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Ecological factors influencing wild pig damage to planted pine and hardwood seedlings

Micah P. Fern, Union University, 1050 Union University Drive, Jackson, TN 38305, USA *mfern@uu.edu*

James B. Armstrong, Auburn University, School of Forestry & Wildlife Sciences, 3301 Forestry & Wildlife, Auburn, AL 36849, USA

Rebecca J. Barlow, Auburn University, School of Forestry & Wildlife Sciences, 3301 Forestry & Wildlife, Auburn, AL 36849, USA

John S. Kush, Auburn University, School of Forestry & Wildlife Sciences, 3301 Forestry & Wildlife, Auburn, AL 36849, USA

Abstract: Expanding wild pig (*Sus scrofa*) populations across the southern United States has the potential to impact longleaf pine (*Pinus palustris*) restoration efforts. The depredation of planted pine seedlings is the most widespread and economically costly damage caused by wild pigs in forest plantations. A better understanding of the ecological factors affecting depredation rates will allow managers to implement best management practices to reduce seedling mortality from wild pigs at their most vulnerable stage of growth. From March 2016 to March 2017, we evaluated wild pig preferences for planted pine and hardwood species at a 34.4-ha cutover site and 4.7-ha pecan (*Carya illinoinensis*) orchard in Bullock County, Alabama, USA. Wild pig damage differed for the 5 seedling species tested, with longleaf and cherrybark oak (*Quercus pagodaefolia*) being the most preferred. Ninety one percent of seedlings destroyed by wild pigs were from the cutover site. Wild pigs at the cutover site experienced substantially more hunting pressure compared to those at the other site. We believe the debris scattering practices of the logging crew following a clearcut created a desirable foraging environment that led to the initial discovery of the seedlings. The short-term protection and minimization of seedling depredation in young forest plantations may be the most realistic solution to reducing the impact of wild pigs on forestry and timber resources.

Key words: Alabama, feral pig, hardwood seedlings, human–wildlife conflict, invasive species, longleaf pine, pine seedlings, *Pinus palustris*, *Sus scrofa*, wild pig damage

Wild pigs (*Sus scrofa*) are among the most destructive exotic vertebrates to have become established in the Americas (Figure 1). The term wild pigs is universally applied to Eurasian wild boar, domestic swine, feral pigs, and any hybrids found in the United States (Mayer 2009*a*). They are particularly problematic to landowners because of their tendency to travel in groups and cause extensive damage to timberlands, pastures, and agriculture crops (Graves 1984, Seward et al. 2004, West et al. 2009). Wild pigs impact timber crops in a variety of ways, including girdling trees through rubbing, damaging the lateral roots by rooting and chewing, and removing the bark of trees by tusking (Mayer 2009*b*). However, the most widespread and economically costly damage to the timber industry from wild pigs is the depredation of planted pine seedlings (Mayer 2009*b*).

Timber is most vulnerable to wild pigs during the first few years after planting or germination (Mayer 2009*b*, Sweeney et al. 2003). A single pig is reportedly capable of rooting up to 6 longleaf pine (*Pinus palustris*) seedlings a minute, destroying an estimated 400–1,000 seedlings a day (Hopkins 1947, Wakeley 1954). Thus, wild pigs have the potential to cause complete crop failure in young timber plantations while seedlings are in their initial growth stages.

Wild pigs may also damage loblolly pine (*P. taeda*) and slash pine (*P. elliottii*), but the most extensive damage occurs with longleaf (Frost 1993, Wakeley 1954). Longleaf pine is unique among southern pines in that it has evolved with landscapes exposed to frequent fire. While other tree species focus energy into rapid vertical growth during initial stages of development, longleaf may remain in a fire-resistant grass stage for several years before initiating vertical growth (Croker and Boyer 1975). During the grass stage, longleaf grows a thick tap root, which may prove more appealing to wild pigs

Figure 1. A wild pig (*Sus scrofa*) sounder captured on a trail camera leaving the cutover site in Bullock County, Alabama, USA, March 2016 to March 2017 (*photo courtesy of M. Fern*).

compared to root stems of other planted species (Mayer et al. 2000, Wood and Lynn 1977). Wood and Roark (1980) concluded that the wild pigs were not actually consuming pine saplings, but instead were chewing on the roots to access the sap and starches, then discarding the woody tissue. As a result of not actually ingesting the woody tissue, the group warned that wild pig's use of woody plant parts may be underestimated by stomach analyses.

Depredation of planted seedlings by wild pigs is not exclusive to southern pine species. Mayer et al. (2000) is the only study we are aware of to examine the impact of wild pigs on planted hardwood species. Mayer et al. (2000) reported that wild pigs caused extensive damage to a number of planted hardwood seedlings in a wetland restoration area located in South Carolina, USA. They reported that of 9 hardwood species planted, cherrybark oak (*Quercus pagodaefolia*), swamp chestnut oak (*Q. michauxii*), water hickory (*Carya aquatica*), and swamp tupelo (*Nyssa sylvatica* var. *biflora*) were the only species impacted by wild pig foraging activities. Non-affected seedling species included water oak (*Q. nigra*), green ash (*Fraxinus pennsylvanica*), persimmon (*Diospyros virginiana*), bald cypress (*Taxodium distichum*), and water tupelo (*Nyssa aquatica*). Mayer et al. (2000) hypothesized that depredated tree species were more aromatic than non-impacted species, which made them more appealing to the pigs' highly developed sense of smell. Additional findings from the study suggested one of the leading factors influencing seedling predation was the use of site preparation methods (e.g., prescribed burning), which enabled easy access to planted sites.

A combination of ecological factors may determine the severity of wild pig depredation of planted seedlings (Mayer et al. 2000). Seedlings are found and removed through the rooting process; therefore, factors affecting rooting will ultimately influence mortality from wild pigs. Rooting is the most widespread and observable type of damage done by wild pigs because all pigs root as a primary method of searching out food (e.g., roots, tubers, fungi, and fossorial species; Mayer 2009*b*). Wild pigs root throughout the year, but depending on location, the intensity and frequency of rooting can be seasonal (Mayer 2009*c*). Ballari and Barrios-García (2014) reviewed scientific literature pertaining to factors affecting food selection by wild pigs and found the use of food resources to be related to food availability, energy requirements, seasonal, and geographical variations.

Site conditions in young forest plantations may be widely varied, so determining specific conditions that attract wild pigs is difficult. Wild pigs are very selective in their choice of

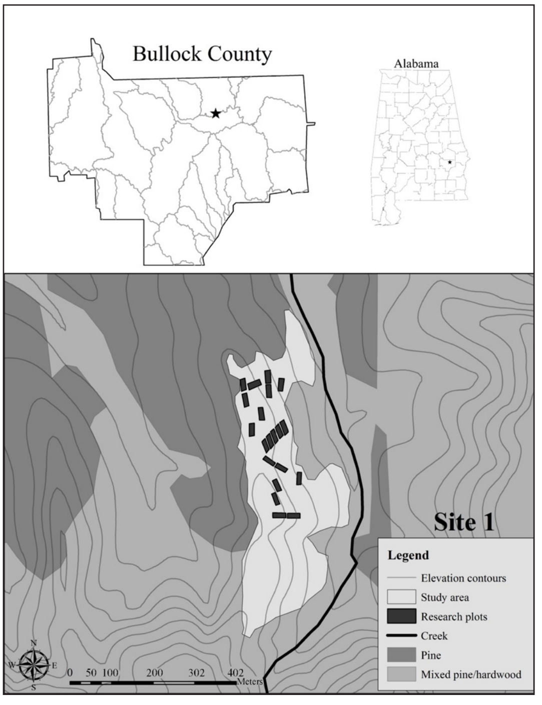

Figure 2. Location of research area at site 1 (S1) for the planted seedling preference by wild pig (*Sus scrofa*) study in Bullock County, Alabama, USA, March 2016 to March 2017.

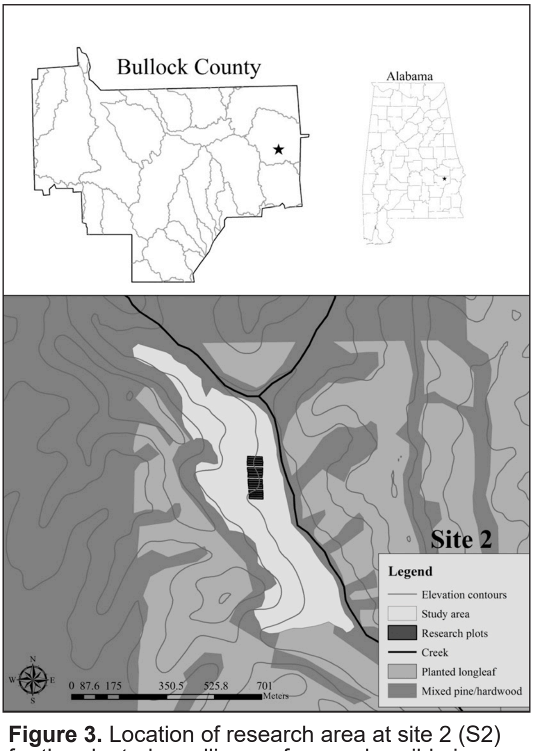

Figure 3. Location of research area at site 2 (S2) for the planted seedling preference by wild pig (*Sus scrofa*) study in Bullock County, Alabama, USA, March 2016 to March 2017.

foraging areas, which can be influenced by vegetation cover and/or soil moisture (Wood and Roark 1980, Dexter 1998, Schley et al. 2008, Siemann et al. 2009). Wild pigs may avoid pastures during abnormally dry years in favor of more hydric or mesic sites (Everitt and Alaniz 1980). Hunting pressure can also affect habitat usage by wild pigs. For example, in Alabama, USA, it was found wild pigs utilized wetland areas when hunting pressure was low but moved toward upland pine forests as hunting pressure intensified (Gaston et al. 2008). The degree of seedling predation in young forest plantations is site-dependent and likely influenced by a combination of food availability, seedling accessibility, pig density, land cover, hunting pressure, and soil moisture.

The goal of our study was to build on research reported by Mayer et al. (2000) and determine if wild pigs had a preference between planted pine and hardwood seedlings. We conducted a field study at 2 research locations with uniquely different site conditions to test for wild pig preference among planted seedlings and make inferences about the damage. Such information is beneficial in guiding forest management decisions as the threat from wild pigs becomes more widespread.

Study area

To conduct our research, we selected 2 sites on private properties in Bullock County, Alabama. The sites were located in the Coastal Plain Region of Alabama. The climate of this area is humid subtropical with an annual precipitation of around 152 cm. In 2016, severe drought conditions were observed throughout Alabama during October and November. Research sites did not receive any rainfall for a 62-day period from September 28 to November 29, 2016. The overall amount of precipitation for the study period was 13% lower than normal. The overall rainfall for the duration of the study period was 132.12 cm.

The first site (S1) was part of the Auburn University Turnipseed-Ikenberry Place, approximately 16 km from the second site (S2), which was owned by a private landowner (Figures 2 and 3). The sites chosen for the study were <91 m from a creek drainage system. Because drainage systems are often utilized by wild pigs for cover and ease of movement, we placed the research

Figure 4. Wild pig (*Sus scrofa*) rooting (A), tree rub (B), and track (C) found at pecan (*Carya illinoinensis*) orchard site in Bullock County, Alabama, USA, March 2016 to March 2017 (*photos courtesy of M. Fern [A–B] and V. Viktor [C]*).

sites close to drainage systems to minimize the amount of time it would take the animals to find the planted seedlings (Ditchkoff and Mitchell 2009). The creeks at each site stem from different river systems, making passage for the pigs from 1 site to the other unlikely; additionally, landscape and anthropologic barriers between sites further decreased the probability the same animals were present at both sites.

Wild pig populations were confirmed at the research sites using Moultrie M-1100i mini game cameras (Moultrie Feeders, Alabaster, Alabama, USA) and by identifying signs of the animal's presence (rooting, tree rubs, and tracks; Figure 4). There was little hunting pressure at S1 (G. L. Pate, E. V. Smith Research Center, personal communication). The groundskeeper for the property did not know of any previous attempts to control wild pigs aside from the occasional shooting on sight by turkey (*Meleagris gallopavo*) and deer (*Odocoileus virginianus*) hunters. At S2, the landowner utilized hunting and trapping in an effort to decrease the wild pig population on the property in and around the area where the study site was located. The field containing the study site was part of a large acreage primarily managed for game species and longleaf production.

The 4.7-ha field where S1 was located had previously been a pecan (*Carya illinoinensis*) orchard and still retained a number of pecan trees dispersed throughout the field. The land cover in the field was primarily dominated by bahaigrass (*Paspalum nontatum*) and was mowed periodically by the groundskeeper. The surrounding forest type varied from pine to mixed hardwood species. The pine stands were located at the top of the hill in the northern section of the study area while the mixed pine and hardwood forest constituted the southern, bottomland portion. Pine species included loblolly and shortleaf pine (*P. echinata*). The overstory in the bottomland portion was dominated by loblolly and water oak, while the mid-story consisted of American sycamore (*Plantanus occidentalis*), eastern red cedar (*Juniperus virginiana*), red mulberry (*Morus rubra*), and sweetgum (*Liquidambar styraciflua*).

The S2 site was located on 34.4 ha of cutover land previously planted with longleaf pine a month earlier. A cutover site is the term given to a track of land after a clearcut timber harvest has taken place. The field at S2 was comprised of frequent stumps and woody debris left over from a loblolly stand clearcut in 2010. After the clearcut, the remaining tree cover immediately surrounding the research area was mixed pine and hardwood forests along the streamside management zone (SMZ). Tree species found in the SMZ primarily consisted of loblolly, laurel oak (*Q. laurifolia*), and water oak. The adjacent forest to the east of the research site consisted of mixed pine and hardwood forest including laurel oak, loblolly, post oak (*Q. stellata*), shortleaf pine, southern red oak (*Q. falcata*), sweetgum, and water oak.

The landowner completed a prescribed burn a few months prior to the planting date to clear and prepare the site. Bare-ground was still visible during the initial months of the field study but became less common as panicgrass (*Panicum* spp.) became more abundant. Other species frequently observed were common ragweed (*Ambrosia artemisiifolia*), dogfennel (*Eupatorium capillifolium*), and sericia lespedeza (*Lespedeza cuneata*).

We classified soils at each site using soil taxonomic information obtained from the web soil survey of the Natural Resources Conservation Service (2017). The majority of the field at S1 was located on an eastern-facing hillside with an estimated slope of 5–20%. The soils in the field were formed in clayey and shaley marine sediments and found on uplands and hill slopes in the Southern Coastal Plains. They are a moderately well drained soil with very slow permeability due to the higher clay content in subsurface horizons. Soils at the bottom of the hill and extending to the drainage system were formed in loamy alluvium and are somewhat poorly drained with moderate permeability. These soils are commonly associated with flood plains in the Southern Coastal Plains.

The S2 site was located on a northeastern-facing hillside with an estimated slope ranging from 5–15%. The soils in the field were formed in stratified marine sediments. Similar to soils at S1, soils at S2 are found on uplands in the Southern Coastal Plains but in areas where erosion has caused the landscape to become dissected. One of the more prominent differences between the soil composition at the sites is in their drainage and permeability properties. Soils at S1 were well drained with moderately slow permeability. In contrast to S1, S2 was associated with higher erodibility and slightly increased amounts of sand and silt.

Methods

The seedling species we used in this study included longleaf pine, loblolly pine, cherrybark oak, chinkapin oak (*Q. muehlenbergii*), and persimmon. The only seedlings not bareroot were longleaf, which were containerized. Species chosen for this study had 2 or more of the following qualifications: (1) previous association with wild pig damage, (2) commonly planted in the Southern Coastal Plains region, and (3) availability from nurseries. Longleaf, loblolly, and cherrybark oak are some of the seedling species most often associated with wild pig damage. Chinkapin oak and persimmon can be commonly found growing in the Southern Coastal Plains and were readily available from nurseries.

We planted the site in March 2016 using a random block design with each block being further divided into plots. The 4 blocks at S1 were further divided into 5 0.04-ha plots while the blocks at S2 were divided into 4 0.04-ha plots. We oriented the plots at S1 so they were not shaded by pecan trees located occasionally throughout the field. There were no trees in the field at S2, so plots were oriented sequentially. Each plot within a block was assigned a tree species to be planted through random assignment without replacement. We planted the plots with the equivalent of 1,346 trees per hectare with 2.5 x 3 m spacing between trees. Each seedling was assigned a numbered flag placed beside it. Ten seedlings in each plot were randomly selected to serve as the control and received protective netted-tubes. The tree tubes were anchored by bamboo or wooden stakes and secured with zip-ties. Planting procedures were uniform between the 2 sites with the exception of the longleaf seedlings at S2.

In February 2016, the landowner planted 162 ha of longleaf, which included the area encompassed by the research site. Due to this previous planting, it was not necessary to plant additional longleaf. Within each 0.04-ha plot at S2, hardwood and loblolly seedlings were planted between longleaf seedlings. Since every other seedling at S2 was longleaf, a plot from each block was chosen through random assignment without replacement to serve as the longleaf plot for control samples and measurements.

We monitored the seedlings throughout the experiment with monthly visits, except for months corresponding with deer and turkey hunting seasons when permission for site access could not be granted (November 2016 to January 2017). During monthly visits, each seedling's status would be marked as either "Alive," "Dead," or "PigMortality." Mortality from wild pigs was easily distinguished by observing rooting where the seedling had been originally planted. In most cases, the seedling was found nearby with the root stock having been masticated. When seedling mortality occurred from wild pigs, the date and location of the damage with respect to hill slope was

Table 1. Wild pig (*Sus scrofa*) seedling preference results including seedlings planted, survival, mortality, and wild pig mortality for sites in Bullock County, Alabama, USA, 2016–2017.

Site	Species	Planted (*n*)	% Alive	% Dead	% PigMortality
S1	Loblolly	220	48	52	2
	Persimmon	220	83	17	0
	Chinkapin	220	72	28	0
	Cherrybark	220	56	44	5
	Longleaf	220	81	19	5
S2	Loblolly	216	57	42	3
	Persimmon	216	63	35	6
	Chinkapin	216	23	77	1
	Cherrybark	216	62	34	12
	Longleaf	787	72	28	26

recorded. A Pearson's chi-square test was used to determine if observed frequencies of mortality differed from that which would be expected. The expected mortality is the number of seedlings that would have had to have suffered mortality due to wild pigs if the damage was equally distributed.

We set up 3 camera traps at each site on game trails between the drainage system and the planted seedlings. We placed field cameras to avoid potential effects from using bait sites. We did not bait the sites to estimate wild pig density because it may have altered foraging behavior or attracted unwanted attention from hunters.

We set the cameras to take 1 photo every 5 minutes and had trigger sensitivity on the high setting. The cameras were kept operational throughout the majority of the study period except for a short period of time when camera maintenance was performed (between July and August 2016). We downloaded photographs monthly and weighted them based on the number of cameras at each site and the number of days cameras were operational. This was done to compensate for when cameras were not in use for maintenance or technical malfunctions. We used the photographs to gauge the level of wild pig activity we were able to monitor in the area surrounding the study site.

We collected data for the precipitation amounts in the area during each month of the study period. These data were gathered from the U.S. climate data website (https://usclimatedata.com/). Precipitation was considered because it is an important factor effecting soil moisture, which impacts seedling growth.

Results

At the S1 site, 89% and 11% of the documented wild pig damage to seedlings occurred in the spring and summer, respectively. All seedling mortality from wild pigs at S1 were from plots located at the bottom of the hill. At the S2 site, 74% and 26% of the documented wild pig damage to seedlings occurred in the spring and summer, respectively. Seedling damage at S2 was evenly distributed between the top, middle, and bottom of the hill.

We summarized the seedling data and whether they survived (alive), suffered mortality not caused by wild pigs (dead), or were destroyed by wild pigs (PigMortality; Table 1). The percent of seedling mortality due to wild pigs was low at S1. Cherrybark and longleaf had the most seedlings damaged (5%), followed by loblolly (2%). We did not detect any pig-related mortality in chinkapin or persimmon. At S1, the difference in pig-related mortality (n = 9) compared to other mortality (n = 243) did not differ (χ^2 = 2.01, df = 2, P = 0.37). At S2, the difference in pig-related mortality (n = 96) compared to other mortality (n = 626)

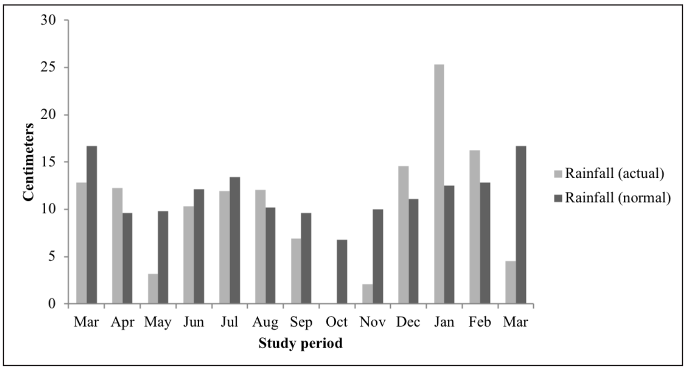

Figure 5. Observed and expected monthly precipitation data (cm) for Bullock County, Alabama, USA, March 2016 to March 2017.

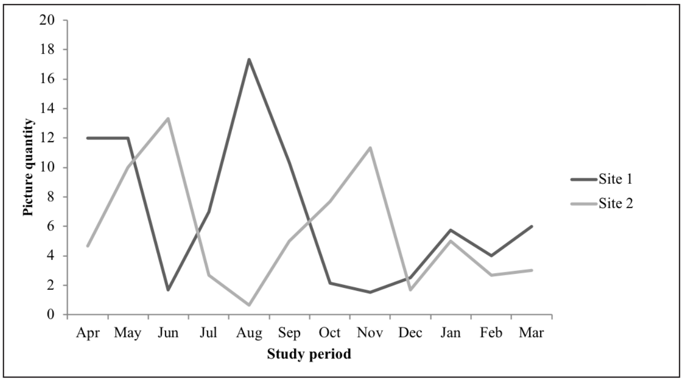

Figure 6. Wild pig (*Sus scrofa*) detection data collected at site 1 (S1) and site 2 (S2) study areas in Bullock County, Alabama, USA. Y-axis values are weighted based on the number of days cameras were operational during March 2016 to March 2017.

did differ ($\chi^2 = 75.34$, df = 4, $P < 0.001$). Longleaf was the most heavily damaged by wild pigs ($n = 77$) and had more than double the expected frequency of mortality ($n = 39.8$). Cherrybark was the second most damaged species by wild pigs and had similar observed mortality ($n = 10$) as expected mortality ($n = 11$). Persimmon seedlings had around half the observed wild pig mortality ($n = 5$) than the expected mortality ($n = 10.6$). Loblolly had considerably less observed mortality ($n = 3$) than the expected mortality ($n = 12.4$). Lastly, chinkapin had the lowest number of seedlings damaged ($n = 1$) compared to the mortality expected ($n = 22.2$).

Monthly precipitation varied during the course of the field study (Figure 5). Also, for comparison purposes, we also included the normal monthly precipitation data based on historic averages (Figure 5).

Wild pigs frequented the research areas more during the spring and summer months compared to winter months (Figure 6). The cyclical pattern of wild pig presence at S2 was most likely due to intense periods of hunting and trapping efforts by the landowner. The largest drop in wild pig detection around S2 in August can be explained by the landowner hunting over the study site more frequently compared to other months. There was another large drop in detection at the first site during the month of June; what caused the pigs to disappear from the research area during this time is unknown.

We observed differences between sites for the time of year when piglets were detected by the camera traps. Piglets were captured by photograph at S1 for 3 months out of the study period compared to S2 where they were present for 6 months. At S1, piglets were seen in April and May 2016 and February 2017. At S2, piglets were observed in May, June, July, September, and November 2016 and January 2017. Our observations suggest the wild pig offspring were born in the late winter and spring at S1 while offspring were born in each season at S2.

Discussion

Mayer et al. (2000) reported that wild pigs exhibited a foraging preference among planted hardwood species. However, no previous studies examined both planted pine and hardwood species. Our results at the S2 site were consistent with historic and scientific reports of wild pig preference toward planted longleaf pine and cherrybark oak (Wakeley 1954, Wood and Lynn 1977, Mayer et al. 2000). If the resulting wild pig damage to longleaf and cherrybark seedlings from S2 were extrapolated to a per-hectare basis, the result would be 119 and 62 seedlings per hectare, respectively. The per-hectare seedling loss may be more substantial in situations where cherrybark is planted because planting densities are normally not as high as in longleaf plantations. Longleaf appeared to be the most highly preferred seedling species among those tested. It should be noted that at S2, the sample group for longleaf was nearly 4 times larger than the other species tested; therefore, there was a higher chance of longleaf being damaged. Only a small portion of the total area of the property planted with longleaf was monitored for the purposes of this study, so similar damage could be assumed to be occurring elsewhere in unmonitored areas.

In a similar study conducted in South Carolina, Lipscomb (1989) used the following density indices to describe the population of wild pigs in an area: low (<1 pig per 8 ha), medium (>1 pig per 8 ha but <1 per 4 ha), and high (>1 pig per 4 ha). Our detection results suggest the wild pig population density at both S1 and S2 would be considered high.

Gaston et al. (2008) found varying levels of hunting pressure caused modifications in wild pig behavior. It is possible that the difference in hunting pressure differences between sites caused a variation in wild pig behavior as well as seedling damage. Optimal foraging theory suggests time spent foraging in the open is a trade-off between accessing optimal food sources and the risk associated with leaving cover. Under the premise of the optimal foraging theory, wild pigs at S2 would likely have lingered in the open for less time and been forced to forage more quickly than those at S1. In contrast to S2, wild pigs at S1 would be able to forage in the open for longer periods of time and be more selective. These wild pigs might not have found seedlings to be the most desirable food source in the pasture and therefore avoided them.

By studying the damage in the experimental plots, we also gained insights on factors potentially influencing wild pig damage in young forest plantations. These insights are beneficial to landowners and managers and could help prevent wild pigs from causing heavy financial losses among forest plantations. Perhaps the most important postulation derived from the evident difference in levels of seedling damage between the 2 sites is that seedling predation of planted species is apparently a learned behavior among wild pigs.

As habitat generalist, wild pigs are an efficient invasive species because they are able to meet their dietary needs even in non-native ranges (Ballari and Barrios-García 2014). This is accomplished by using heightened olfactory senses to explore and discover desirable foods (Moulton 1967). If all wild pigs found longleaf as a highly favored food source, then the pig-related mortality at S1 would have been much higher. The amount of rooting next to 1 plot confirmed wild pigs had found the longleaf seedlings, yet only 1% of all available longleaf seedlings were consumed. Additionally, extensive rooting was done in 80% of 1 cherrybark plot at S1, yet no seedlings were damaged or consumed.

In contrast to the wild pig population at S1, the wild pigs at S2 would have been less naive about planted seedlings as a food source because the landowner had multiple-aged stands located on the property, which meant planted seedlings had been available in previous years. It is possible a few of the remaining pigs still present on the property were familiar with planted longleaf seedlings as a food source. Predation on seedlings could have been observed by other pigs, which would explain why seedling damage was more common at S2. This theory has important management implications for forest plantation owners because if wild pigs begin to learn that planted seedlings are a desirable food source, then that population would need to be removed so the behavior would not be passed along to other pigs. On the other hand, if the population of pigs is naive to eating the planted seedlings, it may prove beneficial to leave them alone; otherwise, new wild pigs that recognize the seedlings as a desirable food source may move into the area. This concept concerning wild pigs and planted seedlings has not been encountered in scientific literature and warrants more research.

Another observation with important management implications for forest landowners is that cutover sites appear to create very attractive foraging areas for wild pigs. The woody debris left after the clearcut at S2 appeared to be an attractant to wild pigs interested in searching for invertebrates among the decomposing logs and stumps. Similarly, a study in South Carolina by Zengel and Conner (2008) found a positive association between rooting frequency and amounts of coarse woody debris. Invertebrates make up a small percentage of wild pig diet but play an important role as a source of protein required year-round (Wood and Roark 1980, Schley and Roper 2003, Ballari and Barrios-García 2014). Consequently, wild pigs were frequently attracted to foraging in the research site and were more likely to encounter seedlings in their search for food.

Interestingly, seedling damage at S2 was minimal later in the year as seedlings were hidden under thick amounts of vegetation, which would have made them difficult to access. The idea that depredation of planted seedlings is related to accessibility was suggested by Mayer et al. (2000), who found that areas pretreated (clearing and burning) were the most severely impacted by pigs. The conditions at S2 would support this observation, but not at S1. In September 2016, the bahaigrass and briars had made observational visits difficult, so the field was mowed around the seedling plots. After the grass had been mowed, the seedlings would have been very accessible to pigs for the rest of the study period, yet seedling damage did not occur. This suggests that factors other than accessibility may be more important in influencing predation of planted seedlings by pigs.

Wild pig damage at S1 was notably less than the amount that occurred at S2. Given the differences in the 2 sites, it is likely land cover played a role in the observed damage. Initially it was assumed the damage at S1 would have occurred at a higher level than observed because wild pig damage in pastures is quite common. Schley et al. (2008) found wild pig damage to grasslands in Germany to be severe and occur frequently. Damage was mostly limited to a small section in the northeastern quadrant at the bottom of the hill where water drainage would have kept the soil more moist compared to the rest of the pasture. Everitt and Alaniz (1980) observed wild pigs avoided pastures in abnormally dry years, which may explain why damage at S1 was minimal.

The soil composition of the sites appeared to be an important factor in limiting pig damage to periods when rain events allowed pigs to penetrate the soil surface in search of food. The high content of clay, which causes this particular soil to have very slow water permeability, created a cement-like barrier when soil was devoid of sufficient amounts of moisture. With 2016 being a drier year than normal in Alabama, it is possible the field was not conducive for wild pigs to root and forage for food compared to other areas. It was evident the majority of wild pig activity was concentrated in areas near the drainage system where higher sand and silt content would have made rooting relatively easier. Soils at S2 appeared to be more beneficial to rooting activities because despite how dry it was throughout the year, the sand and loam components of the soil made it easier to penetrate the soil surface than at S1. The friability of the soil structure was also evident because of the amount of erosion occurring in the area.

The vegetation diversity was greater at S2 and included a large abundance of panicgrass, which is one of the most frequently consumed herbages by wild pigs in this part of the world (Wood and Roark 1980). Panicgrass and other flora would mainly have been consumed during the spring when new shoots and herbs were most luxuriant (Wood and Roark 1980, Ballari and Barrios-García 2014). As was initially expected, the majority of seedling damage occurred in the spring of 2016 at both sites as pigs foraged for succulent shoots and roots. The amount of seedling damage decreased by a third during summer months compared to the spring, which was not surprising considering that the summer diet of wild pigs consists primarily of fruit (Ballari and Barrios-García 2014). Seedling damage was minimal through the fall and winter months as hard mast became available. Seedling damage was expected to be higher in the winter as aboveground plant parts became scarce and sources of hard mast were depleted; however, this was not the case at either site for reasons that could not be determined.

Management implications

The level of damage among planted seedlings is likely driven by wild pig preference and familiarity with the species as a food source. Reducing the amount of time wild pigs spend in the plantation should lower the likelihood of the animals becoming educated about seedlings as a preferred food source. Not all seedling species are preferred, and wild pig presence in the area does not guarantee seedlings will be targeted. A combination of ecological factors discussed earlier, rather than just a single factor, is likely to influence the severity of wild pig damage in forest plantations. The results of this project are an additional step toward better understanding variations of wild pig behavior in young forest plantations. Research projects like these are important for finding how changes in management could improve seedling survival during the stage of vulnerability to wild pigs.

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Associate Editor: Jessica Tegt

Micah P. Fern, Ph.D., CWB, is an assistant professor in the Department of Biology at Union University. His B.S. degree is in conservation biology from Union University. While at Auburn University, he received his master's degree in fisheries and allied aquaculture and a Ph.D. degree in forestry. He currently teaches courses in wildlife sciences and anatomy as well as co-manages a plastination lab and raptor rehabilitation center. These days his research interest has him and his dog, Carl, pursuing alligators who have relatively recently expanded their range into Tennessee.

James B. Armstrong, Ph.D., CWB, is professor emeritus in the School of Forestry and Wildlife Sciences, Auburn University. He has served as chair of the TWS Wildlife Damage Working Group and editor/co-editor of the Proceedings of the Wildlife Damage Conference. He has served in numerous capacities in the Alabama and Georgia chapters of TWS. Research interests include human–wildlife interactions and prescribed fire for managing wildlife habitat. He continues to teach an online course in human–wildlife conflicts. These days he spends much of his time helping his grandchildren enjoy and understand our natural resources.

Rebecca J. Barlow is an Alabama Cooperative Extension System forestry specialist and professor within the School of Forestry and Wildlife Sciences at Auburn University. She strives to inspire forest landowners to manage their property to meet multiple objectives. Forestland management basics are a focus of her outreach work. She also works in the area of agroforestry research and extension to provide landowners with options for generating additional revenue from their lands. In addition, she teaches several upper-level forestry courses in Auburn University's School of Forestry and Wildlife Sciences.

John S. Kush (retired) was a research fellow in the School of Forestry and Wildlife Sciences at Auburn University. His B.S. degree in forest science came from the University of Illinois, Urbana-Champaign. He received his master's and Ph.D. degrees, both in forest ecology, from Auburn University. He conducted research for >39 years with a focus on stand dynamics, fire effects, and restoration and taught several classes related to forest ecology. He teaches a forest fire management class and several classes with the restoration ecology graduate certificate program at Auburn.