2012 Feral Swine Management Report

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EXECUTIVE SUMMARY

Feral swine (*Sus scrofa)* are a growing problem all across the country and a serious concern for New York. They are highly adaptable and can exploit a diversity of habitat types, including states with harsh winters such as Michigan and North Dakota (West et al. 2009). Feral swine have a high reproductive capacity and populations can quickly expand to colonize new areas (Wood and Barrett 1979, Waithman et al. 1999). Currently in New York, there are four breeding populations of feral swine, located in Onondaga, Cortland, Tioga, Sullivan, Delaware, and Clinton Counties. The breeding populations are thought to be a result of escaped swine from shooting preserves and breeding facilities. The Wildlife Services (WS) program in New York continues its management of these populations to eliminate them and the damage they cause.

Wildlife Services personnel have acquired access to 35 properties, comprising over 17,000 acres, in Cortland, Onondaga, and Tioga Counties to conduct feral swine management. In all, WS identified 43 individual swine, traveling either alone or in groups, and removed 40 of them by trapping 35 with corral traps and shooting 5 from treestands. No feral swine were captured or killed in Cortland County or Tioga County, and 3 feral swine were detected on trail cameras in Tioga County.

Feral swine are highly mobile disease reservoirs and can carry at least 30 viral and bacterial diseases in addition to 37 parasites that affect people, pets, livestock, or wildlife. WS performed disease surveillance by testing captured feral swine for classical swine fever (CSF), swine brucellosis (SB), pseudorabies (PRV), swine influenza (SIV), Hepatitis E Virus (HEV), and leptospirosis.

Other impacts that feral swine have had and potentially may have on the state of New York include natural resource (ecological) damage, agricultural damage, property damage, and threats to human health and safety. The loss of wetlands from feral swine rooting, trampling, and wallowing is of conservation concern statewide—the Environmental Protection Agency estimates that one feral swine will destroy ten acres of wetland in its lifetime (Engeman et al. 1997). In Cortland and Onondaga Counties, Wildlife Services documented damage to apple orchards and pastures as well as to fields of corn, oat, soybean, pumpkin, wheat, and hay. In Tioga County, damage to pastures and fields of corn, oats, and hay were documented. Feral swine also increase levels of pathogenic bacteria and fecal coliform in waterbodies (Kaller et al. 2007, Timmons et al. 2011). In some areas of the U.S. water quality degradation by feral swine is so severe that the waterbody cannot support contact recreation (swimming and wading) or aquatic life (Timmons et al. 2011).

The most effective and efficient way to eliminate feral swine is by managing whole sounder groups, which is different from hunting. It has been important to communicate with sportsmen's and conservation groups the impacts of feral swine and how to best eliminate them. Several states have attempted to eliminate feral swine by encouraging hunting, which has proven unsuccessful in each instance. Open hunting seasons with few regulations have expanded the populations through intentional releases by hunters (Anderson and Yoest 2012). For these reasons, Wildlife Services sought out opportunities to conduct outreach to as many audiences as possible on the impacts of feral swine and their elimination.

States that have successfully prevented feral swine populations from becoming established have done so by reacting swiftly while populations were still low, such as Kansas and Oregon (Rouhe and Sytsma 2007, Biles 2011). Escape of swine from shooting preserves, breeding facilities, and intentional releases of swine by hunters interested in pursuing them in New York are factors that need to be addressed if the elimination efforts in the state are to be successful. With the proper legislation in place to prohibit the sale, possession, or transportation of feral swine, elimination is a feasible goal for New York State.

TABLE OF CONTENTS

INTRODUCTION

Feral swine (*Sus scrofa)* are a growing problem across the country and a serious concern for New York. Various resources are damaged by feral swine. Feral swine cause damage to agricultural crops such as corn, hayfields, and vineyards; create soil erosion; and reduce water quality (Seward et al. 2004). They are a direct threat to natural resources and native wildlife, including endangered plants and animals. The diseases feral swine carry are a major concern pork producers and health officials. Feral swine can carry up to 30 diseases and 37 parasites that can affect people, pets, livestock, and wildlife (Hutton et al. 2006).

Feral swine populations in NY are low compared to other states like Georgia and Alabama. New York's first breeding populations were found in 2008. The feral swine problem needs to be acted upon quickly to avoid the economic losses that come with an increasing feral swine population. Georgia estimated that in 2011 feral swine caused $81 million in agricultural and property damage (Mengak 2012). A 2009 survey estimates that feral swine caused $75 million in damage to agricultural crops in Alabama (Shi et al. 2010). A 2004 study estimated that damage to Texas agriculture is $52 million annually with an additional annual expenditure of $7 million to repair damage and to control feral swine. The South Carolina Feral Hog Task Force estimates that feral swine cause $45 million in damage annually. The damage caused by New York's feral swine population is limited to small areas. If feral swine are not eliminated from NY, the state's residents can expect to receive large amounts of future damage to their property as do the residents of other states such as GA and AL.

As feral swine hunting has grown in popularity across the United States so have feral swine populations. Feral swine populate the landscape by escaping from enclosed shooting facilities and intentionally being released into the wild to increase hunting opportunities. The intentional release of swine by hunters and the accidental release of European wild boar from enclosed shooting facilities are the major factors in the increase of feral swine populations across Missouri (Missouri Dept. of Conservation 2012) and New York (USDA 2010).

Currently, there are four breeding populations of feral swine in New York; each population is in proximity to a shooting enclosure. Eurasian wild boar are known to escape from enclosed shooting preserves and create populations of feral swine. Kaller and Reed (2010) reported that Eurasian wild boar escaping from enclosed shooting facilities was the source of Michigan's feral swine population. Michigan is now reporting feral swine in 72 of 83 counties, including counties in the Upper Peninsula previously assumed to be too cold for feral swine (Kaller and Reed 2010, Michigan DNR 2012).

USDA, APHIS, Wildlife Services managed feral swine damage to sensitive native habitats in New York State from March 2012 through September 2012 through a grant from the Environmental Protection Agency's Great Lakes Restoration Initiative. This report provides an update on Wildlife Services' 2012 field activities and a risk assessment outlining the potential damage feral swine could cause in New York State if they were left unmanaged.

Cooperating Agencies

There is a growing network of partners assisting Wildlife Services with feral swine management in New York. Wildlife Services (WS) works closely with New York State Department of Environmental Conservation (NYSDEC), New York State Department of Agriculture and Markets, and USDA Veterinary Services in the investigations of reported feral swine sightings. Additionally, the United States Department of Agriculture's Farm Service Agency in Cortland County worked with landowners that received feral swine damage and referred them to WS. WS also worked with New York State Office of Parks, Recreation and Historic Preservation; Cornell Cooperative Extension; and non-governmental organizations including The Nature Conservancy and Finger Lakes Land Trust.

Public Outreach

Wildlife Services worked with cooperating agencies and news outlets to inform the public, build public awareness of the program, and encourage people to report feral swine sightings to WS. From January to November 2012, WS spoke to 9 organizations about feral swine management and disease surveillance in New York, with a total of approximately 230 participants. These groups included chapters of the New York Forest Owners Association (NYFOA), the Columbia County Farm Bureau, the American Wildlife Conservation Foundation, the New York State Fish and Wildlife Management Board, and the New York State Partnerships for Regional Invasive Species Management (PRISM), among others.

From January to September 2012, WS was interviewed for articles on feral swine appearing in 8 newspapers and periodicals. Some of the news stories appeared in the *New York Times, Times Herald-Record, Syracuse Post Standard*, and *Lancaster Farming*. In addition to these interviews, other news outlets such as *Hamilton County Express, New York Outdoor News, New York Magazine,* and *New York State Conservationist* ran stories about feral swine in NY with information provided by WS.

METHODS

Population Reduction

Wildlife Services (WS) initiated efforts to remove feral swine from New York State in March 2010. With reduced funding in 2011, limited feral swine management was conducted by WS personnel. In March 2012, WS obtained funding for feral swine management through the Great Lakes Restoration Initiative, administered by the Environmental Protection Agency. During the project, elimination efforts focused on Cortland, Onondaga, and Tioga Counties. These areas were initially selected in 2010 because they were known to have breeding populations of feral swine; consequently, each area contains a shooting preserve offering wild boar hunts. In 2012 WS continued to work in these areas due to farmers reporting crop damage caused by feral swine.

Locating Feral Swine

In March 2012, WS personnel contacted landowners in Cortland, Onondaga, and Tioga Counties who previously permitted WS to perform swine management on their properties. These permissions provided access and management to 12,083 acres. An additional 5,031 acres of new properties were established through word of mouth from farmers, public outreach, cooperative agencies, and the use of GIS tax maps during the project. In total, WS provided feral swine management on 17,114 acres in Cortland, Onondaga, and Tioga Counties.

Scouting Properties

WS personnel searched 35 parcels of property for evidence of feral swine. Evidence of feral swine activity was monitored examining six different criteria: tracks, scat, rooting, tree rubs, wallows, and visual verification. Fresh tracks and scat are signs that swine were potentially in the area. Fresh rooting typically indicated that swine were feeding in the area and may frequent it again. Feral swine feeding activity is concentrated in areas where there is an abundance of fruit and mast-bearing trees, hayfields, and cornfields. Tree rubs were generally seen in close proximity to wallows. Feral swine frequent wet areas to help them remain cool and deter biting insects during summer months, so fresh wallows and tree rubs are good indications of swine loafing and sheltering in the area. Swine seek out shelter during the day under coniferous trees or dense vegetation in close proximity to shallow standing water.

Two methods of visual verification were used to document the presence of feral swine: trained staff sighting feral swine or with the use of electronic surveillance. Landowners were the best people to alert WS to the potential presence of feral swine as they are on site every day and have the highest probability

of seeing feral swine. Landowners also know their property best and are useful in identifying recent activity or damage.

Because feral swine are typically a nocturnal species, electronic surveillance proved to be a useful tool. For days when personnel were unable to be in the field or for sites that were hard to access, infrared trail cameras were indispensable. Feral swine have poor eyesight and rely primarily on their sense of smell which makes them sensitive to human presence. WS personnel were able to minimize human presence at trapping sites and monitor large tracts of land by using remote trail cameras. These cameras contain a wireless GPS modem which transmits images instantly to a private access web site. This allowed WS personnel to monitor feral swine activity without disturbing bait sites and to minimize travel expenses. With the use of trail cameras, feral swine movement patterns could be monitored, which aided in management efforts.

Removal Techniques

WS employed a variety of management techniques to remove feral swine. Trapping and shooting were the most used tools for feral swine removal. A management technique was selected based on six factors: number of swine frequenting the area, topography, vegetation density, time of the day the swine are frequenting the area, local features (e.g., wallows), and access to the site.

When implementing feral swine management, the objective is to capture the greatest number of individuals as quickly as possible. Swine are a gregarious species and tend to form sounders or family groups. When hunters shoot at them, individual swine in sounders disperse (Missouri Dept. of Conservation 2012). Not only are these large groups of swine then scattered across the landscape, they become more elusive and associate human presence with danger making it more difficult to manage them. Because of this scattering effect, the most effective way to eliminate whole sounder groups is by using a corral trap. A description of removal techniques including corral traps, cable restraints, and shooting, were described in the report *2010 Status of Feral Swine in New York State* (USDA 2010).

Carcass Disposal

Once feral swine were captured, dispatched, and sampled, the carcass was composted and buried. On occasion, the landowner requested the meat, and it was provided.

Disease Surveillance

WS accomplished disease surveillance by testing captured feral swine in New York for classical swine fever (CSF), swine brucellosis (SB), pseudorabies (PRV), swine influenza (SIV), and Hepatitis E Virus (HEV). Wildlife Services also deposited four aliquots from each feral swine sample into the WS National Wildlife Disease Program's Feral Swine Serum Archive (FSSA). A subset of archive samples was used to test for *Toxoplasma gondii*, *Trichinella spiralis*, and leptospirosis. Starting May 15, 2012, kidney samples were collected in counties already identified as seropositive for leptospirosis. A description of the sample collection and processing procedures were described in the report *2010 Status of Feral Swine in New York State* (USDA 2010).

RESULTS

Population Reduction

Trail cameras monitoring bait sites or travel corridors were instrumental in determining swine presence and visitation schedules. Two WS field personnel spent 668 hours scouting for swine sign, 171 hours performing lethal control, and 21 hours consulting landowners (Figure 1) (D. M. Hojnacki, J. T. Gansowski, and C. R. LaMere, USDA, APHIS, WS, unpublished data). During the project we monitored

48 locations in 3 counties and identified 43 individual swine, traveling either alone or in groups. During 2012, WS removed 40 feral swine in Onondaga County, 35 using corral traps and 5 by shooting from treestands. No feral swine were captured or killed in Cortland County or Tioga County. Only three swine were detected on trail cameras in Tioga County. Table 1 lists the sex and age demographics of feral swine that were killed in Onondaga County. All of these swine were removed during the months of April, May, and June in 2012.

- Onondaga County
  Wildlife Services routinely monitored 12 properties encompassing 6,120 acres in Onondaga County. Feral swine were seen or photographed on 5 of the 12 properties during the project. Damage caused by feral swine on these properties varied. WS personnel documented wallows, tracks, rooting damage in cornfields, hayfields, under wild apple trees, and in forested areas where native vegetation was destroyed. WS removed 40 feral swine from these properties.

  Three unique sounders were photographed in Onondaga County via trail cameras. The first sounder captured contained 1 adult sow and 17 subadults. The second sounder contained 2 adult boars, 2 adult sows, and 8 juvenile swine. The last sounder contained 10 subadult swine. Two weeks prior to WS personnel implementing management, a local farmer killed an adult sow from the third sounder. WS personnel removed all feral swine photographed by trail cameras in Onondaga County in 2012.

- Cortland County
  Wildlife Services monitored 13 properties for feral swine activity encompassing 8,520 acres in Cortland County. Two local farmers reported damage to crop fields and one farmer photographed a sounder of 10 subadults located near the Cortland/Onondaga County line. Within two weeks of being photographed, WS personnel captured this sounder in Onondaga County. Therefore, no feral swine were captured in Cortland County and WS personnel did not obtain any additional photographs of feral swine on trail cameras in Cortland County.

- Tioga County
  Wildlife Services monitored 10 properties for feral swine activity in Tioga County, totaling 2,474 acres along the Pennsylvania border. Extensive rooting in forested areas and damage to cornfields and hayfields was documented. Three unique pigs were photographed on 3 of the 10 properties. These swine consisted of an adult boar and sow traveling together and a lone adult boar. These swine are suspected of crossing the New York/Pennsylvania border several times during the summer of 2012. No other feral swine sightings were reported by landowners, many of whom noted that feral swine activity in the area had decreased since WS personnel have been performing feral swine management during the past several years.

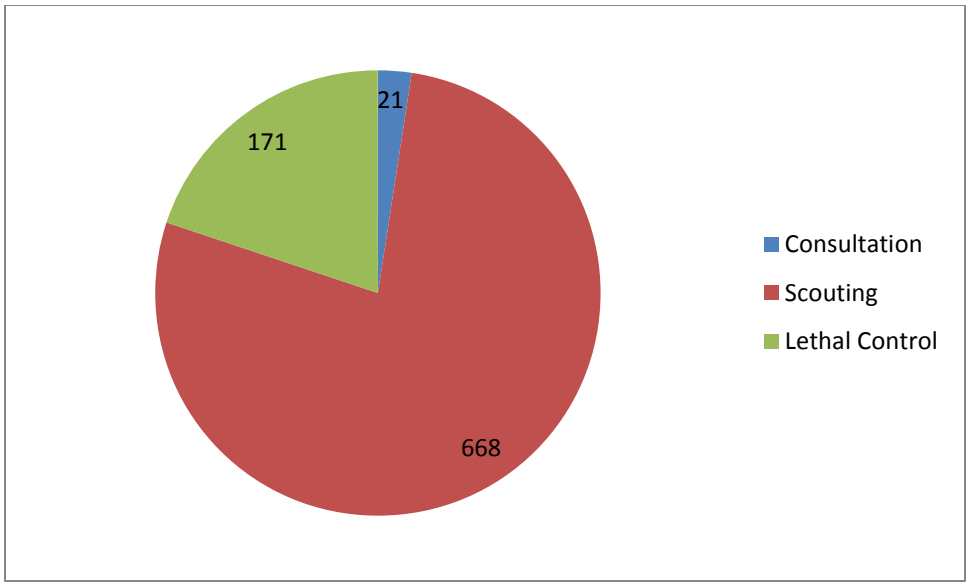

Figure 1. Distribution and number of hours spent in the field by Wildlife Services personnel during feral swine management in New York, 2012.

Table 1. Age and sex demographics of captured feral swine by Wildlife Services in Onondaga County, New York, 2012.

Feral Swine Removed	Onondaga County
Adult Female	3
Adult Male	2
Subadult Female	12
Subadult Male	15
Juvenile Female	2
Juvenile Male	6
Total	40

Disease Surveillance

Wildlife Services collected 28 feral swine samples from 2 counties in New York State. Test results were received from the National Wildlife Disease Program Data and Results Transmission website as results became available (Table 2). All of the feral swine samples from New York tested negative for CSF, PRV, SB, and HEV. One of the serum samples tested positive for leptospirosis. As of the publication of this report, the kidney sample is undergoing analysis to determine the specific strain of leptospirosis. Tests for *Toxoplasma gondii* and *Trichinella spiralis* will be performed subsequent to this report.

Table 2. New York feral swine sampling results for classical swine fever (CSF), pseudorabies virus (PRV), swine brucellosis (SB), and Hepatitis E Virus (HEV) from 1 November 2011 to 30 September 2012.

Collection Date	County	Subject ID	Age Class	Sex	CSF Results	PRV Results	SB Results	HEV Results
3-Nov-2011	Clinton	ID0001641	Sub-Adult	Female	Negative	Negative	Negative	Negative
3-Nov-2011	Clinton	ID0001642	Sub-Adult	Male	Negative	Negative	Negative	Negative
3-Nov-2011	Clinton	ID0001643	Juvenile	Female	Negative	Negative	Negative	Negative
16-Mar-2012	Clinton	ID0001644	Sub-Adult	Male	Negative	Negative	Negative	Negative
16-Mar-2012	Clinton	ID0001645	Sub-Adult	Female	Negative	Negative	Negative	Negative
13-Apr-2012	Onondaga	ID0001650	Sub-Adult	Female	Negative	Negative	Negative	Negative
13-Apr-2012	Onondaga	ID0001651	Sub-Adult	Male	Negative	Negative	Negative	Negative
13-Apr-2012	Onondaga	ID0001652	Sub-Adult	Male	Negative	Negative	Negative	Negative
13-Apr-2012	Onondaga	ID0001653	Sub-Adult	Female	Negative	Negative	Negative	Negative
13-Apr-2012	Onondaga	ID0001654	Sub-Adult	Male	Negative	Negative	Negative	Negative
13-Apr-2012	Onondaga	ID0001655	Sub-Adult	Female	Negative	Negative	Negative	Negative
13-Apr-2012	Onondaga	ID0001656	Sub-Adult	Female	Negative	Negative	Negative	Negative
13-Apr-2012	Onondaga	ID0001657	Sub-Adult	Female	Negative	Negative	Negative	Negative
13-Apr-2012	Onondaga	ID0001658	Sub-Adult	Male	Negative	Negative	Negative	Negative
13-Apr-2012	Onondaga	ID0001659	Sub-Adult	Male	Negative	Negative	Negative	Negative
8-May-2012	Onondaga	ID0001660	Adult	Female	Negative	Negative	Negative	Negative
10-May-2012	Onondaga	ID0014001	Adult	Male	Negative	Negative	Negative	Negative
10-May-2012	Onondaga	ID0014002	Adult	Female	Negative	Negative	Negative	Negative
10-May-2012	Onondaga	ID0014003	Juvenile	Male	Negative	Negative	Negative	Negative
10-May-2012	Onondaga	ID0014004	Adult	Male	Negative	Negative	Negative	Negative
10-May-2012	Onondaga	ID0014005	Juvenile	Male	Negative	Negative	Negative	Negative
10-May-2012	Onondaga	ID0014006	Juvenile	Female	Negative	Negative	Negative	Negative
23-May-2012	Onondaga	ID0014007	Sub-Adult	Female	Negative	Negative	Negative	Negative
23-May-2012	Onondaga	ID0014008	Sub-Adult	Male	Negative	Negative	Negative	Negative
23-May-2012	Onondaga	ID0014009	Sub-Adult	Female	Negative	Negative	Negative	Negative
24-May-2012	Onondaga	ID0014010	Sub-Adult	Female	Negative	Negative	Negative	Negative
24-May-2012	Onondaga	ID0014011	Sub-Adult	Male	Negative	Negative	Negative	Negative
24-May-2012	Onondaga	ID0014012	Sub-Adult	Female	Negative	Negative	Negative	Negative

IMPACTS AND THREATS IN NEW YORK

While the current population of feral swine in New York is relatively low and therefore damage is limited to small areas, the impacts will become more noticeable as the population grows and feral swine stake out home territories rather than roaming widely (Esch 2011). In an action plan developed for the state of Oregon, which also has a relatively small and dispersed feral swine population, Rouhe and Systma (2007) made the important point that the lack of major feral swine impacts in the state to date is not a good

predictor of the likelihood of impacts in the future. In fact, the presence of small feral swine populations for long periods prior to rapid population expansion is a common occurrence (Rouhe and Systma 2007).

As part of the feral swine management program in New York, the NYSDEC and Wildlife Services have removed 143 feral swine in a 4-county area between 2008 and 2012 (USDA 2012*a*). Feral swine have high population growth rates; high survival rates; young breeding age; and large litter sizes, allowing populations to expand at a rapid pace (Chavarria 2006). Wildlife Services estimated the size of the feral swine population stemming from those 143 feral swine if they had not been lethally removed by the two agencies using previously published information on reproduction, survival, and mortality. By presuming a 50:50 sex ratio in the population and an average litter size of 6 piglets per year with an 80% survival rate for piglets, WS estimated those 143 feral swine removed previously and their offspring could have produced over 10,000 swine in a 4-county area of central New York in six years (USDA 2012*a*).

In New York, there is a high risk of feral swine becoming established statewide. Feral swine are highly adaptable and can exploit a diversity of habitat types across the United States, including states with harsh winters such as Michigan and North Dakota (Chavarria et al. 2007, West et al. 2009). WS has determined through GIS analysis that 72% of New York presents suitable habitat for these invasive animals (C. R. LaMere, J. T. Gansowski, and D. M. Hojnacki, USDA, APHIS, WS, unpublished data). Feral swine have a high reproductive capacity and populations can quickly expand to colonize new areas (Wood and Barrett 1979, Waithman et al. 1999). If feral swine are not eliminated from New York, residents can one day expect to receive significant property damages similar to those experienced by residents of states with high feral swine populations such as Georgia and Alabama. The impacts that feral swine have had and potentially may have on the state of New York are presented in four categories: natural resource (ecological) damage, agricultural damage, property damage, and threats to human health and safety.

Natural Resource (Ecological) Damage

Predation and Resource Competition

Feral swine are opportunistic omnivores that negatively impact wildlife species through direct predation, competition for food, or destruction of habitat. They will compete for mast crops such as acorns (*Quercus* spp.) and beechnuts (*Fagus* spp.) with native wildlife, especially during years of poor mast production (Campbell and Long 2009). Mast crops are an important food source for white-tailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), black bear (*Ursus americanus*), and squirrels (*Sciuridae* spp.), and are the preferred food for feral swine (Mayer and Brisbin 2009). Each adult feral swine can consume up to 1300 lbs. of mast per year (Coblentz and Bouska 2005). They are highly efficient foragers that can exploit a food source in a short period of time. In 2011, one macadamia nut grower in Australia estimated feral swine consumed a quarter of his harvest, over 3 tons of nuts (Atkinson 2012). Feral swine are able to forage throughout the winter and obtain acorns and beechnuts that otherwise would have remained under the snow for use by wildlife during early spring (Mayer and Brisbin 2009). Wildlife Services in New Hampshire found that feral swine outfitted with radio collars traveled up to four miles during the winter to feed on beechnuts, which were frequently located through rooting behavior. Feral swine populations in oak woodlands of California were found to reduce acorn availability for native wildlife (Sweitzer and Van Vuren 2002). As noted in a previous report, USDA WS observed swine foraging activity in oak and American beech *(Fagus grandifolia)* stands in New York, indicating that feral swine are competing with native wildlife for important mast crops.

It is also understood that feral swine displace native wildlife such as white-tailed deer and wild turkey from desirable habitats because of their disruptive foraging behaviors and aggressive nature (Beach 1993, Kaller and Reed 2010). Reports of decreased white-tailed deer sightings by hunters in areas with feral swine in Tioga County, New York have led to increased cooperation with the Wildlife Services management program among landowners. This is consistent with the perceptions of residents that

responded to a feral swine survey in Georgia that attributed the decline in white-tailed deer, wild turkey, and northern bobwhite populations in part to feral swine abundance and activity (Mengak 2012). Further, 78% of participants in the Georgia study did not consider feral swine a welcome addition to the suite of big game species they can hunt.

Feral swine prey upon a diversity of animal species including small mammals, amphibians, reptiles, fish, white-tailed deer fawns, and invertebrates (Seward et al. 2004, Jolley et al. 2010). Many ground nesting bird species including wild turkey and ruffed grouse (*Bonasa umbellus*) are at risk from nest destruction and the consumption of eggs (Campbell and Long 2009). A north-central Texas study found that feral swine may have a detrimental effect on nesting success of northern bobwhite quail (*Colinus virginianus*), accounting for up to 28% of depredation in simulated nests (Tolleson et al. 1993). Consumption of wild turkey eggs by feral swine was found to negatively affect nest success in central Texas (Timmons et al. 2011). Feral Swine have also been documented preying on turkey poults (Wood and Lynn 1977). A recent study on Fort Benning Army Post in Georgia concluded that feral swine consume a substantial number of herpetofauna annually (Jolley et al. 2010). Researchers determined the feral swine population on Fort Benning could reasonably consume 3.16 million reptiles and amphibians per year.

Feral swine pose a distinct risk to threatened and endangered wildlife species. Notably, feral swine are known to consume the eggs and adults of several sensitive reptile species and have been implicated in extinction or severe reductions in these species (Coblentz and Baber 1987, Taylor and Hellgren 1997). In New York, feral swine have already been documented by Wildlife Services rooting out and consuming the eggs of Blanding's turtles (*Emydoidea blandingii*) in St. Lawrence County. The Blanding's turtle is a semi-aquatic turtle that is listed as threatened by NYSDEC and takes 18-22 years to become sexually mature (NYSDEC 2012*a*). The destructive habits of feral swine on nests and habitat combined with the slow reproduction rate of the Blanding's turtle have the potential to pose a survival threat to the species. In other parts of the U.S., feral swine have been observed consuming native freshwater mussel species and decreasing mussel populations through deposition of fecal coliform and pathogenic bacteria, which is of concern for New York's state and federally endangered dwarf wedge mussel (*Alasmidonta heterodon*) (Kaller et al. 2007, Zengel and Conner 2008). Dwarf wedge mussels occur in streams and rivers of slow to moderate velocity with substrates of silt, sand and gravel (NYSDEC 2012*b*). The only population of dwarf wedge mussels in the state and one of the largest populations remaining in the country is in the lower Neversink River in Orange County (NY Natural Heritage 2011). The breeding population of feral swine in Sullivan County is currently less than 20 miles from the Neversink River watershed in Orange County.

Disrupting Native Plant and Soil Communities

Much of a feral swine's diet is obtained by rooting, using their snout to overturn large amounts of soil in search of plant matter (e.g., roots, tubers, bulbs) and invertebrates (Mayer and Brisbin 2009). This foraging activity results in considerable damage to native plant and soil communities. In hardwood forests where rooting occurs the understory is absent, the herbaceous layer is eliminated, the litter layer is significantly reduced, and the surface organic soil horizons are mixed into one indistinguishable layer (Bratton 1975, Singer et al. 1984). The effects of this disturbance include accelerated decomposition rates and increased nutrient uptake resulting in a decrease in the amount of nutrients available in the system (Singer et al. 1984).

Forest regeneration is often compromised in areas affected by feral swine rooting and trampling. Rooting by feral swine in a beech forest in the Great Smoky Mountains was found to be so severe that recovery was unlikely to occur (Bratton 1975). In oak woodlands of California feral swine significantly reduced acorn survival and germination, and rooting activity likely reduced the survival of tree seedlings (Sweitzer and Van Vuren 2002). Rooting in longleaf pine (*Pinus palustris*) forests in the southeastern U.S. resulted in the destruction of 8,320 two-year-old pine seedlings per acre, with a single swine able to

destroy an acre of planted pines in a day (Hanson and Karstad 1959). Rooting and trampling disturbance can also threaten native plant communities by promoting the establishment and spread of invasive, exotic plant species (Kotanen 1997, Tierney and Cushman 2006).

In New York, Wildlife Services has documented the disruption or destruction of large areas of natural plant communities, leaving only bare, compacted soil where feral swine densities were high. As Wildlife Services reported previously, of the 6 plant species listed as threatened or endangered by the Endangered Species Act of 1973 in New York, 2 species are at direct risk from feral swine. Northern wild monkshood (*Aconitum noveboracense*) is a federally-threatened species found along stream banks in Ulster, Delaware, and Sullivan Counties (NYSDEC 2012*c*, USFWS 2012*a*), and over 90% of the U.S. population of American Hart's-tongue fern (*Asplenium scolopendrium* var. *americanum*) is found on moist soils in Niagara, Onondaga, and Madison Counties (NYSDEC 2012*c*, USFWS 2012*b*).

Water Quality and Wetlands

Ecological damage by feral swine is most pronounced in wet environments where damp soils may facilitate foraging for below-ground plant matter (Engeman et al. 2007). Feral swine rooting activity loosens the soil surface, accelerating erosion and increasing siltation in streams (Howe and Bratton 1975, Dunkell et al. 2011). Foraging by swine in wetland floodplains has resulted in increased turbidity, destruction of aquatic macrophytes, and expansion of bare ground and open water (Doupe et al. 2010).

In addition to rooting for food, feral swine wallow in or near water sources to keep cool and cover themselves in mud which they then rub on trees to reduce external parasites. Wallowing damages surrounding vegetation and increases sedimentation in waterbodies. Swine also defecate in and near the water, increasing levels of pathogenic bacteria and fecal coliform (Kaller et al. 2007, Timmons et al. 2011). In some areas, such as Plum Creek in Texas, water quality degradation by feral swine is so severe that the waterbody cannot support contact recreation (swimming and wading) or aquatic life (Timmons et al. 2011). Feral swine have also been implicated by the EPA as nonpoint sources of *Escherichia coli* (*E. coli*) bacteria in Buck Creek in Texas and fecal coliform bacteria in Flat Creek and Sweetwater Creek in the Florida panhandle (Bridger and Ralys 2009, EPA 2012). In each of these waterbodies levels of harmful bacteria were too high to support contact recreation.

In addition to precluding recreational use, feral swine populations can contribute to protozoal contamination of drinking water supplies, potentially causing outbreaks of water borne illnesses. Atwill et al. (1997) found that feral swine in western California shed the intestinal parasites *Cryptosporidium parvum* and *Giardia* spp. when they defecate in and around the margins of water bodies. They reported that under appropriate environmental conditions, feral swine may contaminate surface water supplies with these protozoa leading to additional water treatment requirements by municipalities. The odds of swine shedding these parasites increased with increasing densities of feral swine**.** Indeed, the New York City Department of Environmental Protection currently manages to protect New York City's drinking water supply from contamination by wildlife. The Catskill/Delaware and Croton watersheds supply New York City's drinking water, and most of the Delaware watershed lies within Delaware and Sullivan Counties. There is currently a breeding population of feral swine inhabiting these 2 bordering counties.

There is a breeding population of feral swine in the Skaneateles Lake watershed in New York's Finger Lakes Region. The lake is the source of drinking water for approximately 250,000 residents of Onondaga County and an estimated 1,000 lakefront residents have private intakes, although it is not known how many of those households use the intakes for drinking water (EPA 2010, Village of Skaneateles 2012). The lake water is of such high quality that the water suppliers operate under a filtration waiver with no expiration date, although chlorine is added as a disinfectant (City of Syracuse Dept. of Water 2012). Water quality protection is a high priority for stakeholders in the watershed; the Skaneateles Lake Watershed Agricultural Program provides environmental protection plans and financial assistance for

improvements to qualifying farms and the Skaneateles Lake Watershed Land Protection Program was a cooperative effort between the City of Syracuse Water Department and landowners in which conservation easements were purchased on 858 acres of environmentally sensitive land in the watershed to protect against new sources of pollution (EPA 2010, City of Syracuse Dept. of Water 2012). A feral swine population explosion in the watershed could confound much of the recent work that has gone into water resource protection. To be clear, Skaneateles Lake is a long way from the levels of water quality degradation occurring in waterbodies such as Plum Creek and Buck Creek in Texas, but small tributaries to the lake will endure significant impacts from a rapidly growing feral swine population. As reported previously, Wildlife Services has observed feral swine wallows, or areas of rooting, in and around 1st order streams, seeps, and springs.

Another breeding population of feral swine in the state is located in Clinton County on the eastern edge of the Adirondack Park and there have been escapes from a shooting facility in St. Lawrence County outside the northwest corner of the Park. The water resources of the Adirondacks are vital to the Park, as the forest preserve was initially created in part to protect the major watersheds of the state. The objective set by the State of New York's Adirondack Park State Land Master Plan (2011) of maintaining high water quality could be difficult to sustain with a rapidly growing population of feral swine in the Park.

The loss of wetlands from feral swine rooting, trampling, and wallowing is of conservation concern in the Adirondack Park and statewide. As previously reported, Wildlife Services documented feral swine damage in ephemeral pools, on pond edges, or in small wetlands in the three counties where swine were trapped. It is difficult to measure the value of wetlands in economic terms, but careful study into the public's "willingness to pay", i.e., the amount of money people are willing to spend to restore different types of wetlands, allows researchers to place a monetary value on acres of wetlands damaged by feral swine (Engeman et al. 1997, King 1998). Using methods similar to Engeman et al. (2007), WS estimated the monetary value of wetlands in New York based on a report to the EPA in 1997 for the northeastern U.S. (King 1998). Because it is not known which freshwater wetland type in New York receives the most damage from feral swine, the lowest "willingness to pay" value per acre was used, which was for the emergent wetlands type. After adjusting for inflation (BLS 2012), a conservative estimate of the value of restoring wetlands lost to feral swine damage in New York would be approximately $62,970.10 per acre. Using the Environmental Protection Agency's estimate of 1 feral swine destroying 10 acres of wetland in its lifetime, the 40 individuals culled from the population in 2012 represented a potential $25,188,040 worth of damage to wetlands in the state.

If the feral swine breeding populations in New York State were allowed to grow unchecked, natural resource damage documented in other parts of the U.S. would soon be occurring on our landscape on a much larger scale than at present.

Agricultural Damage

Crop Damage

The economic costs associated with feral swine damage are most severe in the agricultural sector. Agricultural crops are a highly preferred food item when available, making up to 71% of the plant material in a feral swine's diet (Schley and Roper 2003, Mayer and Brisbin 2009). While feeding on crops, swine also trample them which often causes more damage to the harvest than direct consumption (Schley and Roper 2003). Because feral swine often travel in family groups, damage from rooting and wallowing can be extensive and encompass several acres. A single group of feral swine can destroy a 10-acre cornfield in less than a week (Gates 2012). A 2007 study calculated that feral swine are causing at least $1.5 billion in crop damages and control costs annually in the U.S. (Pimental 2007). According to a 2011 survey in Georgia, the average loss due to feral swine on agricultural land was $12,646 per property

(Mengak 2012). The statewide estimate for crop damage and crop related damage for 2011 in Georgia was over $57 million (Mengak 2012).

In 2011, New York ranked 5th in the nation in both the value of production ($328,470,000) and the total area harvested (58,530 acres) of fresh market vegetable crops (USDA 2012*b*). The USDA based these rankings on 27 vegetable commodities including snap beans, cabbage, sweet corn, cucumbers, onions, pumpkins, squash, tomatoes, cauliflower, and strawberries, among others. All of these crops are at risk of damage by feral swine. Additionally, the most common crop damage by feral swine in New York to date has been to corn and forage crops. These damages have the potential to be costly considering the amount of land in the state used to produce these crops. The harvested area of sweet corn, corn for grain and corn silage in New York in 2011 was over 1.1 million acres, and forage crops totaled over 2.4 million acres (USDA 2011).

Looking to Alabama as an example of a state with an expanding feral swine population, an estimated $3,760,000 in soybeans and $49,281,000 in corn were lost to feral swine in that state in 2009 (Shi et al. 2010). In addition to row crops, feral swine also damage pastures, land used for hay, and sod farms by their rooting and wallowing activities (Beach 1993). New York has over 3 million acres of forage hay worth an estimated $312 million (USDA 2011). Hay is an important feed crop in New York and supports many agricultural industries.

The 4 breeding populations of feral swine in New York are relatively small. However, farmers have already sustained damage in each county where swine occur, with more incidents likely going unreported. In Cortland and Onondaga Counties, Wildlife Services documented rooting damage to apple orchards and pastures and to fields of corn, oats, soybeans, pumpkins, wheat, and hay. Total feral swine damage to properties in Cortland and Onondaga Counties was estimated to be greater than $15,000 involving 34 acres of damaged crops. A single landowner received $12,000 worth of damage to corn, oat, and hay fields. In Tioga County, damage to pastures and fields of corn, oats, and hay have been documented. In one incident in Tioga County, feral swine destroyed 15 acres of field corn, with a replacement cost of $3,667. In Delaware County, a cattle farm reported damage to 11 acres of corn planted for silage at an estimated loss of $14,850 (Westenbroek 2011). A dairy farm in Sullivan County sustained damage to pastures at an estimated loss of $1,000. A farm in Clinton County reported approximately $25,000 in damage to sweet corn, apples and strawberries due to feral swine (Hall 2012). It is important to note that damage effects may be more subtle than a lost harvest, taking the form of wasted fertilizer, tractor time and operator time (Mengak 2012). These secondary losses from feral swine are difficult to quantify, but may be significant to individual landowners.

New York ranks fourth in the country in milk production with 5,700 dairy farmers operating statewide. Damage to feed crops could impact the grain production industry for feeding livestock and cause negative repercussions in secondary industries from milk production including cottage cheese and yogurt (NYSDAM 2011). Dairy farming and processing is a major contributor to New York's economy, adding $8.9 billion in 2011 (Dairy Today 2012). Corn appears to be the most preferred agricultural crop by feral swine when it is available (Schley and Roper 2003). The WS program in New York has documented feral swine rooting corn seed out of the soil immediately following planting, consuming corn seedlings, and knocking down mature plants and consuming corn from the ears. Some dairy farmers in the state have expressed concern over the risk of planting corn for livestock feed when feral swine inhabit their property and have damaged crops in the past. Wildlife Services has worked with these individuals to remove feral swine on their property, preventing loss of planted corn. Based on crop damages and control costs of about $300 per swine annually, the 40 feral swine killed by WS this year represented $12,000 in losses to local farms for the year 2012 alone (Pimental 2007).

The economically important wine and grape industry in New York State is also poised to incur damages by feral swine. Grape growers in Texas and California have reported problems with feral swine damaging vines and rooting up plants resulting in administration of costly lethal control efforts (Kane 2010, McCoy 2012). Expanding feral swine populations can cause economic losses in vineyards to increase rapidly; in the Hérault area of southern France compensation paid to vineyards for damage by wild boar increased from $31,352 (U.S.) in 1990-1992 to $700,890 in 1993 (Calenge et al. 2004). The New York wine production industry has recently grown to be the third largest wine producing state in the country with a $3.76 billion economic impact from nearly 1,400 vineyards statewide (NYS Governor's Office 2011). With a breeding population of feral swine and about a third of the state's wineries, the Finger Lakes Region in central New York could experience setbacks to the recent growth of wine production if feral swine expansion continues.

Livestock Health Risks

- **Depredation and Injury**
  In addition to crop damage, agricultural losses from feral swine can involve livestock depredation and injury, and disease transmission. Predation occurs primarily on young livestock but feral swine can also kill weakened or injured livestock (Kaller and Reed 2010, Stevens 2010). In Texas, feral swine have been known to prey on lambs, adult sheep, kid goats, adult goats, and calves (Beach 1993). Feral swine are efficient predators and often remove and consume newborn animals before they are accounted for by producers. Beach (1993) reports that with such little evidence left of predation, resource owners may overlook feral swine predation as a cause for low production. Feral swine have also been observed chasing down and preying on lambs in Australia (Pavlov and Hone 1982). In Georgia and Tennessee, feral swine have been reported to enter barnyards, inflict wounds on domestic boars and breed with domestic sows (Hanson and Karstad 1959). Due to disease and parasite risk from exposure to feral swine, this interaction often results in economic losses to the producer (Coblentz and Bouska 2004). Though rare, damage and attempted damage to livestock have been documented in New York. In Tioga County, feral swine have damaged fences and animal enclosures. In Sullivan County, feral swine broke through a fence and into a barn, attacking and injuring a domestic brood sow. Due to possible disease exposure, the owner took the animal out of production resulting in lost revenue.

- **Disease Transmission**
  At least 30 diseases and 37 parasites transmissible to people, domestic animals, and livestock have been documented in feral swine (Seward et al. 2004). The ability of feral swine to move freely across the landscape makes them effective agents of disease and parasite transmission, and livestock that share an interface with feral swine at water sources and fence lines are particularly vulnerable (Mason et al. 1998, Witmer et al. 2003). In 2012, there were 66,000 domestic hogs and pigs in New York, and 66.3 million in the U.S. (USDA 2013). Since feral swine and domestic pigs are the same species, the largest concern for disease transmission is to domestic swine raised in fenced enclosures, also called transitional swine. The following is a partial list of diseases that would be highly detrimental to the livestock industry if transmitted to domestic herds from feral swine:

  - *Pseudorabies* is a viral disease that primarily occurs in pigs, causing infertility in adults and death in piglets. The disease also infects other domestic and wild animals; dogs, cats and wildlife survive only 2-3 days after becoming infected. Pseudorabies is highly infectious and can persist in aerosol form for up to 7 hours with the ability to travel over a mile in air currents. The virus can also survive up to 7 hours in well water, 2 days in grass, soil, feces and shelled corn, and 4 days in straw bedding (Kahn 2009). This disease is considered a threat to the well-being of the commercial pork industry and approximately $200 - $250

million has been spent to achieve pseudorabies-free status in the U.S. (Hutton et al. 2006). Expensive and time consuming eradication programs involve destroying whole herds, segregating offspring, and testing and removal strategies (Kahn 2009). These procedures combined with shipping and marketing restrictions would add up to large economic costs for pork producers if the pseudorabies virus were reintroduced (Witmer et al. 2003). Feral swine may jeopardize the 17-year effort to eliminate the disease in domestic swine herds (Hutton et al. 2006).

- *Swine influenza virus* is a highly contagious, respiratory disease that occurs in pigs worldwide. The virus spreads quickly through the herd with no effective treatment. Symptoms of infection include fever, anorexia, coughing, trouble breathing, weakness, and occasionally death (Kahn 2009).

- *Swine brucellosis* is a highly infectious bacterial disease that is similar to bovine brucellosis in cattle. It is passed through breeding and ingestion of bacteria. This disease causes reduced fertility in boars and abortion or production of weak piglets in sows (Neumann et al. 2009). Infection can also cause lameness and arthritis. This disease is considered a threat to the pork industry with millions of dollars spent each year to detect and prevent outbreaks. Similar to pseudorabies, entire herds may need to be destroyed once infection occurs and costly marketing and shipping restrictions are sustained (Witmer et al. 2003). Feral swine remain a reservoir for the disease and a source of exposure to domestic herds, complicating the eradication program and jeopardizing the commercial swine industry (Neumann et al. 2009, Pederson et al. 2012). Cattle in close contact with infected swine can acquire swine brucellosis which causes a false positive test for bovine brucellosis (Timmons et al. 2011). A positive test for bovine brucellosis results in economic losses for the producer when the herd is quarantined or destroyed. Since the National Brucellosis Eradication Program began in 1934, $3.5 billion has been spent on eradication measures (Bittner 2004).

- *Porcine reproductive and respiratory syndrome virus (PRRS)* is a viral disease considered to be the most economically important disease to affect swine production in the U.S. since the eradication of classical swine fever (Neumann et al. 2009). PRRS causes reproductive impairment or failure in breeding pigs and respiratory disease in pigs of any age. This virus can persist for over 200 days in its host, making eradication problematic and expensive. Some methods for dealing with a PRRS infected herd include destroying whole herds and repopulating them with PRRS-free stock, or isolating the herd for 200 days with appropriate biosecurity measures to prevent re-infection (Neumann et al. 2009). There is no single control strategy for PRRS due to variation in the virus, large swine populations, and unidentified routes of transmission.

- *Leptospirosis* is a disease caused by a bacterial infection and is found in domestic and wild animals worldwide. It is usually acquired by contact with urine and less commonly by intake of urine-contaminated feed or water. The bacteria species that cause this disease can survive for extended periods in surface waters, such as swamps, streams, and rivers. Infections in pigs most often result in the abortion of fetuses, and in other livestock and dogs it may also cause fever, weakness, anemia, kidney failure, and death (Kahn 2009).

- *Cholera*, *trichinosis*, *porcine parvovirus*, *classical swine fever*, and *African swine fever* are additional diseases that can be transmitted between livestock and feral swine. Feral and domestic swine are also susceptible to many parasites including nematodes such as the one that causes trichinosis, roundworms, and flukes as well as lice and ticks (Witmer et al. 2003, Neumann et al. 2009).

All of the diseases described in detail here have been detected in feral swine populations in the U.S. Disease surveillance efforts have detected pseudorabies in feral swine populations throughout the country including Texas, Hawaii, Florida, Georgia, and other southeastern states with a range of prevalence rates (Witmer et al. 2003). As part of the National Wildlife Disease Program, WS developed a project to detect the prevalence of brucellosis by sampling feral swine from 35 states from March 2009 to December 2010. Positive tests for brucellosis were found in 13 of the 35 states tested in this project including Kansas, North Carolina, Oklahoma, Missouri, and Arkansas to name a few (Pederson et al. 2012). Separate from that monitoring project, brucellosis was found in Iowa after a pork producer contracted the disease from his herd which had acquired it from a feral boar. The producer's swine had been suffering abortions for 6 months as a result of infection. The depopulation and compensation costs for this incident totaled approximately $60,000, without including lost productivity or medical costs (Hutton et al. 2006). According to the Texas Animal Health Commission (2013), Texas is currently classified as free of swine brucellosis for large commercial herds, but infection is still found in smaller operations and is usually the result of exposure to feral swine. Leptospirosis has been detected in Tennessee, Texas, and Oklahoma and PRRS and swine influenza have been found in Oklahoma as well (Saliki et al. 1998, Witmer et al. 2003).

In New York, the WS program participates in the National Wildlife Disease Surveillance Program and has tested 89 feral swine for various diseases between June 2008 and June 2012. Of those tested, 10 of the feral swine tested positive for disease: five with leptospirosis, two with pseudorabies and two with swine influenza. Additionally, one feral swine tested positive for the parasite *toxoplasma gondii*.

Property Damage

Feral swine turn over sections of sod when rooting for food in greenspaces such as lawns, sports fields, and golf courses. Repairing this type of damage can be costly as groups of feral swine can overturn large areas in a short amount of time leaving bare ground vulnerable to erosion. These types of property damage are increasing in frequency in states where growing feral swine populations are moving into populated areas adjacent to adequate habitat (Higginbotham 2012). In a recent study in Texas, respondents to a survey reported an average economic loss due to feral swine damage of $7,515 over the lifetime ownership of their land (Adams et al. 2005). Some New York landowners in counties with feral swine populations have already suffered costly damage to their lawns. Although cost estimates from property damage are not often reported, WS documented two instances of damage to lawns in Sullivan County that amounted to an estimated $400 each in repair costs. Feral swine have also been known to attack domestic dogs, and there have been two separate incidents reported in Tioga County. In one instance the pet dog was killed, and in the other the dog survived with injuries.

Rooting in pastures and fields creates depressions and mounds of soil that may not be visible to equipment operators (Beach 1993). Farm machinery is often damaged when running over rooted areas, resulting in increased costs and lost productivity (Wood and Lynn 1977, Coblentz and Bouska 2004, Graves 2010).

Wildlife food plots planted to attract native game species can receive significant damage by feral swine (Hanson and Karstad 1959, Mayer and Brisbin 2009). Over 70% of respondents to a feral swine damage survey in Georgia reported damage to their wildlife food plots (Mengak 2012). In 2012 the WS program in New York observed feral swine damaging a food plot that was planted for white-tailed deer in Tioga County.

Vehicle collisions with feral swine are another costly source of property damage. According to a feral swine-vehicle collision study conducted in South Carolina, most collisions involved one animal, but

individual accidents involving groups of up to 7 feral swine were also documented (Mayer and Johns 2011). Of the 179 feral swine-vehicle collisions analyzed in the study, the average vehicle damage estimate was $1,173. The projected cost of vehicle collisions with feral swine in the U.S. could be as high as $36 million annually (Mayer and Johns 2011). As populations of this invasive species continue to increase, costly vehicle collisions are becoming more commonplace (Burns 2009, Mildenberg 2012).

Human Health and Safety

While rare, feral swine attacks on humans do occur (Gunduz et al. 2007, Moore 2008, Associated Press 2012). Feral swine, like many animal species, may react aggressively when they perceive humans as a threat, e.g., being surprised to their presence or lacking an apparent route of escape. However, the more pertinent threats to human safety by feral swine are from vehicle collisions and disease and parasite transmission.

The heavy body mass (up to 400 lbs.) and relatively low center of gravity of feral swine constitutes a safety hazard for vehicle collisions (Mayer and Johns 2011). Further, feral swine are difficult to see in a roadway at night because they are usually dark in color and they lack the eyeshine that reflects light from headlights that other mammals have (Higginbotham 2012). Vehicle collisions with feral swine have resulted in personal injury and death in other states (Mayer and Johns 2011). In New York, there have been 5 feral swine vehicle collisions reported in recent years, though officials believe that some go unreported.

Zoonotic diseases are diseases that can be passed from animals to humans. Brucellosis, leptospirosis, salmonellosis, toxoplasmosis, trichinosis, tuberculosis, and tularemia are some of the zoonotic diseases that can be carried by feral swine (Mason et al. 1998, Seward et al. 2004, Stevens 2010). When humans are infected with brucellosis it is characterized by a fluctuating body temperature and accordingly called undulant fever. Some symptoms of leptospirosis in humans include fever, chills, and vomiting. Hunters can contract leptospirosis by handling tissue, blood, or urine of infected feral swine and people can potentially pick up the bacteria after it is shed in water and mud by feral swine (Mason et al. 1998). As with other diseases contracted by humans from feral swine, symptoms associated with undulant fever and leptospirosis are similar to the common flu and infections likely go unreported or are misdiagnosed (Hutton et al. 2006).

An Iowa pork producer contracted brucellosis from his domestic swine herd after they were infected by a feral swine (Hutton et al. 2006). Hunters have contracted brucellosis from field dressing feral swine in Texas, Florida, and South Carolina (CDC 2009, Herriman 2009). In Florida, health officials reported that 7 of the 9 human cases of brucellosis in 2010 were linked to the hunting and handling of feral swine (Florida Department of Health 2011). Recently, officials from the Centers for Disease Control and Prevention (CDC) issued a warning to feral swine hunters to protect themselves from brucellosis (CDC 2012). Hunters are advised to avoid direct contact (bare skin) with fluid or organs from the animal when cleaning and handling feral swine carcasses.

Infections caused by *E. coli* bacteria have also been linked to feral swine. An outbreak of *E. coli* in 2006 that caused illness in 200 people and the death of three people nationwide were attributed to feral swine depositing feces on spinach fields in California (Nordqvist 2006, FDA 2007). In a Texas study, 57% of feral swine tested in one small area had strains of *E. coli* which could be pathogenic to humans (Bodenchuk 2008). As mentioned previously in this report, feral swine can shed the intestinal parasites *Cryptosporidium parvum* and *Giardia* spp. when they defecate in and around the margins of water bodies. This could cause outbreaks of water borne illness under the appropriate environmental conditions (Atwill et al. 1997).

DISCUSSION

Management Challenges

Reducing feral swine populations can be challenging, logistically and socially. One of the most common challenges Wildlife Services encountered was human traffic near traps or baiting sites. Feral swine are a novelty to hunters in New York, and many hunters express a personal interest in hunting or trapping them. Private internet forums direct hunters, trappers, and wildlife watchers interested in feral swine to Hewitt State Forest, located at the center of the project management area in Cortland and Onondaga Counties. WS personnel took extra effort to set up trap locations that were hard to access to discourage human activity. Further, WS personnel worked with landowners, keeping them informed whenever hunters trespassed on their property. As a result, unauthorized human activities near baiting sites were eliminated, increasing trap success.

Non-target species were attracted to baiting sites and hindered trapping efforts. On several occasions raccoons (*Procyon lotor*) consumed all the bait, leaving nothing to attract feral swine. Trail cameras also photographed raccoons and feral swine feeding together at bait sites. Trail camera pictures documented raccoons, skunks (*Mephitis mephitis*), opossums (*Didelphis virginiana*), grey fox (*Urocyon cinereoargenteus*), red fox (*Vulpes vulpes*), coyote (*Canis latrans*), turkeys, deer, crows (*Corvus brachyrhynchos*), songbirds, red squirrels (*Tamiasciurus hudsonicus*), gray squirrels (*Sciurus carolinensis*), chipmunks (*Tamias striatus*), feral cats (*Felis catus*), bobcats (*Lynx rufus*), black bear, and elk (*Cervus canadensis*; escaped captives) all feeding at or crossing bait sites.

To avoid bait and trap site disturbance, accidental or otherwise, by hunters, WS modified trapping practices during hunting seasons. In May 2012, WS limited field activities to afternoons and evenings to minimize public visibility during spring turkey hunting. In coordination with DEC Region 7, WS continued baiting at sites where corral traps were assembled prior to hunting season and there was no potential conflict with turkey hunters. And in October, all field operations ceased when New York State's deer season opened.

Shooting preserves, both in and out of state, can be a source of feral swine damage to New York. Coincidentally, there is a Pennsylvania shooting preserve with Eurasian boar that shares a property boundary with the Tioga County (New York) border. A Tioga County landowner has photographic documentation of a feral boar on his property. Additional Tioga County properties that reported feral swine damage are also adjacent to the state border.

Future Feral Swine Management in New York

There are 4 breeding populations producing litters averaging 4 to 6 piglets in 6 counties of New York (Figure 2). Future population reduction in these areas is critical to prevent the further expansion of feral swine in the state. In the absence of aggressive professional management these populations will likely continue their expansion and become firmly entrenched in New York State. Once established, feral swine populations are difficult to eliminate (Waithman et al. 1999). Current feral swine populations in New York are low, offering the possibility of elimination with timely management efforts.

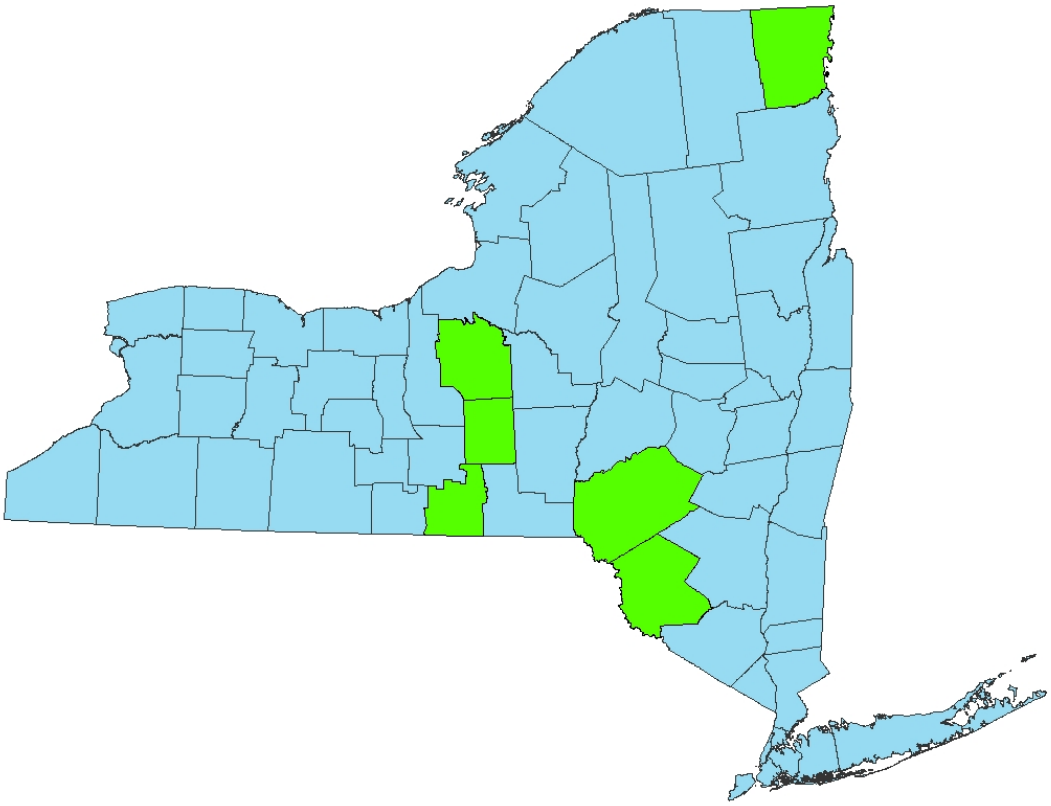

Figure 2. Counties in New York State with breeding populations of feral swine (in green): Clinton, Cortland, Delaware, Sullivan, Onondaga, and Tioga Counties. These counties represent 4 breeding populations.

Through newspaper articles and feral swine management presentations, the public and cooperators are becoming more informed on the damage that swine can cause. In recent years, television shows have increased public awareness of swine geographic distribution and methods of feral swine management. It is important to continue public education on the agricultural, ecological, and economic damage feral swine can cause.

Through outreach efforts, NYSDEC and Wildlife Services are able to enhance detection and information gathering. NYSDEC has provided an online report for the public to report information about feral swine, and this information is shared with WS. Further, WS has established and maintains local agency and public contacts across all regions of New York State where feral swine populations are present. These sources of information are valuable as current and historical information that will be important for future management of feral swine.

The most effective and efficient way to eliminate feral swine is by managing whole sounder groups. Whole sounder management involves conditioning family groups of feral swine to frequent a specific location so they can be eliminated in a single control action, usually trapping. It can take weeks of pre-baiting before feral swine are suitably conditioned to the trap site. In New York, WS recorded sounder sizes of 10, 12, and 18 feral swine in 2012. If, while these sounders were being baited to a control location, a hunter killed one or two of the animals, the rest of the group would scatter to new areas beginning the lengthy elimination process all over again (Missouri Dept. of Conservation 2012). Trapping a whole sounder is the most effective way to eliminate large numbers of swine from the

landscape without dispersing them. Feral swine management activities are best performed by a public agency to ensure that the state's management goals are not compromised by competing interests.

Several states have attempted to eliminate feral swine by encouraging hunting, which has proven unsuccessful in each instance. Rather than having the intended effect of reducing feral swine numbers, open hunting seasons with little or no regulations have expanded the populations through intentional releases by hunters. While the majority of the hunting community may understand the severe economic and environmental threats that feral swine pose, it only takes a few imprudent individuals to spread the problem across the state in a short period of time.

Wildlife Services in New York recently completed an Environmental Assessment for feral swine damage management in the state and included a detailed summary of the feral swine population reduction efforts carried out in other states (USDA 2012*a*). This assessment highlighted the fact that in states such as Texas, Alabama, and California, the popularity of feral swine as a game animal has resulted in intentional releases of feral swine by people, expanding their populations and hampering damage management efforts (Ziven et al. 2000, Wolf and Bartz 2009). The Environmental Assessment describes population reduction efforts in Tennessee as follows:

> In Tennessee, when feral swine hunting was expanded to allow hunting statewide, wildlife managers began to see an increase in feral swine populations throughout the state, as well as feral swine appearing in locations where they had not previously existed (Anderson and Yoest 2012). As a result, there is no longer a statewide hunting season for feral swine in Tennessee. The state has determined that "Unfortunately, sport hunting is not an effective way to keep wild hog populations from spreading. In fact, it's being proven nationally that sport hunting opportunities lead to the further spread of hogs into new areas" (Tennessee Wildlife Resources Agency 2012).

The conclusions to be drawn from analyzing the feral swine management programs in other states were summed up in the WS Environmental Assessment for New York (USDA 2012*a*):

> States that have successfully prevented feral swine populations from becoming established have done so by reacting swiftly while populations were still low, such as Kansas and Oregon (Rouhe and Sytsma 2007, Biles 2011). The success of these states is attributed to legislation that halted the release or escapes of domestic swine and facilitated the removal of feral swine from public and private land (Rouhe and Sytsma 2007). States that have made it illegal to hunt feral swine (Kansas) or made it illegal to keep Eurasian wild boar (Wisconsin) have had some of the greatest population reductions (Spratt 2010, Durban 2011). Kansas wildlife biologists credit much of their success to preventing hunting of feral swine populations (Spratt 2010).

Even without intentional releases of feral swine, sport hunting alone would not be sufficient to keep populations from growing. In Texas an estimated 29% of the feral swine population was harvested in 2010. According to models created by Timmons et al. (2012), at that harvest rate the population would double approximately every five years. An annual harvest of 66% is required to hold a population stable with no growth, and it has been shown that nationwide, hunting typically removes an average of 24% of the population (Burns 2011).

In addition to elimination of the existing feral swine populations in New York, preventing future releases or escapes of Eurasian wild boar-type swine is necessary. Escape of swine from shooting preserves, breeding facilities, and intentional releases of swine by hunters interested in pursuing them in New York are factors that need to be addressed if the elimination efforts in the state are to be successful. With the

proper legislation in place to prohibit the sale, possession, or transportation of feral swine, elimination is a feasible goal for New York State.

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