid feral hog which exists today. Hybrid descendents were released near San Francisco in 1925 by a California rancher (Barrett 1993, Waithman et al. 1999). Descendents of European wild hogs adapted to areas with a wider range of temperature and forage availability, and limited water resources which facilitated their spread (Waithman et al. 1999).

Hawaii's domestic hogs were first introduced by Polynesian settlers around 400 B. C. (Stone 1984). Historical documentation of Polynesian farming practices suggested that domestic hogs were kept mostly within villages and not allowed to roam because of their importance as a food source (Stone 1984). In 1778, European explorers brought domestic hogs to Hawaii allowing them free range, which spawned the first self-sustaining feral hog population (Stone 1984). Excluding the islands of Lana'i and Kaho'olawe, feral hogs have been found on all major islands (Stone 1984).

Current Population

In the 1960s, feral hogs (subsequently referred to as hogs) ranged from Texas to the Virginia coast, with an estimated population size of 1.5 million, spreading rapidly to the central United States (McKnight 1964, Gipson et al. 1998). Hogs were thought to be in 19 states in 1991; 23 states in 1993; and 26 states in 1998 (Miller 1993, Gipson et al. 1998). In 2001, the U.S. hog population was conservatively estimated at 4 million

(Pimentel and McNair 2001). In 2004, the Southeastern Cooperative Wildlife Disease Study (SCWDS) released the most recent distribution map displaying hogs in 28 states (SCWDS 2004). The map was compiled with information collected from state fish and wildlife agencies, agricultural agencies, and universities (SCWDS 2004).

Texas was reported to have the largest feral hog population, between 2 and 3 million hogs, with 217 of its 254 counties reporting hogs (Burns 1998, Taylor 2003). Florida had the second largest population with hogs reported in all 67 counties (Belden 1975, Belden 1993). In California, hog populations were confined to the coastline until the 1950s when they were designated as a game animal and expanded inland, most likely through illegal transportation and release in undisturbed areas for future hunting opportunities (Waithman et al. 1999, Kammermeyer et al. 2003). In the 1980s, the hog population in California was estimated at 70,000 to 80,000, covering 33 counties, and by 1997, 47 counties had established hog populations estimated at 133,000 individuals (Frederick 1998, Updike 1998, Waithman et al. 1999). Georgia's hog population increased by 350% in 15 years, with populations found in 137 of the 159 counties, and in Mississippi, hog populations were found in 65 of the 82 counties (Pavey 2003, Tullos et al. 2005).

During the early 1990s hogs expanded to Colorado, Indiana, Illinois, Kentucky, Kansas, and West Virginia (Gipson et al. 1998, Gipson and Lee 1999). Historically, hogs were released in Kansas during the 19th century, but reports of hogs did not begin until 1985, with the first documentation of an established population in 1993 (Gipson et al. 1994, Gipson et al. 1998). The estimated hog population of Kansas in 1998 was less than 200 (Gipson et al. 1998). Hogs were first reported in Wisconsin in 2000 with sightings in

29 counties (Madden 2005). With an unknown population size, hogs were reported in 55 of Oklahoma's 77 counties (Healey 1999). In 1999, Indiana's hog population was estimated between 500 and 1,000, Missouri had hogs in 10 counties with an estimated population of 1,000 to 3,000, and Arkansas had hogs reported in 55 of the 75 counties (Harbinson 1999, Hutton 1999, Marsh 1999, Missouri Department of Conservation 2005). Range expansions were most likely a product of transportation and release for hunting purposes or released from bankrupt domestic hog farms (Mays 1999).

Hogs inhabit every continent, except Antarctica, and human encounters have increased. The range of affected stakeholders has grown to include not only natural resource, agricultural agencies and timber industries, but also park managers, golf courses owners, and suburbanites (Rollins 1993, Frederick 1998, Waithman et al. 1999, Anderson 2003). The objective of my study was to update the current hog distributional map, looking for possible extirpated and new populations, estimate perceived densities, frequency of sightings, population trends, and factors leading to distribution expansion.

Methods

Sampling and Survey Design

My study included a survey of each state's district level wildlife biologists (n = 614). As opposed to previous efforts, I assumed that a survey of district level wildlife biologists would be the most appropriate way to estimate distributions, because they would be less occupied with administrative duties, more likely to be in the field, and more engaged with the local public. These factors should increase their awareness of localized problems, such as early hog sightings and evidence. I collected address information from Internet searches and phone contacts with state and district offices.

I collected information from a larger research project through a 10-page self-administered mail questionnaire which investigated numerous issues regarding feral hogs. I used a subset of questions from the questionnaire. Specifically, I asked biologists to identify on a map of their state the counties included in their jurisdiction, which was defined as all counties they were in charge of servicing, and which, if any, had a hog presence. I asked how long the respondents had worked as a wildlife biologist or similar occupation and how long they have held their current position. I asked all biologists, based on their perception, what the ideal number of hogs was for their jurisdiction. Finally, I gathered data on their socioeconomic characteristics (i.e., race, age, education level, gender) and had an open-ended section for written comments.

I asked 6 suites of questions specifically to those who indicated hog presence (i.e., sightings) in their jurisdiction. First, I asked what year hogs were introduced to their jurisdiction, how many days hogs were seen from January 2004 to December 2004, and which month had the greatest frequency of sightings. Second, I asked if they considered hog sightings by the public to be: 1 = ‘rare’, 2 = ‘common’, or 3 = ‘abundant’, and from what stakeholder group they received the most inquires about hogs. Third, I asked them to estimate number of public inquiries (i.e., phone calls, e-mails, letters) they received per year about: 1 = ‘hog sightings’, 2 = ‘hunting of hogs’, 3 = ‘hog hunting locations’, 4 = ‘hog hunting laws and regulations’, 5 = ‘hog damage’, 6 = ‘hog control methods’, and 7 = ‘general hog questions’. Fourth, I asked if biologists used any methods to control hog populations, and if they did, which methods they used, preferred, and were the most effective. Fifth, I asked biologists to give their best estimate of hog numbers in their jurisdiction. Finally, I asked them to determine if the general trend in hog numbers in their jurisdiction over the past 5 years had: 1 = ‘greatly increased’, 2 = ‘somewhat increased’, 3 = ‘remained stable’, 4 = ‘somewhat decreased’, or 5 = greatly decreased’, and what they thought was the reason leading to the specified trend.

Survey Implementation

I used a modified version of Dillman’s Total Design Method (TDM; Dillman 1978) for survey implementation, which included a series of 4 mailings, each containing an introductory letter, a questionnaire, state map, and a postage paid business reply envelope (subsequently referred to as a complete packet). The introductory letter included the purpose and project sponsors, my contact information for questions or to request a replacement survey, the Mississippi State University Institutional Review Board (IRB) approval number and contact information, and a confidentiality statement. All protocols and materials were approved by the MSU IRB (Docket #04-171). Three and 6 weeks after the initial mailing, I sent a complete packet to non-respondents. As necessary, I sent non-respondents a fourth mailing consisting of only a state map and a letter requesting the return of the map marked with all counties within their jurisdiction, and those counties that contained hogs; no additional attitudinal information was collected. The most notable TDM modification was replacing the reminder/thank you postcard with an additional mailing (Dillman 1978).

All correspondence was personalized to enhance response; specifically all letters were hand signed by myself and the Director of the Human Dimensions and

Conservation Law Enforcement Laboratory, all name and addresses were printed directly on the envelopes and letters to simulate a first class mailing, and all envelopes had a first class postage stamp. Questionnaires were labeled and cataloged using a barcode system, with the corresponding number on the introductory letter. I used the bar code system to monitor returned surveys and non-respondents so future mailings could be determined.

Analysis

As questionnaires were returned, I coded non-numerical values as numeric and entered data into a Microsoft Access® database. Responses to open-ended questions and requests were grouped by commonality and given a numerical code (e.g., 1 = illegal release, 2 = inability to control population growth). For each map, every county was assigned an ArcGIS® county ID code. I used the ArcGIS® joins/relate feature to create maps displaying all U.S. counties, plus the county respondents who indicated a hog presence, and a map comparing my results to the 2004 SCWDS map.

After I completed data entry, I randomly selected 10% (n = 42) of the questionnaires to calculate the overall data entry error rate, which was 0.17% (103 errors/60,060 survey questions). Errors were random and no pattern was found for any specific variable that warranted data re-entry. Errors were recorded and corrected. Frequency distributions and mean scores, where applicable, were generated as a final check. The survey’s effective response rate was calculated by dividing the number of questionnaires returned usable by total number of questionnaires sent minus number of non-deliverables minus number of questionnaires returned non-usable.

Results

Of the 614 questionnaires sent, 458 were returned usable. When non-deliverables (*n* = 57) and non-usable questionnaires (*n* = 5) were excluded from consideration, an effective response rate of 82.4% was achieved. All returned non-usable questionnaires were attributed to the respondents' refusal to answer. I received a minimum of one response from every state, but I did not receive all individual responses from 19 states.

Overall, 46.8% (*n* = 206) of the biologists, representing 38 states, indicated feral hog presence in their jurisdiction, which is an increase of 10 states when compared to the 2004 SCWDS distributional map (Table 2.1, Figure 2.1, Figure 2.2). Respondents were primarily Anglo (*n* = 336, 97.1%), males (*n* = 326, 93.4%), with an average age of 45.5 years (*n* = 349, SE = 0.48). Average number of years of education completed by respondents was 17.7 years (*n* = 341, SE = 0.11). Respondents indicated they were employed as a wildlife biologist, or similar occupation, for an average of 18.9 years (*n* = 274, SE = 0.60) and employed in their jurisdiction for an average of 12.9 years (*n* = 262, SE = 0.56). When asked what they believed was the ideal hog number for their jurisdiction, 94.8% (*n* = 417) indicated zero hogs, whereas 5.2% indicated populations should range from one to 50,000 hogs (*n* = 23, $\bar{x}$ = 5,122.5, SE = 2,264.0, median = 1,000).

When biologists were asked about the trend in hog numbers in their jurisdiction over the past 5 years, 52.4% (*n* = 99) indicated the hog population had 'somewhat increased', 16.4% (*n* = 31) indicated it had 'greatly increased', 21.7% (*n* = 41) indicated hog populations had 'remained stable', 6.9% (*n* = 13) indicated hog populations had 'somewhat decreased', and 2.7% (*n* = 5) indicated it had 'greatly decreased'. "Illegal release" was the most cited factor leading to current increase in hog distribution (30.9%, *n* = 55), whereas 17.4% (*n* = 31) cited "the inability to control population growth" (Table 2.2). Other likely factors included "increased hunting pressures causing dispersal" (15.7%, *n* = 28), "inefficient control measures" (11.2%, *n* = 20), "availability of preferred habitat" (9.5%, *n* = 17), and "weather" (5.6%, *n* = 10).

When asked about the types of control methods used when managing hog populations, biologists indicated the top 3 most common were "open season hunts" (56.7%, *n* = 55), "trapping" (19.9%, *n* = 19), and "on-site elimination" (17.5%, *n* = 17). Likewise, the top 3 most preferred methods for hog control were "open season hunts" (48.4%, *n* = 46), "trapping" (21.1%, *n* = 20), and "on-site elimination" (21.1%, *n* = 20). Similarly, a plurality of biologists indicated that "open season hunts" (36.3%, *n* = 33) and "trapping" (33.0%, *n* = 30) were the most effective methods for population control followed by "on-site elimination" (22.0%, *n* = 20). Other less important methods, such as snaring and controlled hunts, were reported in all 3 categories (Table 2.3).

Ninety-five percent of biologists (*n* = 196) with hogs in their jurisdiction received reports of hog sightings from the general public and/or landowners. Hunters (77.7%, *n* = 143) were indicated as the main source of inquiries, with landowners as the second most inquisitive stakeholder group (9.2%, *n* = 17). Farmers comprised 6% (*n* = 11) of the inquiries, and 4.4% (*n* = 8) came from ranchers. Remaining inquiries (*n* = 5) came from private land managers. Of all public inquiries, 24.1% (*n* = 7,977) requested "general information" about hogs, 19.5% (*n* = 6,458) requested information about "hog hunting", and 18.3% (*n* = 6,043) requested information about "hunting locations of hogs." Only 11.6% (*n* = 3,834) inquired about "hog sightings", whereas 10.8% (*n* = 3,564) inquired about “hunting laws regarding hogs.” “Hog damage” comprised 9.6% (*n* = 3,170) of the inquiries, and only 6.1% (*n* = 2,006) were specifically about “hog control.”

Biologists with hogs in their jurisdiction reported that hog sightings were most frequent during October (12.7%) and November (11.9%) and observed them an average of 12 days/year (range = 0 – 200, median = 3) (Table 2.4). When asked to estimate population density based on their perceptions, 78 biologists did not give an estimate, and the estimate per jurisdiction for those that provided one ranged from 5 to 100,000 hogs (*n* = 130, $\bar{x}$ = 7,588.2, SE = 1,665.2, median = 400).

Discussion and Management Implications

Distributional Increases

There are 3 plausible methodological explanations, besides an actual increase, for why I identified hogs in more states than previously reported and/or had discrepancies within states: sampling frame, lack of information transfer, and study limitations. First, the sampling frame, or stakeholder groups surveyed, was one variation between the SCWDS study and mine. I focused solely on district level wildlife biologists who I assumed would be more knowledgeable and reliable than statewide biologists about the status of hogs on a local level. For the SCWDS distributional map, 3 stakeholder groups were used: heads of state natural resource agencies, university faculty, and agricultural departments (SCWDS 2004). I assumed district biologists would be more involved with the public and local landowners making them the first level of contact for those reporting hog sightings and evidence. Agency policies may or may not require district level biologists to report hog sightings or evidence to state level biologists or administration, which may lead to the second reason for discrepancies between my studies and others. A disconnect in the hierarchy of information transfer may have affected my study results. In one state I surveyed, the head biologist of the game and fish agency prior to the survey declared in a phone conversation with me that hogs were absent in his state, but district biologists reported otherwise. For better management, agencies need improved methods for reporting new sightings, damage, and established populations, within and among agencies. I suggest a creation of an interactive Internet map with a feedback mechanism allowing biologists to identify counties and specific locations of hog sightings, damage, and populations. This allows for state biologists and administration to quickly assess their state's hog situation, and other agencies to monitor hog distribution on a regional and national level. This also may encourage communication among agencies, allowing other governmental agencies the opportunity to report information. I also suggest a telephone and Internet hotline for the public to report sightings and evidence with a follow-up investigation from the appropriate regulatory agency in previously undocumented areas. Better communication between the public and agencies will allow more public involvement; a better assessment of local, statewide, and national hog distribution; and opportunities for improved hog management.

A final explanation for discrepancies between my study and others may be the study limitations, which include the variety of responses I received. Not all necessary data was collected due to non-response, questionnaires returned without maps, and refusals where some biologists declared they had little experience with hogs and did not feel comfortable completing the questionnaire. Also, some state agencies allowed only one biologist's reply to serve as the response for the entire state, whereas most other state agencies did not intervene, allowing numerous replies. This may account for missing information in my map when compared with the SCWDS map. The reasoning behind obtaining multiple responses was to assess distribution on a county wide basis, and knowing the information was reliable because biologists personally knew of the hog status in their jurisdiction. Allowing only one response to represent the entire state defeated the purpose of surveying on a district level. Some biologists refused to answer the questionnaire declaring hogs were under the state's U. S. Department of Agriculture's jurisdiction, or that they were unsure of which agency had jurisdiction over hog control and management. Occasionally, jurisdiction was shared between the state's game and fish agency and the agricultural department, which may have led to problems with determining which agency should receive reports about hog sighting and damage, and which agency has authority over hog management. In one central U.S. state, a biologist was unaware of which agency had jurisdiction over hogs because there were no established populations. To alleviate this problem, each state, regardless of hog presence, should determine which agency, or both, should have control over hog management. If authority is divided, establishment of duties by each agency should be determined and made known to all agencies and to the general public. Either way, game and fish and agricultural agencies need to work together to identify hog locations to enhance the informational database. With improved communication between and within agencies accurate distributional maps could be created including private lands which may be more accessible to agricultural agencies, and may improve management strategies.

Trends for Actual Distributional Increases

If distributional increases were actual, possible explanations could be anthropogenic and/or natural causes. Wildlife biologists indicated the hog distribution was expanding with the most likely anthropogenic reason being from illegal transportation and release, which was consistent with previous research (Gipson et. al 1997, Mays 1999, Waithman et al. 1999). The inability to control population growth was another reason given by biologists which may have accounted for differences in reported hog expansion. Hunters' desire for improved hog stock and more convenient hunting opportunities may have contributed to a number of differences in reported hog locations. A plurality of wildlife biologists believed that people were the primary reason for the increased distribution. Therefore, educational materials should be developed to inform hunters and the general public of laws and regulations regarding the transportation of hogs. With hunting considered the most common and preferred method of hog control (Thompson 1977, Peine and Farmer 1990) agencies could work with individuals and hunting clubs to further population reduction and management goals. Information and educational programs could be developed to inform hunters and the general public of hog locations, recognizing hog signs, hogs effect on preferred hunting species, and the potential impact of hogs on local habitat and native wildlife as ways to reduce populations.

Promoting hogs as a game species may perpetuate their spread through illegal transportation, and does not need to be a management focus. More so, the focus should be on reducing hog populations to a minimum, if not eliminating them completely, to preserve natural habitats, native wildlife populations, and agricultural crops and livestock. Overall, a majority of wildlife biologists did not want hogs in their jurisdiction, therefore agencies may want to implement or campaign for stricter and more enforceable laws on intra and interstate transportation of hogs. Through education, public involvement, and policy reform, the increase in hog distribution from illegal transportation and release may be further mitigated thus creating benefits for native wildlife, agencies, forest managers, agricultural producers, and the general public.

The hog's natural history may be another explanation for differences in reported distribution. Hogs prefer habitats such as swamps and wetlands, as they need these moist areas to regulate their body temperature (Dickson et al. 2001). Detection is difficult in these often dense and remote locations, therefore the development of an effective method or index to estimate population size is needed. One biologist admitted it was likely his state had established hog populations, but he had "not seen them or had any verified occurrence" and, therefore, could not report that hogs existed in his state. The variability of available food sources and the hogs' crepuscular and/or nocturnal behavior may explain partially the lack of hog sightings and the few days per year hogs were seen (Peine and Farmer 1990, Barrett and Birmingham 1994, Dickson et al. 2001). Most hog sightings occurred in October and November which may be linked to fall mast production, supplemental wildlife feeding, or the hunting season which may place more wildlife biologists in the field then during other times of the year. Past research indicated that during fall and winter seasons, acorns, tubers, wintering grubs and supplemental feedings constituted the majority of hog diets (Everitt and Alaniz 1980, Peine and Farmer 1990, Kotanen 1994). With their crepuscular and nocturnal behavior in mind, hog population reduction efforts should be increased during fall and winter mast crop seasons, and occur at dusk or night.

Control

The most effective and commonly used methods for controlling populations were hunting and trapping. Nevertheless, previous research has found that there were problems with these 2 methods, such as locating hogs, difficulty of trapping in dense habitats preferred by hogs, disposal, and increasing trap shyness and trap avoidance (Burns 1998). Hunting without other control methods was considered an unsuccessful tool in reducing populations unless a minimum of 70% of hogs could be culled each year (Gipson et al. 1994, Richardson et al. 1997), but legal hunting could be encouraged to assist in population reduction. Other methods have been used or suggested for population growth control, such as relocating hogs to an already infested area or a hunting preserve. This may locally reduce some populations, but was considered to be ineffective by biologists (Burns 1998). Aerial hunting was considered effective mainly in open areas, but due to the high costs and ineffectiveness in forested areas, it was not widely used (Mapston 1999, Dickson et al. 2001). Poisoning was not approved for hog control in the U. S. and has not been considered an option due to complications, such as hogs avoiding or not locating bait, carcass disposal, and direct or indirect poisoning of non-target species (Tisdell 1982, Mapston 2004). A successful contraceptive program has yet to be developed. Others have used repellants, or scare tactics (e.g., noise-activated lights, motions sensor noise makers) to prevent or reduce hog damage, but these tactics do not reduce hog numbers (Barrett and Birmingham 1994, Anderson 2003). Fences were successful in preventing damage, but building hog proof fences and electric fences were expensive and impractical for large areas or areas with rough terrain (Mapston 1999). Conducting intense management during times of high hog activity logically may be the best management practice. Further research on the most effective temporal management should be conducted.

Agencies may find it beneficial to develop workshops demonstrating trapping methods, trap designs, trap placement, and suggestions on baits. Agencies also could provide locations for carcass disposal, and health check stations to monitor harvested hogs for diseases. Hunters and trappers could be encouraged to donate surplus meat to local charities. Providing educational opportunities for the public to learn how to better control hog population growth, understand laws regarding hog transportation, and understand effects of hogs on native wildlife and habitat may assist wildlife biologists in managing the species, while also slowing or stopping the expansion of hog populations.

Table 2.1 Number of counties reported to have a hog presence, percentage of total counties with a hog presence, and year hogs were first sighted by individual states district level wildlife biologists (n = 206) in the United States.

State	Number of counties with feral hogs	Number of counties	Percentage of counties with feral hogs	Year of feral hog introduction
Alabama	22	67	32.8	1989
Alaska[a]	1	27	3.7	1970
Arizona	5	15	33.3	1960
Arkansas	60	75	80.0	1900
California	14	58	24.1	1900
Colorado	16	64	25.0	1985
Florida	60	67	89.6	1600
Georgia	72	159	45.3	1600
Hawaii	3	5	60.0	1778
Illinois	11	102	10.8	1991
Indiana	4	92	4.3	1988
Iowa	3	99	3.0	2001
Kansas	27	105	25.7	1985
Kentucky	13	120	10.8	1993
Louisiana	39	64	60.9	1950
Maine[b]	1	16	6.2	Not reported
Maryland	1	23	4.3	2004
Michigan	1	83	1.2	Not reported
Mississippi	78	82	95.1	1950
Missouri	21	114	18.4	1990
Nebraska	4	93	4.3	1995
Nevada	1	16	6.3	1992
New Hampshire	3	10	30.0	1890
New Jersey	1	21	4.8	1999
New Mexico	2	33	6.1	1985
New York	2	62	3.2	Not reported
North Carolina	16	100	16.0	Not reported
North Dakota[b]	1	53	1.9	2004
Ohio	14	88	15.9	1980
Oklahoma	70	77	90.9	1930
Oregon	5	36	13.9	1996
Pennsylvania	7	67	10.4	1993
South Carolina	30	46	65.2	1960
Tennessee	32	95	33.7	1986
Texas	201	254	79.1	1800
Virginia	6	95	6.3	1950
Washington	3	39	7.7	1999
West Virginia	7	55	12.7	1970
Wisconsin	10	72	13.9	2001

[a] Reported feral hog sightings but status of an establish feral hog population was undetermined.

[b] Reported feral hog escapes from hunting preserves, but no known established population.

Table 2.2 Factors leading to the current feral hog population trend in jurisdictions with feral hogs as reported by individual states district level wildlife biologists in the United States from 2000-2004.

Reported factor	*n*	%
Illegal release	55	30.9
Inability to control population growth	31	17.4
Increased hunting pressures causing dispersal	28	15.7
Inefficient control measures	20	11.3
Availability of preferred habitat	17	9.6
Weather	10	5.6
Putting out feeders	5	2.8
No hog problem at this time	3	1.7
Long established population	3	1.7
Public awareness of laws and regulations	2	1.4
Predator control reducing hog population	1	0.6
Habitat loss	1	0.6
No predators	1	0.6
TOTAL	177	100.0

Table 2.3 Feral hog control methods reported by individual states district level wildlife biologists in the United States in 2004, and the most commonly used, most preferred, and most effective method.

Control Method	Most Common		Most Preferred		Most Effective	
	n	%	*n*	%	*n*	%
Open season hunts (i.e., public)	55	56.7	46	48.4	33	36.3
Traps	19	19.6	20	21.1	30	33.0
On-site elimination	17	17.5	20	21.1	20	22.0
Controlled hunts (Arranged by agency or game wardens)	5	5.6	4	4.2	2	2.2
Snares	1	1.0	3	3.2	4	4.4
Relocation	-- [a]	--	1	1.1	--	--
Closed season hunts (e.g., Lottery)	--	--	1	1.1	--	--
Electric fences	--	--	--	--	2	2.2

[a] Indicates control method was not reported by biologists.

Table 2.4 Month of most frequent feral hog sightings from January 2004 to December 2004 as reported by individual states district level wildlife biologists in the United States.

Month	Frequency of Sightings	%
January	11	9.3
February	9	7.6
March	10	8.5
April	7	5.9
May	7	5.9
June	5	4.2
July	5	4.2
August	12	10.2
September	5	4.2
October	15	12.7
November	14	11.9
December	11	9.3
Seen all months	7	5.9
TOTAL	118	100.0

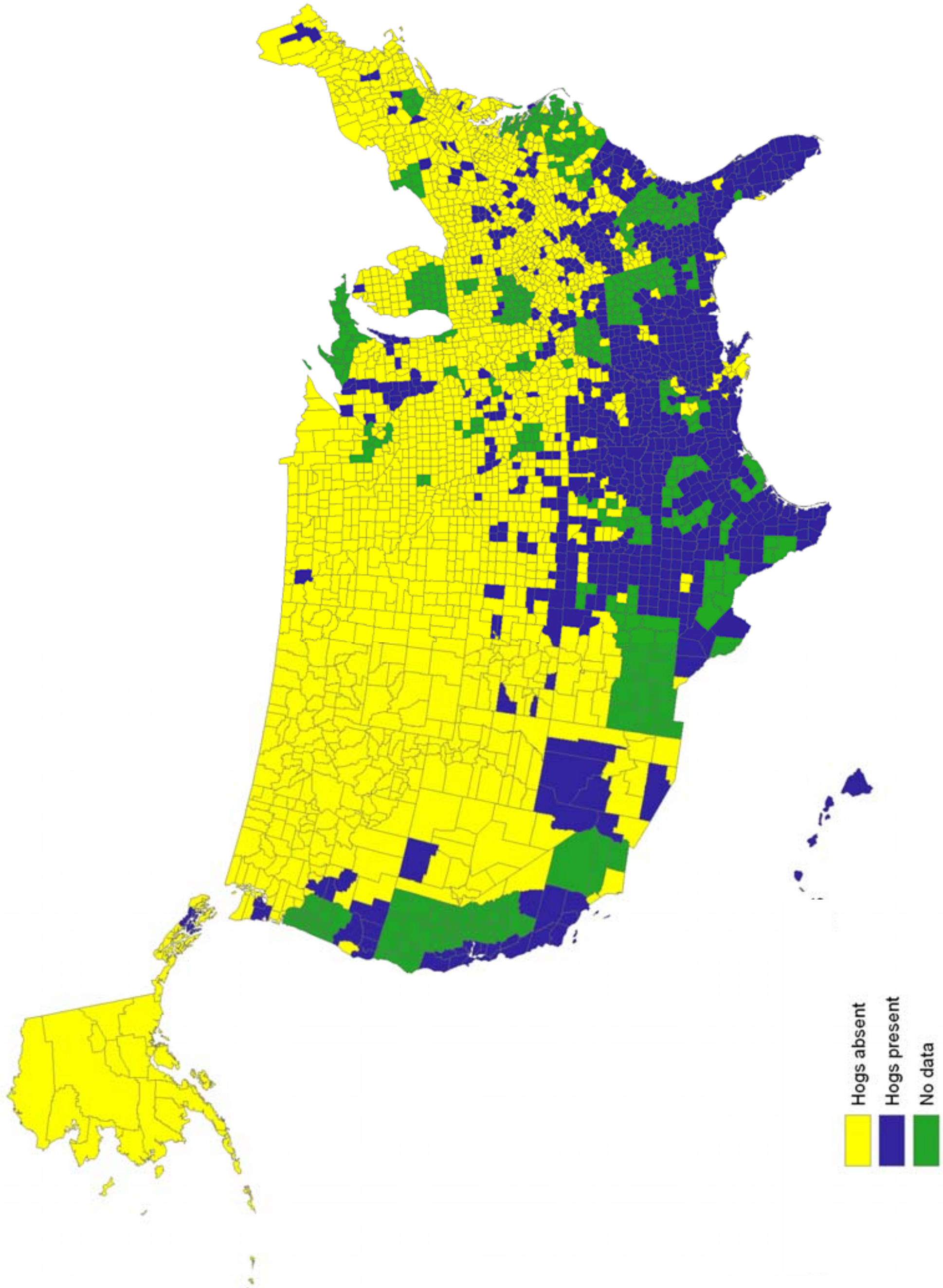

Figure 2.1 United States feral hog distribution map as reported by individual states district level wildlife biologists in 2004.

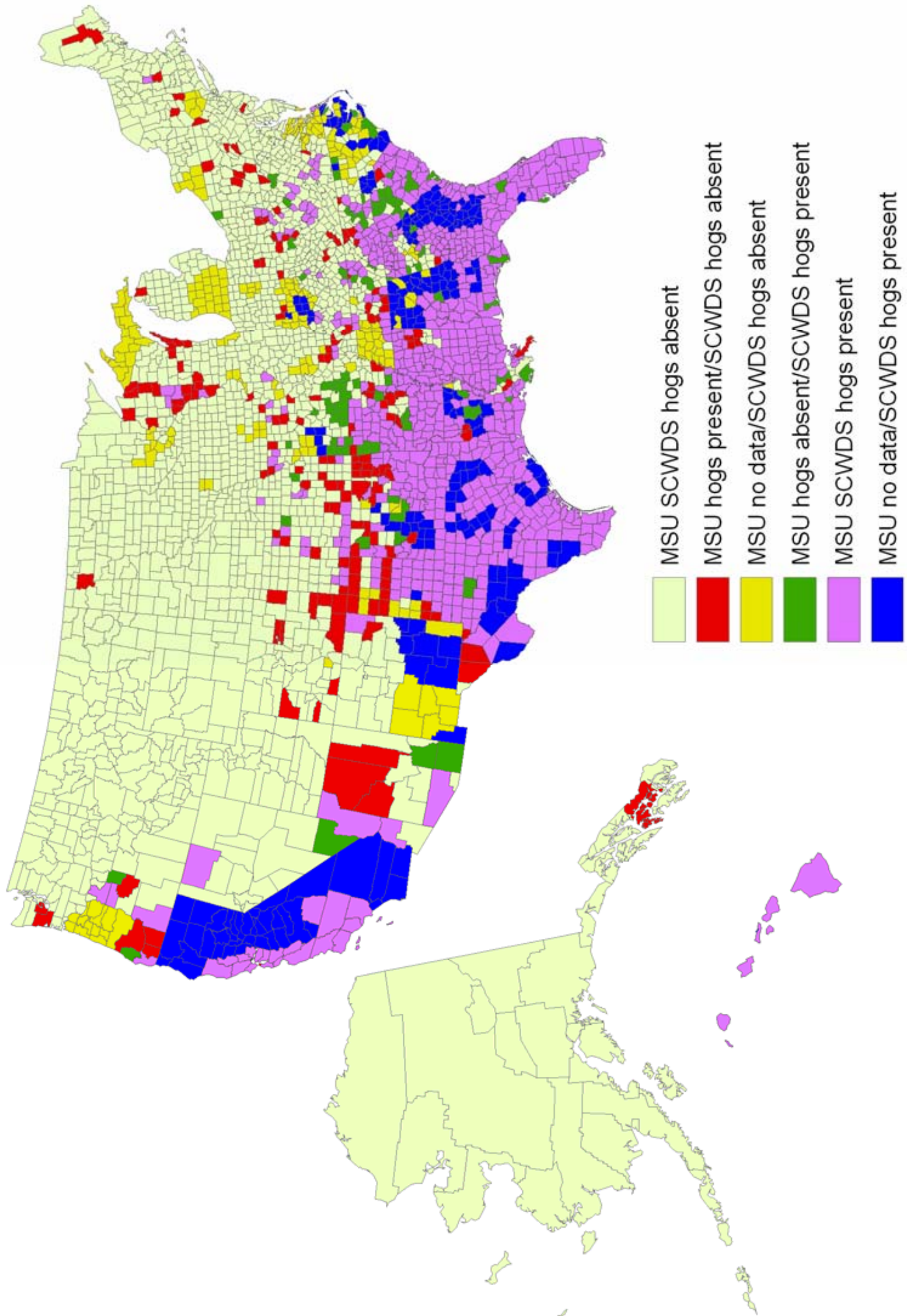

Figure 2.2 Combination of feral hog distributional information collected from individual states district level wildlife biologists and the 2004 SCWDS results.

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CHAPTER III

FACTORS INFLUENCING WILDLIFE BIOLOGISTS' WILDLIFE STAKEHOLDER ACCEPTANCE CAPACITY OF FERAL HOGS

Introduction

With feral hog distribution expanding, wildlife biologists and natural resource managers have been concerned with impacts feral hog (*Sus scrofa*; subsequently referred to as hogs) have on wildlife and wildlife habitat, and how to best manage these impacts. Hogs can impact wildlife, and wildlife habitat and management in 5 major ways. First, the hogs' omnivorous diet overlaps the diets of native wildlife, such as the wild turkey (*Meleagris gallopavo*), raccoon (*Procyon lotor*), black bear (*Ursus americanus*), white-tailed deer (*Odocoileus virginianus*) and even the endangered Sandhill crane (*Grus canadensis*) (Beach 1993, Synatzske 1993, Taylor 2003). Second, research has indicated hogs may impact wildlife populations by preying upon small mammals, newborn fawns, nests of ground nesting birds and sea turtles, herpetafauna, and invertebrates (McKnight 1964, Matschke 1965, Tolleson et al. 1995, Gipson et al. 1998). Third, rooting and wallowing impacts include decreased water quality in streams and rivers, increased soil erosion, and disrupted native plant assemblages (Stone 1984, Beach 1993, Arrington et al. 1999). Fourth, the hogs' potential as a disease vector may impact wildlife, livestock, and human populations (Tisdell 1982, Stone 1984, Beach 1993, Choquenot et al. 1996). Finally, designating hogs as a game animal has perpetuated their expansion as humans illegally transport hogs for increased revenue and hunting opportunities, thus further impacting wildlife, and wildlife habitat and management (Bach and Conner 1993, Barrett 1993, Miller 1993, Rollins 1993).

With these negative impacts, my study objective was to examine if attitudes, risk beliefs, hog presence, education levels, and length of time in occupational roles influenced wildlife biologists preference for a specific trend in future hog populations (i.e., increase or decrease). Previous research has indicated that attitudes toward a species have been based on many factors, including economic and environmental benefits and liabilities, land use operations, economic investment, actual and perceived damage, perceived density, presence, and previous experience, but these studies have not looked at factors influencing attitudes of wildlife biologists toward hogs (Decker and Purdy 1988; Decker 1991, Bach and Conner 1993, Rollins 1993).

Theoretical Background

My study was based on the Wildlife Stakeholder Acceptance Capacity (WSAC) theory which builds off the Wildlife Acceptance Capacity (WAC) theory. The WAC theory was defined as the "maximum wildlife population level in an area that was acceptable to people," but it was not defined as a static number (Decker and Purdy 1988). It was an assessment of one stakeholder group's attitude toward one species at one point in time. The WSAC theory extended the WAC theory to examine the stakeholder's desire for a specific population trend and how other independent factors influence that desire, such as perceived or actual costs and benefits, and how stakeholders were affected by wildlife management (Carpenter et al. 2000). Wildlife biologists and other natural resource management agencies can be considered a stakeholder group because they are affected by management decisions and/or assist in the creation of management plans (Decker et al. 2001). Different stakeholders can simultaneously have different acceptance levels which reflect their particular set of "limiting factors" (e.g., depredation of crops, hunting opportunities, aesthetic appreciation) relative to a wildlife population (Decker and Purdy 1988). The primary limiting factor for most acceptance studies was the threshold of acceptance of wildlife damage (Decker and Purdy 1988). Estimation for acceptance levels has been determined by using either estimates of economic loss or preference for a specific population trend (i.e., decrease or increase in future populations) as the dependent variable, and the perceived or actual species presence and/or density as the independent variable (Decker and Purdy 1988). One stakeholder may be affected positively and negatively by one species depending on the temporal scale (Carpenter et al. 2000). Spatial scale also affects WSAC levels, where an individual stakeholder may be affected differently than a community (Carpenter et al. 2000). I chose the WSAC theory because I felt it could best determine what factors, if any, influenced wildlife biologists desire for a specific future hog population trend.

Riley and Decker's (2000) WSAC mountain lion (*Puma concolor*) research was the methodological basis for my study. With this study, a survey was conducted of Montana residents examining risk beliefs, desire for future population, perception of current population, and attitudes toward cougars. They attempted to identify factors (e.g., risk belief, attitudinal responses, demographic variables) influencing peoples' desire for a specific future population trend (i.e., increase or decrease) assuming that preference for future population trends was an accurate index relative to the stakeholder perception of the current population, attitudes toward cougars, and risk beliefs (Riley and Decker 2000). This research indicated those who desired a future population decrease believed the current population was high, increasing their risk of having a negative encounter with a cougar, and held more negative attitudes toward cougars (Riley and Decker 2000). Stakeholders that perceived the current population as low had lower risks beliefs, held more positive attitudes toward cougars, and preferred the future population to remain stable or increase (Riley and Decker 2000).

Based on previous research, physical presence, aesthetic value, economic benefits and liabilities, attitudes and perceptions of hog impacts on wildlife and wildlife habitats should influence a stakeholder's desire for an increase or decrease in future hog populations. As one stakeholder group, I assumed wildlife biologists with hogs in their jurisdiction would have less tolerance for hogs, hold more negative attitudes toward hogs, have higher risk beliefs of hogs, and desire a decreased hog population than those without hogs in their jurisdiction.

Methods

Sampling and Survey Design

My study included a survey of each state's district level wildlife biologists (n = 614). As opposed to previous efforts, I assumed that a survey of district level wildlife biologists would be the most appropriate way to estimate distribution, because they would be less occupied with administrative duties, and more likely to be in the field. These attributes should increase their awareness of localized problems, such as early hog sighting and evidence. I collected address information from Internet searches and phone contacts with state and district offices.

I collected information for this paper as part of a 10-page self-administered mail questionnaire which investigated numerous issues regarding hogs, including hog presence, experiences with hogs, evidence of hogs, and risk beliefs and attitudes toward hogs. I also asked socioeconomic characteristics (i.e., race, age, education level and gender) and had an open-ended section for any written comments. I used a subset of questions from the questionnaire for my paper.

To assess WSAC, I collected information regarding hog presence, biologists attitudes and risk beliefs of hogs, desire for a specific future hog population, education levels, years in current job, and total years as a wildlife biologist. To assess biologists attitudes and risk beliefs, I modified and combined survey questions from Rollins' attitudinal statewide questionnaire (1993) and Riley and Decker's mountain lion WSAC questionnaire (2000). I asked biologists the extent to which they agreed or disagreed with 21 attitudinal and risk belief statements on a 6-point Likert-type scale with the following response format: 1 = 'strongly disagree', 2 = 'disagree', 3 = 'neutral', 4 = 'agree', 5 = 'strongly agree' and 6 = 'no opinion'. To assess respondents desires for future hog populations (FUTUREPOP) I asked if they wanted: 1 = 'more hogs', 2 = 'less hogs', 3 = 'same number', 4 = 'no hogs' or 5 = 'no opinion'. I also attempted to obtain a measure of hog density within each biologist's jurisdiction, which was defined as all counties they were in charge of servicing, by asking each biologist to give his/her best estimate of hog numbers based on observations.

Survey Implementation

I used a modified version of Dillman's Total Design Method (TDM; Dillman 1978) for survey implementation, which included a series of 4 mailings, each containing an introductory letter, questionnaire, and postage paid business reply envelope (subsequently referred to as a complete packet). The introductory letter included the purpose and project sponsors, my contact information for questions or to request a replacement survey, Mississippi State University Institutional Review Board (IRB) approval number and contact information, and a confidentiality statement. All protocols and materials were approved by the MSU IRB (Docket #04-171). Three and 6 weeks after the initial mailing, I sent a complete packet with a letter of appreciation for those who recently returned their questionnaire and a reminder to non-respondents. If necessary, I sent non-respondents a fourth mailing consisting of only a state map and a letter requesting the return of the map marked with all counties within their jurisdiction, and those counties that contained hogs; no additional attitudinal information was collected. The most notable TDM modification was replacing the reminder/thank you postcard with an additional mailing (Dillman 1978).

All correspondence was personalized to enhance response; specifically all letters were hand signed by myself and the Director of the Human Dimensions and Conservation Law Enforcement Laboratory, names and addresses were directly printed on the envelopes and letters to simulate a first class mailing, and envelopes had a first class postage stamp. Questionnaires were labeled and cataloged using a barcode system, with the corresponding number on the introductory letter. I used the bar code system to monitor returned surveys and non-respondents so future mailings could be determined.

Analysis

As questionnaires were returned, I coded non-numerical values as numeric and entered data into a Microsoft Access® database. Responses to open-ended questions and requests were grouped by commonality and given a numerical code (e.g., 1 = 'illegal release', 2 = 'inability to control population growth'). After I completed data entry, I randomly selected 10% (*n* = 42) of returned surveys to calculate the overall data entry error rate, which was 0.17% (103 errors/60,060 survey questions). Errors were random and no pattern was found for any specific variable which warranted data re-entry. Errors were recorded and corrected. The effective response rate for the survey was calculated by dividing number of questionnaires returned usable by total number of questionnaires sent minus number of non-deliverables minus number of questionnaires returned non-usable.

Following the example in Riley and Decker (2000) WSAC study, I combined responses for analysis purposes. I combined respondents that indicated they wanted 'more hogs' and those that wanted the 'same number of hogs', if they had hogs in their jurisdiction. Respondents that wanted the 'same number of hogs', but did not indicate a presence were combined with the 'less hogs' and 'no hogs' responses. This combination increased my sample size for the 'more hog' group thereby lending a stronger statistical power. The 'no opinion' responses were deleted. I combined the attitudinal and risk belief responses 'strongly agree' with 'agree' and 'strongly disagree' with 'disagree', and I deleted the 'no opinion' responses.

To determine scale validity, I conducted an exploratory factor analysis on the statements measuring attitudes and risk beliefs using principal component analysis (PCA) with varimax rotation. I examined the Eigenvalues and a corresponding scree plot to determine number of factors present, where any factor with an Eigenvalue > 1.0 was considered a factor if verified by the scree plot (Zwick and Velicer 1986, Fabrigar et al. 1999). Items were included in a factor if it had a factor loading of 0.5 or greater. I conducted a reliability analysis on individual items in each factor using Cronbach's alpha to determine the effectiveness of each factor as a measurement scale accepting scores above 0.70 as having high reliability (Cronbach 1951, Nunnally 1978, Miller 1995).

I ran a stepwise logistic regression to determine what factors influenced WSAC, using FUTUREPOP as the dependent variable. Independent variables included hog presence, education levels, years in current job, total years as a wildlife biologist or similar occupation, and average score attitude and risk belief factors identified through PCA. For the significant variables, I conducted a Chi-Square or Wilcoxon rank sum test (Mann Whitney U test) as necessary to determine whether the desire for a specific future population trend affected attitudes toward hogs. An alpha level of 0.05 was used to determine statistical significance for all group comparison tests.

Results

Of the 614 questionnaires sent, 458 were returned usable. When non-deliverables ($n = 57$) and non-usable questionnaires ($n = 5$) were excluded from consideration, an effective response rate of 82.4% was achieved. All returned non-usable questionnaires were attributed to the respondents' refusal to answer.

Respondents were primarily Anglo ($n = 336$, 97.1%), males ($n = 326$, 93.4%) with an average age of 45.5 years ($n = 349$, SE = 0.48). The average number of years of education completed by respondents was 17.7 years (n = 341, SE = 0.11). Respondents indicated they were employed as a wildlife biologist, or similar occupation, for an average of 18.9 years (n = 274, SE = 0.60) and employed in their jurisdiction for an average of 12.9 years (n = 262, SE = 0.56).

Respondents reported hogs present in 46.8% (n = 206) of their jurisdictions. When asked about the desired trend in future hog populations (FUTUREPOP), 25 respondents (7.0%) wanted an increase in future hog populations, and the majority wanted a decrease (n = 334, 93.0%). A significant difference for those that wanted an increase and those that did not (P = 0.008, Normal Approx. Z = -3.36) was found between those that had hogs present in their jurisdiction and those that did not. Examining demographic variables of respondents that desired an increase in future hog populations with those that did not resulted in one statistically significant variable, total years worked as a wildlife biologists or similar occupation (P = 0.04, Normal Approx. Z = -2.01). Those that desired a decrease in population (n = 334, $\bar{x}$ = 19.34, SD = 0.64) had worked more years as a wildlife biologists or similar occupation than those that desired an increase in future hog populations (n = 25, $\bar{x}$ = 16.85, SD = 1.90) (Table 3.1). Although requested from biologists, hog density was not obtained because most felt their data was too unreliable to make estimates.

Three factors were identified in the rotated component matrix of the PCA (Table 3.2). One factor contained 8 statements and related to respondents opinions about how hogs affect people and wildlife habitat, benefits of hog presence, and hogs effect on wildlife habitat, so I titled this factor ATTITUDE. The next factor contained 6 statements relating mainly to the hogs' potential as a disease vector and the hogs' effect on livestock, so I titled this factor as LIVERISK. The last factor included 5 statements related mainly to the hogs' potential effect on native wildlife so I titled it WILDRISK.

When testing the reliability of the statements in each factor, ATTITUDE had a Cronbach's Alpha of 0.874, LIVERISK 0.869, and WILDRISK 0.783. Thus, all items were retained and I considered each scale to be a reliable measure of the constructs identified in the PCA. Stepwise logistic regression indicated that only 2 factors significantly influenced respondents desire for a specific population trend, ATTITUDE ($P < 0.001$, $\chi^2 = 18.40$, df = 1) and WILDRISK ($P < 0.001$, $\chi^2 = 32.58$, df = 1). Wilcoxon rank sum indicated significant differences on all ATTITUDE statement items (Table 3.3), and determined a significant difference ($P < 0.001$, Normal Approx. Z = 4.74) between the overall ATTITUDE score of respondents wanting a decrease in future hog populations ($n = 334$, $\bar{x} = 2.74$, SD = 0.05) and those who wanted an increase ($n = 25$, $\bar{x} = 3.57$, SD = 0.15). Although stepwise logistic regression determined LIVERISK insignificant as an influential WSAC factor, the Wilcoxon rank sum test determined significant differences overall between groups ($P = 0.001$, Normal Approx. Z = -3.90) and on 3 of the 6 items (Table 3.4). A significant difference ($P < 0.001$, Normal Approx. Z = -5.78) was determined between the overall WILDRISK score of respondents wanting a decrease in hog populations ($n = 334$, $\bar{x} = 4.58$, SD = 0.03) and those who wanted an increase ($n = 25$, $\bar{x} = 3.80$, SD = 0.17) (Table 3.4). Significant differences between groups on individual WILDRISK items were found for all but one item (Table 3.5).

Discussion

Methodological Comparisons with Previous Research

Overall, district level wildlife biologists employed by state agencies did not want hogs in their jurisdictions and wanted future hog populations to decrease. Determining what factors influenced this desire was assessed using WSAC theory. Methodological differences between my study and previous research may have contributed partially to why my results did not follow exactly the results of previous WSAC research when attempting to determine the factors that influenced a stakeholder's preference for a specific hog population trend. Previous research and theory stated that presence or perceived species density was one major influence, but the results of my study determined presence as an insignificant WSAC factor. Although I made an attempt to determine hog density, most wildlife biologists were not comfortable with estimating population size because of lack of reliable data.

Methodological differences included species in question, stakeholders surveyed, and use of more than one source for attitude and risk statements. Feral hogs are an exotic and invasive species in the United States, which is a different status from Riley and Decker (2000)'s WSAC study of native cougars in Montana. Primarily, WSAC and other stakeholder attitudinal studies were conducted about native species such as white-tailed deer, prairie dogs (*Cynomys ludovicianus*) and black bear (Decker et al. 1981, Conover 1998, Zinn and Andelt 1999, Christoffel and Craven 2000). People generally do not accept the presence of exotic species, especially if that species negatively impacts stakeholders (Perrings et al. 2002). Hogs are an exotic and invasive species, which may have affected the results of my study more so than if the study species was native. How, if at all, species status affected the results of my study was not examined. Future studies should investigate if native or exotic status or invasive verses non-invasive status affects the determination of influential WSAC factors.

Stakeholders of the Rollins (1993) and Riley and Decker (2000) studies varied from mine. Rollins (1993) queried Texas county agents to serve as surrogates for farmers, ranchers, and other natural resource agencies, and Riley and Decker (2000) queried the general public of Montana. Responses I received cannot be compared directly to either due to differences in stakeholders. Rollins (1993) admitted that county agents responses may have been biased in favor of their constituents (i.e., farmers and ranchers), but without directly surveying farmers and ranchers of Texas, the extent of bias is unknown and responses can only be inferred. A limitation of my study was the lack of various stakeholders for a comparison of WSAC among stakeholders. Future WSAC hog studies should attempt to include important groups such as hunters, the general public, agricultural producers, timber industries, and livestock producers. This would allow for statewide, regional, or national stakeholder comparisons which may assist in better, and more applicable custom management plans.

Another methodological difference between my study and Rollins (1993) was the theory the research was based upon. Rollins (1993) conducted an exploratory attitudinal study, inquiring of attitudes, types of damage and risk beliefs, and it did not use WSAC theory to obtain what factors influenced stakeholders' WSAC of hogs. By combining Rollins (1993) attitude and risk statements with Riley and Decker's (2000) statements, I ended up with 3 factors, one attitude and 2 risk factors (WILDRISK and LIVERISK).

Both attitude and risk statements were significant in Riley and Decker (2000), whereas ATTITUDE and only one risk factor (WILDRISK) were significant in my study. The insignificance of the LIVERISK factor could be because the statements dealt mainly with hogs as a disease vector and the hogs' effect on livestock, which may be considered outside the wildlife biologists professional realm. This was the first attempt for determining influential WSAC factors for district level wildlife biologists on a national level. In future studies, creating relevant factors specifically for stakeholder groups may be necessary for detecting influential WSAC factors.

Feral Hog Impacts

Hogs negatively impact native wildlife through forage competition, as the hog's omnivorous diet, comprised of forbs, grasses, sedges, woody plants, invertebrates, and animal matter, potentially overlaps with the diets of native wildlife (Everitt and Alaniz 1980, Beach 1993, Synatzske 1993, Fournier-Chambrillon et al. 1995, Taylor and Hellgren 1997; Taylor 1999; Taylor 2003). A diet overlap does not necessarily indicate that competition is occurring, but that potential competition may exist for limited resources during harsh conditions (Rollins 1999, Taylor 1999). Respondents that wanted a decrease in future hog populations were more likely to agree that hogs compete with wildlife for food. Forage competition was most likely a concern to wildlife biologists because competition not only impacts wildlife, but also wildlife management, such as hogs consuming supplemental feed (Rollins 1999).

Hogs have been cited as preying upon small mammals, ground nesting birds and sea turtles, herpetafauna, invertebrates, and as being attracted to birthing grounds for feeding on afterbirth and/or newborn (McKnight 1964, Matschke 1965, Peine and Farmer 1990, Tolleson et al. 1995, Gipson et al. 1998). Respondents that desired a decrease in future hog populations were more likely to agree that hogs posed a threat to wildlife. Both groups agreed that hogs were a threat to ground-nesting birds, but respondents that wanted a decrease in future hog populations were more likely to agree. Studies on hogs as a nest predator have produced conflicting conclusions, which may be why opinions differed slightly among respondents (Matschke 1965, Henry 1969, Wood and Lynn 1977, Babbit and Lincer 1993, Tolleson et al. 1995, Rollins 1999).

Although few studies indicated hog rooting had some positive benefits for wildlife habitat (McKnight 1964, Everitt and Alaniz 1980, Lacki and Lancia 1983, Arrington et al. 1999, Taylor 1999), most research has indicated that hogs negatively impact wildlife habitat by increasing soil erosion, decreasing water quality in streams and rivers, spreading soil fungi and wildlife diseases, and disrupting native plant assemblages through their rooting and wallowing behavior (Spatz and Mueller-Dombois 1975, Stone 1984, Beach 1993, Synatzske 1993, Kotanen 1994, Arrington et. al 1999, Pimentel et al. 1999). Hog rooting has also impacted timber production and forest health through decreased soil quality by reducing organic soil matter and changing soil pH, and by uprooting planted saplings (Lacki and Lancia 1983, Peine and Farmer 1990). Hogs' negative impact on habitat quality was another concern to wildlife biologists, where those that desired a decrease in future hog populations had lower attitude scores, believing that hogs were not good to have in their jurisdiction and were a sign of a diminished wildlife habitat. Differences in responses may be due to personal experience or education, but a majority of biologists, regardless of hog presence, did not want hogs in their jurisdiction.

Research indicated hogs can serve as a potential vector for disease such as leptospirosis, African swine fever, tuberculosis, avian pox, and psuedorabies which can affect wildlife, livestock, and humans (Tisdell 1982, Stone 1984, Beach 1993, Choquenot et al. 1996). Research indicated that hogs spread diseases directly and indirectly (e.g., insects) to wildlife and livestock at watering holes, mineral licks, and wildlife feeders (Matschke 1965, Tisdell 1982, Stone 1984, Beach 1993, Synatzske 1993, Taylor 2003). Disease transmission to and from livestock also has been a concern as it may affect agricultural producers and ranchers on local levels, and the food supply on national and international levels (Rollins 1993, Lawhorn 1999, Wheeler 1999). Although no significant differences were found between groups, all respondents strongly agreed hogs were a potential vector for wildlife, livestock, and zoonotic diseases.

The desire to hunt hogs and increased hunting revenues has perpetuated hog expansion throughout the U.S. which has contributed to hog impacts on wildlife and wildlife management (Barrett 1993, Miller 1993). Hog hunting opportunities have created a source of extra income for landowners through hunting leases, and created a monetary value for hogs which has encouraged humans to illegally transport and release hogs for increased revenue and hunting opportunities (Bach and Conner 1993, Barrett 1993, Miller 1993, Rollins 1993). Respondents that desired a decrease in future hog populations were less likely to agree that hogs could increase the revenue generating power of hunting leases, and should not be promoted as managed wildlife. In Texas and California, hog hunting has proven to be a lucrative business, but in other states hog hunting was limited due to lack of accessible hunting lands, lack of information for hunters, or restrictive laws (Bach and Conner 1993, Rollins 1993). In California, a fee based hog hunting operation was successfully established to offset financial liabilities associated with hog damage, but a later study indicated that without the cooperation of neighboring landowners, reducing hog populations and damage through a hunting operation was difficult (Barrett 1993). Property owners that allow hunters on their land must decide if profits from leases outweigh the associated costs of damage from hogs and hunters. Most respondents that wanted a decrease in future hog populations were less likely to agree that hog presence could make hunting leases more valuable and increase landowner revenues. Profits generated through fees and leases may not recover the total cost of hog damage (Frederick 1998). Respondents wanted a decrease in future hog populations, so I suggest that the promotion for hunting hogs be geared towards reducing or eliminating hogs to diminish the monetary impacts caused by hog damage. I suggest that wildlife biologists or other agencies connect those that want to hunt hogs with those that want hogs off their land. Each state should develop educational materials that do not promote fee-based hog hunting programs, but explain the economic and environmental impacts hogs cause, thus encouraging landowners to allow hunting on their land with the express purpose of reducing their numbers.

A majority of respondents wanted no hogs in their jurisdiction and a decrease in hog populations. Even with the small benefits hogs may provide to some landowners and agencies, they do not outweigh the cost of having an established hog population. Hogs should not be promoted as a managed game species, but as a species that should be heavily reduced and controlled, if not eliminated. The designation and promotion of hogs as a game species has caused increased problems with illegal transportation and further expansion of hog populations which has fostered more problems and concerns for various stakeholder groups (Waithman et al. 1999, Kammermeyer et al. 2003). Determining the best management practices may depend on attitudes held by stakeholders, and through my study I determined that wildlife biologists' desire for a decrease in future hog populations was influenced by attitudes held toward hogs and their belief that hogs have negative impacts on native wildlife.

To assist in the reduction/elimination of hog populations, I suggested the creation of a multi-layered team combining federal and state agricultural and fish and wildlife agencies to determine the best management strategies for states with complex hog issues where stakeholder attitudes and desires conflict. I suggested the creation of informative education materials for all stakeholders, especially the public, showing current distribution, identification of hog signs and presence, negative impacts hogs have on native habitats and wildlife, and who to contact in their state for information about hog management and control. I advocated the creation of persuasive educational information showing all negative aspects of hogs which should be directed not only to the public, but to wildlife biologists and other natural resource agencies. This information should be available, especially in states that currently do not have hogs, and should include current distribution, and problems and management challenges affecting other agencies and states. Future studies should include WSAC research of various stakeholders so the best and most palatable management practices may be created.

Table 3.1 Education level, length at current job, and total years as a wildlife biologist or similar occupation as reported by individual states district level wildlife biologists expressing a preference on hog populations in the United States in 2004 (Mean and Standard Deviation).

Demographic Variable (Years)	Desired Increase in Future Population[a] Mean (SD) (n = 25)	Desired Decrease in Future Population[b] Mean (SD) (n = 334)	*P-value* (Normal Approximate Z)[c]
Education level	18.12 (0.45)	17.70 (0.12)	0.38 (0.88)
Years at current job	11.35 (1.54)	13.20 (0.62)	0.20 (-1.28)
Wildlife biologist or similar occupation	16.85 (1.90)	19.34 (0.64)	0.04 (-2.01)

[a] Combined 'more hogs' respondents with those that indicated feral hog presence in their jurisdiction and indicated 'same number' of hogs.
[b] Combined 'less hogs', 'no hogs' and those without feral hog presence that indicated 'same number' of hogs.
[c] Statistically significant difference indicated; P-value <0.05.

Table 3.2 Factor loadings of attitudes and risk belief responses held by individual states district level wildlife biologists in the United States in 2004 using Varimax rotation.

Statement Each statement began with "I believe…"	Attitude	LIVERISK	WILD RISK
feral hogs are good to have in my jurisdiction	0.754		
the presence of feral hogs can be a sign of a quality wildlife habitat	0.733		
feral hogs have the right to exist wherever they may occur	0.727		
the presence of feral hogs in my jurisdiction increases my overall quality of life	0.721		
feral hogs can generate a significant source of income for landowners through hunting leases	0.632		
feral hogs can add value to hunting leases on private property	0.620		
hog rootings can provide soil aeration benefits	0.552		
feral hogs should be promoted as an animal that is good to eat	0.514		
hogs can transmit diseases that are harmful to humans		0.765	
feral hogs can be a threat to adult livestock.		0.734	
feral hogs can transmit harmful diseases to domestic livestock		0.693	
feral hogs can transmit harmful diseases to other wildlife		0.683	
having feral hogs on a persons' land can increase the amount of unwanted hunters		0.662	
feral hogs can be a threat to new born livestock (e.g., lambs)		0.652	
feral hogs can pose a significant threat to native wildlife			0.750
feral hogs can compete for food with other wildlife species			0.703
feral hogs can be a threat to ground-nesting birds			0.676
feral hog rootings can increase soil erosion			0.663
feral hogs should be treated as pest animals			0.630

Table 3.3 ATTITUDE beliefs which influenced Wildlife Stakeholder Acceptance Capacities of individual states district level wildlife biologists in the United States in 2004.

Factor Score Each statement began with "I believe…"	Desired Increase in Future Population[a] Mean (SD) (n = 25)	Desired Decrease in Future Population[b] Mean (SD) (n = 334)	*P-value* (Normal Approx. Z)[c]
feral hogs are good to have in my jurisdiction	3.25 (0.19)	1.28 (0.03)	<0.001 (9.32)
the presence of feral hogs can be a sign of a quality wildlife habitat	3.13 (0.18)	1.91 (0.05)	<0.001 (5.40)
feral hogs have the right to exist wherever they may occur	2.25 (0.18)	1.42 (0.04)	<0.001 (5.31)
the presence of feral hogs in my jurisdiction increases my overall quality of life	3.14 (0.15)	1.50 (0.04)	<0.001 (7.48)
feral hogs can add value to hunting leases on private property	4.09 (0.11)	3.08 (0.07)	<0.001 (4.42)
feral hogs can generate a significant source of income for landowners through hunting leases	3.63 (0.22)	2.85 (0.07)	0.001 (3.20)
hog rootings can provide soil aeration benefits	3.25 (0.17)	2.38 (0.07)	0.001 (3.90)
feral hogs should be promoted as an animal that is good to eat	4.00 (0.12)	3.30 (0.08)	0.009 (2.60)
Factor Average[d]	3.57 (0.15)	2.74 (0.05)	<0.001 (4.73)

[a] Combined 'more hogs' respondents with those that indicated feral hog presence in their jurisdiction and indicated 'same number' of hogs.
[b] Combined 'less hogs', 'no hogs' and those without feral hog presences that indicated 'same number' of hogs.
[c] Statistically significant difference indicated; P-value <0.05.
[d] Mean based on response format where 1 = 'Strongly Disagree', 2 = 'Disagree', 3 = 'Neutral', 4 = 'Agree', 5 = 'Strongly Agree', divided by the number of scale items.

Table 3.4 LIVERISK beliefs of individual states district level wildlife biologists in the United States in 2004.

Factor Score Each statement began with "I believe…"	Desired Increase in Future Population[a] Mean (SD) (n = 25)	Desired Decrease in Future Population[b] Mean (SD) (n = 334)	*P-value* (Normal Approximate Z)[c]
feral hogs can transmit harmful diseases to domestic livestock	3.64 (0.10)	4.07 (0.04)	0.002 (-3.07)
feral hogs can be a threat to new born livestock (e.g., lambs)	3.36 (0.19)	3.86 (0.08)	0.038 (-2.08)
feral hogs can transmit harmful diseases to other wildlife	3.57 (0.15)	3.90 (0.05)	0.048 (-1.97)
hogs can transmit diseases that are harmful to humans	3.39 (0.19)	3.59 (0.05)	0.450 (-0.75)
feral hogs can be a threat to adult livestock.	2.61 (0.19)	3.42 (0.09)	0.230 (-1.20)
having feral hogs on a persons' land can increase the amount of unwanted hunters	3.17 (0.17)	3.03 (0.07)	0.591 (0.53)
Factor average[d]	3.57 (0.17)	4.26 (0.05)	0.001 (-3.89)

[a] Combined 'more hogs' respondents with those that indicated feral hog presence in their jurisdiction and indicated 'same number' of hogs.
[b] Combined 'less hogs', 'no hogs' and those without feral hog presence that indicated 'same number' of hogs.
[c] Statistically significant difference indicated; P-value <0.05.
[d] Mean based on response format where 1 = 'strongly disagree', 2 = 'disagree', 3 = 'neutral', 4 = 'agree', 5 = 'strongly agree', divided by the number of scale items.

Table 3.5 WILDRISK beliefs which influenced Wildlife Stakeholder Acceptance Capacities of individual states district level wildlife biologists in the United States in 2004.

Factor Score Each statement began with "I believe…"	Desired Increase in Future Population[a] Mean (SD) (n = 25)	Desired Decrease in Future Population[b] Mean (SD) (n = 334)	*P-value* (Normal Approximate Z)[c]
feral hogs can pose a significant threat to native wildlife	3.44 (0.21)	4.46 (0.04)	<0.001 (-5.37)
feral hogs can compete for food with other wildlife species	4.16 (0.17)	4.65 (0.04)	<0.001 (-4.08)
feral hogs should be treated as pest animals	3.00 (0.24)	4.51 (0.05)	<0.001 (-7.0)
feral hogs can be a threat to ground-nesting birds	3.95 (0.13)	4.46 (0.04)	0.001 (-3.80)
feral hog rootings can increase soil erosion	3.92 (0.20)	4.26 (0.05)	0.067 (-1.83)
Factor average[d]	3.80 (0.17)	4.58 (0.03)	<0.001 (-5.79)

[a] Combined 'more hogs' respondents with those that indicated feral hog presence in their jurisdiction and indicated 'same number' of hogs.
[b] Combined 'less hogs', 'no hogs' and those without feral hog presence that indicated 'same number' of hogs.
[c] Statistically significant difference indicated; P-value <0.05.
[d] Mean based on response format where 1 = 'strongly disagree', 2 = 'disagree', 3 = 'neutral', 4 = 'agree', 5 = 'strongly agree', divided by the number of scale items.

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CHAPTER IV

MISSISSIPPI FARM BUREAU COUNTY PRESIDENT ATTITUDES TOWARD FERAL HOGS BASED ON PRESENCE AND PRODUCTION TYPE

Feral Hog Impacts

How farmers manage feral hogs (*Sus scrofa;* subsequently referred to as hogs) and hog impacts on their property depends on the landowners' economic investment and land usage (Bach and Conner 1993, Higginbotham 1993). Hogs impact landowners through agricultural crop damage, disease transmission to livestock, and competition with and predation on livestock (Bach and Conner 1993, Frederick 1998, Mapston 2004). First, hogs create damage as they forage and root for food in crops, timber, and pasture lands. Hog rootings have been found to increase soil erosion, contribute to mineral leaching from the soil, spread soil fungi (e.g. root rot), and severely damage land surfaces to the point that resurfacing was required (Singer et al. 1984, Peine and Farmer 1990, Mapston 2004). Some farmers attempting to repair heavily damaged fields have suffered secondary damage to tractors and other heavy equipment (McKnight 1964, Beach 1993). Other farmers experienced monetary losses as they replanted damaged crops, installed fences, built traps, or completely changed the products produced on their farms in an attempt to reduce or eliminate future hog damage (Bach and Conner 1993, Sekhar 1998). Second, hogs serve as a potential vector of zoonotic diseases, such as African swine fever or leptospirosis which has concerned many farmers, especially commercial pork producers in the United States (Taft 1999). Disease outbreaks may decrease the farms productivity and profits by decreased growth and reproduction of crops and livestock, and may create additional expenses from veterinary bills or livestock culling to prevent diseases from spreading (Bach and Conner 1993, Rollins 1993, Taft 1999). Disease outbreaks could make livestock unfit for consumption affecting export food commodities, further impacting farmers financially (Evans 2002). Finally, hogs impact agricultural producers through competition with livestock for food and water sources, and by predation on newborns (Everitt and Alaniz 1980, Tisdell 1982, Peine and Farmer 1990, Mapston 2004). Due to the hogs sometimes aggressive nature, livestock may abandon areas frequented by hogs, including water sources, food plots, or feeders (Mapston 2004). Hogs also have been documented as being attracted to livestock birthing grounds to feed on afterbirth and at times newborn livestock (Mapston 2004).

One of the few benefits from having hogs present on agricultural land was that it may provide additional revenue created from hunting leases (Rollins 1993, Zivin et al. 2000). In the 1990s, the average amount paid for a weekend hog hunt in Texas ranged from $500 to $1,000/person depending on the complexity and hunt length (Rollins 1993). Some agricultural producers believed public hunting on their property would reduce the amount of hog damage (Irby et al. 1997). With their distribution expanding, hogs have been considered a liability, benefit, or sometimes both to agricultural producers depending on the economic investment, land usage, and the extent of negative impacts caused by hogs.

Wildlife management is affected and influenced by the public, so stakeholder preference should be studied and considered when making management decisions. No studies about agricultural producer attitudes toward hogs in Mississippi have been conducted, and few studies have been conducted elsewhere. Therefore, there were 2 objectives to my study. First, I wanted to assess agricultural producer attitudes toward hogs in relation to hog presence. Second, I wanted to determine hog locations in Mississippi at the county level. Differences in attitudes may be due not only to hog presence, but economic involvement, perceived or actual damage, and experiences with hogs.

Theoretical Background

My study was based on the Wildlife Stakeholder Acceptance Capacity theory (WSAC) which builds off Wildlife Acceptance Capacity theory (WAC). WAC theory was defined as the "maximum wildlife population level in an area that was acceptable to people," but it was not defined as a static number (Decker and Purdy 1988). It was an assessment of one stakeholder group's attitudes toward a species at one point in time. WSAC theory extended the WAC theory by examining the stakeholder's desire for a specific population trend and how other independent factors influence that desire, such as perceived or actual costs and benefits, and how stakeholders were affected by wildlife management (Carpenter et al. 2000). Different stakeholders can simultaneously have different acceptance levels, such as a desire for a decrease in the population, which reflect the stakeholders' particular set of "limiting factors" (e.g., depredation of crops, hunting opportunities, or aesthetic appreciation; Decker and Purdy 1988). The limiting factor may be depredation of crops. At a low population level, the stakeholder may tolerate an increase in the population due to little or no crop depredation. The population may increase to a point to where the stakeholder has suffered great losses and then desire the population to decrease so he/she will not suffer further crop loss. The primary limiting factor was the threshold of acceptance of wildlife damage (Decker and Purdy 1988).

Estimation for acceptance levels has been determined by using either estimates of economic loss or preference for a specific population trend (i.e., decrease or increase in future populations) as the dependent variable, and the perceived or actual species presence and/or density as the independent variable (Decker and Purdy 1988). A stakeholder may be affected positively and negatively by one species depending on the temporal or spatial scale, where over time an individual stakeholder may be affected differently than a community (Carpenter et al. 2000). I chose WSAC theory to best determine what factors, if any, influenced FBCP desire for a specific future hog population trend.

Riley and Decker's (2000) WSAC mountain lion (*Puma concolor*) research was the methodological basis for my study. With this study, a survey was conducted of Montana residents examining risk beliefs, desire for future population, perception of current population, and attitudes toward cougars. They attempted to identify factors (e.g., risk belief, attitudinal responses, demographic variables) influencing the publics desire for a specific future population trend (i.e., increase or decrease) assuming that preference for future population trends was an accurate index relative to stakeholder perception of the current population, attitudes toward cougars, and risk beliefs (Riley and Decker 2000). This research indicated those who desired a decrease in the future population believed the current population was high, increasing their risk of having a negative encounter with a cougar, and held more negative attitudes toward cougars (Riley and Decker 2000). Stakeholders that perceived the current population as low had lower risks beliefs, held more positive attitudes toward cougars, and preferred the future population to remain stable or increase (Riley and Decker 2000).

Few studies on factors that influenced attitudes of stakeholders toward hogs have been conducted, but based on previous research hog presence, economic investment, and perceptions of positive and negative impacts caused by hogs should affect stakeholder attitudes toward hogs (Decker and Purdy 1988). I assumed Farm Bureau county presidents (FBCP) with hogs on their property would express more negative attitudes toward hogs than those without hogs on their property. Also, I assumed agricultural producers that produced cash crops as their primary product would have more negative attitudes toward hogs than those that produced livestock on their property.

Methods

Sampling and Survey Design

A survey of Mississippi FBCP (*n* = 79) was conducted in 2005, with contact information obtained from the Natural and Environmental Resources department within the Mississippi Farm Bureau Agency. FBCP were assumed to well representative of

Mississippi producers because of the wide variety of products they produced, including timber, and because they had to receive >50% of their income from farming. Information for 3 counties was not given and was not included in the study. I designed a 10-page self administered mail questionnaire containing questions about county location of agricultural properties, products produced, hog presence, evidence of hog presence, hog control, hunting practices, attitudes toward hogs, characterization of the stakeholder (i.e., race, age, education level, gender), and an open-ended section for written comments. To access attitude differences based on agricultural producers desire for a specific trend in hog numbers (i.e., increase or decrease), I modified and combined survey questions from Rollins' attitudinal statewide questionnaire (1993) and Riley and Decker's mountain lion WSAC questionnaire (2000). Nineteen attitudinal and risk statements asked FBCP the extent to which they agreed or disagreed with the statements on a 6-point Likert-type scale with the following response format: 1 = 'strongly disagree', 2 = 'disagree', 3 = 'neutral', 4 = 'agree', 5 = 'strongly agree' and 6 = 'no opinion'. Using the same 6-point Likert-type scale I asked each FBCP if they agreed or disagreed to changing the status of hogs to a game species. To assess respondent desires for future hog populations I asked if they wanted: 1 = 'more hogs', 2 = 'less hogs', 3 = 'same number', 4 = 'no hogs' or 5 = 'no opinion'.

Next, I asked the producers if they thought the trend in the hog population over the past 5 years: 1 = 'greatly decreased', 2 = 'somewhat decreased', 3 = 'remained stable', 4 = 'somewhat increased', or 5 = 'greatly increased'. Furthermore, in an open-ended response format, I asked each FBCP to identify what event they felt led to the trend they specified. Then, I asked only those with hogs on their property about the following evidence of hog presence on their property: rooting, rubbings, trampling, wallows, fence damage, damage to livestock food plots, damage to wildlife food plots, damage to feeders, possible transmission of disease to livestock, and damage to crops. I asked if they have observed it, and whether or not they considered the evidence of hog presence to be damaging. Further, I asked if they considered hog evidence was: 1 = 'not a concern', 2 = 'tolerable', 3 = 'mild annoyance', 4 = 'annoying' or 5 = 'intolerable'. I asked each FBCP if they, or their family members, hunted on their own property, in general, and specifically for hogs. Finally, I asked whether or not they leased any of their properties for hunting, in general, and specifically for hog hunting.

Survey Implementation

I used a modified version of Dillman's Total Design Method (TDM; Dillman 1978) for survey implementation, which included a series of 3 mailings, each containing an introductory letter, questionnaire, and postage paid business reply envelope (subsequently referred to as a complete packet). The introductory letter included the purpose and project sponsors, my contact information for questions or to request a replacement survey, Mississippi State University Institutional Review Board (IRB) approval number and contact information, and a confidentiality statement. All protocols and materials were approved by the MSU IRB (Docket #04-171). Three and 6 weeks after the initial mailing, I sent a complete packet with a letter of appreciation for those who recently returned their questionnaire and a reminder to non-respondents.

All correspondence was personalized to enhance my response rate; specifically each letter was printed on Mississippi Farm Bureau letter head with electronic signature images of the Director of the Human Dimensions and Conservation Law Enforcement Laboratory and the head of the Natural and Environmental Resource Department of Mississippi Farm Bureau, names and addresses were directly printed on the envelopes and letters to simulate a first class mailing, and envelopes had a first class postage stamp. Questionnaires were labeled and cataloged using a barcode system, with the corresponding number on the introductory letter. I used the bar code system to monitor returned surveys and non-respondents so future mailings could be determined.

Analysis

As questionnaires were returned, I coded non-numerical values as numeric and entered data into a Microsoft Access® database. Responses to the open-ended request for the types of stakeholder inquiry were grouped by commonality and given a numerical code (e.g., 1 = 'hunting pressures', 2 = 'increase preferred habitat'). After I completed data entry, I double checked all questionnaires for accuracy. The overall data entry error rate was 0.07% (6 errors/7,524 survey questions). Errors were random and no pattern was found for any specific variable that warranted data re-entry. Errors were recorded and corrected. The effective response rate for the survey was derived by dividing the number of questionnaires returned usable by total number of questionnaires sent minus number of non-deliverables minus number of questionnaires returned non-usable. To create the distribution map, every county was given an ArcGIS® county ID code, and I used the ArcGIS joins/relate feature to create a map displaying property and hog locations as reported by FBCP.

Due to no farmers indicating that they wanted more hogs on their property, I could not determine the specific WSAC factors that influenced FBCP desires for a specific future trend in hog numbers. I resorted to the preliminary WAC theory to examine if attitudinal differences existed based on the presence/absence of hogs on FBCP properties. I also examined possible attitudinal differences of those with hogs on their property and those without based on production type.

I used a Wilcoxon rank sum test to determine significant differences between FBCP attitudes with and without hogs on their property and to examine significant differences in attitudes toward hog damage based on production type. Producers were divided into 2 production type categories; *Livestock* and *Crops*. *Livestock* contained those who indicated one of the following as the primary product produced: beef cattle, dairy production, horses, sheep, goats, chickens, or domestic hogs. *Crops* contained those who indicated one of the following as the primary product produced: grain, hay, cotton, soybean, vegetables, timber, fruit, nuts, sod, or greenhouse/nursery products. Non-parametric tests were used because data were ordinal, from independent samples of different sizes and non-normal. An alpha level of 0.05 was used to determine statistical significance.

Results

Of the 79 questionnaires sent, 68 FBCP responded to the survey. All returned questionnaires were usable and there were no non-deliverables resulting in an effective response rate of 86.1%.

Overall, 33.3% (*n* = 22) of the producers indicated that hogs were present on their property in 26 counties (Figure 4.1). Respondents were primarily Anglo (*n* = 68, 100%), males (*n* = 63, 97%), with an average age of 58.2 years (*n* = 65, SE = 1.43). The average number of years of education completed by respondents was 15.2 years (*n* = SE = 0.29). No significant differences were found between those that had hogs on their properties and those with no hogs when examining 4 demographic variables: race (*P* = 1.00, Normal Approx. Z = 0.0), gender (*P* = 0.33, Normal Approx. Z = -0.98), age (*P* = 0.48, Normal Approx. Z = -0.70), and education (*P* = 0.88, Normal Approx. Z = 1.43).

Of the all the respondents, one (1.6%) indicated hog numbers had 'greatly decreased' over the past 5 years, 7.9% (*n* = 5) indicated numbers had 'somewhat decreased', 12.7% (*n* = 8) indicated hog numbers had remained 'stable', 46.0% (*n* = 29) indicated hog numbers had "somewhat increased", and 31.8% (*n* = 20) indicated hog numbers had "greatly increased". A plurality of producers (22.2%, *n* = 10) cited "hunting pressures" as the main cause of hogs migrating to new areas and their increase in numbers. "Increased preferred habitat" and "high reproductive rate" were equally cited as the second most likely reason for the increase (15.6%, *n* = 7). "Relocation of hogs" and "inefficient control measures" were equally cited as the third most likely reason for the increase (13.3%, *n* = 6). The remaining 4 reasons totaled 20.0% (*n* = 9) of the responses (Table 4.1).

Of all respondents, 68.2% (*n* = 45) held negative attitudes toward hogs, 22.7% (*n* = 15) held mixed feelings, 6.1% (*n* = 4) held positive feelings, and 3.0% (*n* = 2) were indifferent. An overwhelming majority of producers (94.7%, *n* = 63) wanted “no hogs” on their property, 4.7% (*n* = 3) wanted the “same number of hogs”, of which 2 producers reported no hogs on their property and one producer estimated 20 hogs on their property, and no producers wanted more. Of the 20 (91.1%) respondents that indicated they hunted on their own property, 45.0% (*n* = 9) hunted specifically for hogs, and all allowed relatives and/or friends to hunt on their properties. Only 40.0% (*n* = 8) allowed other people (i.e., not a relative or a friend) to hunt on their property, and no producers charged hunting lease fees specifically for, or that included, hog hunting.

Producers with hogs on their property (*n* = 22) reported various evidence of hog presence (Table 4.2). Of the 95.5% (*n* = 21) that reported finding hog rooting on their property, 81.1% (*n* = 17) considered it damaging. Of the 17 producers (77.3%) that reported wallows as evidence of hog presence, 71.1.0% (*n* = 12) considered wallows damaging. Rubbings and trampling/hoof prints were equally reported as the third highest evidence of hog presence (68%, *n* = 15). Of these, trampling/hoof prints were considered to be more damaging (46.7% *n* = 7) than rubbings (26.7%, *n* = 4). Thirteen producers (59.9%) reported evidence of hog presence through crop damage, and all agreed that it was damaging. Twelve producers (55.0%) reported evidence of hog presence through damaged livestock food plots, and all agreed it was damaging. Less than half of the producers reported evidence of hogs through damage of wildlife food plots (45.5%, *n* = 10), but 90.0% (*n* = 9) considered it damaging. Few producers reported damage to feeders, fences, or possible transmission of disease to livestock. When asked if the hog status should be changed to a game species, there was no significant different between those that had feral hogs on their property and those that did not. A majority of producers 'disagreed' (*n* = 13, 21.0%) or 'strongly disagreed' (*n* = 20, 32.2%) with the statement, whereas 13 (21.0%) producers 'agreed' and 6 (9.7%) producers 'strongly agreed' with the statement. Ten producers (16.1%) were neutral.

No respondents indicated they wanted more hogs on their property therefore, factors that influence attitudes could not be determined. Comparing responses from producers with and without hogs on their property indicated no statements to be significant; therefore, it could not be determined if respondent attitudes were affected by hog presence (Table 4.3). Also, no significant differences between the *Crops* and *Livestock* groups were detected.

Discussion

Distribution

Hog populations were reported by FBCP as increasing over the past 5 years, with hunting pressures cited most often as the reason for the increase in distribution. The second and third reasons indicated by FBCP were the increase in available habitats and high reproductive rates. Determining how hogs have spread from one area to another was difficult to assess. Few studies on how hunting affects the spread of hogs have been conducted, but it has been noted that extreme disturbance may encourage hogs to disperse into areas with less disturbance (Barrett and Birmingham 1994, McGaw and Mitchell 1998). Hogs naturally spread to areas of more suitable habitat, and farms provide that through crops, livestock feed, food plots, increased water supplies from irrigation, and livestock or aquaculture ponds (Waithman et al. 1999). Hog populations can quickly double in size in one year due to a high fecundity rate, early sexual maturity, and often multiple litters per year (Dickson et al. 2001).

With an increase in hog distribution, producers need to be aware of the status of hog sightings or populations in their county and surrounding counties. Combining location results from this portion of my study and location results from individual states district level wildlife biologists (Fogarty 2007) indicated differences in the identification of hog locations in Mississippi (Figure 4.2). Wildlife biologists reported more locations of hogs in Mississippi (78 counties), but did not report them in 3 counties in which producers did report them. This does not indicate inefficiency on the part of either group, but that state agencies can benefit from better communication with agricultural producers and vise versa. It was unknown whether producers in counties where wildlife biologists reported hog presence knew of the possibility that hogs were located somewhere within their county. A difference may have been that hog populations reported by wildlife biologists exist within a county but that FBCP did not experience or have any hogs on their property. Also, hogs may have been transient between counties or properties when originally sighted causing discrepancies between groups. This is one example of the type of educational information about hogs needed for producers and other stakeholders in Mississippi. Also, communication between producers, private landowners, and state wildlife biologists will help produce a more accurate map of hog locations within the state. Easily accessible information should be available so producers can learn to identify hog evidence, and know who to contact for information about control and other support services. Hot lines should be developed where producers can report hog sightings to help natural resource agencies keep track of current hog situations. For those with hogs on their properties, information should be available demonstrating ways to prevent damage. A collection of fence designs, effective control methods, and trap designs should be available (e.g., Internet, public libraries, FBCP local offices). As hog populations expand in Mississippi, more information of hog locations should be gathered to alert agricultural producers of the locations of hogs in Mississippi.

Attitudes of FBCP

Overall, respondents held negative attitudes toward hogs, indicated they did not want more hogs on their property, and were intolerant or annoyed by damage. Of the reported evidence that indicated hog presence; rootings, wallows, and damage to crops were considered most destructive. Throughout the United States, producers have reported many cases where hog rootings have caused substantial damage, such as in California where rooting caused over $1.7 million in agricultural damage in 1996 (Frederick 1998). Also in 1996, producers in Queensland, Australia, suffered a reduction in crop yield valued around $11.9 million (McGaw and Mitchell 1998). Respondents strongly disagreed that hogs create soil aeration benefits, and strongly agreed hogs increase soil erosion, which also was supported by previous research (Singer et al. 1984, Peine and Farmer 1990, Tolleson et al. 1995, Taft 1999, Mapston 2004). Producers, even those without hogs on their properties, did not want hogs and this desire may be easily incorporated into Mississippi's hog management plans by encouraging producers to assist with population reduction management.

Hogs can affect livestock in several ways, including competition over supplemental feed and food plots, and the predation of offspring. A majority of respondents reported observing hog damage to livestock food plots, but few reported observation of hogs damaging livestock feeders. Previous research indicated that a majority of the hog diet, especially in winter, included supplemental sources such as food plots and livestock feed (Everitt and Alaniz 1980, Peine and Farmer 1990, Kotanen 1994). Hog activity in pasture land also negatively affects livestock by reducing availability of natural fodder and may promote an increase in undesirable pasture weeds (McGaw and Mitchell 1998). A majority of groups with and without hogs believed that hogs were a threat to newborn livestock, whereas a plurality of respondents believed hogs were a threat to adult livestock. Previous research indicated that hogs can prey upon newborn livestock such as lambs, but the exact rate of predation was difficult to determine since hogs leave little evidence behind (Tisdell 1982, Bach and Conner 1993, Sekhar 1998). One rancher in Texas claimed a 15 to 20% reduction in young goats in areas of new feral hog establishment (Kammermeyer et al. 2003). Information on hogs' negative impacts hogs have on livestock should be included with the educational information provided to Mississippi producers.

Most FBCP agreed that hogs could be a potential vector for livestock diseases, but their response indicated a degree of uncertainty. Infected hogs can spread diseases, such as psuedorabies or swine brucellosis, when close to domestic livestock (Rollins 1993, Tolleson et al. 1995). Documented cases of disease transmission were not frequent, but there were 2 separate cases where hogs transmitted swine brucellosis to dairy cows and domestic hogs (Lawhorn 1999, Wheeler 1999). Another concern indicated in previous research was the spread of diseases from one domestic hog farm to another by way of infected feral hogs (Lawhorn 1999). Potentially, an epizootic could lead to a national or international ban on livestock products, as in the case of BSE and the ban of U.S. beef in the international meat trade, which still has lasting impacts on national and international consumer trust (Evans 2002, Jin et al. 2004). Agricultural agencies need to create information pamphlets informing producers that hogs could serve as a potential disease vector. Agricultural producers could be instructed on how to use blood sampling kits, available through Mississippi Department of Wildlife, Fisheries and Parks (MDWFP), to help monitor the state’s feral hog disease status. These kits also could be disseminated through more venues, such as Mississippi Farm Bureau or local United States Department of Agriculture (USDA) offices. With producers being more involved in hog management and information collection, they may participate more readily in hog management.

Respondents believed that having hogs on their property would increase the amount of unwanted hunters, and that hunting hogs would not decrease the amount of hog damage. Promoting hogs as a challenging game animal potentially may make hogs valuable, which may indirectly increase hog distribution and decrease control over population growth (Waithman et al. 1999). A plurality of respondents without hogs on their property indicated they believed having hogs on their property would increase revenues generated from hunting leases, but almost an equal amount were neutral. A plurality of those with hogs on their property disagreed. Mississippi has not been known as a popular hog hunting venue, thus establishing fees for hog hunting would require a promotion of hog hunting, potentially pushing for an increase in hog numbers. Producers were unsure about the possibility of increasing revenues through hog hunting opportunities which could make any attempt at promoting hog hunting as profitable difficult, especially since most of respondents disagreed with establishing hogs as a game species in Mississippi. In Texas and California, landowners were able to recover some revenues from hosting hog hunting programs on their property, but revenues generated did not outweigh costs associated with hog damage (Barrett 1993, Rollins 1993). In Texas, farmers and ranchers held negative attitudes toward hogs despite the possible monetary gain from hunting leases (Rollins 1993). One respondent indicated that hog damage outweighed any “small benefit” hogs may bring.

Most FBCP indicated they, their friends, or their family hunted on their property. Therefore, producers with hogs on their property could be encouraged to use hunting, whether organized through a natural resource agency or a private hunting party, with the specific goal of reducing and eventually eliminating hog populations. Hogs, a nuisance species in Mississippi (Mississippi Code of 1972: 49-7-1), should not attain the designation as a game species, but be promoted as a pest species in need of stringent population reduction and elimination.

No significant differences were found between *Crops* and *Livestock* group. In previous research, livestock producers typically had more positive or indifferent attitudes toward hogs then crop producers who suffered more damage (Bach and Conner 1993, Rollins 1993, Fredrick 1998). Occasionally, hog rootings can significantly reduce the amount of pasture land and increase the risk of injury to livestock traveling over deeply rooted land (Hone and Robards 1980, Mapston 2004). One explanation may be that most respondents produced more than one product on their property, such as hay, soybeans, and beef cattle. Further research is necessary to ascertain whether farmers and ranchers can be treated as a homogenous group or if significant differences between groups exist when examining stakeholder attitudes toward hogs.

Examining the attitude of agricultural producers toward hogs may help natural resource agencies understand and develop effective and more palatable management practices. In Mississippi, agricultural producers own most of natural lands, and to control the spread of hogs, agricultural producers must be involved. With further research, Mississippi agricultural producer attitudes may reflect that of the FBCP. Knowing this may help natural resource and agricultural agencies to produce successful educational and feral hog management practices involving agricultural producers.

Table 4.1 2004 Farm Bureau county presidents' opinion of what event led to the trend in an increase in feral hog numbers over the past five years.

Event	*n*	%
Hunting pressures (causing dispersal and increase)	10	22.2
Increased preferred habitat	7	15.6
High reproductive rate	7	15.6
Relocation of hogs	6	13.3
Inefficient controlling measures	6	13.3
Lack of information about hogs	3	6.7
Don't know	3	6.7
Few natural predators	2	4.4
Difficulty hunting – not enough hunting for control	1	2.2
TOTAL	40	100.0

Table 4.2 Number and percentage of producers with hogs on their property that observed evidence of hog presence in Mississippi in 2004; and whether it was considered damaging (*n* = 22).

Feral Hog Evidence	Evidence of hog presence		Respondents that considered evidence of hog presence to be damaging	
	n	%	*n*	%
Rooting	21	95.5	17	81.1
Wallows	17	77.3	12	71.1
Rubbings	15	68.2	4	26.7
Trampling/Hoof prints	15	68.2	7	46.7
Damage to crops	13	59.1	13	100.0
Damage to livestock food plots	12	55.0	12	100.0
Damage to wildlife food plots	10	45.5	9	90.0
Fence damage or hair left on fences	9	41.0	4	44.4
Damage to feeders	3	14.0	3	100.0
Possible transmission of disease to livestock	3	14.0	3	100.0

Table 4.3 2004 Mississippi Farm Bureau county presidents' responses when asked the extent to which they agree or disagree with statements about feral hogs on their property.

Statement Each statement began with "I believe..."	Group	*n*	Disagree %[a]	Neutral %	Agree %[b]	Normal Approx. Z	*P-value* [c]
can be hunted to reduce the amount of feral hog damage	Hogs	22	77.3	4.6	18.2		
	No Hogs	41	92.7	7.3	0	-1.92	0.060
are good to have on my property	Hogs	22	90.9	0	9.1		
	No Hogs	41	95.1	2.4	2.4	0.09	0.930
should be treated as pest animals	Hogs	22	9.1	4.5	86.4		
	No Hogs	43	9.3	7.0	83.7	-0.22	0.830
can compete for food with other wildlife species	Hogs	22	22.7	4.5	72.7		
	No Hogs	41	12.2	7.3	80.5	-1.16	0.250
should be promoted as an animal that is good to eat	Hogs	21	23.8	9.5	66.7		
	No Hogs	40	32.5	35.0	32.5	1.48	0.140
can be a threat to newborn livestock	Hogs	21	19.1	23.8	57.1		
	No Hogs	34	8.8	23.5	67.6	-0.54	0.591
presence on my property increases my overall quality of life	Hogs	22	81.8	9.1	9.1		
	No Hogs	39	95.0	2.6	2.6	0.76	0.470
rootings can provide soil aeration benefits	Hogs	22	86.4	9.1	4.5		
	No Hogs	37	78.4	11.0	11.0	0.22	0.830
can be a threat to ground-nesting birds	Hogs	21	4.8	19.1	76.2		
	No Hogs	40	5.0	7.5	87.5	-0.63	0.530
rootings can increase soil erosion	Hogs	22	4.5	13.6	81.8		
	No Hogs	39	5.1	12.8	82.1	0.02	0.981

Table 4.3 (continued) 2004 Mississippi Farm Bureau county presidents' responses when asked the extent to which they agree or disagree with statements about feral hogs on their property.

Statement Each statement began with "I believe..."	Group	*n*	Disagree %[a]	Neutral %	Agree %[b]	Normal Approx. Z	*P-value* [c]
can pose a threat to native wildlife	Hogs	22	0	0	100.00		
	No Hogs	38	5.2	5.2	89.5	1.60	0.111
can transmit diseases to domestic livestock	Hogs	20	0	25.0	75.0		
	No Hogs	33	0	21.2	79.0	0.40	0.700
can generate a source of income for landowners through hunting leases	Hogs	21	43.0	19.1	38.1		
	No Hogs	39	20.5	28.2	51.3	-0.21	0.831
can transmit diseases that are harmful to humans	Hogs	19	10.5	52.6	36.8		
	No Hogs	29	24.1	44.8	31.0	0.63	0.530
presence can be a sign of a quality wildlife habitat	Hogs	22	59.1	22.7	18.2		
	No Hogs	37	62.2	10.8	27.0	1.21	0.230
on a person's land can increase the amount of unwanted hunters	Hogs	21	14.3	23.8	62.0		
	No Hogs	41	22.0	26.8	51.2	1.88	0.060
can add value to hunting leases on private property	Hogs	22	45.5	22.7	31.8		
	No Hogs	38	26.3	34.2	39.5	-0.83	0.403
can be a threat to adult livestock	Hogs	20	25.0	35.0	40.0		
	No Hogs	36	30.6	22.2	47.2	-0.33	0.741
have the right to exist wherever they may occur	Hogs	22	100.00	0	0		
	No Hogs	42	83.3	9.5	7.1	-0.85	0.40

[a] Combined 'disagree' and 'strongly disagree' responses.
[b] Combined 'agree' and 'strongly agree' responses.
[c] Statistically significant difference indicated; P-value <0.05.

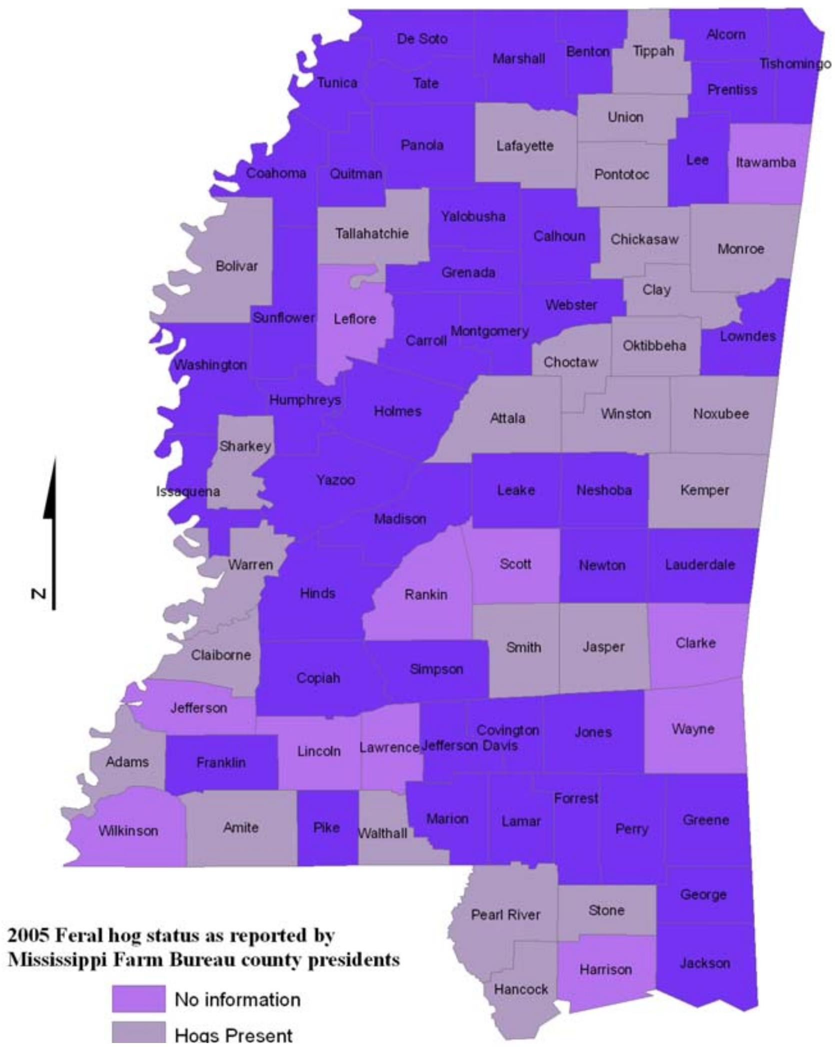

Figure 4.1 Feral hog status reported by 2004 Mississippi Farm Bureau county presidents (FBCP).

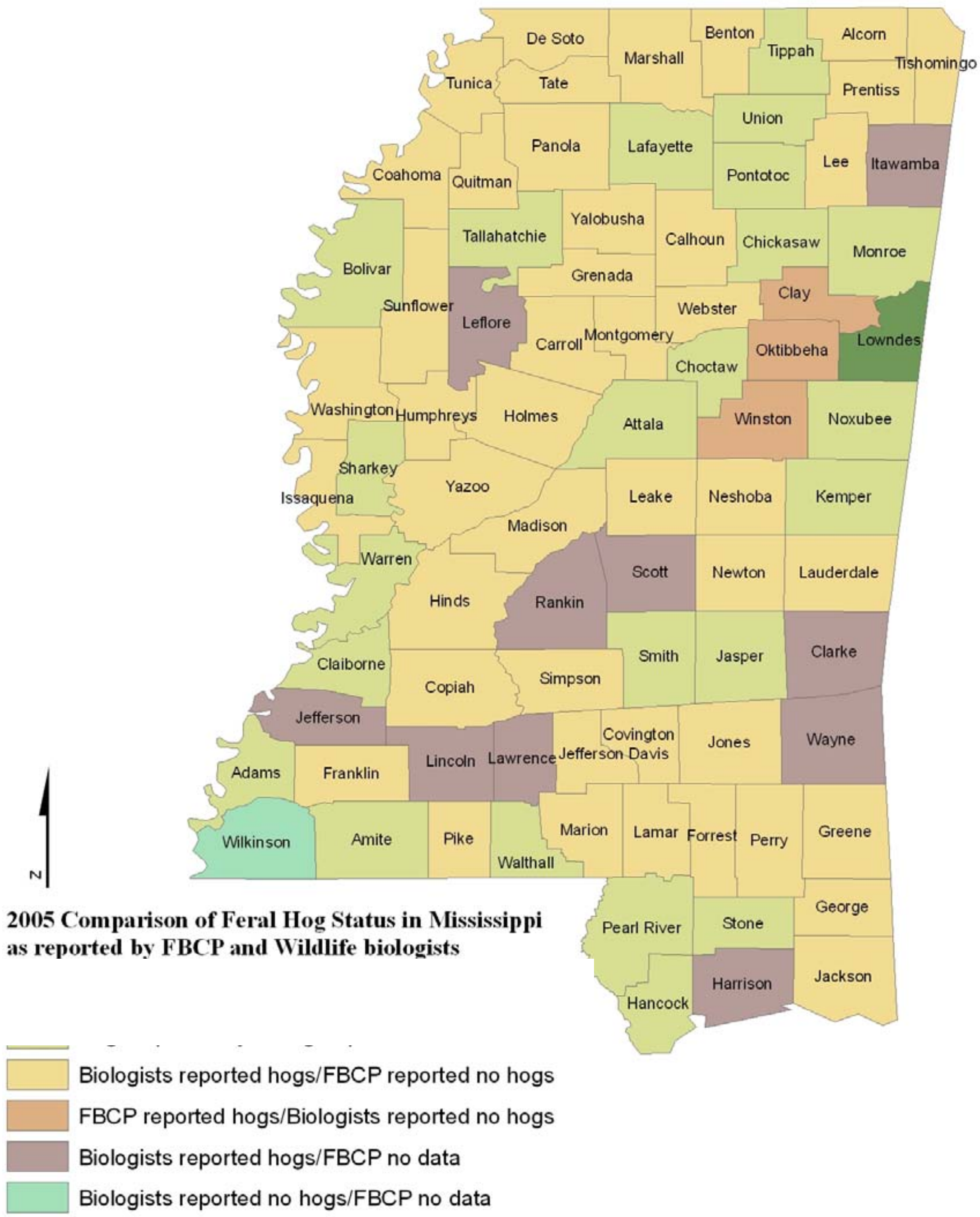

Figure 4.2 Comparison of feral hog status as reported by 2004 Mississippi Farm Bureau county president and 2004 Mississippi district level wildlife biologists.

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CHAPTER V

SYNTHESIS

As feral hog populations increase, their management has become a complex issue when stakeholder desires conflict. Knowing stakeholder desires about feral hog management may be the best way to develop effective strategies addressing their desires and increasing support for feral hog management. I assessed stakeholder attitudes, risk beliefs and desires for a specific trend in the future feral hog population of two stakeholder groups. From this, I identified three main areas of need. First, the creation of feral hog management teams in each state that addresses complex hog issues. Second, encouragement of hunters and trappers to increase feral hog harvest by increased assistance and support from state and federal agencies. Third, the revision of educational information that promotes public involvement and sound feral hog management and control. Progress on controlling and reducing feral hog populations may increase when these areas of need are addressed.

Each stakeholder group identified the need for more effective feral hog management and goals, which included a need for an interagency team that addressed feral hog management. Each state should create a multilayered team including both state and federal agencies that assesses stakeholder desires for feral hog management. From that each team should develop and implement plans that address complex feral hog management issues, especially in areas where stakeholder desires conflict. States without a feral hog presence should also create a multilayered team that addresses the potential immigration of feral hogs into their state and what management strategies should be implemented if feral hog presence is detected. All feral hog management teams should work with the local, state and federal public and private agencies to ensure that all stakeholder groups are represented when making decisions about feral hog management. Respondents stated that the specific regulatory agency that has authority over feral hog management is sometimes difficult to identify. The regulatory agency that has authority should be determined by each state and announced to state and federal agencies and to the public. If responsibilities are shared between agencies, the public should be informed which agency should be contacted with specific questions or concerns. Respondents indicated a need for more organized feral hog management with stated goals. By creating feral hog management teams that encourage interagency communication and public outreach, feral hog management goals may be attainable.

Attaining feral hog population management goals may be achieved with more assistance for hunters, trappers and landowners, and stakeholder education. Open season hunts and trapping were the primary method for controlling and reducing feral hog populations, but more technical assistance for trappers, hunters and landowners should be available. This includes information on the best methods for harvesting hogs, trapping methods, trap design, trap placement and bait suggestions. Hunters and trappers also should be encouraged to donate surplus feral hog meat to charitable organizations, such as Hunters for the Hungry, which may persuade hunters and trappers to harvest more hogs. In addition to knowing the appropriate regulatory agencies, stakeholders should be informed about the negative impacts on desirable games species, such as white-tailed deer (*Odocoileus virginianus*) or wild turkey (*Meleagris gallopavo*), appropriate management practices, and why feral hogs should not gain species status. Finally, respondents indicated a need for updated distributional maps that would make them aware of pending threats to their livelihood.

To increase the accuracy of feral hog distributional maps, regulatory authorities should create an interactive Internet map with a feedback mechanism allowing locations of sightings and damage. This should allow agencies to monitor hog distribution on local, regional and national levels, as well as to quickly assess their state's hog situation. This type of interactive map may encourage communication between governmental agencies by allowing other agencies the opportunity to report information. To keep the public involved a telephone and/or Internet hotline for reported sightings and evidence should be created with a follow-up investigation by the appropriate regulatory agency in previously undocumented areas. Also needed is persuasive educational information showing all negative aspects of feral hogs which should be directed to the public, and state and federal agencies. This information should be available to states that currently do not have feral hogs, and include current distribution and management challenges. Better communication between the public and regulatory agencies will allow more public involvement; a better assessment of local, statewide, and national hog distribution; and opportunities for improved hog management.

To create well rounded management plans additional information about other affected stakeholders and their desires is needed. I only studied two stakeholders, one at a national level and one at a statewide level, but the results of my study indicated neither wanted feral hogs. Further research on the attitudes, risk beliefs and desires for future feral hog management should to be assessed from private landowners, hunters, timber industries and the general public.