ECOLOGY AND MANAGEMENT OF WILD PIGS

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PREFACE

This publication is intended to serve as an informative document to provide the most current information available to the public as well as natural resource managers on wild pig ecology and management. Wild pig control in Texas and throughout the United States is a collaborative effort between many governmental and private entities with expertise in specific areas of wild pig control, management, and damage mitigation. Thus, this document will provide some links to informative resources from those entities based on their area of expertise.

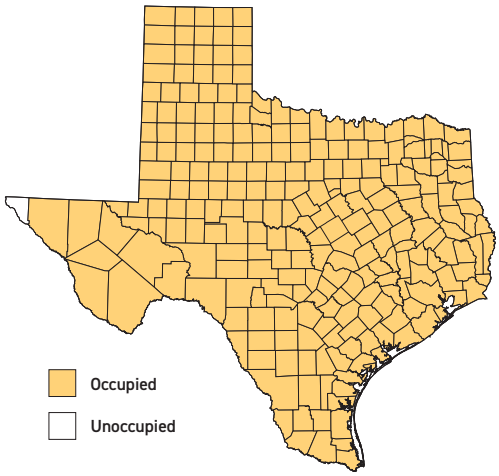
Because specifics about wild pig behavior, life history, and ecology vary throughout their range and because they are a relatively understudied species, this document is not intended to be Texas specific and will provide information from across the continental United States. However, it will offer Texas specific examples where possible and appropriate.

INTRODUCTION TO NORTH AMERICA

Pigs (*Sus scrofa*) are not native to North America (*1, 2*). The species was first introduced to the West Indies by Christopher Columbus in 1493 and then to the continental United States by Spanish explorer Hernando de Soto in 1539 when he landed at the Florida coast (*3, 4*). Domestic pigs were often carried on these excursions as a sustainable, low maintenance source of food. As explorers moved across the continent those domestic pigs would often be left behind, establishing the first populations of feral pigs in North America (*5*). The term feral refers to a domestic animal that has gone wild. Following these initial introductions, European settlers and Native Americans implemented free-ranging farming practices of domestic pigs that promoted the spread of feral pig populations (*1, 6*). Free-range farming methods were still practiced in some states through the 1950s (*1*). In addition to these feral pigs, Eurasian wild boar have been imported and released as an exotic game species for recreational hunting purposes across the United States since the early 1900s (*1*). Today's free-range pig population in the United States is made up of feral pigs, Eurasian wild boar, and hybrid populations resulting from cross-breeding of Eurasian wild boar and feral pigs (*4*). Though there are morphological differences among the three, they are all referred to by the same scientific name and all recognized as exotic invasive species in the United States. Thus, for the purposes of this document all three subpopulations will be treated as one and will hereafter be referred to as wild pigs (*1, 7, 8*).

POPULATION TRENDS

Wild pigs are now the United States' most abundant free-ranging introduced ungulate (*9*). The term ungulate refers to animals which have hooves. From 1982 to 2016, the wild pig population in the United States increased from 2.4 million to an estimated 6.9 million, with 2.6 million estimated to be residing in Texas alone (*10, 11*). The population in the United States continues to grow rapidly due to their high reproduction rate, generalist



This figure represents the distribution of wild pigs across Texas, by county, using data from the Southeastern Cooperative Wildlife Disease Study. As indicated in the map, El Paso County is the only county in Texas not occupied by feral swine as of 2019.

diet, and lack of natural predators (*2, 9*). Wild pigs have expanded their range in the United States from 18 States in 1982 to 35 States in 2016 (*2*). It was recently estimated that the rate of northward range expansion by wild pigs accelerated from approximately 4 miles to 7.8 miles per year from 1982 to 2012 (*12*). This rapid range expansion can be attributed to an estimated 18-21% annual population growth and an ability to thrive across various environments, however, one of the leading causes is the human-mediated transportation of wild pigs for hunting purposes (*13-15*).

PREDATION

In Europe and Asia, predation by natural predators can account for up to 25% of annual mortality at the population level (*16*). In the United States, however, humans are the most significant predator of wild pigs (*5*). Though predators such as coyotes (*Canis latrans*), bobcats (*Lynx rufus*), and golden eagles (*Aquila chrysaetos*) may opportunistically prey upon immature wild pigs; it is only where wild pigs exist with American alligators (*Alligator mississippiensis*), mountain lions (*Puma concolor*), and black bears (*Ursus americanus*) that any frequent intentional predation of the species may occur (*17-19*). Even where this type of predation does occur, it plays a minor role in wild pig mortality (*5*).

REPRODUCTION

The age at which reproductive maturity is reached is highly variable among populations of wild pigs (*20*). Males have been documented to reach sexual maturity by five months of age and have been observed attempting to breed at six months. However, breeding success is strongly correlated with size (*20, 21*). Thus, males are not typically successful in breeding until 12 to 18 months of age (*18*). Reproductive maturity has been documented in female wild pigs as early as three months of age, though successful first breeding is generally reported to occur between the ages of 6 and 10 months (*18, 22*). As with males, female reproductive maturity is also correlated with size. Researchers have found that females did not reach reproductive maturity until they reached approximately 100-140 lbs (*22*).

Litter of approximately 2-month-old wild pigs. (Heather Stearling, TPWD)

Pigs have the highest reproductive rate of any ungulate; but like reproductive maturity, it is highly variable among populations (*23-25*). Females (sows) have multiple estrous cycles annually and can breed throughout the year with an average litter size of 4-6 young per litter (*5*). The average gestation period for a sow is approximately 115 days and they can breed again within a week of weaning their young, which can occur approximately one month after birth (*26, 27*). Though it is a physiological possibility for a sow to have three litters in approximately 14 months (*28*), researchers found that in southern Texas adult and sub-adult sows averaged 1.57 and 0.85 litters per year, respectively (*25*). Birthing events can occur every month of the year, though most wild pig populations exhibit prominent peaks in birthing events that correlate with forage availability (*25, 29*) with peaks generally occurring in the winter and spring months (*30*). In areas where forage is not a limiting factor, such as lands in cultivation or where supplemental feeding for wildlife is common practice, reproduction rates can be higher than average (*31*).

DIET

Wild pigs are omnivores, generally categorized as opportunistic feeders, and typically consume between 3% and 5% of their total body mass daily (*32*). They exhibit a generalist diet consuming a variety of food sources which allows them to thrive across a wide range of environments (*1, 10, 33*). Throughout their range their diet is mostly herbivorous, shifting seasonally and regionally among grasses, mast, shoots, roots, tubers, forbs, and cacti as resource availability changes (*4, 30, 34*). When available, wild pigs will select for agricultural crops, often making up over 50% of the vegetative portion of their diets and causing significant damage to agricultural fields (*35, 36*). Invertebrates are often consumed while foraging for vegetation throughout the year including insects, annelids, crustaceans, gastropods, and nematodes (*37*). Studies have shown that, in some cases, invertebrates are highly selected for and seasonally make up over 50% of wild pig diets (*38, 39*). Wild pigs will also consume tissues of vertebrate species through scavenging and direct predation (*37, 40, 41*). Studies have documented intentional predation of various vertebrate species by wild pigs including juvenile domestic livestock, white-tailed deer (*Odocoileus virginianus*) fawns, ground nesting bird nests (*Galliform* sp.), and various species of reptiles and amphibians (*41-43, 97, 98*).

DAMAGE

Wild pigs have been listed as one of the top 100 worst exotic invasive species in the world (*44*). In 2007, researchers estimated that each wild pig carried an associated (damage plus control) cost of $300 per year, and at an estimated 5 million wild pigs in the population at the time, Americans spent over $1.5 billion annually in damages and control costs (*45*). Assuming that the cost-per-wild pig estimate has remained constant, the annual costs associated with wild pigs in the United States are likely closer to $2.1 billion today (*10, 11, 45*).

Damage to soil and vegetation caused by wild pig rooting. (TPWD)

Most damage caused by wild pigs is through either rooting or the direct consumption of plant and animal materials (*5*). Rooting is the mechanism by which wild pigs unearth roots, tubers, fungi, and burrowing animals (*5, 46*). They use their snouts to dig into the ground and turn over soil in search of food resources, altering the normal chemistry associated with nutrient cycling within the soil. Further, the mixing of soil horizons that often accompanies rooting by wild pigs has also been shown to alter vegetative communities, allowing for the establishment and spread of invasive plant species (*33*). It has been estimated that a single wild pig can significantly disturb approximately 6.5 ft^2 in just one minute (*47*). This large-scale soil disturbance can increase soil erosion rates and have detrimental effects to sensitive ecological areas and critical habitats for species of concern (*41, 48, 49*). When wild pigs root or wallow in wetland or riparian areas,

Wild pig wallowing in a pond. (John C. Kinsey, TPWD)

it tends to increase the nutrient concentration and total suspended solids in nearby waters due to erosion (*48, 50*). Wild pigs also directly contribute fecal coliforms into water sources, increase sedimentation and turbidity, alter pH levels, and reduce oxygen levels (*51, 52*). Such activities lead to an overall reduction in water quality and degradation of aquatic habitats. Impacts from wild pigs are positively correlated with population density and vary in severity among ecosystems. Native habitat degradation as well as loss of biodiversity and ecosystem services caused by wild pigs are difficult to quantify and impossible to fully assign monetary value. However, monetizing such damage would undoubtedly increase the estimated costs associated with the species (*35*).

Economically, wild pigs have the greatest impact on the agricultural industry in the United States (*2*). In 2005, researchers estimated that in a single night, one wild pig can cause at least $1,000 in damages to agriculture (*53*). In Texas, a 2006 publication reported that wild pigs caused approximately $52 million in agricultural damage annually (*54*). More recent studies published in 2016 and 2019 estimate that the annual loss to agriculture in Texas is approximately $118.8 million (*95, 96*). Impacts to crops are not limited to direct consumption. Trampling of standing crops and damage to soil from rooting and wallowing activities account for 90-95% of crop damage, in some cases (*55*). Standing crops are not the only form of agriculture damaged by wild pigs. Wild pigs also cause damage to hay fields, orchards, farming equipment, and fences.

Damage to agricultural crops caused by wild pigs. (Bethany Friesenhahn, Research Specialist at Caesar Kleberg Wildlife Research Institute)

The human population of the United States is rapidly growing, and the majority of that population lives in urban areas. In general, the resulting expansion of urban sprawl has increased human-wildlife interactions (*62*). That trend along with the recent population growth and range expansion of wild pigs has resulted in an increase in damage to private property and common recreational areas (*5*). Wild pigs often seek out food and water in residential areas during times of drought which leads to damage of landscaping, fencing, and irrigation systems in residential areas as well as communal areas such as golf courses and parks (*5, 63, 64*). In addition, wild pig-vehicle collisions can result in

significant property damage as well as human injury and death (*56*). Researchers conservatively estimated damages associated with wild pig-vehicle collisions to be $36 million annually in the United States alone (*67*). Because projections show rapid expansion of both human and wild pig populations the frequency of wild pig-vehicle collisions will likely increase, as well (*65*). Not only do wild pigs physically damage natural resources and agricultural crops, personal property, and equipment, they also have a high potential to transmit various diseases to domestic livestock (*56*).

DISEASE

Wild pigs are capable of carrying and transmitting at least 30 bacterial, fungal, and viral diseases which threaten humans, livestock, and wildlife (*7, 57*). Some of those which can infect humans are brucellosis, leptospirosis, toxoplasmosis, and trichinosis (*58*). Though disease transmission to humans is a real concern, the largest threat from wild pig diseases is the potential transmission to domestic livestock. Diseases such as swine brucellosis, pseudorabies, classic swine fever, and African swine fever can result in birth defects and death of various livestock and wildlife species (*7*). Diseases such as classic swine fever and foot and mouth disease have been eradicated from the United States pork industry and are considered foreign-animal diseases. Wild pigs, however, have the potential to act as a reservoir for these diseases making it difficult or impossible to eradicate them again in areas with infected wild pig populations (*59*). A scenario where one of these diseases is reintroduced could cause crippling damage to the United States agricultural industry (*7, 60*). One extreme scenario is the reemergence of foot and mouth disease in the United States. If this disease were to be reintroduced to the domestic livestock industry, it could cause up to $21 billion in loss of agricultural income and a portion of small farmers to lose their farms (*61*). For more information on diseases transmissible to humans, domestic animals and wildlife, please visit the link below:

Diseases of feral swine:
https://vet.uga.edu/wp-content/uploads/2019/07/diseases_of_feral_swine_brochure.pdf

POPULATION CONTROL

Though non-lethal means of reducing damage from wild pigs is sometimes effective at small scales, the only way to alleviate wide-spread impacts from wild pigs is to reduce the overall population. Lethal control measures are currently the only effective means of reducing wild pig populations. There are multiple lethal control techniques currently available to land managers and owners in the United States (*56*). However, no single method approaches the scale necessary to have a significant, long-term effect on wild pig populations across large tracts of land, and most certainly not at a national scale (*68*). The most popular methods of lethal control currently legal in the United States are trapping and dispatching, ground shooting, and aerial gunning.

Trapping

Dispatching after trapping is the most popular method of lethal control for wild pigs (*69*). There are a wide range of trap designs for wild pigs, but they generally fall under two categories; box traps and corral traps. Box traps vary in design, but are typically enclosed traps that are designed to be easily transportable and set up by one person. These types of traps are most effective when used to target small groups or single animals that frequently cause property damage. The small box traps facilitate transportation from one trap site to another, but limit the number of animals that can be caught at

A typical box trap. (John C. Kinsey, TPWD)

A typical corral trap made from cattle panels and T-posts. (John C. Kinsey, TPWD)

one time. If used to target large sounders, those that are not successfully trapped may develop learned behavior which makes them more difficult to trap in the future (*68*).

Corral traps are typically much larger semi-permanent structures, though there are several portable corral traps commercially available. These traps allow for more animals to be caught at one time which more effectively reduces populations and increases the cost efficacy of trapping. Studies have found that corral traps provided a capture rate greater than four times that of individual box traps (*68*). Cost associated with corral trapping have been shown to vary greatly, ranging from $14.32 to $121 per pig. After the initial purchase of either pre-constructed trap or trap building materials, the main contributor to the high costs associated with this method is the time it takes to set up and monitor corral traps (*68*). Researchers have found that the use of corral traps resulted in the removal of 0.20 and 0.43 wild pigs per man-hour, respectively (*70, 71*). This equates to approximately 2-5 hours of work per each wild pig removed.

Efficacy of trapping whole sounders has increased with recent advances in remote camera technology. These motion activated cameras can be used to monitor wild pig activity at trap sites with still photographs or short videos. The most recent advancement in remote camera technology allows real-time monitoring of wild pig activity on your phone, tablet, or computer using cellular data. Understanding wild pig behavior at a trap site allows trappers to make more educated decisions on when to set the trap trigger so that the number of wild pigs caught is maximized. In addition, the same cellular technology that allows for real-time camera monitoring has facilitated the advent of remotely triggered trap gates. This allows for trappers to monitor wild pig activity on a personal device in real time and trigger the trap gate remotely from the same device once the entire sounder has entered the trap. Though trapping is one of the most effective means of large-scale population reduction currently available in the United States, its impacts are often limited by the inability to deploy traps in remote areas difficult to reach by vehicle or boat (*68, 72*). For more information on various trap designs, trapping strategies, and proper implementation, please visit the links below:

Texas A&M Natural Resource Institute:
https://wildpigs.nri.tamu.edu

Texas A&M AgriLife Extension: Coping with Feral Hogs:
https://feralhogs.tamu.edu/

Using Game Cameras for Feral Hogs
https://landassociation.org/using-game-cameras-for-feral-hogs/

Aerial Gunning

Shooting wild pigs while flying in fixed wing or rotary aircrafts is often referred to as aerial gunning. Aerial gunning is a highly effective means of quickly reducing wild pig populations in areas with large expanses of sparse canopy cover and high densities of wild pigs (*5, 73, 74*). As visibility and population density decrease, however, so does the efficacy of this method in both cost and reduction of populations (*56, 74, 75*). Thus, this method is most effective in areas with sparse tree canopy and high wild pig densities. There is also some debate as to whether or not this method alters behavior in wild pig populations causing them to increase home ranges and learn to avoid aircraft, making them more difficult to find via helicopter (*74, 76, 77*). In private-land states like Texas, gaining permission and sufficient acreage from contiguous landowners can be a challenge. Similarly, the high costs associated with aircraft rental and pilots may not be feasible for some. However, where tree canopy allows, aerial gunning can be the most effective means of rapid wild pig population reduction available (*56, 72*). For more information on aerial gunning, please follow the links below:

Costs and effectiveness of damage management of an overabundant species (*Sus scrofa*) using aerial gunning:
https://www.aphis.usda.gov/wildlife_damage/nwrc/publications/18pubs/rep2018-164.pdf

TPWD Permitting:
https://tpwd.texas.gov/business/permits/land/wildlife_management/aerial_wl_management/

TPWD Q&A:
https://tpwd.texas.gov/publications/nonpwdpubs/feral_hog_aerial/feral_hog_hunting_from_a_helicopter_faq.pdf

GROUND SHOOTING

Ground shooting encompasses several methods, but the most commonly used methods in the United States are running trained tracking dogs, night shooting, and recreational hunting.

Tracking Dogs

The success of removing wild pigs using tracking dogs is dependent on the skill of both the hunter and the dogs being used. One study indicated that dogs could only catch 4 pigs per day before getting too tired to hunt (*78*). They also noted that catch success declined as sounder size increased. Thus, hunting wild pigs with dogs is not an effective means of large-scale population reduction. However, the use of highly skilled dogs may be necessary to remove wild pigs which avoid other control techniques as trained dogs can track individuals through dense vegetation and across rugged terrain (*5, 72*).

Night Shooting

Wild pigs are generally active at dusk and dawn, but human activity and climatic conditions may cause them to exhibit nocturnal feeding behaviors across portions of their range. In these areas it may be most efficient for hunters to shoot pigs at night under the cover of darkness. Night vision optics and the recent increase in use of sound suppressed rifles has greatly enhanced the success of this method (*5*). Using this type of equipment allows individuals to remove large portions of wild pig populations, whole sounders in some cases, at one time in large open terrain. Night shooting is

highly effective in agricultural fields, but its efficacy also declines as vegetation density increases and wild pig density decreases (*56*). The best prescription for this method of population reduction is likely in agricultural areas reporting high levels of damage from wild pigs, in conjunction with other large-scale population control methods.

Recreational Hunting

Recreational hunting of wild pigs is common in the United States (*56*). In fact, wild pigs are considered a desirable species in some of these states for both "trophy" and meat (*79*). Recreational hunting can occur in the form of stalking or hunting over baited areas, and as with the other forms of control, has the limited potential be effective in reducing localized populations of wild pigs in areas of high density (*5, 56*). Increased human activity associated with control measures can influence the behavior of wild pigs and recreational hunting has been shown to increase the dispersal of wild pig populations. In addition, selective harvest of only large males as "trophy" animals can also be counterproductive in population reduction efforts. Removal of females and juveniles have the greatest impact on lowering production of the population, thus, choosing not to harvest that portion of the population in favor of males is much less effective than indiscriminate harvesting across all sex and age classes (*80*).

Some states which historically did not allow recreational hunting of wild pigs have established statewide hunting programs in an effort to solicit assistance from the public in controlling wild pig populations. Even though the intentions were good, these statewide hunting programs have sometimes resulted in population increases and rapid range expansions (*15, 83, 84*). Popularity of wild pigs as a game species coupled with economic incentives generated by trophy hunting industries has resulted in the human-mediated transportation of wild pigs (illegal in Texas) to areas previously not populated by wild pigs (*84-86*). For example, Tennessee implemented a statewide hunting program in 1999, and by 2011 wild pig populations expanded from 6 to 70 counties (*84*). Similarly, in 1956 when wild pigs were designated a game animal in California, their range was limited to just a few coastal counties. By 1999, however, they had spread to 56 of the state's 58 counties (*83, 85*). One scientific

Wild pigs congregated at supplemental feed. (John C. Kinsey, TPWD)

study also stated that the financial incentives associated with the wild pig hunting industry directly led to the intentional transportation and release of wild pigs on private properties, and that anyone who argues that hunting wild pigs is an effective means of reducing their population is ignoring the power of such incentives to private landowners (*83*).

BOUNTY PROGRAMS

To overcome the challenges of selective harvest by recreational hunters, some local governments have implemented bounty programs to incentivize hunters in an effort to increase hunting pressure in certain areas. These efforts are often futile and have failed to increase hunting pressure significantly. Further, some studies have shown that bounty programs actually result in an increase in wild pig populations due to the use of supplemental feed as bait and selective "trophy" hunting (*80, 81*). In addition, these programs often incentivize fraud or farming for bounties. Bounty programs are typically implemented at the county level and provide fiscal rewards for the harvest of animals within county boundaries. When the fiscal reward is perceived to outweigh the risk of punishment, unscrupulous people will turn in animals harvested outside those county boundaries as part of the bounty program. This type of fraud can greatly reduce the already low cost efficacy of bounty programs (*80, 82*). In addition, when there is an economic incentive to harbor an invasive exotic species for future gain, it may become increasingly difficult to remove that species. If an individual can economically profit from the harvest of wild pigs, there is an incentive to leave portions of the population on the landscape and in some cases, raise them for future profit (*82*).

CLOSING

Wild pig populations in the United States cause irreversible ecological damage and have an enormous economic impact. The extent of these economic damages are highly correlated with population size and density (*14, 45*). Population models indicate that the wild pig population size and range will continue to grow if left unchecked; thus, damages from wild pigs will also increase (*11, 12, 14*). It is estimated that annual population control efforts would need to continuously achieve 66-70% population reduction just to hold the wild pig population at its current level (*14, 28*). Estimates from Texas indicate that with current control methods, however, annual population reduction only reaches approximately 29% (*14*). The need for novel methods of wild pig population control is obvious.

ADDITIONAL RESOURCES

A Landowner's Guide to Wild Pig Management – Practical methods for wild pig control:
https://extension.msstate.edu/sites/default/files/publications/publications/p2659_0.pdf

United States Department of Agriculture Animal and Plant Health Inspection Service – Feral Swine-Managing an Invasive Species:
https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/operational-activities/feral-swine

United States Department of Agriculture Animal and Plant Health Inspection Service – Feral Swine and Ungulate Impacts:
https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/programs/nwrc/research-areas/sa_feral_swine/ct_project_feral_swine_ungulate0

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