Feral Hog Control Efforts on a Coastal South Carolina Plantation

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Abstract: During a 19-month intensive control program 589 feral hogs (*Sus scrofa*) were removed from 4,500 ha of forest-marsh habitat in the lower Coastal Plain of South Carolina. Of 112 adult females removed, 66 were pregnant, 79 were lactating, and 44 of these were pregnant and lactating. Of 43 females in the 6–11 months age class, 34 had conceived at least 1 litter by the time of death and 9 had conceived twice. Litter size in 45 females was 5.0 ± 2.3. Cost per animal removed was $54. A substantial number of animals remained in the habitat after the program was terminated. Incidence rates for swine brucellosis and pseudorabies were 13.3% and 9.7%, respectively. Where feral hog population densities are substantial, herd reduction efforts must be intensive and continuous until the goal is reached.

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Feral hog populations are distributed across the Southeast (Wood and Lynn 1977). These populations can adversely affect a wide array of plant communities (Wahlenberg 1946, Lucas 1977, Springer 1977, Wood and Brenneman 1977, Lipscomb 1990). Southern forest managers typically believe that feral hogs can adversely affect native wildlife through competition for hard mast (Wood and Lynn 1977). Numerous observers have indicated their belief that hogs adversely affect wild turkey (*Meleagris galapavo*) habitat (Hewitt 1967). Reports of serious problems with feral hog depredation on lambs in Australia (Pavlov and Hone 1982) and a food habits study by Wood and Roark (1978) suggested that hogs may prey on white-tailed deer fawns (*Odocoileus virginianus*). A wide array of vertebrate and invertebrate species have been found in feral hog stomachs (Hanson and Karstad 1959, Springer 1977, Wood and Roark 1978). Recently, studies by the Georgia Department of Natural Resources indicated that feral hog depredations resulted in the loss of 80% of sea turtle nests on Ossabaw Island (J. Kurz, pers. commun.).

One of the most serious problems with feral hog populations is their potential as disease reservoirs. Hone (1987) listed 6 important diseases associated with feral hogs in Australia. Wood and Barrett (1979) listed 5 diseases known to occur in feral hogs in the United States and that were contractible by humans or domestic livestock. Swine brucellosis has been reported in feral hogs in South Carolina and Florida (Wood et al. 1976, Becker et al. 1978), as has pseudorabies (H. N. Becker cited in Wood and Barrett 1979, G. W. Wood, unpubl. data). The most recent evidence of substantial concern for wild hog populations as disease reservoirs is provided by the 1989 Feral Pig Symposium which was focused on disease potential (Livestock Conserv. Inst. 1989) and a U.S. Department of Agriculture bulletin prepared by the Southeastern Cooperative Wildlife Disease Study that indicated wild pigs may be a hidden danger for farmers and hunters (Anon. 1991).

Although the feral hog is an exotic species and the literature is replete with references on its potential pest nature, an interest in the animal as a game species continues to exist in the Southeast. We present a case history of efforts to control a feral hog population in the lower Coastal Plain of South Carolina. The documentation of extraordinarily high annual reproduction, incidence of diseases of economic importance, and program costs should be helpful to southeastern wildlife management decision-makers.

History of the Hobcaw Barony Herd

The history of feral hogs on Hobcaw Barony appears to have paralleled that of populations in other southern Coastal Plain areas. The first wild hog herds came from domestic swine introduced by Spanish explorers and colonists in the early 16th Century (Towne and Wentworth 1950). Hogs, either abandoned or escaping captivity, adapted well to the coastal forest-marsh landscape. Populations thrived so well that the Native Americans harvested and sold pork in the 16th and 17th centuries (Hanson and Karstad 1959). Later, free-range practices resulted in populations of feral hogs being widely distributed across the South.

On rice plantations of coastal South Carolina and Georgia it is unlikely that hog populations were allowed to reach substantial size during the rice culture period, mid-1700s to 1865. Hogs would have been totally incompatible with rice culture, and rice was the primary economic commodity. However, as rice culture disappeared between 1865 and about 1900, subsistence agriculture replaced the tightly controlled management of plantation days.

Williams and Lipscomb (1983) showed that only 3 stands of longleaf pine were regenerated on Hobcaw Barony subsequent to 1900. These lands were subjected to fire regimes that should have been conducive to longleaf pine regeneration but feral hogs are notorious for destroying longleaf seedlings. Using the lack of longleaf regeneration success as an indicator, the hog population likely reached a very high density by the early 1900s, and continued to remain at a high level with possible short-term fluctuations until the mid-1970s. Clemson University forester A. T. Shearin (pers. commun.), stationed at Hobcaw from 1969 to 1974, speculated that the herd was reduced in size by perhaps two-thirds in the early 1970s by the plantation manager. Wood and Brenneman (1977) described the herd condition based on extensive research which began in 1974. By 1981, the herd was thought to be at about one-third to one-half of its mid-1970s level and herd control was stopped by administrative order. By June 1983 (G. W. Wood, unpubl. data) the herd was thought to have increased by at least 5-fold. That there had been a great increase in both hog numbers and rooting damage was obvious to all observers.

Control efforts were renewed in 1984. D. J. Lipscomb (pers. commun.) reported removing 313 hogs in 1984, 125 in 1985, and 67 in 1986. Possibly the most significant loss of hogs in this period, however, resulted from a winter die-off in 1984. There was a major acorn failure in fall 1983, and the population went into one of the coldest winters on record with little to no fat deposits which might serve both metabolic and thermal conservation needs. The relative size of the die-off was not estimated.

An intensive control effort began 2 January 1987 and ended 31 July 1988 with the removal of 589 animals. A less intense control program was instated 1 August 1988 and continued until April 1990 when all control efforts were stopped by administrative order. During the last control effort 233 animals were removed, but no data were taken on the animals. Between fall 1983 and spring 1990, 1,317 hogs were removed from Hobcaw Barony. Feral hogs, although low in number, were still extant on the property.

Methods

Study Area

Hobcaw Barony is a 7,000-ha plantation located about 3 km east of Georgetown, South Carolina. It is at the end of a peninsula known as the Waccamaw Neck and is bounded to the west and south by Winyah Bay and to the east by the Atlantic Ocean. About 3,000 ha are forested, 3,000 ha are saltmarsh, and 1,000 ha are freshwater, brackish marshes, and abandoned ricefields. Feral hogs used about 4,500 ha of the saltmarsh-forest interface, forest, abandoned ricefield, and freshwater and brackish marsh habitats. The area is a private property owned by the Belle W. Baruch Foundation.

Hogs were trapped using portable box traps or a corral trap. Portable box traps were 2.4 m long x 1.8 m wide x 1.5 m high and had a guillotine-type door. These traps had neither floors nor tops and could be moved as a unit or dismantled into 4 sections for transport on a trailer or pick-up truck. The second type of trap was a corral trap which had 10 panels and a vertical-swing gate. Each panel was 3 m long and 1.5 m high. It was framed with 3.8-cm galvanized pipe and covered with 5- x 10-cm 12 gauge welded-wire. One panel was used for the gate. When erected, the corral trap was about 20 m in diameter. A portable box trap was used as a catch box. Traps were baited with shelled corn which had been fermented in water.

Eleven traps were kept operational throughout the intensive control effort. The corral trap was used primarily when hogs refused to enter the box traps. Traps were activated on Monday and closed on Friday of each work week. Trap site selection was based on a continuous survey to spot newly rooted areas on or near the approximately 160 km of roads and trails on the upland areas. Trapping in marshes and swamps was restricted to edges.

Methods of removal other than trapping were disallowed by regulation or efficacy. The Baruch Foundation did not allow recreational hunting on the property. The use of high-powered rifles to shoot free-ranging hogs was so tightly restricted that as a technique it was rarely effective and never efficient. The use of catch-dogs was also controversial and therefore not applied.

All trapped animals were shot, and 2 15-cc blood samples were drawn by cardiac puncture. Serum was separated by centrifuging and frozen until it could be delivered to the diagnostic laboratory of the South Carolina Department of Livestock and Poultry Health for swine brucellosis and pseudorabies testing.

Sera were tested for antibodies to swine brucellosis and pseudorabies. Swine brucellosis testing consisted of a battery of 3 tests done on all samples: buffered acid plate antigen (BAPA), card test or buffered brucella antigen (BBA), and standard tube test (STT). The rivanol test (RIV) was run periodically. Reactors to the STT and RIV tests were placed in titer categories as follows (where I = incomplete reaction at titer level and C = complete reaction): I25, C25, I50, C50, I100, C100, I200, and C200. Pseudorabies antibody tests were done by microtitration serum neutralization. Animals with titers ≥1:8 were considered reactors. The diagnostic veterinarian interpreted the results of all serological tests.

Each animal was aged by dentition (Matschke 1967), weighed, and sexed. Reproductive tracts were removed from all females ≥3 months in age. In utero litter size was determined whenever embryos were visible to the naked eye. Stage of pregnancy was designated as ≤30 days, 31–60 days, 61–90 days, and ≥91 days based on estimated age of fetuses using crown-rump length (Henry 1968).

Due to the demonstrated presence of swine brucellosis and pseudorabies, a quarantine was in effect and all carcasses were buried on site. The alternative of sale of live animals direct to slaughter was available, but it was prohibitively expensive. Disperal of the meat for human consumption was prohibited due to risks of legal liability which the Baruch Foundation was not in a position to assume. All carcasses were buried at a site on the property which was approved by the South Carolina Department of Health and Environmental Control.

Data analyses consisted of χ^2 and *t*-tests and followed the procedures described by Steel and Torrie (1960).

Results

Chronology of Removal

During 1987–1988, 589 feral hogs were removed. Proportions of the total removal during the intensive control effort by calendar season were: winter 1987 =

18.3%, spring 1987 = 10.2%, summer 1987 = 19.9%, fall 1987 = 15.1%, winter 1988 = 19.7%, spring 1988 = 13.1%, and summer 1988 = 3.7%. Changes in personnel and differences in personnel commitment and talent appeared to affect trapping success to a greater extent than did availability of animals to trap. Seasonal availability of alternate foods, particularly acorns, also appeared to affect success rates.

Age/Sex Composition

Animals <6 months old dominated the harvest in both 1987 (62.0%) and 1988 (57.2%) (Table 1). There was no significant difference between 1987 and 1988 in sex ratios (χ^2 = 0.36, 1 df, P = 0.61), but the distribution among age classes did differ significantly (χ^2 = 32.16, 6 df, $P < 0.01$).

Mass

There were no significant differences in mass of animals by sex and season within an age class. Mass (kg; χ^2 ± SD) by age class was: <3 months = 7.4 ± 3.8, 3–5 months = 15.2 ± 6.0, 6–11 months = 32.4 ± 8.4, 12–17 months = 40.8 ± 12.7, 18–23 months = 48.4 ± 11.6, 24–35 months = 57.3 ± 14.5, and >36 months = 60.7 ± 15.5. This result is somewhat misleading in the older age classes where males in good condition are typically heavier than females. However, some females get to be as heavy as the largest males and there was great variation in physical condition. On the very sandy soils of the lower Coastal Plain, the teeth of feral hogs appear to be worn to near gum level by 6 years of age. Premolars were heavily worn before the animals were 3 years old. As the teeth wear out, nutrition appears to be the major determinant of animal health.

Of the 112 females ≥6 months old, 80 were lactating, 65 were pregnant and 44 of these were lactating and pregnant (Table 2). In the 6–11 months age class (N = 43), 16 were lactating, 27 were pregnant, and 9 of these were lactating and pregnant.

The mean number of lactating mammaries for all females was 5.0 ± 1.95 and

Table 1. Age and sex distribution of feral hogs removed from Hobcaw Barony January 1987 through July 1988.

Age class (months)	Number animals removed					
	1987[a]		1988[b]		Total	
	Males	Females	Males	Females	Males	Females
<3	52	48	42	44	94	92
3–5	65	65	17	20	82	85
6–11	21	35	24	8	45	43
12–17	14	14	8	10	22	24
18–23	10	7	5	5	15	12
24–35	14	12	4	7	18	19
≥36	11	6	13	8	24	14
Total	187	187	113	102	300	289

[a]No removal effort in May 1987.
[b]No removal effort after 31 July 1988.

Table 2. Reproductive condition of mature females removed from Hobcaw Barony January 1987 through July 1988.

	Age class (months)				
	6–11	12–17	18–23	24–35	≥36
N Mature females	43	24	12	19	14
N pregnant	27	14	8	10	7
N in gestation period:					
≤30 days	10	4	3	4	6
31–60 days	9	4	2	2	0
61–90 days	3	3	2	2	0
>90 days	5	3	1	2	1
Litter size:					
N[a]	18	11	6		2
$\bar{X}$	3.7	5.6	5.8	5.8	8.0
SD	1.8	1.7	2.6	2.8	2.8
Lactation:					
N	16	20	15	15	13
$\bar{X}$	5.4	5.2	4.8	4.6	5.2
SD	2.3	1.0	2.2	2.3	2.6
N lactating and pregnant	9	11	8	9	7

[a]Determined if fetuses visible to naked eye.

the mean litter size was 5.0 ± 2.3. Wood and Brenneman (1977) in an earlier study found a litter size of 5.3 ± 2.1 and 4.3 ± 1.8 lactating mammaries in the Hobcaw herd. That the mean number of lactating mammaries was so close to litter size and exceeded, although not significantly, litter size in the 6–11 months old age class was surprising since high mortality rates among piglets is expected normally (Wood and Barrett 1979). We can only speculate that these were aberrations in the data.

Litter size ranged from 1 to 10 among all females, but never exceeded 6 in the 6–11 months old class. Litter sizes ≤5 accounted for 62.3% of all females and 58.3% of females 6–11 months old. Litters were being produced continuously. There was no evidence of important seasonality in breeding.

Diseases

Blood could not be drawn or samples were either lost or untestable in 20 cases. Of 569 animals tested, 13.4% were brucellosis reactors (Table 3). While the reactor incidence rate was 15.2% in 1987 and 10.1% in 1988, the years were not significantly different ($\chi^2 = 2.58$, 1 df, $P = 0.11$). Incidence rates were not significantly different among standard age classes ($\chi^2 = 2.63$, 6 df, $P = 0.85$) nor when age classes were combined into immature (<6 months old) and adult (≥6 months old) ($\chi^2 = 3.34$, 3 df, $P = 0.36$).

Seventeen (21.5%) of the 80 lactating females were brucellosis reactors compared to 3 of 30 non-lactating adult females, but the difference was not significant ($\chi^2 = 1.25$, 1 df, $P = 0.47$). Sixty-five females were pregnant and 13 (20.0%) were reactors. Seven (15.5%) of 45 non-pregnant adult females were reactors.

Neither STT nor RIV titers differed ($P > 0.05$) between sexes or age classes of reactors (Table 4). When seasons were compared, 32 of 36 SST titers were complete at 1:50 or above in winter as compared to 22 of 40 for all other seasons combined. RIV titers were complete at 1:50 or above in 16 of 19 tests in winter as compared to 13 of 17 in all other seasons combined.

Of the 569 animals tested, 55 (9.7%) were pseudorabies reactors (Table 4). The incidence rate was 14.1% in 1987 and 1.9% in 1988 ($\chi^2 = 18.5$, 1 df, $P < 0.001$). Incidence rates differed among age/sex classes when age classes were combined into immature and adult ($\chi^2 = 10.53$, 3df, $P < 0.001$). Incidence rate by season in 1987 was: winter = 7.8%, spring = 14.0%, summer = 13.8%, and fall = 22.1%.

Thirteen (11.9%) of 109 adult females were pseudorabies reactors. Eleven (16.8%) of 65 pregnant females were reactors while 2 of 30 non-lactating females were reactors ($\chi^2 = 4.99$, 1 df, $P = 0.025$). Animals with high titers appeared to be prevalent in the older age classes of both males and females (Table 5).

Costs

The 19-month intensive control effort cost an estimated $31,667. Unit costs were about $54 per animal removed and $444/km² of habitat/year. In the period January 1984 through April 1990 an estimated $92,000 was budgeted for feral hog control and resulted in the known removal of 1,317 animals. Estimated unit costs were about $70/animal removed and $323/km²/year. During the 19-month period when some costs were attributable to research efforts, the removal costs were 23% lower per animal and 27% higher per unit area than for the 6-year program as a whole.

Discussion and Conclusions

The literature on feral hogs is replete with references indicating the explosive nature of their populations (Hone 1987, Tisdell 1982, Wood and Barrett 1979). This study further documented those conclusions but also added emphasis to the potential problems in south Atlantic Coastal Plain ecosystems.

That wild hogs are among the most adaptive animals in southeastern ecosystems is documented by the occurrence of high population densities from the Great Smoky Mountains to Florida to south Texas (Wood 1977). Feral hog effects on native flora and fauna are usually adverse, and once a population is well established it can be very difficult to control. Hone (1987), Hone and Stone (1990) and Choquenot et al. (1990) defined the extensive and serious nature of feral hog effects in Australia and the extreme means required to address the problem. It is unlikely that those methods would be acceptable to contemporary American society.

Wood and Barrett (1979) were of the opinion that the introduction or enhancement of feral hog populations in wild ecosystems was ecologically unsound. While the hog has been promoted as a game animal in some portions of the Southeast, huntable population growth has carried with it the adverse effects of competition with native wildlife species, forest and agricultural crop depredation, and the

Table 3. Incidence of brucellosis and pseudorabies in feral hogs removed from Hobcaw Barony January 1987 through July 1988.

Age class (months)	Males			Females			Total		
	N tested	Brucellosis reactors	Pseudorabies reactors	N tested	Brucellosis reactors	Pseudorabies reactors	N tested	Brucellosis reactors	Pseudorabies reactors
<3	86	10	14	86	15	5	172	25	19
3–5	81	8	2	85	5	3	166	13	5
6–11	45	7	2	43	6	2	88	13	15
12–17	21	2	0	23	4	2	44	6	0
18–23	15	2	2	15	2	2	30	4	2
24–35	16	4	7	16	5	4	32	9	7
>36	23	3	7	14	3	3	37	6	7
Total	287	36	34	282	40	21	569	76	55

Table 4. Distribution of reactors to the standard tube test (STT) and rivanol test (RIV) for brucellosis in feral hogs removed from Hobcaw Barony January 1987 through July 1988.

Age class (months)	Number in STT titers[a]						Number in RIV titers[b]					
	≤1:50			>1:50			≤1:50			>1:50		
	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total
<3	9	5	14	1	10	11	0	4	4	1	3	4
3–5	2	3	5	6	2	8	1	0	1	4	2	6
6–11	4	1	5	3	5	8	0	2	2	2	3	5
12–17	1	1	2	1	3	4	1	0	1	0	3	3
18–23	0	2	2	2	0	2	0	0	0	2	0	2
24–35	1	4	5	3	1	4	3	0	3	1	1	2
≥36	1	1	2	1	1	2	0	1	1	2	0	2
Total	18	17	35	17	22	39	5	7	12	12	12	24

[a] N tests = 76.
[b] N tests = 36.

Table 5. Distribution of 55 pseudorabies reactors among titer levels found in feral hogs harvested from Hobcaw Barony January 1987 through June 1988.

Age class (months)	*N* in titer level											
	Males				Females				Total			
	1:8	1:16	1:32	1:64	1:8	1:16	1:32	1:64	1:8	1:16	1:32	1:64
<3	4	4	4	2	1	1	3	0	5	5	7	2
3–5	1	1	0	0	2	0	1	0	3	1	1	0
6–11	1	0	1	0	0	1	0	1	1	1	1	1
12–17	0	0	0	0	0	2	0	0	0	2	0	0
18–23	0	0	2	0	0	2	0	0	0	2	0	0
24–35	0	3	1	3	0	0	3	1	0	3	4	4
≥36	1	3	1	2	0	1	0	2	1	4	1	4
Total	7	11	9	7	3	7	7	4	10	18	16	11

existence of a reservoir for diseases communicable to humans and domestic animals.

Brucellosis and pseudorabies are 2 endemic diseases that can cause serious economic impacts on the swine industry. Both diseases can cause fetus mummification, abortion storms, and high neonate mortality in domestic swine. Wood et al. (1976) found a 17.1% incidence of brucellosis reactors in the Hobcaw population. In 1987 the incidence of reactors was 15.2%.

Pseudorabies was first documented in the Hobcaw herd in 1980 when 37% of the animals tested were reactors. At that time this herd was the only herd, wild or domestic, known to be infected with the disease in South Carolina. One domestic herd in South Carolina became infected in 1987. The source of infection was traced to a North Carolina farm. This pseudorabies incident resulted in legislation in 1988 which classified all hogs in South Carolina as the property and responsibility of the landowner. The legislation implies legal liability for spread of a disease from a wild herd to a domestic herd.

Brucellosis and pseudorabies apparently affect feral and domestic hogs differently. In domestic hogs, these diseases can drastically lower reproductive success. However, in the Hobcaw herd, we rarely saw evidence of mummified fetuses (1 instance during the intensive control effort) and no evidence of abortion. That the herd was producing large numbers of young was evident in the age structure of the harvest. It may be that, at least in the Hobcaw herd, there has been a selection for animals tolerant of these diseases.

While indexing hog abundance is critical to documentation of efficacy of a control or depopulation strategy, there are no good indexing techniques for southern forest conditions. Hone (1988) found rooting indices to yield poor indications of population change in Australia. Helicopter counts can be used in marshes under some vegetation conditions but not in areas of forest cover. Choquenot et al. (1990) reported reasonable precision in estimators based on spotlight counts in Australian rangelands. Fox and Pelton (1977) reported on the visibility of hogs at night in open areas in Great Smoky Mountains National Park. Our experience during extensive spotlight counts of deer (Wood and Woodward 1989) on Hobcaw over a 15-year period indicated that hogs, even at high densities, were rarely visible at night under forest cover. We therefore had no measure of how populations changed in response to control efforts.

We believe that the lesson from the Hobcaw feral hog herd is that once a population is established, it can be both difficult and expensive to control. Because the hog is a continuous and high producer, any control efforts must be continuous and intensive. That a feral hog population can be effectively reduced by a control program and then kept at low levels by recreational hunting has been demonstrated on the Francis Marion National Forest in coastal South Carolina (Holbrook 1957). However, since recreational hunting is usually periodic and hunters are primarily interested in adults, it is unlikely that it can be an effective population reduction tool.

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