A document created to enhance and support the creation of local, regional and statewide feral hog eradication within the state of New Mexico.
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Introduction

According to the Nature Conservancy (2010), invasive species have directly contributed to the decline of 42% of the threatened and endangered species in the United States and cause an economic impact of $120 billion per year. Feral hog (Sus scrofa) damage in the United States is estimated at $800 million annually, assuming an approximate hog population of 4 million. These estimates are conservative, as they do not account for environmental degradation, disease outbreaks or more difficult to document impacts (Pimental et al. 2002). Correspondingly, feral hogs are candidates for the World’s 100 Worst Invasive Alien Species, illustrating their tremendous potential for worldwide impact (Invasive Species Specialist Group 2008). In Australia, feral hogs cause an estimated $100 million per year in agricultural and environmental damage (Cowled et al. 2004). Engeman et al. (2004) cited the Supreme Court case law, Tennessee Valley Authority versus Hill 1978, which deemed the values of threatened and endangered species to be “incalculable.” Additionally, Executive Order 13112 “Invasive Species” was signed on February 3, 1999 and directs all federal agencies to:

i. prevent the introduction of invasive species,
ii. detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner,
iii. monitor invasive species populations accurately and reliably
iv. provide for restoration of native species and habitat conditions in ecosystems that have been invaded,
v. conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species, and
vi. promote public education on invasive species and the means to address them.

Feral Hog Biology

Reproduction

Feral hogs have a remarkable reproductive capacity and within the United States, are known to reproduce twice annually when environmental factors are suitable. Sows are reproductive at approximately 6-9 months of age, depending on favorable conditions. The number of piglets per litter can vary greatly, ranging from 3-18. Pohlmeier and Sodeikat (2003) found sows larger than 29.9 kg, or 8-9 months of age, had tertiary follicles. Additionally, they found nearly 60% of sows this age were pregnant (mean of 4.42 embryos). Young sows produced 25% of the total reproductive effort within a population. While Nogueira et al. (2007) observed that parturition peaks were correlated to rainy seasons and therefore possibly to abundance of food and water availability, Rosvold and Andersen (2008) found a high degree of parturition synchrony related to high mast crop years. Conversely, parturition was more scattered and random during years of poor mast yields. The availability of agricultural crops is known to increase the reproductive success of sows and is considered one of the primary rationales for increasing densities of boar in Europe. This ability of sows to leverage agricultural crops in order to increase fecundity weighs heavily on local farmers and landscapes.
Juvenile feral hogs display mixed coloration.  USDA/APHIS/WS

As parturition approaches, sows create farrowing nests in which to give birth and nurse piglets. Piglets remain in farrowing nests for approximately 2-3 weeks, and are weaned at approximately 3-4 months of age (Nogueira et al. 2007). Sows willingly accept and safeguard other piglets within their sounder, which may confound attempts to correlate photographs or visual observations to litter size (Diong, 1982). The most reliable indicator of reproductive capacity is during necropsy of sows, during which placental scars or fetuses can be counted visually. This number, however, may not represent true reproduction without considering some factor of juvenile mortality, which can be severe. Baubet et al. (2009) conducted a study in an effort to document piglet mortality by capturing piglets in farrowing nests. Not only did they find sows not being defensive of their nests, as is often purported, but in 50% of cases sows entirely abandoned their litters. Of the remaining cases, all sows transferred their litters to newly fabricated farrowing nests 300-400 meters away.

Mortality

Fruzinski and Labudzki (2002) discovered 15% of piglets died within the first three months of life and up to 48% within the first year. Similarly, Meynhardt (1980) estimated 36.9% of piglets died within year one. These figures were attributed to competitiveness and consequently, resource availability; leaving weaker piglets vulnerable to disease, and
predators. Survivability was therefore highest during snowless winters that yielded large oak mast crops.

Predatory carnivores native to New Mexico include black bears (*Ursus americanus*), mountain lions (*Puma concolor*), jaguars (*Panthera onca*), Mexican gray wolves (*Canis lupus baileyi*), coyotes (*Canis latrans*) and bobcats (*Lynx rufus*). The majority of studies document young of the year or juveniles as having the highest mortality rates. Nores et al. (2008) found wolf predation on wild boar to be minimal and primarily affected juveniles. Similarly, Rosvold and Anderson (2008) documented 2% of wild boar mortality was contributable to Eurasian brown bear (*Ursus arctos arctos*), Eurasian wolves (*Canis lupus lupus*), lynx (*Lynx lynx*), feral dogs (*Canis familiaris*), and wolverine (*Gulo gulo*). Although golden eagles (*Aquila chrysaetos*) depredate feral hog piglets, the influence birds of prey have on feral hogs is largely unstudied outside of the Channel Islands, California (Roemer et al. 2001). Predation of feral hogs in New Mexico is likely minimal due to the wary, aggressive behavior of sows when defending offspring. Additionally, sounders practice group vigilance and defensiveness, further inhibiting predation.

### Defensive Behavior

Feral hogs have poor vision and communicate instead through acoustic and olfactory signals (Diong 1982). Hogs can perceive humans within 0.8 kilometers, due to their incredible sense of smell. Quenette and Desportes (1992) documented wild boar adjusting their vigilance and scanning behavior as a function of group size. Video and photographs taken with remote cameras by USDA New Mexico Wildlife Services’ personnel have documented increased vigilance and scanning behavior at wallows, bait piles and trap sites.

### Matrilineal Grouping

Numerous authors describe the behavior of feral hogs within their home range as being focused around one lead sow (Pohlmeyer and Sodeikat 2003, Janeau et al. 1995). It is widely accepted that sows and their offspring remain within a group known as a sounder; whereas boars are relatively nomadic, visiting various sows within their home range to investigate breeding opportunities. Kaminski et al. (2005) hypothesized that the potential advantages of daughters staying with the sounder include (i) learning the family home range especially relative to resources, sites, and refuge areas; (ii) heightened protection against intraspecific competition and increased accessibility to feeding sites; and (iii) the indirect benefits of older, female relatives being able to rear their young, thereby increasing their inclusive fitness.

While investigating the advantages of employing males versus females as Judas animals, Wilcox et al. (2004) found that when disturbed, a sounder would reorganize around one female as the nucleus. Should studies in NM reflect that a singular sow is responsible for directing a sounder through a home range, optimal eradication practices may be to maintain this particular matriarchy until the entire group is captured. Because diseases may be harbored within sounders, the probability of fragmenting and dispersal should be minimized.
Wallowing

Feral hogs generate wallows, depressions or pools of water or mud, because of their inability to thermoregulate. Wallows are one of the most reliable signs of feral hog activity. Feral hogs may use wallowing to provide insect relief, although it has been reported that this behavior occurs even in areas of low tick and external parasite prevalence. Fernandez-Llario (2005) discovered a synchrony of estrus and wallowing behavior by breeding aged boars. Forty-four of 47 wild boar utilizing wallows during a two month period were breeding age adult males. This information indicates that while wallows may proffer life functions including insect control, wound disinfecting, and thermoregulation; wallowing may also provide a method of communicating reproductive signals. Utilizing global positioning units [GPS] to map important biological markers within feral hog home ranges may contribute largely to eradication efforts.

Preferred Habitat

Cargnelutti et al. (1995) unearthed a preference of wild boar to resting sites with dense low vegetation to open areas with minimal cover. Adkins and Haverson (2007) found that feral hogs occupying Chihuahuan Desert study sites had a generalized habitat use but preferred open canopy, evergreen woodlands. They acknowledged that “the adaptability and mobility of feral hogs has allowed populations to establish themselves in the Chihuahuan Desert and utilize limited resources in areas that are ecologically sensitive (e.g., rare riparian habitats). This utilization of riparian habitat has been apparent as feral hogs have expanded their range in New Mexico. While it is oftentimes difficult to encounter sign in open rangelands, sign is generally abundant at stock tanks, seeps, springs, streams and river corridors. Mersinger and Silvy (2007) witnessed a greater distance from preferred cover during nighttime hours versus dial activity. Preferred screening cover was similar to improved pasture at ground level, but included tree canopy shading and availability of free water. Underutilized farm fields are an attractive cover and shelter element, beneficial to hog populations (Rosvold and Andersen 2008).

Diet

Feral hogs are omnivorous and opportunistic, depending on season and availability. Generally, 40% or more of the dietary intake consists of grasses, roots and other plant parts; while carrion, invertebrates and predated vertebrates compose the remaining percentages. Feral hogs are excellent at adapting to available resources and compensate for protein deficiencies by consuming a variety of vertebrate and invertebrate species. Feral hogs demonstrate definitive preferences in food sources and are able to migrate to address seasonal nutritional requirements. Nogueira et al. (2007) documented the shift of feral hogs away from staple food sources when preferred sugar saturated fruits, such as guava and sweet banana pokka fruits, were available. Additionally, he witnessed feral hogs feeding on hog and goat carcasses during an eradication effort in Hawaii. Mitchell et al. (2007) described how feral hog movements were strongly correlated to seasonal availability and location of above ground foods (i.e. fruit) and below ground foods (i.e. earthworms). Consequently, seasonal rainfall patterns influenced the distribution and scale of rooting behavior in the environment. In New
Mexico, USDA Wildlife Services’ personnel have observed the selection of microhabitats suggested by Mitchell et al. (2007), including rooting within drip lines around mesquite plants and cacti in open rangeland. According to Howe et al. (1981), wild boar invading the northern hardwoods of Great Smoky Mountains National Park feed mostly upon the corms of spring beauty (Claytonia virginica). Corms appeared in 98% of the stomachs investigated and constituted 33% by volume of contents. Corm availability appears to correlate to heavy rooting activity along roadsides in Quay County, New Mexico (pers. comm., USDA Wildlife Services). Feral hogs noticeably follow cow trails, two tracks and riparian channels until arriving at preferable forage. Rooting behavior is then persistent until the food source has been depleted. In NM, absence of feral hogs on properties where they previously were present seems to sometimes correlate with a lack of cholla cacti (Opuntia spp.) fruits. Necropsies revealed cholla fruit seeds throughout the intestinal tract and stomachs of several groups of feral hogs. Because cactus fruits were relatively absent, perhaps due to rainfall patterns on neighboring properties, feral hog sign decreased substantially. Consequently, the utilization of and damage to rangelands and riparian areas by hogs increased dramatically. Assessing seasonal differences in dietary intake via continual monitoring of gross stomach contents will facilitate the understanding and estimating of feral hog movements and damage impacts.

Feral Hog Movement

Feral hog home ranges can shift seasonally, depending on resource availability and avoidance of hunting or predation pressures. According to Pohlmeyer and Sodeikat (2003), one lead sow is responsible for home range size and use. And utilization of the home range was strongly contingent upon food, water, and vegetation structure for cover and hiding places. If the lead sow was removed, a second sow would lead the group but the group would wander loosely and lack the tight, controlled movements of the original sow. Janeau et al. (1995) studied the movements of multiple ages and sexes of wild boar and found the adult sows decided movements within and around a home range. Noguerira et al. (2007) and Kueling et al. (2008) determined that receding availability of watering holes during drought periods necessitated the continuous, meandering movements of feral hogs. Feral hogs inhabiting Santiago Island’s xeric communities expanded their range due to forage growth after El Nino rains (Coblentz and Baber, 1987). Hayes et al. (2009) found that home ranges in Mississippi during the dry season doubled in size, conceivably due to increased wanderings to secure water resources. Feral hogs in the Chihuahuan Desert exhibited larger home ranges and lower densities than those inhabiting more mesic environments (Adkins and Harveson 2007). Additionally, hogs were habitat generalists with little apparent preference other than for riparian resources. Furthermore, population densities exhibited a strong correlation to precipitation. While an increase of food resources due to added precipitation could be a cause of increased density; differences in temperature extremes, juvenile mortality and external pressures likely vary as well. Feral hog movements should be investigated before and after employing control efforts, to understand not only natural home range dynamics but how home ranges may shift or adjust relative to resources or removal pressures.
Distribution of Feral Hogs in New Mexico

There are presently known populations of feral hogs in Chaves, Curry, De Baca, Eddy, Grant, Harding, Hidalgo, Lea, Lincoln, Otero, Quay, Roosevelt, San Miguel, and Union counties. Additionally, feral hogs and rooting damage were recently confirmed on Bosque Del Apache.
National Wildlife Refuge within Socorro County. And there are unconfirmed reports of feral hogs in other counties.

Although some New Mexico feral hog populations are remnants of homesteader free range and escaped livestock populations, the majority of feral hogs are the result of intentional releases for sport hunting opportunities. There are also populations along the Pecos River corridor that have likely migrated in as a result of increasing populations in the neighboring state of Texas. Every state that borders New Mexico has either established feral hog populations or newly released populations that threaten an eradication program. This makes it necessary to work across political boundaries with neighboring states to stem the potential tide of feral hogs immigrating into New Mexico.

Legal Status of Feral Hogs in New Mexico


A. The purpose of this section is to ensure the public health, safety and welfare and to prevent the introduction or spread of disease to New Mexico’s livestock and wildlife.

B. No person shall import into the state, transport within the state, hold for breeding, release or sell a live feral hog or operate a commercial feral hog hunting enterprise.

C. Any person who violates this section is guilty of a misdemeanor and shall be punished by a fine of not more than one thousand dollars ($1,000) or by imprisonment for a definite term of less than one year or both.

D. As used in this section, “feral hog” means a pig that exists in an unwanted state from domestication.”
Invasive Weed Spreading

Invasive plants are estimated to spread as fast as 200 acres per hour on federal lands in the western United States. Invasive weeds have infiltrated approximately 17 million acres of public lands and quadrupled their range from 1985 to 1995. This acreage does not include the rate of spread on non-federal lands, so the rate of spread and its impact is actually much greater (http://www.invasiveweeds.com/care/welcome.html).

Feral hogs have been implicated in the spread of invasive weeds through their rooting and behavior. While foraging for earthworms, feral hogs initiate soil erosion and promote the invasion of exotic weeds, further exacerbated by hogs passing weed seeds in their feces (Diong 1982). McCann and Garcelon (2007) documented the weed spreading behavior of feral hogs in Pinnacles National Monument in California. USDA Wildlife Services has
documented various rangeland sites and roadside rooting areas where shortly afterwards, colonies of invasive weeds begin to grow.

Feral hog rooting provides invasive weeds with invasion potential. USDA/APHIS/WS

Many of these sites have been photographed and have not returned to native forage and plant communities despite several growing seasons. Other studies have suggested the mechanical vector of weeds via fur and hooves and in mud, from wallows to distant locations (Heinken et al. 2006, Mitchell and Kanowski 2003). Feral hog wallowing behavior provides a moist substrate for “hitchhiker seeds” to stay hydrated until scraped off on nearby rub trees. Heinken et al. (2006) further documented twice the plant diversity at rub trees used by boars than other control sites. Feral hog rooting is likely to cause shifts in vegetative communities when rooting areas are exposed to invasive weed species (Tierney and Cushman 2006, Mitchell et al. 2007). Due to the gastric process in feral hogs, seeds smaller than 5mm in diameter pass completely unaffected and leave the body in droppings (Beckmann and Davidson 1990). The passing of seeds could have immense ramifications when feral hogs are consuming invasive weed seeds and other noxious plant or tree species. When rooting in native plant communities occurs, efforts should be made to document not only the magnitude of the impact temporally, but to document the successional plant community. This information, combined with the knowledge of New Mexico’s noxious plant species, will generate a better understanding of the impacts to native rangelands. Additionally, forage deficits for livestock and wildlife is a corollary of feral hog feeding behavior, which could lead to plant communities that are toxic for both grazing groups.

In March 2009, a Quay County USDA Wildlife Specialist found an entire pasture adjacent to a playa lake rooted by feral hogs, with many of the rooting patches reaching a depth of nearly 50.8 cm (Figure 1). Figure 2 is the same area 4 months later and shows the rapid colonization of various weed species. Searching through this rooting, no appreciable native forage for wildlife or cattle could be found. Sites like these are important accounts of the direct and
indirect impacts of feral hog rooting behavior on New Mexico rangelands. Additionally, it is important to note that while this rooting patch may seem significant, it is not unusual in this landscape.

**Fig. 1 – Rooting damage to rangeland.** USDA/APHIS/WS  
**Fig. 2 – Invasion of weeds after feral hog rooting.** USDA/APHIS/WS

### Competition with Native Species

Mast crops are important to numerous, native wildlife species worldwide. Acorns from *Quercus* spp. have been identified as critical and preferred food for both wild boars and feral hogs. This preference and requirement for acorn crops by feral hogs has significant implications for native wildlife and oak regeneration in the state of New Mexico. Wild boars choose acorns (*Quercus* spp.) and beechnuts (*Fagus sylvatica*) to all other foodstuff, including agricultural crops and supplemental feed proffered by hunters (Rosvold and Andersen 2008). Wood and Roark (1980) investigated seasonal diets of feral hogs in South Carolina woodlands and found that in poor mast years, white-tailed deer were negatively affected by their consumption of acorns. During fall and winter, acorn percentage by weight was as high as 79.8%, showing a high affinity by feral hogs for this critical food source. Focardi et al. (2000) discovered wild boars in holly-oak groves in Italy were supplementing the lack of aboveground acorns during the spring season by invading the belowground hoards created by small mammals. This underground exploitation was strongly correlated to the birthing and lactating activities of sows, thereby raising energy availability beyond aboveground food sources. While investigating recruitment of holm oak (*Quercus ilex*), Gomez and Hodar (2008) found that boar feeding activities nullified the acorn caches of birds, including jays. Feral hogs can be highly selective in their foraging practices and as such, prefer forbs over grasses during summer months (Coblentz and Baber, 1987). Forbs in New Mexico are required during the life cycle of numerous wildlife species including mule deer (*Odocoileus hemionus*), and quail (*Colinus* spp.) Feral hogs have an acute sense of smell, an advantage in harvesting the maximum from fallen mast crop. This ability favors feral hogs over native wildlife, such as deer and wild turkey (*Meleagris gallopavo*), that are unable to changeover to other food sources when availability of acorns ceases (Beach 1993). In areas of rising population densities, overlap and resource competition with native wildlife will escalate.
Predation on Native Species

Feral hogs are inherently omnivorous and have been widely documented consuming a multitude of vertebrate and invertebrate species. The state of New Mexico has 180 listed and sensitive species, all of which are subject to negative impacts from feral hog populations. Schley and Roper (2003) documented increases in wild boar populations correlated with major declines in woodcock (*Scolopax rusticola*) numbers. They suggested this was due to boar predation of eggs and nestlings, although due to the rapid gastric cycle of 4-5 hours, this was difficult to document. Similarly, in Germany, wild boar were observed destroying nests and killing adult woodcock (Nyenhuis 1991). The Lesser Prairie-Chicken (*Tympanuchus pallidicinctus*) is currently a candidate for listing under the Endangered Species Act [ESA]. Of the 10 NM counties inhabited by Lesser Prairie-Chicken, 80% are known to harbor feral hog populations. Tolleson et al. (1997) found that feral hogs predated 28% of simulated quail nests in a Texas study. Feral hogs have also been implicated as predators of multiple avian species in wetland environments. Gimenez-Anaya et al. (2008) found that during the moulting season, ducks were consumed by wild boar utilizing wetlands. Among the species consumed were *Anas* spp., teal, turtle dove, coot, crane, rail and pheasant. A common moorhen (*Gallinula chloropus*), its nest, and the nest of a purple gallinule were found in the stomach of one wild boar (Herrero et al. 2004). In New Mexico, feral hogs are often closely associated with wetlands and riparian areas where waterfowl nesting, moulting and brood rearing occur.

Feral hogs inhabit 100% of the counties that support the Sacramento Mountain salamander (*Aneides hardii*). The rooting behavior and diet of feral hogs may grievously influence *A. hardii* throughout its life cycle, including egg laying, aestivation and torpor. Studies conducted by USGS on the Sacramento Mountain salamander assert “any action that opens the forest canopy and reduces the density of understory vegetation or the depth of the leaf litter can affect the abundance and above-ground activity of terrestrial salamanders. Red-cheeked salamanders (*Plethodon jordani*) are consumed by hogs in Great Smoky Mountains National Park (Peine and Farmer 1990). Howe et al. (1981) found salamanders in the stomachs of Appalachian feral hogs. Singer et al. (1984) described the near extirpation of two forest dwelling vertebrates that depend on leaf litter for habitat. The southern red-backed vole (*Clethriomys gapperi*) and northern short-tailed shrew (*Blarina brevicauda*) were nearly eliminated from study sites due to feral hog rooting activity. This same type of leaf litter rooting behavior by feral hogs has been observed in salamander habitat in the mountains of Lincoln and Otero counties. It has also been observed that as herpetofauna including salamanders, frogs, turtles, snakes and lizards take thermal shelter or enter torpor, vulnerability to predation by feral hogs increases (Jolley et al. 2007). One feral hog in Jolley’s study on Ft. Benning consumed a shocking 49 spade-foot toads during one feeding cycle. The researchers witnessed two individual hogs “making repeated 1-meter lunges as if pursuing prey. They appeared to be hunting the toads that were observed in great numbers that night.” By utilizing estimates of area and consumption rates, he estimated that within Fort Benning’s 736 km² area, it was not unreasonable that an entire population of feral hogs could consume 2.85 million reptiles and amphibians per year. Wood and Roark (1980) studied feral hog diets in South Carolina and found lizards (*Anolis carolinensis*), snakes (*Thomnophis sirtalis*), and frogs (Rana pipiens sphenophala) in stomach contents.
Of the 21 ESA listed small mammals, 90% inhabit areas of expanding pig populations. During an investigation of predation on small mammals by feral hogs in California oak woodlands, “one male wild pig was radio tracked... foraged in oak woodland, grassland and riparian habitats 11 hours before being shot. Its stomach contained seven voles, two gophers, one dusky-footed woodrat (Neotoma fuscipes), one deer mouse (Peromyscus maniculatus), one pinon mouse (Peromyscus truei), and one western harvest (Reithrodontomys melagotis)” Considering the rapid rate of gastric emptying (4-5 hours), true predation rates of small mammals may be substantial. Additionally; as rump fat decreased in the population, predation of vertebrates increased, being more pronounced in sows than boars. Accordingly, protein deficiencies and peaks in predation were synchronous (Wilcox and van Vuren 2009). Loggins et al. (2002) sampled one hog that had a complete adult California ground squirrel (Spermophilus beecheyi) in its stomach. This hog was observed standing motionless for more than 20 minutes as it intently waited above a ground squirrel burrow immediately before being shot.

In Australia, Chelodina rugosa, the northern snake-necked turtle, annually experiences predation by feral hogs during nesting season. In areas of high hog abundance, pig predation accounts for 96% of fatalities during dry years. Predation levels of greater than or equal to 40% is predicted to cause extirpation or substantial population suppression of C. rugosa within 50 years (Fordham et al. 2007). Feral hogs crush and consume turtles smaller than 160 mm and those larger, “they would tear off the neck, legs and head leaving partially damaged or consumed shells on the beach” (Fordham et al. 2006). The rooting depth observed on billabongs (small lake or pool) was 19 cm, more than sufficient to excavate turtles aestivating at only 11 cm. In Florida feral hogs destroy up to 80% of nests created by threatened and endangered species of turtles (Seward et al. 2002).

Feral hogs occupy 100% of the counties inhabited by the sand dune lizard (Sceloporus arniculus) in southeastern New Mexico. Sand dune lizards are currently being petitioned for listing as threatened or endangered species under the Endangered Species Act [ESA]. In New Mexico, approximately 48.9% of the sand dune lizard’s range occurs on BLM lands, 20.1%
Habitat destruction is the primary source of concern for protecting the sand dune lizard. Feral hog rooting is documented to cause shifts in native plant communities, potentially impacting this species. Additionally, feral hogs consume a variety of herpetofauna and may cause losses through direct predation on lizards, as well as their clutches of eggs. Further investigation is needed to assess the potential impacts feral hogs present to this species. Coblentz and Baber (1987) identified direct predation of feral hogs on Santiago Island’s lava lizard species, which grow much larger than the native sand dune lizard.

Nine of 10 endangered springsnails in the United States are endemic to New Mexico. Because springsnails are associated with seeps and springs with both hot and cold water, they are exceedingly vulnerable to the habits of feral hogs. The Pecos assiminea, found northeast of Roswell on Bitter Lakes National Wildlife Refuge, is sensitive to any destruction of vegetative cover along stream margins. Likewise, the Pecos springsnail, which inhabits two distinct geographical regions, has difficulty surviving any type of disturbed soil near its aquatic habitat (MacCarter 1996). The ability for these snails to survive is directly related to the health, quality and quantity of the same groundwater human populations depend upon. A single localized event could extirpate these species.

**Disease Concerns**

Feral hogs are susceptible to at least 30 viral and bacteriological diseases, 20 of which are zoonotic. Additionally, hogs are latent hosts to at least 37 parasites, including the nematode which causes trichinosis (Tables 1, 2, 3) Feral hogs are also a species of concern for potential outbreaks of foreign animal disease including foot and mouth disease [FMD] and classical swine fever [CSF] (Hutton et al. 2006).

Hogs can carry a vast array of diseases transmissible to livestock including brucellosis, pseudorabies, leptospirosis, and bovine tuberculosis. USDA Wildlife Services currently tests feral hogs as they are removed, for pseudorabies [PRV], swine brucellosis (*Brucella suis*) and classical swine fever [CSF]. To date, feral hogs inhabiting New Mexico have tested positive for both swine brucellosis [SB] and pseudorabies. These hogs were from distinct geographical areas, separated by more than 250 miles. Although domestic swine production within New Mexico is nominal, nationally pork sales surpass $1 billion, with retail sales exceeding $34 billion (Hartin et al. 2007).

Pseudorabies virus; additionally referred to as Aujeszky’s disease, mad itch, suid herpesvirus 1, and *Herpes suis* is a highly contagious, economically significant disease of pigs. This virus causes neurologic signs begetting high mortality rates in young animals. Older pigs may exhibit both neurologic and respiratory signs, and adult pregnant females may abort. While pigs are natural hosts for pseudorabies, numerous domestic and wild mammals are susceptible to infection including cattle, sheep, domestic dogs, raccoons, coyotes, cougar, rodents and deer. In cattle and sheep, the disease is typically fatal within days. Although nasal and oral aerosol fluids are the primary route of transmission between swine; pseudorabies may persist in the environment for up to 18 days in soils, 2-7 days in nonchlorinated water, and 2 days in swine sewage lagoon seepage. (Williams and Barker 2001). Domestic and wild carnivores
that have ingested infected animal carcasses typically die within 48 hours of onset (Center for Food Security and Public Health 2006). There are conflicting reports on mortality of wild carnivores, including a fatality in Florida panther (*Felis concolor coryi*) (Glass et al. 1994). Muller et al. (1998) found antibodies to pseudorabies virus in 5.5% of 309 red fox (*Vulpes vulpes*) tested in areas inhabited by wild boar. These authors suggest that wild carnivores surviving pseudorabies may act as excellent bioindicator species. Where threatened or endangered carnivores predate or scavenge feral hog carcasses, research should be conducted to acquire information regarding mortality rates.

Swine brucellosis (*Brucella suis*) is a contagious, bacterial infection causing abortions and weakened or stillborn piglets in sows and testicular pain, reluctance to mate and semen abnormalities in boars. The Texas Animal Health Commission (pers. comm.) reported the quarantining of 41 swine operations as a result of 10 having concurrent PRV and SB infections. Additionally, since January 2006; 27 cattle from 20 different herds were infected with swine brucellosis. These infections occurred across 13 counties and it was suggested that whole herd tests may be required to rule out *Brucella abortus*, the primary organism isolated from cattle. Brucellosis in humans is largely a derivative of occupational hazards, with handling of reproductive products from recently aborted or parturient animals being the most significant means of transmission (Williams and Barker 2001).

Feral hogs are highly susceptible to *Mycobacterium bovis*, the causative agent of bovine tuberculosis [bTB] infections in livestock. In one New Zealand study, feral hogs were released into the environment to evaluate their usage as sentinels for bTB. Cultural examination for mycobacteria was positive for all hogs, 13 of which had gross lesions characteristic of the disease. Researchers were searching for a sentinel animal to assist in the detection of bTB in nonnative Australian brushtail possum (*Trichosurus vulpecula*) populations. Following the removal of cattle and water buffalo (*Bubalus bubalis*), the prevalence of bTB decreased, indicating that feral hogs serve as spillover hosts (Nugent et al. 2002). Dondo et al. hypothesized that wild boar may contract bTB through the scavenging of infected cattle carcasses or by rooting environments where the bacterium is prevalent. Although feral hogs are thought to be spillover hosts for bTB in New Zealand, they are considered maintenance hosts in Spain. Naranjo et al. (2008) found epidemiological, pathological and microbiological evidence that strongly suggests wild boar are able to maintain bTB in the environment. Patterns of generalized lesions found in wild boar, coupled with the absence of cattle acting as maintenance hosts, strengthen this theory. Adults were less likely to show evidence of infection during gross necropsy, whereas young animals exhibited large, calcified lesions. The differential mortality of juveniles suggests an inability to convalesce from large lesions originating from *M. bovis*. Naranjo et. al (2008) concluded wild boar populations were likely to transmit the disease to additional species, thereby functioning as a true wildlife reservoir. The possibility of bTB transmission within feral hog populations remains and requires further investigation (Nugent et al. 2002).

Within the past decade, bovine tuberculosis has been a concern for New Mexico’s agricultural industry, triggering dairy depopulations and economic hardship. As bTB has been isolated within Roosevelt and Curry county operations, uneasiness regarding the potential dissemination into wildlife populations has arisen. In 2009, wildlife surveillance commenced,
resulting from a cooperative agreement between USDA Wildlife Services, New Mexico Livestock Board [NMLB] and USDA Veterinary Services [USDA VS]. Feral hogs currently exist in Roosevelt and Curry counties, designated the Modified Accredited Advanced [MAA] zone, although these populations are elusive and their proximity to dairy operations is unknown. The illegal relocation of hogs from neighboring states of Texas and Oklahoma continues to occur as enforcement of current legislation is difficult.

Hog activity is strongly associated with water resources throughout the year, particularly during periods of drought. Vincente et al. (2007) investigated the likelihood of wild boar increasing the potential for bTB transmission by wallowing, drinking, defecating, and urinating in shared watering sources. Because of New Mexico’s extended dry season, feral hog/livestock interactions at water sources should be evaluated.

Infected hogs can spread parasites through direct and indirect pathways by contaminating drinking water. For example, *Leptospira* can be transmitted via contact or consumption of water infected with urine. Contamination of a watering source with urine is consistent with feral hog wallowing behavior (Beach, 1993). Even in subclinical situations, independent studies have proven the relationship between leptospirosis and depressed conception rates in cattle (British Cattle Breeders Club 2008). Heise-Pavlov et al. (2009) found leptospirosis to be a limiting factor in feral hog populations by causing stillbirths, abortions and neonatal disease in piglets.

**Impacts on Domestic Water Supply**

Feral hogs are carriers of the top five waterborne pathogens for drinking water including *E. coli*, *Campylobacter*, *Salmonella*, *Cryptosporidium* and *Giardia* (Environmental Protection Agency 2009).

*Escherichia coli* O157:H7 was isolated from both cattle and feral hogs on the central California coast (Jay et al. 2007). Feral hogs were the only wildlife species positive for *E. coli* O157, matching the major spinach-related outbreak strain. Although spinach production areas and associated water sources were inaccessible to cattle, feral hogs had unobstructed access to areas in and around spinach fields. This was the first isolation of *E. coli* O157 from feral hogs in the United States.

In 2008, seven feral hogs from the Leon River Watershed in Texas were tested for the presence of *E. coli*. This watershed is one of hundreds currently exceeding EPA standards for bacteria levels relative to recreational use. Six of seven feral hogs had strains of *E. coli* considered pathogenic to humans, whereas four had a strain pathogenic to livestock. Additionally, researchers in the eastern Texas Panhandle traced 49% of *E. coli* bacterium present in Buck Creek to feral hogs (Bodenchuk, pers. comm.).

Hampton et al. (2006) suggest rooting behavior and the affinity of feral pigs to the moist soil associated with riparian areas markedly increases water turbidity. Turbidity is a critical parameter of drinking water quality, high levels of which can protect waterborne pathogens from the chemical disinfection process used in water treatment facilities. This study included
examining feral hog feces for protozoan parasites including *Giardia*, *Cryptosporidium*, *Balantidium coli* and *Entamoeba*. Pigs are the only source of *B. coli* infection in humans, whom acquire the infection by drinking water containing environmentally resistant cysts. The levels of chlorine used for drinking water are not high enough to kill cysts of *B. coli*. These researchers concluded that feral hogs represent a potential risk to drinking water in catchments. Consequently, hogs should not have access to feeder streams or rivers that empty into municipal reservoirs. Furthermore, hogs should be excluded from areas where crops are being raised.

Cryptosporidium, caused by the coccidian parasite *Cryptosporidium parvum*, occurs frequently in young ruminants, including pigs and calves. Atwill et al. (1997) found feral pigs shed both *Cryptosporidium parvum* oocysts and *Giardia* cysts in California. Considering the affinity of hogs to riparian areas, the likelihood of perpetuating the disease via protozoal surface water contamination is substantial. Source water protection has been advocated as a method of reducing *Cryptosporidium* and *Giardia* concentrations in surface water. Young pigs and pigs from high density populations were more apt to shed oocysts. The pattern of adult shedding in feral hogs jeopardizes watersheds after horses and cattle have been excluded.

Sparganosis, caused by the cestode *Spirometra*, is a worldwide parasitic zoonosis found in snakes, reptiles and mammals including swine and man. Ingesting larvae via contaminated water or inadequately cooked swine can pose a considerable health risk for human sparganosis. Sparganosis has been discovered in feral hogs originating from Texas and Florida (Bengston and Rogers 2001).

**Impacts on Rangeland Water Supply**

Feral hogs intrinsically require a continual water supply. Multiple studies have documented the proximity of feral hog and wild boar populations to established riparian habitats. Park and Lee (2003), during a habitat suitability study of wild boar, found distances from water only ranged 5.4 – 10.6 meters.

New Mexico rangelands are susceptible to damage from rooting, destruction of stock tanks, impoundments and irrigation lines. Adkins and Harveson (2007) found feral hogs concentrated around limited free water resources, both manmade and natural. It was ascertained that these areas comprise some of the highest levels of species biodiversity. Similarly, in Big Thicket National Preserve, Chavarria et al. (2007) found that sites with high-intensity damage by feral hogs were typically neighboring fresh water sources. Rosvold and Andersen (2008) observed farrowing nests were consistently adjacent to water, as sows’ need for water sources increase during periods of young rearing and lactation. Feral hog activity concentrated around stock watering facilities can lead to water contamination and physical damage to the facilities themselves. Wallowing can cause turbidity, algae blooms and reduce oxygen supplies for fish and aquatic invertebrates. Similarly, rooting in riparian areas results in muddy water, depletion of flora and siltation of available water supplies (Beach 1993). Peine and Farmer (1990) described this riparian damage as detrimental to native brook trout...
(Salvelinus fontinalis) in Great Smoky Mountain National Park. New Mexico has 28 listed and sensitive fish species, 85% of which subsist in feral hog inhabited ecosystems.

Feral hogs visiting stock tank overflow to wallow and rehydrate. USDA/APHIS/WS

Webb et al. (2006) documented resource partitioning among feral hogs and cattle visiting water sources in Texas. Feral hogs were apt to visit stock tanks at different times of day than did cattle, suggesting potential avoidance behavior or differential water requirements. Feral hogs routinely colonize water sources that permit either drinking directly from tanks or consuming and wallowing in spillovers. The potential for disease transmission or parasite loading in these environments is heightened, as remote game cameras have shown these wallows are also utilized by livestock, deer and birds, even if stock tanks are readily available. Stock tanks are routinely undermined by the rooting behavior of feral hogs. Without alleviation, damage to stock tanks will inevitably fail, causing thousands of dollars in replacement costs to landowners. Feral hogs take advantage of both permanent and ephemeral stock ponds and playa lakes, primary water sources for livestock and wildlife. During summer months, as ephemeral ponds recede, wallowing behavior persists until only residual damp clay remains.

**Rangeland and Forest Destruction**

The devastating effects of feral hogs on native rangelands, forests and plant communities have been described both within the United States and internationally. In a study of feral hog damage to imperiled wetland habitats of Florida, damage was lessened by $1.5 million dollars following a 1.7 year removal project. The cost-benefit ratio achieved during this study was 1:27.5 and the economic benefit of removal exceeded costs by 55.2% within first year (Engeman 2007). This type of study facilitates awareness of the dramatic effects feral hogs, an invasive, have and their ability to cause long lasting degradation of native ecosystems.
Engeman et al. (2003) documented 70% of shoreline ecotone and 58% of upland ecotone being damaged by feral hogs. These transitional areas were conservatively valued at $1.2 and $4.0 million, respectively. Although the economical consequences of feral hog damage are considerable, the ecological impact to the environment is immeasurable. Bratton (1975) investigated the effects of feral hogs in Great Smoky Mountain National Park and found beech (Fagus spp.) forest understory was reduced by 95-108% and hog rooting significantly decreased the number of plant species. In Europe, wild boar directly affect holm oak (Quercus ilex) recruitment by consuming acorns and destroying seedlings. Boar activity kills not only new seedlings, but older established seedlings, as well (Gomez and Hodar 2008). Mitchell et al. (2007) noted high levels of rooting in swamps and creeks influences the survival rates of threatened and endangered species. Additionally, the timing of rooting may cause maximum disturbance during a vulnerable phase of an endangered species’ life cycle. In a subsequent study, Mitchell et al. (2007) ascertained seedling survival was greater inside enclosures barring feral hog activity. Accordingly, restoration projects in areas of feral hog populations are likely to be affected by rooting behaviors. Gimenez-Anaya et al. (2008) investigated the food habits of wild boar in Mediterranean coastal wetlands, and found that Alkali bulrush (Scirpus maritimus) was consumed in high frequency (47%). Consumption of these roots ultimately caused plant death and subsequent erosion. Rooting of wetland plant species, coupled with New Mexico’s seasonal rains and flooding, may dramatically increase sedimentation via erosion. Additionally, there is strong evidence that feral hogs spread fungal spores, including root-rot fungus (Phytophthora cinamomi) (Beckman and Davidson 1990).
Feral hog rangeland rooting in moist soil. USDA/APHIS/WS

Rooting in Lincoln National Forest pine duff. USDA/APHIS/WS

Rooting at Bitter Lakes National Wildlife Refuge. USDA/APHIS/WS
Livestock Predation

While feral hogs are notorious for landscape destruction, they are also predators of domestic livestock; including lambs, kids, and calves. A study conducted in 24,000 acre sheep paddocks illustrated a 29% predation rate by feral hogs, which directly correlated to population density (Choquenot et al. 1997). Additionally, twin bearing ewes were 5-6 times more likely to suffer predation losses. This loss may be an effect of split vigilance behavior of ewes or nutrition and strength levels of twins versus single lambs. Pavlov et al. (1981) investigated Merino lamb depredation by feral hogs and found 44% loss. During the same study, ten depredation events of lambs were observed and documented. All ten cases disclosed the following sequence of events:

- 10 seconds after death – feral hog bites through ventral side of thorax and with forefeet on body, rips lamb open
- 2-10 minutes after death – hog has removed the heart, lungs, liver, stomach and intestines
- 11-20 minutes after death – hog has eaten the ends of ribs, broken the back, and pulled one or both forelegs, exposing the muscle to the stifle joint; hog has removed muscle from scapula, humerus and radius
- 21-30 minutes after death – hog has eaten muscle on ventral side of backbone, backbone and ribs, and all muscle from legs, which are exposed to stifle joint
- 31-37 minutes after death – hog has crushed skull and eaten brains, eyes and tongue; has trampled skin and eaten portions; may have eaten tibiae and radii
- 38-45 minutes after death – only metatarsi and phalanges, with fragments of skull and other bones, remain

Rowley (1970) included testimony from agricultural agents and producers regarding feral hog predation of lambs; “A number of us have witnessed attacks by pigs on live lambs. I have seen pigs attack the very newborn lambs before they have even found their feet and also ewes that were down after lambing.” Rory Treweeke, Chairman of the Western Catchment Management Authority, says “When ewes are lambing, they will literally wait behind a ewe … and they just take the lamb as it comes out. They are one of the nastier imports.”
Plant et al. (1978) documented 600 lambs lost to 1,422 ewes as a result of feral hog depredation. Feral hogs frequently kill lambs and kid goats, and predate upon adults of both species when opportunities exist (Littauer, 1997). Occasionally, adult animals giving birth are fed upon and killed by feral hogs. Hogs feed much like bears do, although they are less proficient at skinning prey out (Wade and Bowns 1985). Additionally, evidence of feral hog depredation includes consumption of rumen and its contents, which is atypical for bears. Beach (1993) described the methodical consumption of lambs and kid goats by feral hogs. “There are no carcasses present to detect, examine, or attract vultures (Cathartes aura, Coagyps atratus). Frequently, even when predation is considered, pigs escape suspicion because people generally underestimate the hog’s capabilities as a predator.” In 2009, Texas USDA Wildlife Services’ reported feral hogs killed or injured adult sheep, lambs, kid goats and calves (Bodenchuk pers. comm.). Roemer et al. (2001) discovered the occurrence of hyperpredation on island foxes by golden eagles correlated to feral hog population density on California Channel Islands. Golden eagles are familiar predators for livestock producers, and increasing population densities of feral hogs on New Mexico rangelands may elicit increases of eagle depredation.

Value of Agricultural Damage

From FY 1992 through FY 2004, the NM USDA Wildlife Services’ Management Information System (MIS) database presents only two incidences of feral hog damage to pasture and alfalfa fields. Feral hog damage in NM increased from $300 in FY05 to $218,550 in FY08, likely coinciding with increasing feral hog populations statewide. The value of damage accounts only for those incidences where Wildlife Services’ assistance was requested in addressing feral hog conflicts. There are more than 1.5 million beef cows and 350,000 dairy cows in New Mexico, accounting for $1.1 billion and $2.8 billion, respectively (NASS Statistics 2009). Commodities cultivated for dairy cattle and rangeland forage are equally susceptible to the destructive behavior of feral hogs. New Mexico WS staff believes feral hogs travel great distances to take advantage of agricultural pivots and croplands. When preferred high energy foods are unavailable, wild boar may move 100-150 km to unearth new rations, which commonly includes agricultural crops (Massei and Genov 2004). One case demonstrating this high mobility involves the movement of feral hogs in Ft. Benning, Georgia. When two dominant radio collared sows from one sounder were removed from a sunflower field, an adjacent sounder quickly seized the opportunity to colonize the resource (Sparklin et al. 2009). Given the probability of neighboring sounders recolonizing available resources, eradication of all populations must be a primary objective. Cropland depredation will continue occurring, if additional sounders are left in neighboring areas.

Texas estimates feral hogs annually cause $52 million in damage from destroyed crops, busted levees, downed fences, predation, diminished forage for livestock and wildlife, et cetera. Landowners expend approximately $7 million per year recovering from damage and attempting to control feral hog populations. In European countries, wild boar inflicted agricultural compensations amounting to hundreds of thousands dollars every year (Geisser and Reyer 2004). Crops ravaged in Europe include wheat, maize, rice, grapes, barley, oats, rye and potatoes. Local density of boar, availability of natural foodstuff, and proximity of forest to cultivated fields were factors influencing crop depredation (Massei and Genov 2004).
On Flinders Island, Tasmania, farmers have documented feral hog damage to pasture including reduced productivity, loss of perennial rye-grass and the spread of noxious weeds. Neil Walters, a farmer from Oglesby, Texas, after losing 5 percent of his total corn production, commented “We hunt them, and we also trap them... but that’s just like swatting flies with a fly swatter. We’ll never get ahead of them” (Woods 2009).

FERAL HOG ERADICATION

Goal

The goal of this effort is to facilitate cooperation toward feral hog eradication in NM. Feral hogs inhabit diverse ecosystems and private properties, and are subjected to year-round hunting, potentially causing hogs to relocate away from planned field operations. Coordinated efforts of agency personnel, landowners, and others will be necessary to be successful. Efficacy will be based on cessation of damage, and absence of feral hogs at baited locations or passive track plots.

New Mexico Feral Hog Task Force

NM WS will take the lead in feral hog eradication efforts where funding and staffing permit. However, we suggest the formation of a Feral Hog Task Force (FHTF) consisting of representatives from land management agencies, wildlife and livestock management agencies, non-profit interest groups, sportsmen, and others who wish to participate. The task force would identify resources needing protection, prioritize critical issues/areas needing control or eradication, identify funding requirements, and seek additional funds where possible.

Eradication Techniques

In the United States, the most common methods of feral hog eradication include box trapping, corral trapping, ground hunting, aerial operations, snaring and hunting with dogs. Each strategy has merit depending on objectives, landscape, local regulations and funding. Each strategy is variable, both in cost and number of hogs that may be removed at any one time by its application. While it may be possible to remove a small number of hogs quickly by use of hunting with baying hounds, corral trapping and aerial operations may take several times that number. Likewise, while snaring is very cost effective, this method should only be employed where non-target capture is unlikely. The importance of data collection is demonstrated in the Santa Cruz Island eradication; hunters, dogs and helicopters were marked with GPS units to measure effort, efficiency and document search patterns. And records of location, age and sex need to be recorded for each hog removed to better assess population dynamics (Parkes et al. in press).

Parkes et al. employed a rapid eradication approach with a deliberate structuring of available tools. Trapping, aerial operations, ground hunting with dogs and Judas techniques were sequentially used in an effort to provide the least education to surviving populations of feral hogs. This rapid eradication technique, which correlates to less animals reproducing, results in fewer animals being dispatched over time. Land ownership, economic limitations, topography and feral hog behavior are a quantity of factors influencing which management
tools are employed. Feral hogs become diurnal during winter months, while likely due to thermoregulation, become more nocturnal during summer months (Kurz and Marchinton 1972). This behavioral characteristic of feral hogs illustrates the need to be adaptive relative to eradication approaches. Utilizing the best information available, coupled with on the ground surveillance, the task force can adjust strategies quickly and accordingly.

NM WS staff will deploy a Rapid Response Team [RRT] to maximize success of removing newly discovered populations or known releases of hogs in new areas. This team will consist of individuals scattered throughout New Mexico in order to have local personnel available for deployment. The RRT will be knowledgeable of the most efficient and successful removal techniques and as such, be able to make immediate decisions on the ground. The RRT will develop an action plan addressing the size, scope and objective of each field operation.

**Trapping**

Trapping feral hogs is accomplished with two basic designs of live trap, corral and cage traps. Traps must be positioned in shaded areas and when shade trees are not available, brush or other cover must be placed around the trap to ensure animal welfare. Feral hogs lack sweat glands and therefore have difficulty thermoregulating in hot weather. Mersinger and Silvy (2007) suggest utilizing home range sizes to determine frequency and distribution of traps on the landscape. They also recommend traps be located adjacent to water sources in summer and fall, due to the innate water requirements of feral hogs.

VHF trap monitoring systems enhance trap success and increase animal welfare and economic efficiency. Trap monitors may be mounted to traps so that the transmitter operates continuously until the trap is sprung. Then the VHF signal changes to a faster pulse rate. Depending upon topography and vegetation, the signal can be detected up to several miles away. For example, in Quay County, checking one trapline encompassing 400 square miles required the entire day. With trapseite transmitters, these traps can be checked within 30 minutes and only those emitting this higher pulse rate need tending. Consequently, this shortens the amount of time an animal spends in a trap. Utilizing this technology increases animal welfare, the number of traps that can be maintained, and decreases program costs. Traps can also be modified to increase portability.
Corral traps are widely utilized in the removal of feral hogs throughout the United States and internationally. Mitchell and Kanowski (2003) found trapping to be the most expensive option when compared to aerial hunting and aerial baiting. Cost per hog was $43.84 with corral trapping having an overall effectiveness of 74%. Corral traps are constructed in numerous ways, but the overriding concept is the same; capture multiple hogs in one large trap. Corral traps can be constructed with door systems that allow only one initial capture, or with multiple capture or “rooter” style doors that allow for large numbers to be taken in one trap night.

Pros

- entire groups of feral hogs may be removed in one trap application
- the removal of whole sounders keeps trap education to a minimum
- constructing a corral trap without a top panel allows nontargets to escape

Cons

- difficult to relocate
- expensive
- ground surface must be fairly flat

Box traps for feral hogs are typically 4” x 4” x 8” or larger, constructed of heavy duty welded framing, wire paneling and a door system having a trip wire mechanism. Box traps are widely used in conjunction with other methods to remove feral hogs.

Pros

- highly portable allowing for placement in somewhat inaccessible areas
- multiple hog capture possible
- can be removed from the field for disinfecting
Cons

- smaller size means smaller numbers of hogs may fit in the trap at one time
- closed design does not allow nontargets, especially cervids, to readily escape without assistance
- expensive
- wire floor may discourage some hogs from entering trap

Snaring, a cost effective technique, is widely used for feral hog control. In FY09, snaring accounted for 19% of feral hog removal by USDA Wildlife Services in Texas (Bodenchuk pers. comm.). Snaring techniques involve placement along known travel corridors in an attempt to capture target animals. For feral hogs, heavy duty 1/8 inch snare cable and heavy duty locks and anchoring mechanisms are necessary. Feral hogs may be captured lethally or nonlethally.

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<tr>
<th>Pros</th>
<th>Cons</th>
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<tr>
<td>Inexpensive</td>
<td>Nontarget capture possible</td>
</tr>
<tr>
<td>Ease of placement</td>
<td>Not reusable following capture</td>
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<td>Versatile in field settings</td>
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Hunting

Ground hunting techniques are popular among control and eradication efforts across the United States and foreign countries. There are numerous newly developed tools including advanced optics, truck mounted blinds, forward looking infrared [FLIR] optics, electronic game callers and feeder lights. Baying hounds may also be used to remove feral hogs. Proper humane dispatch of feral hogs requires well placed shots indicative of advanced training with firearms.

Opponents of ground hunting, particularly with baying hounds, argue that feral hogs will disperse great distances. Maillard and Fournier (1995) ascertained that home range increased three fold during drive hunting seasons, although daily movements did not increase by any appreciable amount. Conversely, Pohlmeyer and Sodeikat (2003) found that when hunts were limited to less than 3 disturbances within 14 days, boar did not leave their home range. Even when hunts exceeded this frequency, boar did not move further than 6 km. Both studies involved baying hounds and structured drive hunts through known boar habitat. Hounds have been used in seven noted eradication programs from 1973-2006 (McCann and Garcelon 2007). Feral hog removal with hounds was far more effective on solitary animals and small sounders and decreased as numbers increased (Cowed et al. 2005). The eradication of feral hogs from Santa Cruz Island involved trained dogs working in short arc configurations with trained hunters. When the dogs would bay, the nearest hunter would converge and humanely dispatch the animal (Parkes et al. In press). Littauer (1997) pronounced the necessity of shorter hunts in hot weather, veterinary costs and costs of keeping and maintaining hounds as drawbacks of this management technique.
Another method of ground hunting involves the use of bait or draw stations and several trained personnel to remove feral hogs. Feral hogs are well documented to not only frequent game feeders, but to deter native wildlife species. Game feeders can be set with timers to lure feral hogs into shooting areas at times when other species are absent. Electronic game feeders permit USDA Wildlife Services to target feral hogs and avoid deer and wild turkey, which visit feeders at different temporal periods. McIlroy and Saillard (1989) pronounced that hunting over bait is commonly practiced, during which the hunter attempts to remove as many hogs as possible before they disperse. The Pinnacles National Monument eradication effort used cameras at baited sites to determine when feral hogs were frequenting the area. They positioned hunters to intercept and remove these animals on subsequent visits to the bait pile (McCann and Garcelon 2007). The cost to eradicate 200 feral hogs from Pinnacles National Monument was $623,601 or $3,118 per animal, excluding a $2 million fence to prevent recolonizing by feral hogs.

Aerial hunting operations conducted with a certified pilot and gunner working from a fixed wing aircraft or helicopter may also be used to remove feral hogs. Pilot and gunner are in continuous communication with a ground crew that assist in the operation and provide added safety for the operation. NM WS currently utilizes aerial strategies for feral hog removal, having variable success ranging from 1-18 feral hogs per flight. Where populations of feral hogs occupy open landscapes, aerial operations can be superior to traps, snares and ground hunting operations. Aerial operations during FY09 accounted for 49% of feral hogs removed by Texas Wildlife Services, making it the most successful technique in their program (Bodenchuk pers. comm.). Mitchell and Kanowski (2003) found that aerial hunting was the least expensive method of control when compared to aerial baiting and trapping programs. Overall control effectiveness of aerial hunting was 64% and as high as 80% in comparable studies. Aerial operations on Santa Cruz Island, CA were used daily, 2 to 2.5 hours after dawn and before dusk. This permitted aerial personnel to traverse the same areas multiple times, aiding in this rapid eradication technique (Parkes et al. In press).

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>Highly selective</td>
<td>Affected by topography</td>
</tr>
<tr>
<td>Immediate alleviation of damage</td>
<td>Affected by weather</td>
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<td>Large numbers of animals removed</td>
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**Judas Technique**

The Judas technique involves placing radio transmitters on feral hogs to disclose the whereabouts of other populations. This technique takes advantage of the gregarious behavior of feral hogs and has been utilized in North America on a limited basis and on a greater scale in Australia and New Zealand (McIlroy 1995). Parkes et al. (In press) evaluated the use of the Judas method during a feral hog eradication effort on Santa Cruz Island. Methods implemented included trapping, shooting, aerial hunting and hunting with hounds. The Judas technique, employed as part of a sequence of removal techniques, was responsible for removing 43% of the remaining hogs. Furthermore, the Judas technique was responsible for removing the last two feral hogs on the island. Once efforts were presumed successful, Judas hogs were used as sentinels to determine the presence of any remnant animals. In Pinnacles
National Monument, California, Mcann and Garcelon (2007) utilized the Judas technique along with ground based telemetry and hunters to locate and euthanize feral hogs associating with Judas animals. Within 1-7 days following release, Judas sows were observed to travel distances as far as 8 km to unite with new sounders. Two of these sows were responsible for the eradication of 47 feral hogs in one locale (McIlroy 1995). Parkes et al. (In press) found female Judas hogs to be far more effective than males released for the same purpose. The abundance of information regarding Judas techniques indicates that the efficiency of finding new populations of feral hogs is paramount to eradication. In Santa Clara County, California, Wilcox et al. (2004) found that using Judas hogs reduced search time from 4.1 hours to 1 hour.

In New Zealand, Yockney and Nugent (2006) conducted an investigation of the Judas technique to remove feral hog populations using a helicopter. Their methodology required that the crew search for one hour without the assistance of Judas animals for tracking. Any hogs sighted would be dispatched and any relevant information documented. During the second hour of flight, the pilot operated radio telemetry equipment to track Judas hogs and attempted to remove individuals located within their vicinity. Their results showed that twice as many feral hogs were removed with the aid of Judas hogs and radio telemetry than were taken opportunistically while hunting. Additionally, the density of cover that feral hogs could be located and removed from was far greater (91.3% versus 53.5%) with the aid of Judas methods than with unaided flights. This has tremendous implications for locating feral hogs in diverse habitats where visual observation may be limited. Removal rates varied from 1 hog/hr to 15 hog/hr, with Judas hunting being consistently more cost effective. The authors suggest two caveats may have influenced overall success; hunting unaided during the first hour may have caused Judas associated hogs to take cover, making detection more difficult and during the hour incorporating Judas animals, not having personnel capable of helping pilots quickly navigate towards active VHF signals. Yockney and Nugent (2006) surmised that with unaided hunting there was a high chance of aircraft avoidance behavior and that groups may escape to cover. However with Judas methods these groups would likely be found and eradicated even when hiding in dense cover.

Littauer (1997) indicated limited trials were being initiated in Texas to augment feral hog management programs. Social bonding and cohesion of sounders were critical in making the Judas technique effective in the field. Most studies investigating the Judas technique have small sample sizes due to financial constraints, capture difficulty and other limitations. USDA Wildlife Services’ proposes using this method as an integrated approach to feral hog eradication campaigns throughout the state. Aerial hunting, where possible, will be the preferred method of instituting the Judas technique. Ground hunting will be investigated for effectiveness where topography, elevation, or other criteria prohibit aerial hunting. Ear tag transmitters and radio collars will be employed and evaluated as to which is more successful and economically efficient. Sows that are not sterilized give birth, resulting in a substantial decrease of body weight. Radio collars may fall off due to these drastic weight fluctuations. Consequently, researchers are using harnesses with mounted transmitters (McMurtry pers. comm., Campbell pers. comm.). Yockney and Nugent (2006) use ear tag transmitters (Sirtrack, Havelock, New Zealand) and have found excellent retention during field studies. Because radio collar failure commonly occurs, animals should be sterilized, particularly sows,
to bar releasing a reproductive animal into the environment. USDA Wildlife Services will evaluate both sexes and their effectiveness in the New Mexico program. Parkes et al. (In press) describe two objectives relative to feral hog eradication; an initial goal of using Judas techniques to increase efficiency in locating and removing populations, and a secondary goal of surveillance, once all hogs are assumed removed from an area.

NM WS uses remotely activated game cameras to assist in detecting feral hog populations. When hog sign (e.g. rooting, wallows, tracks) is observed, cameras and bait tubes may be placed to determine the number of hogs in an area. Once feral hogs numbers and presence are verified, Wildlife Specialists will choose the optimal method information can facilitate decision-making. During and after removal efforts, camera systems may act as verification tools in identifying remnant animals. Additionally, photographs from trail cameras can be compared to photographs of dispatched animals to assess whether local sounders have been removed. Passive track plots can be utilized to further reaffirm whether a population of feral hogs has been eradicated. (Engeman 2001).

While verifying eradication is an integral part of a successful program, funding must be managed carefully while conducting confirmation. Ramsey et al. (2008) noted that proving eradication can be cost prohibitive and that only through the passage of time would it be known.

Public Education

WS suggests that the cooperating agencies work together to develop and administer a public education campaign to facilitate an understanding of the negative impacts of this invasive species and foster group goals. Goals of this educational program might include:

- To provide information on the destructive nature and disease issues associated with feral hogs.
- To improve the ability of the public to identify feral hogs and recognize differences between javelinas and feral hogs.
- To develop a reporting system for feral hog sightings.
- To obtain location information for mapping damage.
- To create an awareness of illegal commercial hunting and movement of feral hogs.
- To gain assistance from hunters and landowners in the controlling local hog populations.
- To provide a consistent message from the cooperating agencies.

New Mexico Feral Hog Research Questions

NM WS efforts will focus on eradication, but will assist the National Wildlife Research Center or other entities who would like to address research needs. Although these research questions have been addressed in other areas, New Mexico has not conducted any research studies on feral hogs.

- How many feral hogs occupy New Mexico?
- Where are these populations located?
• How does density vary in different habitats?
• What is the age structure of the feral hog population?
• How many offspring do sows birth in one biological year? How may offspring per litter?
• What are feral hog home range sizes? dispersal distances?
• What are the habitat preferences of feral hogs?
• How much do feral hogs consume per day? What do they consume per day?
• Do feral hogs migrate seasonally for food?
• Are feral hogs reservoirs for important wildlife diseases? livestock diseases? zoonotic diseases?
• Do feral hogs contaminate water sources for rural and domestic usage?
• What parasites are feral hogs carrying? Are they transmissible to humans? to livestock?
• Are feral hogs traveling between New Mexico and Mexico?

Competition with Native Species
• Are feral hogs competing with native species for food
• Are feral hogs occupying unique habitat needed for other species
• Are feral hogs eliminating forage needed by other species

Predation of Native Species
• Are feral hogs consuming native species (ie. herps, birds, fawns, etc…)
• Are T&E species or species of concern being consumed in quantity

Landscape Level Impacts
• Do feral hogs cause long term damage in rangelands
• Do feral hogs cause invasive weed spread through rooting and wallowing
• Do feral hog impact water quality for fish and macroinvertebrates

Management Techniques
• Is there a better capture solution for feral hogs
• Is there a better attractant for feral hogs
• Are feral hogs moving away from capture efforts
• Does removing dominant sows cause wandering in sounders
• Does trapping selectively target sows
• Do boars exclude sows and piglets from trap / bait locations
• Does the “Judas” method work
Literature Cited


